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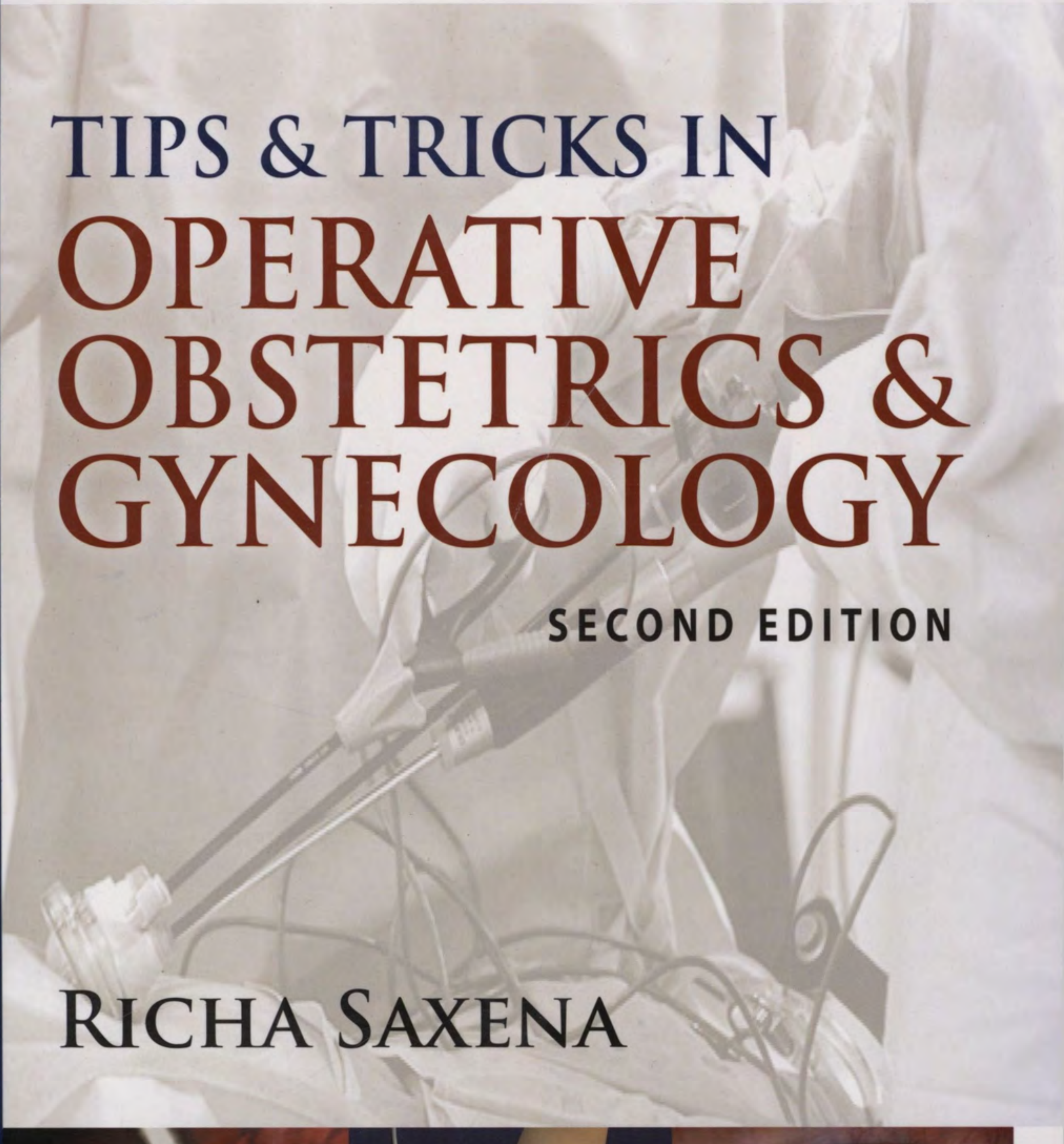


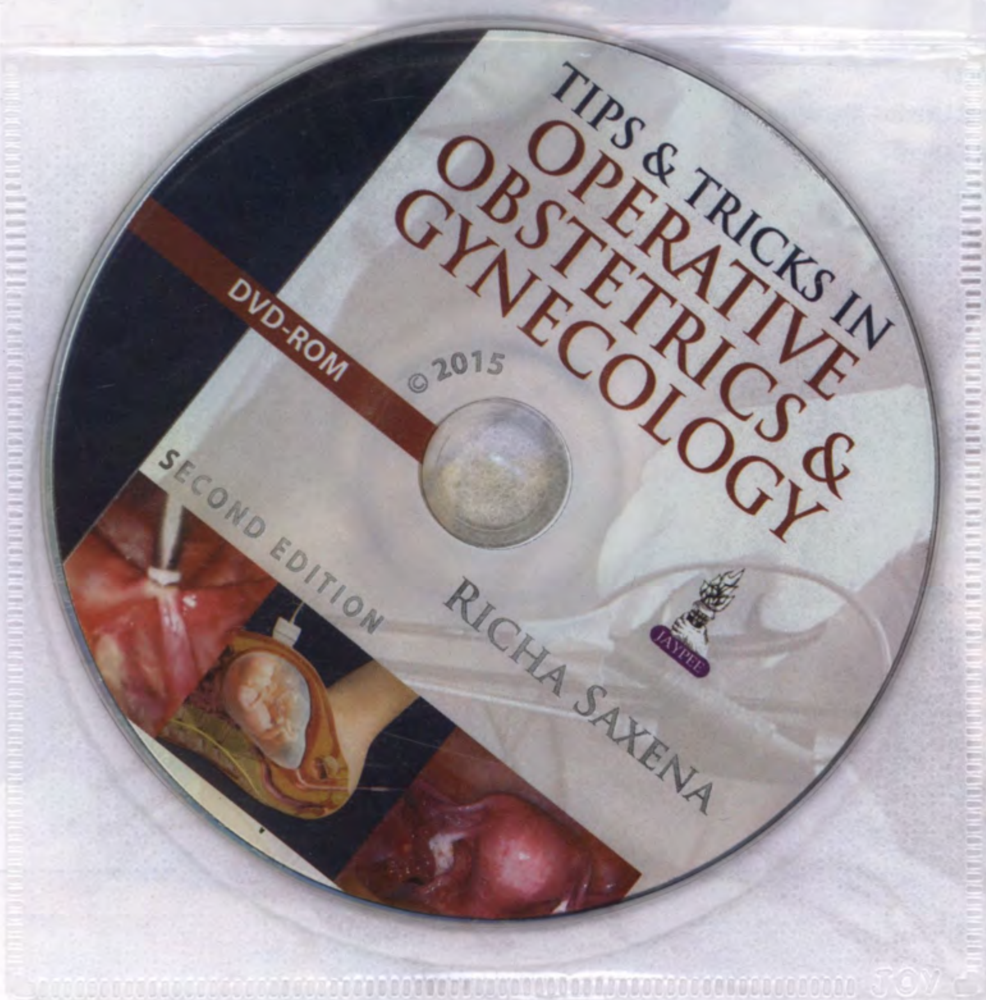
TIPS & TRICKS IN OPERATIVE OBSTETRICS & GYNECOLOGY

SECOND EDITION

RICHA SAXENA



Tips & Tricks in Operative Obstetrics & Gynecology



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DVD Contents

Tips & Tricks in Operative Obstetrics & Gynecology

Second Edition

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Dedicated to

My mother Mrs Bharati Saxena
For being my good luck charm
" I love my mother as the trees love water and sunshine—she helps me grow, prosper, and reach great heights."

—Terri Guillemets

Preface to the Second Edition

The second edition of "Tips & Tricks in Operative Obstetrics & Gynecology" has been inspired by the tremendous success of the first edition. The concept of the book remains the same as the previous edition, "spreading valuable knowledge". There are many extensive textbooks available in the market, which give elaborate details about each surgery. The aim of this book belonging to the "Tips and Tricks series" is to acquaint the reader with different types of obstetric and gynecological surgical procedures used in the clinical practice. The second edition maintains the basic format of text presented in the first edition. Each chapter has a unique style of presentation in form of a template containing headings such as introduction, indications, preoperative preparation, surgical steps, postoperative care, advantages, disadvantages, complications, discussion, conclusion, etc. These headings are set in form of amber-colored arrowheads. This pattern has been followed for all the chapters of Section 2 (Operative Obstetrics) and Section 3 (Operative Gynecology) and would help the reader focus on specific aspects of surgery.

The book provides succinct details about various obstetric and gynecological surgeries, which will be very useful for the postgraduates, intellectual undergraduates, fellow gynecologists and residents in training, obstetric and gynecologic consultants and practitioners. This book would not serve as a textbook, rather as a ready source of reference for the obstetricians and gynecologists to quickly grasp the basic facts related to various obstetric and gynecological surgeries.

The book contains an accompanying CD, which provides 20 interesting case studies. Several new case studies have been added in this edition. This would help in ensuring that the book chapters do not become too theoretical and a definite correlation with clinical practice is maintained. In the second edition, the textual matter has been extensively reconstructed with several current developments, which have taken place in obstetrics and gynecology since the publication of first edition (e.g. revised updated guidelines for screening of cervical cancer, 2012; new nontherapeutic modalities for the treatment of postpartum hemorrhage, etc.). The second edition also encompasses new chapters on labor room procedures and various gynecological surgeries related to the treatment of endometriosis and urinary incontinence. To further simplify the surgeries, the text has been illustrated with the help of newly added beautiful, self-explanatory, multicolor pictures, tables and flow charts. The second edition also describes recent advances in gynecological laparoscopic surgery [especially robotic surgery, laparoendoscopic single site surgery (LESS), natural orifice transluminal surgery (NOTES), hand-assisted laparoscopic surgery (HALS), etc.], fetal surgery and surgeries related to assisted reproductive techniques.

Writing a book is a colossal task. It can never be completed without His divine intervention and approval. I would like to thank the Almighty for helping me in completing this giant project. I believe that writing a book involves a continuous learning process. Though extreme care has been taken to maintain accuracy while writing this book, constructive criticism would be greatly appreciated. Please e-mail me your comments at the email address: richa@drrichasaxena.com. Also, please feel free to visit my website www.drrichasaxena.com for obtaining information related to various other books written by me and to make use of the free resources available for the medical students.

Simultaneously, I would like to extend my thanks and appreciation to all the related authors and publishers whose references have been used in this book. Book creation is teamwork, and I acknowledge the way the entire staff of M/s Jaypee Brothers Medical Publishers (P) Ltd., New Delhi, India, worked hard on this manuscript to give it a final shape. I would like to thank Mr Jitendar P Vij (Group Chairman), Jaypee Brothers Medical Publishers, for being the guiding beacon, and source of inspiration and motivation behind this book. I would also like to thank Mr Ankit Vij (President) and Mr Tarun Duneja (Director-Publishing). Last but not the least, I would also like to thank the entire staff of Jaypee Brothers, especially Mr Amit Rai and Mr Nitish Kumar Dubey (Medical Editors) for editing the manuscript and coordinating the process of publication; Mr Rakesh Kumar (DTP Operator) for typesetting the book; Mr Sumit Kumar (Senior Graphic Designer) and Mr Gopal Singh Kirola (Graphic Designer) for making beautiful illustrations; and Mrs Seema Dogra for designing the cover page. May God bless them all!

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Preface to the First Edition

A colossal task like writing a book cannot ever take place without His divine permission and intervention. Therefore before writing anything else I would like to offer a word of thanks to the Almighty with the belief that God understands our prayers even when we can't find the words to say them...

"Knowledge always desires increase; it is like fire, which must first be kindled by some external agent, but which will afterwards propagate itself."

A perfect stranger once complimented by saying, "When doctors are in clinical practice, they treat one patient, but when they write, they are disseminating knowledge to a large number of doctors and thereby indirectly treating millions of people at the same time. This book has been written keeping this concept of "spreading valuable knowledge" in mind. There are many extensive textbooks available in the market, which give elaborate details about each surgery. The aim of this book belonging to the "Tips and Tricks series" is to acquaint the reader with different types of obstetric and gynecological surgical procedures used in the clinical practice. Old surgical procedures as well as the new ones are concisely described, which will be very practical and handy for the readers. This book is mainly targeted towards the postgraduates and consultant doctors to help them brush up their knowledge and acquire knowledge regarding the various new evolving surgical techniques. This book would prove useful to the postgraduate students, fellow gynecologists in training as well as obstetric and gynecologic consultants and practitioners. An intellectual undergraduate may also find this book as a useful read.

In order to ensure that the readers do not get carried away into the world of theoretical knowledge, an accompanying CD which provides some interesting case studies has been included with the book. This helps in establishing a liaison between clinical practice and academic knowledge. An important feature of this book is its unique style of presentation in the form of a template. There are three sections: general surgical considerations, operative obstetrics and operative gynecology of which all the chapters of sections 2 and 3 have been arranged in the form of a set template. The text has been illustrated with help of beautiful, self-explanatory, four-colored pictures.

Richa Saxena

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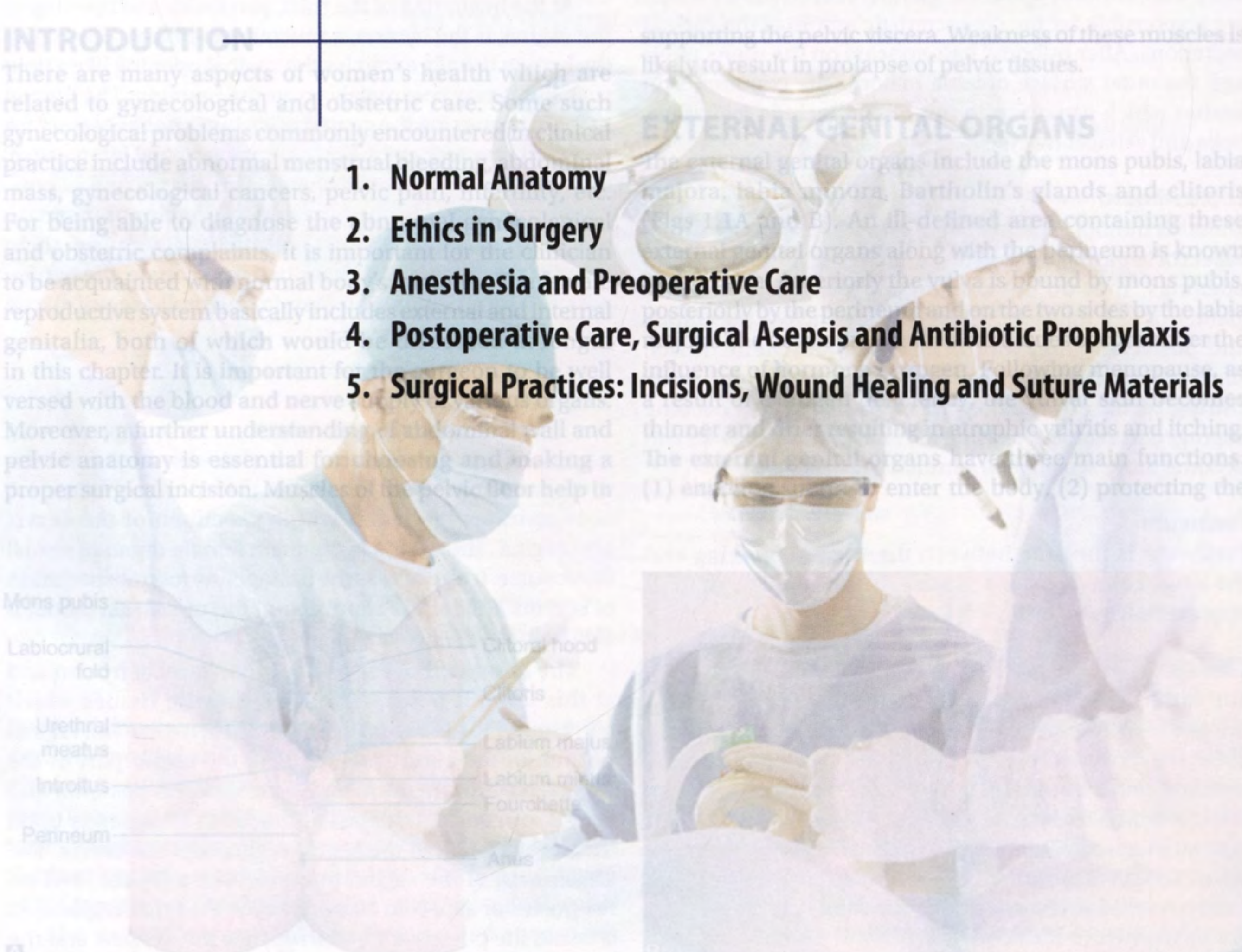
SECTION 1

General Considerations



CHAPTER 1

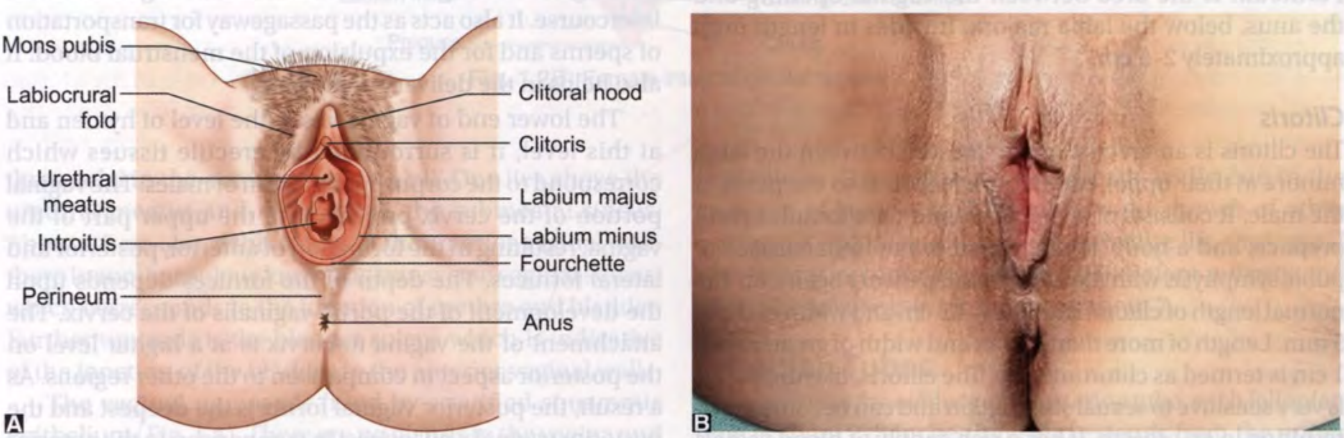
Normal Anatomy

INTRODUCTION

There are many aspects of women's health which are related to gynecological and obstetric care. Some such gynecological problems commonly encountered in clinical practice include abnormal menstrual bleeding, abdominal mass, gynecological cancers, pelvic pain, infertility, etc. For being able to diagnose the abnormal gynecological and obstetric complaints, it is important for the clinician to be acquainted with normal body's anatomy. The female reproductive system basically includes external and internal genitalia, both of which would be discussed at length in this chapter. It is important for the surgeon to be well versed with the blood and nerve supply of various organs. Moreover, a further understanding of abdominal wall and pelvic anatomy is essential for choosing and making a proper surgical incision. Muscles of the pelvic floor help in supporting the pelvic viscera. Weakness of these muscles is likely to result in prolapse of pelvic tissues.

EXTERNAL GENITAL ORGANS

The external genital organs include the mons pubis, labia majora, labia minora, Bartholin's glands and clitoris (Figs 1.1A and B). An ill-defined area containing these external genital organs along with the perineum is known as the vulva. Anteriorly the vulva is bound by mons pubis, posteriorly by the perineum and on the two sides by the labia majora. The development of vulvar tissues occurs under the influence of hormone estrogen. Following menopause, as a result of estrogen deficiency, the vulvar skin becomes thinner and drier resulting in atrophic vulvitis and itching. The external genital organs have three main functions: (1) enabling sperm to enter the body, (2) protecting the



Figs 1.1A and B: Female external genital organs

internal genital organs from infectious organisms and (3) provision of sexual pleasure.

Female External Genitalia

Mons Pubis

The mons pubis is a rounded mass of fatty tissue that covers the pubic bone. During puberty, it becomes covered with hair. The mons pubis contains oil-secreting (sebaceous) glands that release substances which are involved in sexual attraction (pheromones).

Labia Majora

The labia majora are relatively large, fleshy folds of tissue which pass anteriorly from mons veneris to end posteriorly in the skin over the perineal body. They are comparable to the scrotum in males. The inner surface of labia majora is softer, moister and not covered with hair in contrast to the outer surfaces. The labia majora contains sweat and sebaceous glands, which produce lubricating secretions. They also contain apocrine glands, secretions of which are responsible for the characteristic aroma of the vaginal secretions. After puberty, hair appears on the mons pubis and the outer surface of labia majora. The common skin lesions which can occur in this region include folliculitis, boils and sebaceous cysts.

Labia Minora

The labia minora are thin folds of skin which lie on the inner aspect of labia majora and surround the vaginal and urethral openings. They do not contain any sweat or sebaceous glands, or hair follicles. Anteriorly they enclose the clitoris and posteriorly they join to form the fourchette. A rich supply of blood vessels gives the labia minora a pink color. During sexual stimulation, these blood vessels become engorged with blood, causing the labia minora to swell and become more sensitive to stimulation.

Perineum

Perineum is the area between the vaginal opening and the anus, below the labia majora. It varies in length from approximately 2-5 cm.

Clitoris

The clitoris is an erectile organ, located between the labia minora at their upper end that corresponds to the penis in the male. It consists of a glans, covered with frenulum and prepuce, and a body. It is attached to the undersurface of pubic symphysis with the help of a suspensory ligament. The normal length of clitoris is about 1-1.5 cm and width is about 5 mm. Length of more than 3.5 cm and width of greater than 1 cm is termed as clitoromegaly. The clitoris, like the penis, is very sensitive to sexual stimulation and can become erect, resulting in an orgasm. It has a rich supply of blood vessels and nerves. Therefore, injury to clitoris can result in profuse hemorrhage and can be extremely painful.

The external urethral meatus lies posterior to the clitoris. Even more posterior to the urethral meatus is the vaginal introitus (opening) which is surrounded by the hymen in virgins. Sexual intercourse results in the rupture of the hymen. The vaginal introitus acts a passage for the entry of penis during sexual intercourse. This opening also allows the exit of menstrual blood and vaginal discharge as well as the baby at the time of delivery. When stimulated, Bartholin's glands (located besides the vaginal opening) secrete a thick fluid that supplies lubrication for intercourse.

FEMALE INTERNAL GENITALIA

The internal genital organs form the genital tract. This pathway consists of the following (Figs 1.2A and B):

- *Vagina:* This is where sperms are deposited
- *Uterus:* This is where the embryo develops into a fetus
- *Fallopian tubes (oviducts):* This is where the fertilization of sperm with egg occurs
- *Ovaries:* These organs produce and release eggs.

At the beginning of the tract, just inside the opening of the vagina, is the hymen, a mucous membrane. In virgins, the hymen usually encircles the vaginal opening like a tight ring, but it may completely cover the opening. The hymen helps in protecting the genital tract, but is not necessary for health. It may tear at the first attempt at sexual intercourse, or it may be so soft and pliable that no tearing occurs. The hymen may also be torn during exercise or insertion of a tampon or diaphragm. Tearing usually causes slight bleeding. In women who have had intercourse, the hymen may be unnoticeable or may form small tags of tissue around the vaginal opening.

Vagina

The vagina is a narrow, muscular but elastic organ, having a length of about 4-5 inches in an adult woman. It connects the external genital organs to the uterus. Figure 1.3 demonstrates the macroscopic specimen of the cervix and vagina. The vagina is the main female organ of sexual intercourse. It also acts as the passageway for transportation of sperms and for the expulsion of the menstrual blood. It also helps in the delivery of the baby.

The lower end of vagina lies at the level of hymen and at this level, it is surrounded by erectile tissues which correspond to the corpus spongiosum of males. The vaginal portion of the cervix projects into the upper part of the vagina, resulting in the formation of anterior, posterior and lateral fornices. The depth of the fornices depends upon the development of the portio vaginalis of the cervix. The attachment of the vagina to cervix is at a higher level on the posterior aspect in comparison to the other regions. As a result, the posterior vaginal fornix is the deepest and the posterior vaginal wall longest in comparison to the anterior or lateral walls. The posterior wall is about 4.5 inches long, whereas the anterior wall is about 3.5 inches. There are

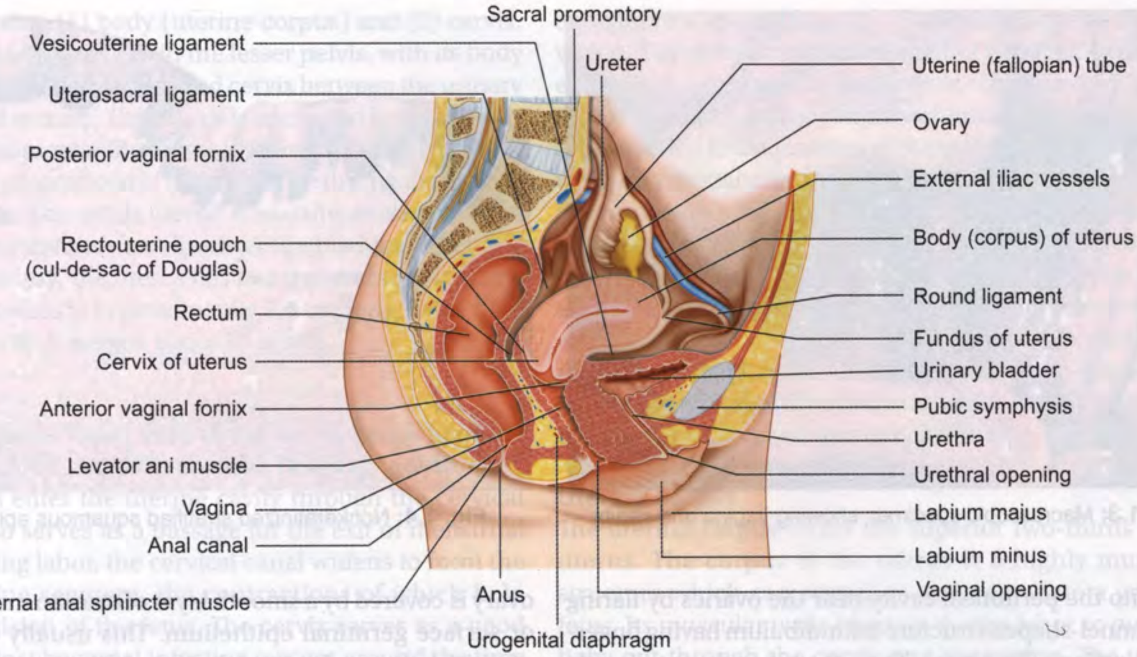


Fig. 1.2A: Midsagittal section of female pelvis

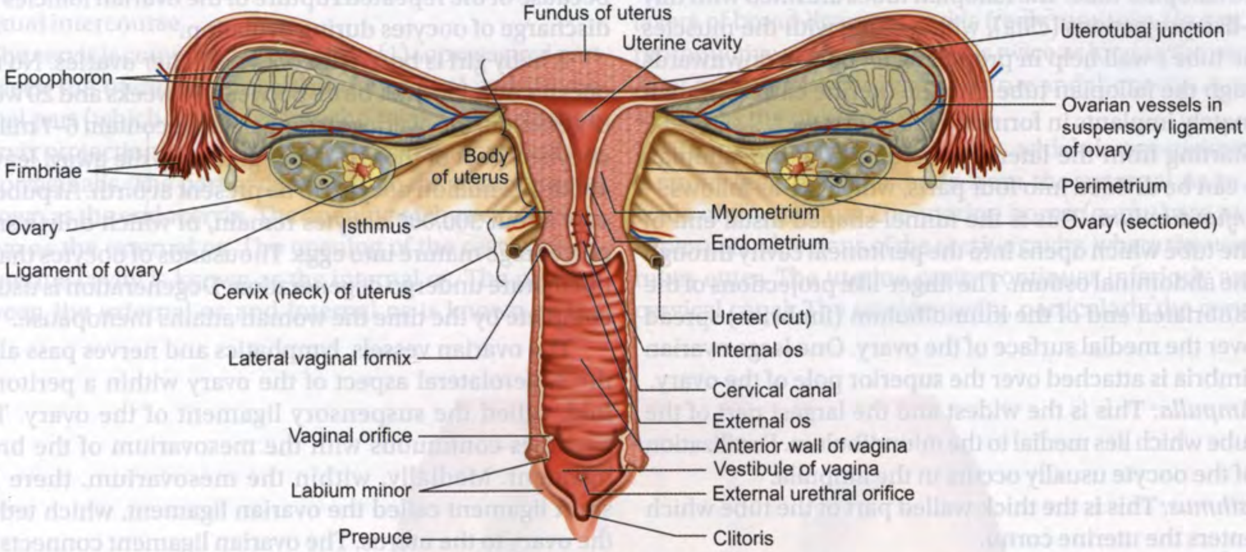


Fig. 1.2B: Female internal genital organs

three sulci in the anterior vaginal wall. One lies above the urethral meatus and is known as the submeatal sulcus. About 3.5 cm above this sulcus in the anterior vaginal wall, there is another sulcus known as transverse vaginal sulcus, which corresponds to the junction of urethra and bladder. Further upwards is the bladder sulcus which is indicative of the junction of the bladder to the anterior vaginal wall.

The vaginal mucosa is lined by stratified squamous epithelium (Fig. 1.4). There are no glands in the vagina and the vaginal secretions are mainly derived from the mucus discharge of the cervix and transudation through the vaginal epithelium. The vaginal secretions are acidic due to the presence of lactic acid. This inhibits the growth of other pathogenic organisms. During reproductive life, the vaginal pH remains on an average about 4.5. Before puberty and after menopause this pH becomes about 7.

Fallopian Tubes

Also known as the oviduct or the uterine tube, each fallopian tube is about 2–3 inches long and extends from the upper edge of the uterus towards the ovaries. The two fallopian tubes normally extend laterally from the uterine cornua and

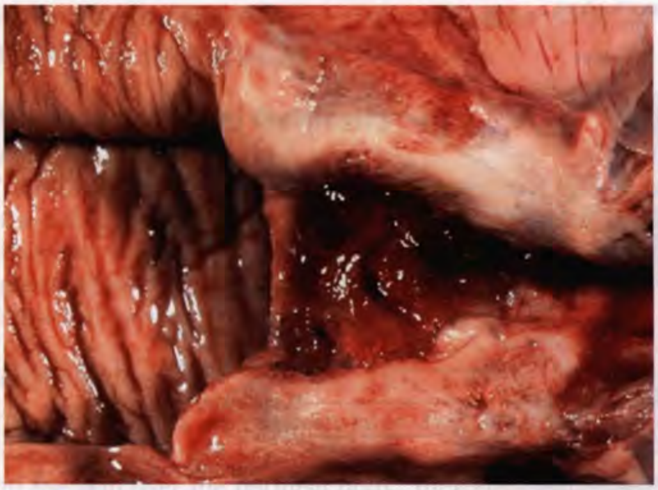


Fig. 1.3: Macroscopic specimen showing vagina and cervix

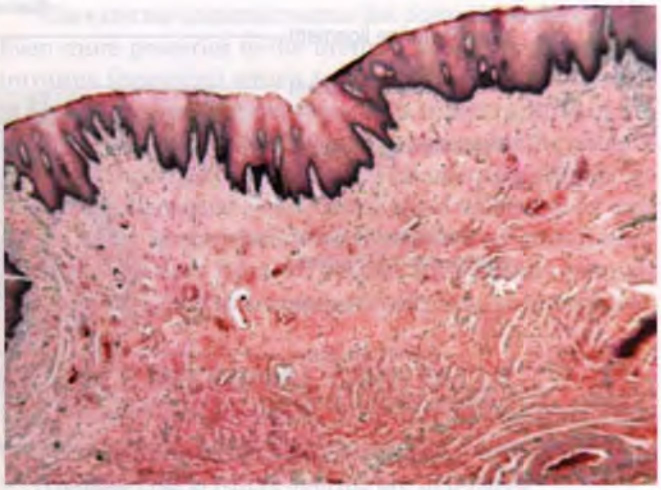


Fig. 1.4: Nonkeratinized stratified squamous epithelium

open into the peritoneal cavity near the ovaries by flaring into a funnel-shaped structure infundibulum having finger-like projections (fimbriae). Thus, the tubes do not directly connect with the ovaries. When an oocyte is released from an ovary, the fimbriae guide it towards the infundibulum of the fallopian tube. The fallopian tubes are lined with tiny hair-like projections (cilia), which along with the muscles of the tube's wall help in propelling an oocyte downwards through the fallopian tube into the uterine cavity where it ultimately implants in form of a blastocyst.

Starting from the lateral to medial side, the fallopian tube can be divided into four parts, which are as follows:

1. *Infundibulum:* This is the funnel-shaped distal end of the tube which opens into the peritoneal cavity through the abdominal ostium. The finger-like projections of the fimbriated end of the infundibulum (fimbriae) spread over the medial surface of the ovary. One large ovarian fimbria is attached over the superior pole of the ovary.
2. *Ampulla:* This is the widest and the largest part of the tube which lies medial to the infundibulum. Fertilization of the oocyte usually occurs in the ampulla.
3. *Isthmus:* This is the thick-walled part of the tube which enters the uterine cornu.
4. *Uterine part:* This includes the short intramural segment of the tube, which passes through the wall of the uterus and opens via the uterine ostium into the uterine cavity at the uterine cornu.

Ovaries

The ovaries are almond-shaped, pearl-colored female gonads responsible for producing the oocytes (female gametes or the germ cells). The developing egg cells (oocytes) are contained in the fluid-filled cavities called follicles in the wall of the ovaries. Each ovary is suspended by a short fold of peritoneum known as the mesovarium, which arises from the broad ligament. In the prepubertal woman, the connective tissue capsule over the surface of the ovary is covered by a smooth layer of ovarian mesothelium or surface germinal epithelium. This usually comprises of a single layer of cuboidal cells which gives the ovarian surface a dull, grayish appearance. After puberty, the surface epithelium becomes progressively scarred and distorted because of the repeated rupture of the ovarian follicles and discharge of oocytes during ovulation.

A baby girl is born with oocytes in her ovaries. No new oocytes develop after birth. Between 16 weeks and 20 weeks of gestation, the ovaries of a female fetus contain 6–7 million oocytes. Most of these oocytes gradually die away, leaving about 1–2 million oocytes to be present at birth. At puberty, only about 300,000 oocytes remain, of which only a small percentage mature into eggs. Thousands of oocytes that do not mature undergo degeneration. Degeneration is usually complete by the time the woman attains menopause.

The ovarian vessels, lymphatics and nerves pass along the superolateral aspect of the ovary within a peritoneal fold, called the suspensory ligament of the ovary. This becomes continuous with the mesovarium of the broad ligament. Medially, within the mesovarium, there is a short ligament called the ovarian ligament, which tethers the ovary to the uterus. The ovarian ligament connects the proximal end of the ovary to the lateral angle of the uterus, just inferior to the entrance of the uterine tube. Since the ovary is suspended inside the peritoneal cavity and its surface is not covered with peritoneum, the oocyte expelled at the time of ovulation passes into the peritoneal cavity. However, its intraperitoneal life is short because it is soon trapped by the fimbriae of the infundibulum of the uterine tube. Eventually, the ovum is carried to the ampulla where it is fertilized.

Uterus

The uterus is a thick-walled, muscular, pear-shaped organ located in the middle of the pelvis, in which the development of fetus and embryo occurs. The adult uterus comprises of two main parts: (1) body (uterine corpus) and (2) cervix. The nongravid uterus lies in the lesser pelvis, with its body lying on the urinary bladder and cervix between the urinary bladder and rectum. The uterus is anchored in its position by several ligaments. The uterus is a very dynamic structure, the size and proportions of which change during the various stages of life. The adult uterus is usually anteverted and anteflexed so that its mass lies over the bladder. When the bladder is empty, the uterus lies in a transverse plane. The nongravid uterus is approximately 7.5 cm long, 5 cm wide and 2 cm thick. It weighs about 90 grams.

Cervix

The cervix forms lower third of the uterus and is approximately 2.5 cm in length in an adult nonpregnant woman. The sperms enter the uterine cavity through the cervical canal. It also serves as a passage for the exit of menstrual blood. During labor, the cervical canal widens to form the lower uterine segment, the contractions of which help in the expulsion of the fetus. The cervix serves as a good barrier against bacterial infection, except around the time of ovulation, during the menstrual period, or during labor. Bacteria responsible for causing the sexually transmitted diseases can enter the uterus through the cervix at the time of sexual intercourse.

The cervix is composed of two parts: (1) supravaginal part (between the uterine isthmus and the vagina) and (2) the vaginal part (which protrudes into the vagina). The portion of cervix projecting into the vagina is known as ectocervix or portio vaginalis. The part of cervix within the uterine cavity is known as the endocervix. The opening of the ectocervix is known as the external os. The opening of the cervix inside the uterine cavity is known as the internal os. The passage between the external os and internal os is known as the endocervical canal (Fig. 1.5). The epithelium of cervix is varied. The ectocervix is composed of stratified squamous epithelium, whereas the endocervix which lies within the uterus is composed of simple columnar epithelium. The area adjacent to the junction of ectocervix and endocervix is known as the transformation zone. The endocervical glands are responsible for producing mucus, whose consistency varies during various phases of the menstrual cycle. This mucus is thick and impenetrable to sperm until just before ovulation. At ovulation, the consistency of the mucus changes and it becomes more thin and stretchable so that sperms can penetrate through it and fertilization can occur. The cervix is mostly composed of fibrous tissue, which mainly comprises of collagen and a small amount of elastin.

Uterine Corpus

The uterine corpus forms the superior two-thirds of the uterus. The corpus of the uterus is a highly muscular structure which can stretch to accommodate a growing fetus. Its muscular walls contract during labor to push the baby out through the cervix and the vagina. The uterine corpus includes the fundus of the uterus, the rounded part of the uterus which lies superior to the uterine cornu. The remaining part of the body lies between the two layers of broad ligament and is freely movable. During the reproductive years, the corpus is twice as long as the cervix. After menopause, the reverse is true and the cervix is twice as long as the uterine corpus.

The uterine cavity is slit-like, which is approximately 6 cm in length and extends from the external os to the walls of the fundus. The uterine horns (cornu) are in the superolateral regions of the uterine cavity, where the uterine tubes enter. The uterine cavity continues inferiorly as the cervical canal. The uterine cavity, particularly the cervical

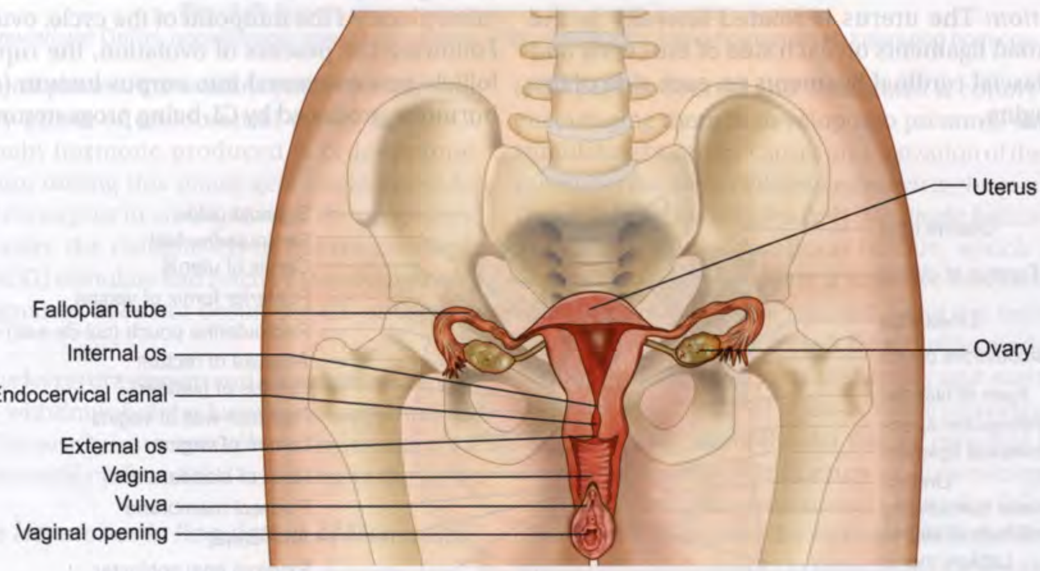


Fig. 1.5: Different parts of the cervix

canal, constitutes the birth canal through which the fetus passes out at the end of gestation. The wall of the body of uterus comprises of three layers:

1. *Parametrium:* This is the serosa or the outer serous coat, which comprises of peritoneum.
2. *Myometrium:* This comprises of the middle coat of smooth muscles, which become greatly distended during pregnancy. The contraction of the myometrial muscles helps in the expulsion of the fetus and placenta.
3. *Endometrium:* This is the inner mucous coat, which firmly adheres to the underlying myometrium. The endometrium is actively involved in the menstrual cycle. If conception occurs, the blastocyst gets implanted in this layer. If the conception does not occur, the inner surface of this layer is shed, resulting in menstrual bleeding.

Relations of the Uterus

The uterus is covered anteriorly and superiorly by the peritoneum except for the cervix. The peritoneum is reflected from the uterus onto the bladder anteriorly and posteriorly over the posterior part of the vaginal fornix onto the rectum. Anteriorly, the uterine body is separated from the urinary bladder by the vesicouterine pouch where the peritoneum is reflected from the uterus onto the posterior margin of the superior surface of the bladder. The relations of the uterus can be summarized as follows (Fig. 1.6):

Anterior relation: The uterus is anteriorly related to the vesicouterine pouch and the superior surface of the bladder. The supravaginal part of the cervix is related to the bladder and is separated from it only by fibrous connective tissue.

Posterior relation: The uterus is posteriorly related to the rectouterine pouch containing loops of small intestine and the anterior surface of the rectum.

Lateral relation: The uterus is related laterally to the peritoneal broad ligaments on each side of the cervix and vagina, and fascial cardinal ligaments on each side of the cervix and vagina.

Supports of the Uterus

The uterus is normally suspended in the position of anteversion and anteflexion. This position is maintained by various pelvic support structures. A basic knowledge of pelvic anatomy and uterine supports is essential for the gynecologist in order to understand the mechanism of prolapse and to perform the surgical procedures for its rectification. The various pelvic supports would be discussed in chapter 22.

NORMAL MENSTRUAL CYCLE

As previously mentioned, the uterine endometrium undergoes regular cyclic changes under the influence of hormones estrogens and progesterone produced by the ovaries. This constitutes the menstrual cycle, which would now be discussed at length.

The events of the normal menstrual cycle are shown in Figure 1.7. The first day of a typical menstrual cycle (day l) corresponds to the first day of menses. The menstrual phase usually lasts for 5 days and involves the disintegration and sloughing of the functionalis layer of the endometrium. Interplay of various prostaglandins (e.g. prostaglandin F2-alpha and prostaglandin E2) is involved in regulation of menstrual cycle. Prostaglandin F2-alpha causes myometrial contractions and vasoconstriction, whereas prostaglandin E2 causes vasodilatation and muscle relaxation. A typical menstrual cycle comprises of 28 days. Ovulation occurs in the middle of the menstrual cycle, i.e. day 14 of a typical cycle.

The first 14 days of the cycle, before the menstruation occurs form the proliferative phase, while the next 14 days of the cycle form the secretory phase. During the follicular phase of normal ovarian cycle (equivalent to the proliferative phase of endometrial cycle), there is an increase in the blood levels of the hormone estrogen. During this phase, the maturation of the dominant follicle takes place. At the midpoint of the cycle, ovulation occurs. Following the process of ovulation, the ruptured ovarian follicle gets converted into corpus luteum (CL); the main hormone produced by CL being progesterone.

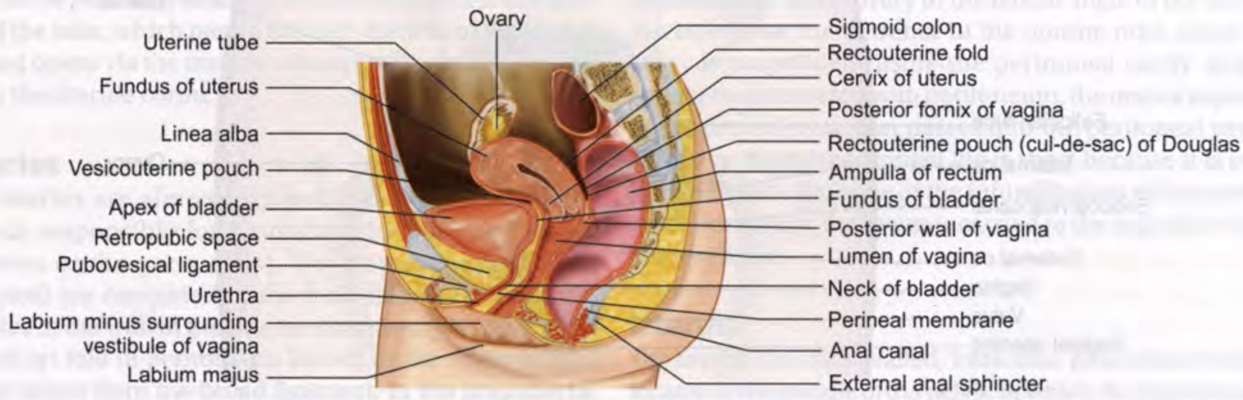


Fig. 1.6: Median view of female pelvis showing anterior and posterior relationship of the uterus

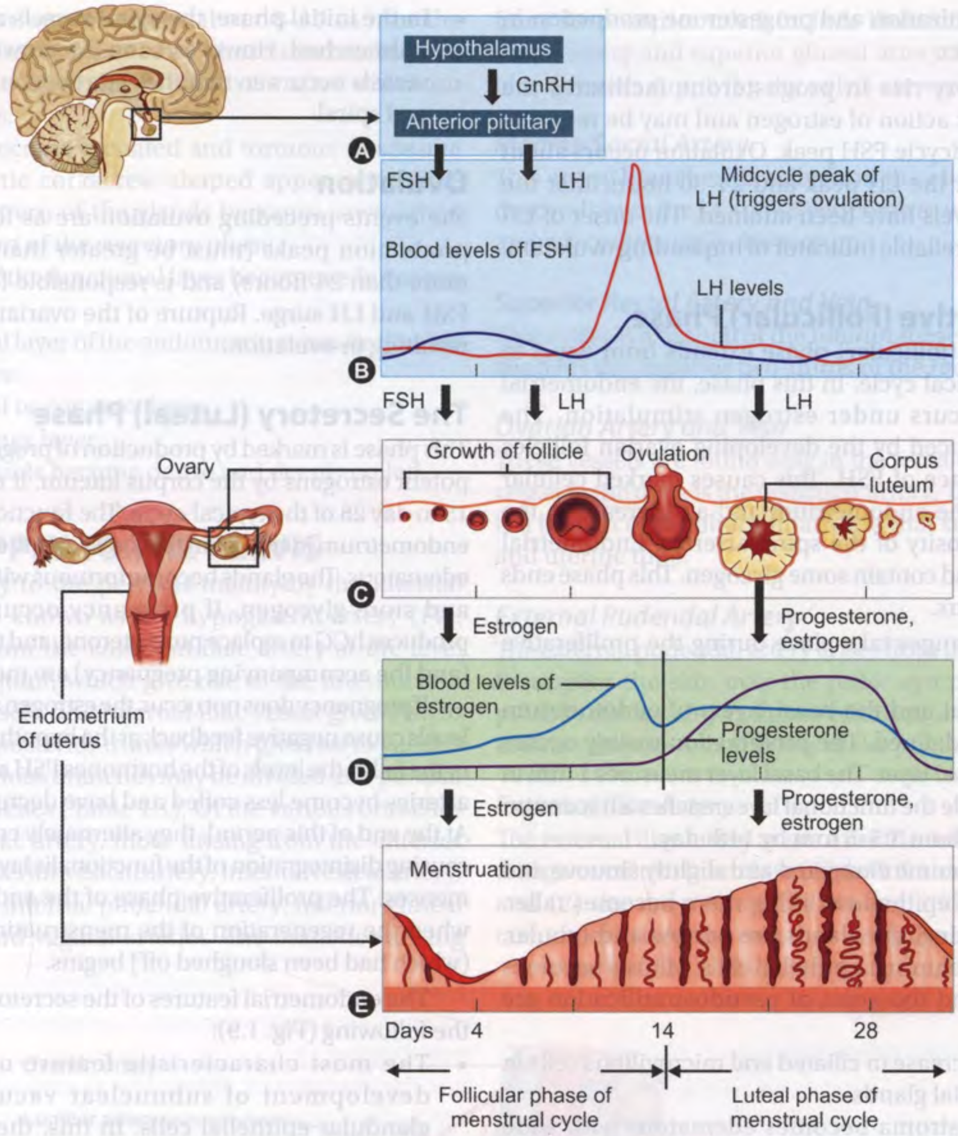


Fig. 1.7: Events taking place during the normal menstrual cycle

Abbreviations: GnRH, gonadotropin releasing hormone; FSH, follicle stimulating hormone; LH, luteinizing hormone

During the luteal phase of the ovarian cycle (corresponding to the secretory phase of endometrial cycle) as the CL matures, the main hormone produced is progesterone. The endometrium during this phase gets transformed for implantation of conceptus in anticipation of the pregnancy. If pregnancy occurs, the rising levels of human chorionic gonadotropin (hCG) stimulate and rescue the endometrium. In case the pregnancy does not occur, the CL undergoes regression.

As a result, the levels of estrogen and progesterone rapidly decline causing withdrawal of the functional support of the endometrium. This results in menstrual bleeding, marking the end of one endometrial cycle and the beginning of the other.

Role of Various Hormones in Regulation of Menstrual Cycles

Initial follicular development is independent of hormonal influence. However, soon follicle stimulating hormone (FSH) takes control and stimulates a cohort of follicles encouraging them to develop into preantral stage. Follicle stimulating hormone causes aromatization of the androgens present in the theca cells into estrogen in the granulosa cells. Out of the various follicles, only one single follicle is destined to develop into a dominant follicle, which undergoes ovulation. Estrogen exerts a negative feedback effect on FSH as a result of which growth of all the follicles except dominant follicle is inhibited. Estradiol levels derived from the dominant follicle increase rapidly and exert a negative feedback effect on FSH release. While causing a decline in FSH levels, the midfollicular rise in estradiol levels exert a positive feedback influence on luteinizing hormone (LH) secretion. The presence of LH in the follicle prior to ovulation is important for optimal follicular development which ultimately results in formation of a healthy oocyte. A surge of LH takes place just prior to ovulation. Luteinizing hormone levels rise steadily during the late follicular phase.

LH initiates luteinization and progesterone production in the granulosa layer.

A preovulatory rise in progesterone facilitates the positive feedback action of estrogen and may be required to induce the midcycle FSH peak. Ovulation occurs about 10–12 hours after the LH peak and 24–36 hours after the peak estradiol levels have been attained. The onset of LH surge is the most reliable indicator of impending ovulation.

The Proliferative (Follicular) Phase

The proliferative (follicular) phase extends from day 5 to day 14 of the typical cycle. In this phase, the endometrial proliferation occurs under estrogen stimulation. The estrogen is produced by the developing ovarian follicles under the influence of FSH. This causes marked cellular proliferation of the endometrium and an increase in the length and tortuosity of the spiral arteries. Endometrial glands develop and contain some glycogen. This phase ends as ovulation occurs.

The following changes take place during the proliferative phase (Fig. 1.8):

- The functional and the basal layers of endometrium become well-defined. The proliferation mainly occurs in the functional layer. The basal layer measures 1 mm in thickness, while the functional layer reaches a maximum thickness of about 3.5–5 mm by 14th day.
- The glands become elongated and slightly sinuous and the columnar epithelium lining them becomes taller. In the beginning, the glands are narrow and tubular, lined by low columnar epithelial cells. Mitosis becomes prominent and the areas of pseudostratification are observed.
- There is an increase in ciliated and microvillous cells in the endometrial glands.
- Endometrial stroma becomes edematous with wide separation of the individual cells. The stroma gets infiltrated with numerous cells including macrophages, leukocytes, etc.
- In the initial phase, the spiral vessels are uncoiled and unbranched. However, soon the growth of the straight vessels occurs so that they start becoming more coiled and spiral.

Ovulation

The events preceding ovulation are as follows: estrogen production peaks (must be greater than 200 pg/mL for more than 24 hours) and is responsible for triggering the FSH and LH surge. Rupture of the ovarian follicle follows, resulting in ovulation.

The Secretory (Luteal) Phase

This phase is marked by production of progesterone and less potent estrogens by the corpus luteum. It extends from day 15 to day 28 of the typical cycle. The functionalis layer of the endometrium increases in thickness and the stroma becomes edematous. The glands become tortuous with dilated lumens and store glycogen. If pregnancy occurs, the placenta produces hCG to replace progesterone, and the endometrium (and the accompanying pregnancy) are maintained.

If pregnancy does not occur, the estrogen and progesterone levels cause negative feedback at the hypothalamus, resulting in the fall in the levels of the hormones FSH and LH. The spiral arteries become less coiled and have decreased blood flow. At the end of this period, they alternately contract and relax, causing disintegration of the functionalis layer and eventually menses. The proliferative phase of the endometrium starts when the regeneration of the menstruating endometrium (which had been sloughed off) begins.

The endometrial features of the secretory phase include the following (Fig. 1.9):

- The most characteristic feature of this phase is development of subnuclear vacuolation in the glandular epithelial cells. In this, the glycogen-filled vacuoles develop between the nuclei and the basement membrane (by the day 17–18). This is the first evidence that ovulation has taken place.

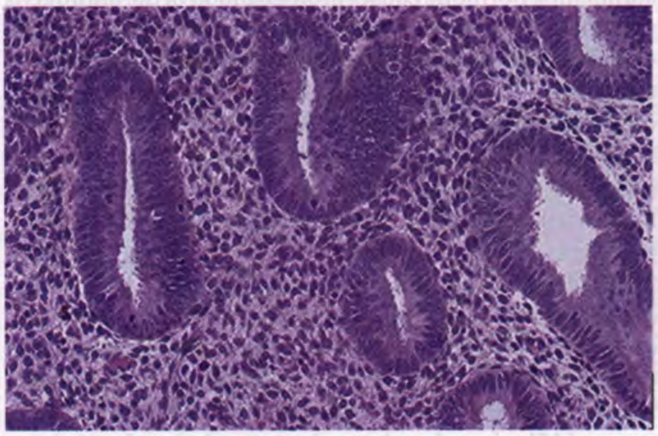


Fig. 1.8: Proliferative endometrium

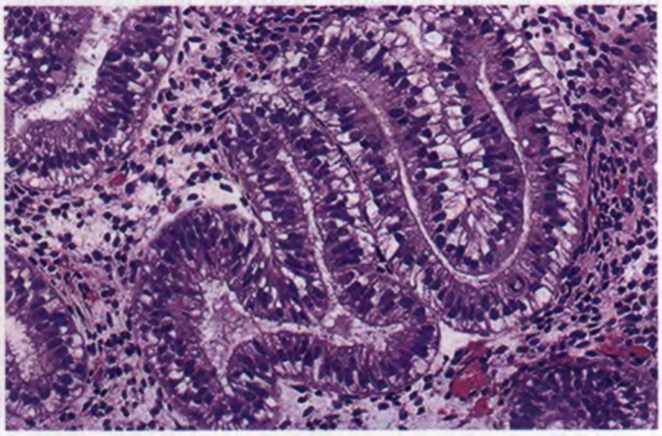


Fig. 1.9: The secretory phase endometrium

- The endometrium measures about 8–10 mm in the secretory phase. The secretory phase reaches its peak activity by the 22nd day of the cycle after which no growth occurs.
- The glands become crenated and tortuous to assume a characteristic corkscrew-shaped appearance. The corkscrew pattern of the glands becomes sawtoothed in the later part of the secretory phase.
- The stroma of the functional layer becomes edematous further.
- The functional layer of the endometrium can be divided into two layers:
  - Superficial or compact layer
  - Deep spongy layer
- The spiral vessels become dense and deeply coiled.

BLOOD SUPPLY TO THE PELVIS

The blood supply to the pelvis is mainly by the internal iliac artery, also known as the hypogastric artery (Fig. 1.10). It arises from the common iliac artery at the level of the sacroiliac joint, which give rise to the internal and external iliac vessels. The internal iliac vessel gives rise to the anterior and posterior trunks which give rise to various branches. The various branches may be divided into parietal and visceral branches (Table 1.1). Of the various branches of the internal iliac artery, those arising from the anterior trunk include superior vesical artery, inferior vesical artery, obturator artery, internal pudendal artery, inferior gluteal artery, uterine and vaginal arteries. The branches arising from the posterior trunk include iliolumbar artery, lateral sacral artery and superior gluteal artery. Other significant blood vessels supplying the pelvis are explained below.

Median Sacral Artery

This artery branches directly from the abdominal aorta. It descends over the L4 and L5 vertebrae as well as the sacrum and coccyx to supply the sacrum.

Superior Rectal Artery and Vein

This artery is a branch of the inferior mesenteric artery and supplies the superior two-thirds of the rectum.

Ovarian Artery and Vein

These vessels are found only in the female. The analogous vessel in the male is the testicular artery. The ovarian artery is a branch of the abdominal aorta that supplies the ovary and uterine tube.

External Pudendal Artery

The external pudendal artery arises from the femoral artery. It supplies the skin over the pubic symphysis (the mons pubis in the female) and gives off anterior scrotal and labial arteries and the dorsal artery of the penis and clitoris.

External Iliac Artery

The external iliac artery arises from the common iliac artery and gives off two branches: (1) the inferior epigastric artery and (2) the deep circumflex artery and vein. The deep circumflex artery and vein runs along the internal surface of

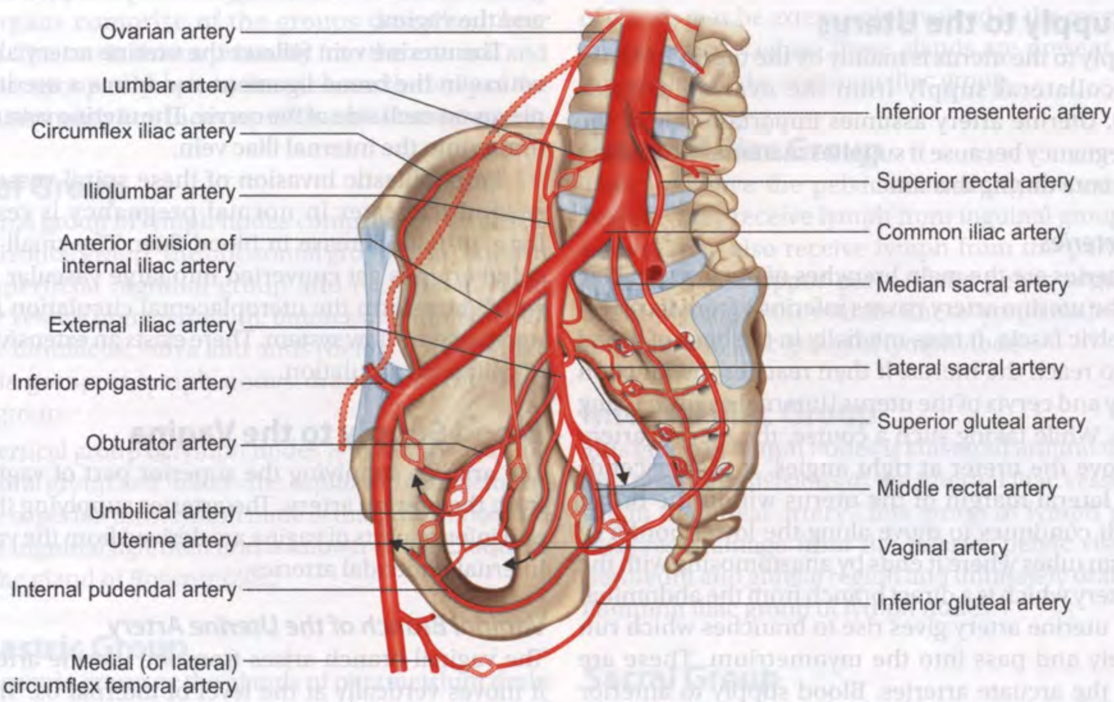


Fig. 1.10: Blood supply to the pelvis

Table 1.1: Branches of the internal iliac artery

Branch	Area of Blood Supply
Parietal Branches	
1. Iliolumbar vessel	Bone and muscle in the iliac fossa
2. Lateral sacral vessels	Branches to the sacrum and coccyx
3. Obturator vessel	Gives rise to anterior and posterior branches, which encircle the margin of the obturator foramen. They supply the medial thigh and hip
4. Superior and inferior gluteal vessels	Supply the gluteal muscles
5. Internal pudendal arteries	These supply the perineum and its muscles and give rise to the following branches: • Inferior rectal artery • Vessels that supply the scrotum (or labia), perineum, bulb of the penis (or vestibule), and urethra
Visceral Branches	
1. The umbilical artery	Returns deoxygenated blood in the fetus from the aorta to the placenta
2. Superior vesical artery	Supplies the bladder
3. Inferior vesical artery	Supplies the posterior bladder, seminal vesicle, and prostate
4. Uterine artery (or the artery of the ductus deferens)	Uterus
5. Vaginal artery	Vagina
6. Middle rectal artery	Rectum

the ala of the ilium to supply the muscles located there. The external iliac artery continues as the femoral artery below the inguinal ligament.

BLOOD SUPPLY TO THE INTERNAL GENITAL ORGANS

Blood Supply to the Uterus

Blood supply to the uterus is mainly by the uterine arteries with the collateral supply from the ovarian arteries (Fig. 1.11). Uterine artery assumes important role at the time of pregnancy because it supplies maternal circulation to the placenta during this time.

Uterine Arteries

Uterine arteries are the main branches of the internal iliac arteries. The uterine artery passes inferiorly from its origin into the pelvic fascia. It runs medially in the base of broad ligament to reach the uterus. It then reaches the junction of the body and cervix of the uterus (internal os) by passing superiorly. While taking such a course, the uterine artery passes above the ureter at right angles. It then ascends along the lateral margin of the uterus within the broad ligament. It continues to move along the lower border of the fallopian tubes where it ends by anastomosing with the ovarian artery which is a direct branch from the abdominal aorta. The uterine artery gives rise to branches which run transversely and pass into the myometrium. These are known as the arcuate arteries. Blood supply to anterior and posterior walls is provided by the arcuate arteries, which run circumferentially around the uterus. From the arcuate vessels, branches known as the radial arteries arise at right angles. They reach the basal layers of endometrium where they are termed as the basal arteries. From the basal arteries, spiral and straight arterioles of the endometrium are derived. The arcuate artery to the cervix is also known as the circular artery of the cervix. The uterine artery also gives off a small descending branch that supplies the cervix and the vagina.

The uterine vein follows the uterine artery all along its course in the broad ligament and forms a uterine venous plexus on each side of the cervix. The uterine vein ultimately drains into the internal iliac vein.

Trophoblastic invasion of these spiral vessels during second trimester in normal pregnancy is responsible for a 10-fold increase in blood flow. The small muscular spiral arteries get converted into large vascular channels, which transform the uteroplacental circulation into a low resistance-to-flow system. There exists an extensive network of collateral circulation.

Blood Supply to the Vagina

The arteries supplying the superior part of vagina derive from the uterine artery. The arteries supplying the middle and inferior parts of vagina are derived from the vaginal and internal pudendal arteries.

Vaginal Branch of the Uterine Artery

The vaginal branch arises from the uterine artery before it moves vertically at the level of internal os. This is also known as the descending vaginal artery because it descends downwards through the parametrium to reach the lateral

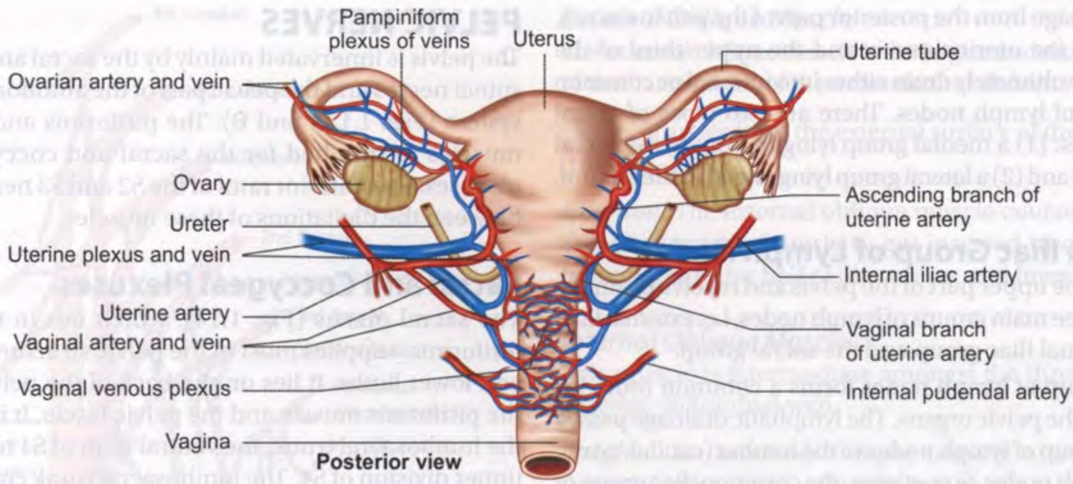


Fig. 1.11: Blood supply to internal genital organs

fornix of the vagina. It gives rise to the anterior and posterior azygos arteries of the vagina.

Arteries of the Vulva and Perineum

The vulva and perineum is supplied by the branches from internal pudendal artery which is a branch of internal iliac artery. It gives rise to a branch called the transverse perineal artery, which supplies the perineum and the external anal sphincter. It also supplies the posterior part of the labia and the erectile tissues surrounding the vaginal orifice. It ends in the form of the dorsal artery of clitoris which supplies the clitoris and the vestibule.

LYMPH NODES OF PELVIS

Lymph nodes of the pelvic region, which drain the female genital organs comprise of the groups described next (Fig. 1.12). The cervix drains primarily into the external and internal iliac group of lymph nodes, whereas the body of the uterus drains mainly into the external iliac and lumbar nodes.

Inguinal Group

The inguinal group of lymph nodes comprises of a vertical and a horizontal group. The horizontal group is also known as the superficial inguinal group and receives afferent lymphatic vessels from perineum, buttocks, abdominal wall below the umbilicus, vulva and anus (below the pectinate line). This group of lymph nodes drains into the deep inguinal group.

The vertical group of lymph nodes is also known as the deep femoral group and follows the saphenous and femoral veins. The superior-most lymph node of this group is located under the inguinal ligament and is known as the Cloquet's node or the gland of Rosenmüller.

Hypogastric Group

The hypogastric group or the glands of parametrium drain the lymphatics from the cervix, bladder, upper-third of vagina and greater part of the body of the uterus. This group

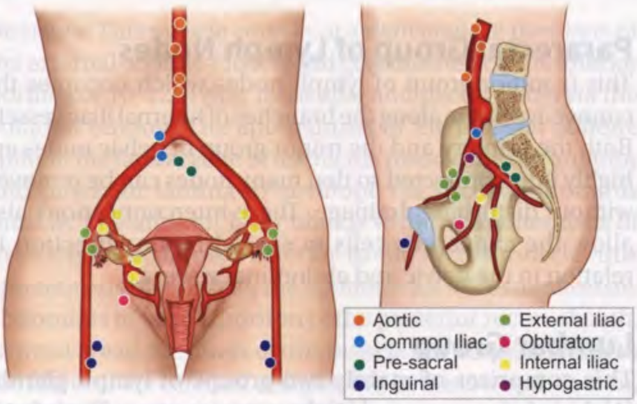


Fig. 1.12: Lymph nodes of the pelvic region

of glands may be extensively involved in the cases of cancer of cervix and vagina. These glands are present below the bifurcation of the common iliac group.

External Iliac Group

They lie above the pelvic brim along the external iliac vessels. They receive lymph from inguinal group of lymph nodes. They also receive lymph from the pelvic viscera, especially the upper parts of the pelvic organs placed anteriorly and in the middle. These lymph nodes drain into the common iliac group of lymph nodes.

Internal Iliac Group

This group of lymph nodes is clustered around the anterior and posterior divisions of the internal iliac vessels and the origin of gluteal artery. This group of lymph nodes also receives drainage from the inferior pelvic viscera, deep perineum and gluteal region and ultimately drains into the common iliac group of lymph nodes.

Sacral Group

These lymph nodes lie in the concavity of the sacrum, adjacent to the median sacral vessels. They receive the lymph drainage from the posterior part of the pelvic viscera, particularly the uterine cervix and the upper-third of the vagina. They ultimately drain either into internal or common iliac group of lymph nodes. There are two types of sacral lymph nodes: (1) a medial group lying in front of the sacral promontory and (2) a lateral group lying lateral to the rectum.

Common Iliac Group of Lymph Nodes

They lie in the upper part of the pelvis and receive drainage from the three main groups of lymph nodes, i.e. external iliac group, internal iliac group and the sacral group.

This group of lymph nodes forms a common route for drainage of the pelvic organs. The lymphatic drainage passes from this group of lymph nodes to the lumbar (caudal/aortic group) lymph nodes. Sometimes, the common iliac group of lymph nodes may receive some direct drainage from pelvic organs such as neck of bladder and inferior vagina.

Pararectal Group of Lymph Nodes

This is minor group of lymph nodes which occupies the connective tissue along the branches of internal iliac vessels. Both the primary and the minor group of pelvic nodes are highly interconnected so that many nodes can be removed without disturbing drainage. These interconnections also allow the cancerous cells to spread in any direction in relation to the pelvic and abdominal viscera.

Lumbar Group

This comprises of mainly two groups of lymph glands: (1) the inferior group and (2) the superior group. The inferior group lies in front of the aorta below the origin of inferior mesenteric artery. The superior group lies near the origin of ovarian artery and receives lymphatics from the ovaries and fallopian tubes as well as from the inferior lumbar group. The lymphatics from the uterine fundus also pass to this group via the ovarian lymphatics.

PELVIC NERVES

The pelvis is innervated mainly by the sacral and coccygeal spinal nerves and the pelvic part of the autonomic nervous system (Figs 1.13A and B). The piriformis and coccygeus muscles form a bed for the sacral and coccygeal nerve plexuses. The anterior rami of the S2 and S3 nerves emerge between the digitations of these muscles.

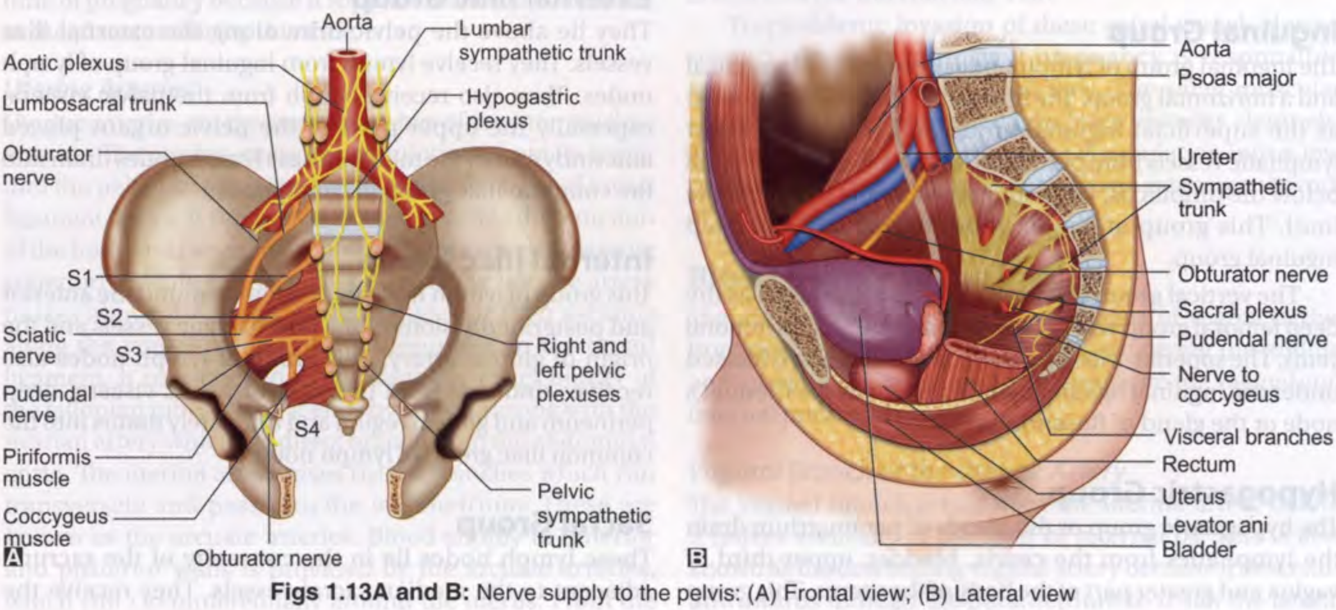
Sacral and Coccygeal Plexuses

The sacral plexus (Fig. 1.14), which lies in the front of piriformis, supplies most of the pelvic structures, buttocks and lower limbs. It lies on the back of the pelvis between the piriformis muscle and the pelvic fascia. It is formed by the lumbosacral trunk, the ventral rami of S1 to S3 and the upper division of S4. The lumbosacral trunk comprises the whole of the anterior division of the fifth and a part of the fourth lumbar nerve.

Most of the innervation of the perineum is by the pudendal nerve (S2, S3 and S4). It contains motor, sensory (pain and reflex), and postganglionic sympathetic fibers. The pudendal nerve traverses the greater sciatic foramen below the piriformis, crosses the back of the ischial spine, and enters the perineum through the lesser sciatic foramen. It traverses the pudendal canal in the lateral wall of the ischiorectal fossa, gives off the inferior rectal nerve, and divides into the perineal nerve and the dorsal nerve of the penis (or clitoris). The perineal nerve divides into a deep branch to perineal muscles and a superficial branch to the scrotum (or labium majus).

Pelvic Part of Autonomic Nervous System: Hypogastric Plexus

Sympathetic fibers reach the pelvis by downward continuations of the sympathetic trunk and of the aortic plexus. In front of the sacrum, the sympathetic trunks consist largely of preganglionic fibers and present three



Figs 1.13A and B: Nerve supply to the pelvis: (A) Frontal view; (B) Lateral view

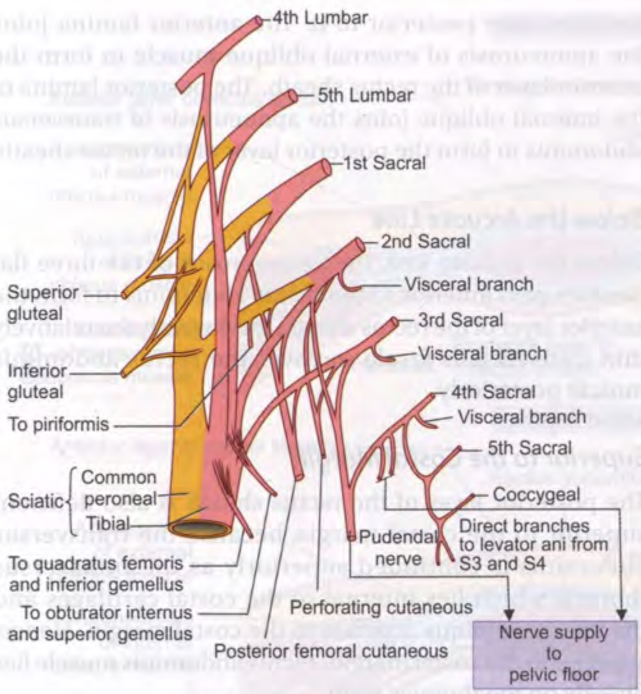


Fig. 1.14: The sacral plexus

or four ganglia each. This forms the hypogastric plexus of nerves, which supplies the viscera of pelvic cavity. This plexus is situated in front of the last lumbar vertebra and sacral promontory. It is formed by the presacral nerve, which lies in front of sacral promontory and divides into two hypogastric nerves which pass downwards and laterally along the pelvic wall. They help to form the inferior hypogastric plexus, which is a diffuse plexus that lies in the region of uterosacral ligaments. This plexus also receives fibers from parasympathetic system comprising of sacral fibers (S2 to S4). The hypogastric plexus divides into two lateral portions called the pelvic plexus. These are situated at the sides of rectum and vagina in females and supply the viscera of pelvis.

The cervix is surrounded by a rich plexus of nerves called the Frankenhauser plexus. The ovaries derive their nerve supply from the celiac and renal ganglia. The lower vagina, clitoris, posterior part of labia majora and the perineum are supplied by the pudendal nerve (S2, S3 and S4). The ilioinguinal nerve (L1) and the genital branch of the genitofemoral nerve (L1 and L2) supply mons pubis and upper and outer aspect of labia majora and perineum.

ANATOMY OF THE ABDOMINAL WALL

Muscles of the Abdominal Wall

The musculature of the abdominal wall is composed of two muscle groups. One group, comprising of the flat muscles, consists of three muscles: (1) the external oblique, (2) the internal oblique and (3) the transversus abdominis. The second group is composed of two muscles that run vertically and comprise of the muscles, rectus abdominis and the pyramidalis.

External Oblique Muscle

The external oblique muscle is the largest and most superficial of the flat muscles of the anterolateral abdominal wall.

Origin: It arises from the external surface of the lower 8 ribs (ribs 5th–12th).

Insertion: The external oblique muscle courses diagonally anteriorly and inferiorly to get inserted upon the pubic tubercle, anterior half of iliac crests, and linea alba.

Internal Oblique Muscle

This muscle is intermediate amongst the three muscles of anterior abdominal wall.

Origin: The internal oblique muscle arises from the thoracolumbar fascia, anterior two-thirds of the iliac crest, and the connective tissue deep to the lateral third of inguinal ligament.

Insertion: This muscle courses at a right angle to the fibers of the external oblique muscle and gets inserted on the inferior borders of 10–12th ribs, linea alba and pectin pubis via the conjoint tendon. The aponeurosis of the internal oblique splits at the lateral edge of the rectus muscle into an anterior and posterior lamina to envelope the rectus abdominis muscle. The anterior layer blends with the aponeurosis of the external oblique. Posterior to the rectus muscle, this aponeurosis blends with the aponeurosis of the transversus abdominis to form a portion of the posterior rectus sheath. In most areas, the fibers of this muscle are perpendicular to the fibers of the external oblique, but in the lower abdomen, their fibers arch somewhat more caudally, and run in a direction similar to those of the external oblique.

Transversus Abdominis Muscle

The innermost of the flat muscles is the transversus abdominis and runs more or less transversely.

Origin: This muscle arises from the internal surface of 7th–12th costal cartilages, thoracolumbar fascia, iliac crest, and connective tissue deep to the lateral third of the inguinal ligament.

Insertion: Coursing transversely to the midline, the upper three-fourths of the transversus aponeurosis lies behind the rectus muscle. The lower one-fourth of the aponeurosis passes in front of the rectus muscle. The fibers of transversus abdominis gets inserted into the linea alba along with the aponeurosis of internal oblique, and into the pubic crest and pectin pubis via the conjoined tendon.

Between the muscle fibers of internal oblique and transversus abdominis, there is a neurovascular plane of the anterolateral abdominal wall which contains the nerves and arteries supplying the anterolateral abdominal wall.

Rectus Abdominis Muscle

Rectus abdominis muscle belongs to the group of muscle which runs vertically. It is the principal muscle of the vertical group. There are three tendinous inscriptions within each rectus abdominis muscle. These fibrous interruptions within the muscle help in firmly attaching it to the rectus sheath. These fibrous interruptions are usually confined to the region above the umbilicus, but sometimes can also be found below the umbilicus. When found below the umbilicus, the rectus sheath is attached firmly to the rectus muscle at the region of inscription. This may cause difficulty at the time of muscle separation during Pfannenstiel incision.

Origin: This muscle takes its origin from the pubic symphysis and the pubic crest.

Insertion: After taking their origin, the rectus muscle fibers run vertically to get inserted into the xiphoid process and the fifth, sixth, and seventh costal cartilages. The muscle fibers contain three fibrous insertions known as the linea transversae. The rectus muscle is surrounded by a sheath, comprising of the aponeuroses of the oblique muscles and the transversus abdominis. The rectus sheath has been described in details later in this chapter.

Pyramidalis

This muscle is absent in approximately 20% of the population and lies anterior to the inferior part of rectus abdominis. This muscle marks the midline and assists in the identification of the medial borders of the rectus muscle.

Origin: A small, vestigial, triangular-shaped muscle, the pyramidalis, arises from the pubic symphysis.

Insertion: It inserts on the anterior surface of the pubis and the anterior pubic ligament. It ends in the linea alba which is especially thickened for a variable distance superior to the pubic symphysis. The pointed insertion of the pyramidalis muscles into the linea alba can be used for locating the midline.

Rectus Sheath

The rectus sheath is formed by the conjoined aponeuroses of the flat abdominal muscles. It is formed by the decussation and interweaving of the aponeurosis of these muscles. The aponeurosis of external oblique muscle contributes to the formation of the anterior wall of the sheath throughout its length. A concentric line, "arcuate line" lies midway between the umbilicus and pubic symphysis and demarcates the transition between the aponeurotic posterior wall of the sheath covering the superior three-fourths of the rectus and the transversalis fascia covering the inferior quarter. Throughout the length of the sheath, the fibers of the anterior and posterior layer of the sheath interlace in the anterior median line to form the complex linea alba. The composition of the rectus sheath above and below the arcuate line is described in Figures 1.15A and B.

Above the Arcuate Line

The superior two-thirds of the internal oblique aponeurosis splits into two layers at the lateral border of rectus abdominis, with one lamina passing anterior to the muscle and the other posterior to it. The anterior lamina joins the aponeurosis of external oblique muscle to form the anterior layer of the rectus sheath. The posterior lamina of the internal oblique joins the aponeurosis of transversus abdominis to form the posterior layer of the rectus sheath.

Below the Arcuate Line

Below the arcuate line, the aponeuroses of the three flat muscles pass anterior to the rectus abdominis to form the anterior layer of the rectus sheath, leaving only the relatively thin transversalis fascia to cover the rectus abdominis muscle posteriorly.

Superior to the Costal Margin

The posterior layer of the rectus sheath is also deficient superior to the costal margin because the transversus abdominis is continued superiorly as the transversus thoracis which lies internal to the costal cartilages and the internal oblique attaches to the costal margin. Hence, superior to the costal margin, rectus abdominis muscle lies directly on the thoracic wall.

Importance for the Surgeon

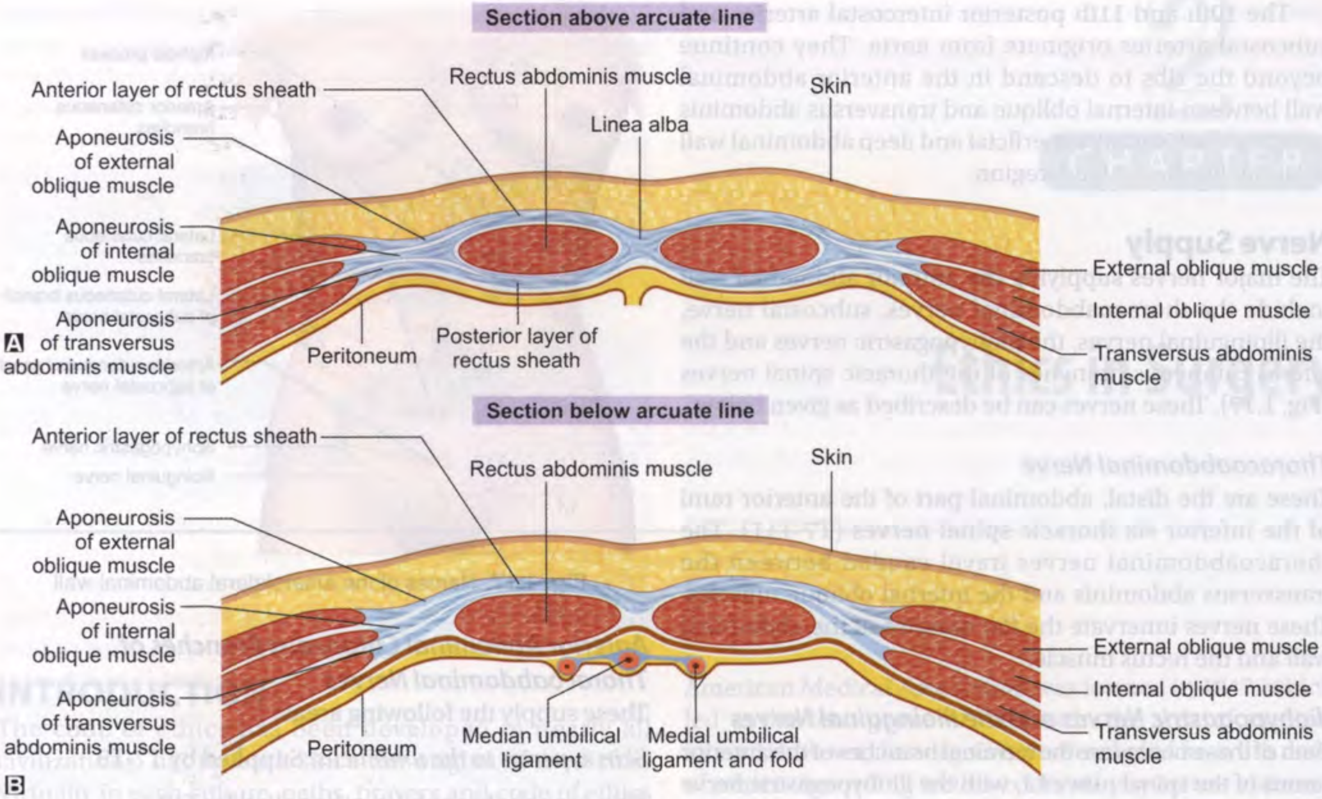
There are several specialized aspects of the rectus sheath that are important to the surgeon. In forming the rectus sheath, the conjoined aponeuroses of the individual flank muscles can be separated lateral to the rectus muscles, but as they reach the midline, they fuse and lose their separate directions. As a result of this midline fusion, these layers are usually incised together in the midline while giving a transverse fascial incision.

Vessels of the Abdominal Wall

The primary blood supply to the abdominal wall is from the superficial and deep blood vessels. The main blood vessels supplying the anterolateral abdominal wall are as follows:

- Superior epigastric vessels and the branches of musculophrenic artery
- Inferior epigastric and deep circumflex iliac arteries
- Superficial circumflex iliac and superficial epigastric arteries
- Posterior intercostal vessels of the 11th intercostal space and the anterior branches of the subcostal vessels.

The blood supply of the anterior abdominal wall is demonstrated in Figure 1.16. The superficial blood vessels originate from the femoral artery and include the superficial epigastric, the superficial circumflex, and the superficial external pudendal arteries. The deep vessels on the other hand, originate from the external iliac and the internal thoracic artery. These include the inferior epigastric artery, the deep circumflex artery and the superior epigastric artery, which is the terminal branch of the internal thoracic artery. The internal thoracic artery also gives rise to the musculophrenic artery, which anastomoses with the deep circumflex artery. Anastomosis between the various vessels



Figs 1.15A and B: The rectus sheath

of abdominal wall helps in ensuring an excellent blood supply to all areas of the abdominal wall. The individual blood vessels would now be described.

Superior Epigastric Vessel

Superior epigastric vessel is the direct continuation of the internal thoracic artery. It enters the rectus sheath superiorly through its posterior layer and supplies the superior part of the rectus abdominis and anastomoses with the inferior epigastric artery in the umbilical region.

Inferior Epigastric Vessel

Inferior epigastric vessel arises from the external iliac artery just superior to the inguinal ligaments. It runs superiorly in the transversalis fascia to enter the rectus sheath below the arcuate line. It enters the lower part of the rectus abdominis and anastomoses with the superior epigastric artery.

Superficial Circumflex Iliac Artery

Superficial circumflex iliac artery is the branch of femoral artery, which runs in the subcutaneous tissue towards the umbilicus. It supplies the superficial abdominal wall of the inguinal region and the adjacent anterior thigh region.

Superficial Epigastric Artery

Superficial epigastric artery begins as a single artery that branches extensively and runs in the subcutaneous tissues towards the umbilicus. It supplies superficial abdominal wall of pubic and inferior umbilical regions.

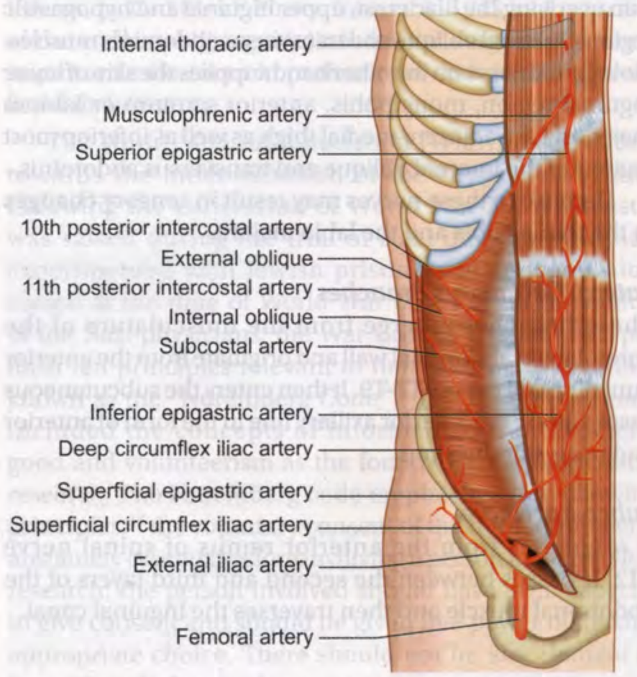


Fig. 1.16: Arteries of the anterolateral abdominal wall

Musculophrenic Artery

The musculophrenic artery originates from the internal thoracic vessels and descends along the costal margin. It supplies the superficial and deep abdominal walls of the epigastric and upper umbilical regions.

The 10th and 11th posterior intercostal arteries and subcostal arteries originate from aorta. They continue beyond the ribs to descend in the anterior abdominal wall between internal oblique and transversus abdominis muscles. They supply superficial and deep abdominal wall of lateral lumbar or flank region.

Nerve Supply

The major nerves supplying the anterior abdominal wall include the thoracoabdominal nerves, subcostal nerve, the ilioinguinal nerves, the iliohypogastric nerves and the lateral cutaneous branches of the thoracic spinal nerves (Fig. 1.17). These nerves can be described as given below.

Thoracoabdominal Nerve

These are the distal, abdominal part of the anterior rami of the inferior six thoracic spinal nerves (T7-T11). The thoracoabdominal nerves travel caudad between the transversus abdominis and the internal oblique muscles. These nerves innervate the flat muscles of the abdominal wall and the rectus muscle.

Iliohypogastric Nerves and the Ilioinguinal Nerves

Both of these nerves are the terminal branches of the anterior ramus of the spinal nerve L1, with the iliohypogastric nerve being the superior terminal branch and the ilioinguinal nerve being the inferior one. Iliohypogastric nerve supplies the skin overlying the iliac crest, upper inguinal and hypogastric regions, internal oblique and transversus abdominis muscles. Ilioinguinal nerve on the other hand supplies the skin of lower inguinal region, mons pubis, anterior scrotum or labium majus and the adjacent medial thigh as well as inferior-most regions of the internal oblique and transversus abdominis.

Damage to these nerves may result in sensory changes in the mons pubis and the labia majora.

Lateral Cutaneous Branches

These branches emerge from the musculature of the anterolateral abdominal wall and originate from the anterior rami of spinal nerves T7-T9. It then enters the subcutaneous tissues along the anterior axillary line in the form of anterior and posterior divisions.

Subcostal Nerve

It originates from the anterior ramus of spinal nerve T12. It passes between the second and third layers of the abdominal muscle and then traverses the inguinal canal.

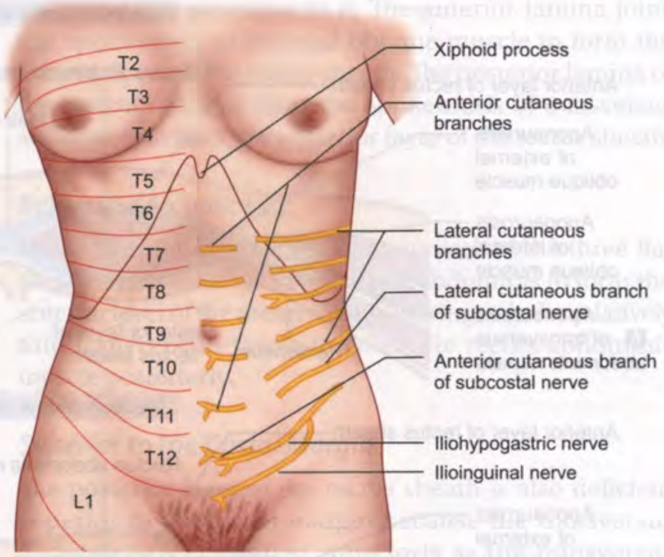


Fig. 1.17: Nerves of the anterolateral abdominal wall

Anterior Abdominal Cutaneous Branches of Thoracoabdominal Nerves

These supply the following areas:

Skin superior to the umbilicus: Supplied by T7-T9

Skin around the umbilicus: Supplied by T10

Skin below the umbilicus: Supplied by T11, and the cutaneous branches of the subcostal, iliohypogastric and ilioinguinal nerves.

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CHAPTER 2

Ethics in Surgery

INTRODUCTION

The code of ethics has been developed in nearly all civilizations, dating back since the origins of medicine. Virtually in each culture, oaths, prayers and code of ethics have originated, which aim at binding the newly trained physicians to their profession by forming a sort of contract between the doctor and patients. These are based on the principles of moral conduct towards patients, colleagues and society. These medical oaths existed in medical fraternities of ancient India, 7th century China and early Hebrew society.[1-3] The newly trained medical doctors were supposed to swear these before starting their professional practice. The most durable medical oath of Western civilization is "the Hippocratic Oath", which graduating medical students swear to at most of the medical schools in the US and rest of the world. Other oaths commonly sworn to by new physicians include the "Declaration of Geneva" (an updated form of the Hippocratic oath formulated by the World Medical Association, Ferney-Voltaire, France).[4] The origins of the Hippocratic Oath presently remain unclear, although most historians agree that the oath's name, "Hippocrates" was not based on the name of its author. Most historians think that the oath originated from a cult of Greek physicians, who were followers of Pythagoras.[5] Alternatively, many researchers also believe that "the Hippocratic Oath" was created by physician-priests of the cult of Asclepius in ancient Greece. The main ethical principles set forth by the Hippocratic Oath include beneficence, nonmaleficence, confidentiality, and prohibition of abortion, euthanasia and sexual relations with patients.[6]

In the early 19th century, some work in the area of medical ethics was done by Sir Thomas Percival.[7] The American Medical Association was formed in 1847, which led to the resurgence of interest in the area of medical ethics.[8] However, the surgeons were excluded from this code of ethics. According to this code, all physicians claiming to have special abilities were criticized and labeled as quacks. The American College of Surgeons (ACS), Chicago, Illinois, by Dr Miles F Porter, formed in 1913 had set some of the earliest ethics guidelines for the surgeons.[9,10] Some important milestones in professional oaths and codes are listed in Table 2.1.

The World Medical Association (WMA) made efforts towards the modernization of the Hippocratic Oath, following the conclusion of World War II.[11] This issue was raised during the trial of Nazi doctors, who had experimented with Jewish prisoners in concentration camps at the time of World War II. After the conviction of the Nazi physicians, the War Crimes Tribunal had put forth ten principles relevant to human experimentation, known as the "Nuremberg Code."[12] The Nuremberg code included the concepts of informed consent, societal good and volunteerism as the foundation for biomedical research. The Nuremberg code emphasizes the following principles:[13] the voluntary consent of the human subject is absolutely essential before involving a person in biomedical research; the person involved should have legal capacity to give consent and should be given free power of making appropriate choice. There should not be any element of force, fraud, deceit, duress or other concealed form of constraint or coercion involved in taking consent.[14] In order to enable the patient to make an enlightened decision, the patient/research subject must be explained in details about the nature, duration and purpose of the procedure/research;

Table 2.1: Milestones in professional oaths and codes

Ethical Code	Author	Date
Hippocratic Oath	Pythagoreans or Asclepiads	4th century BC
Medical Ethics	Sir Thomas Percival	1803
American Medical Association's Code of Medical Ethics	Drs John Bell and Isaac Hays	1847
American College of Surgeons Fellowship pledge	Dr Miles F Porter	1913
Declaration of Geneva	World Medical Association	1947
Nuremberg Code	War Crimes Tribunal	1947
Declaration of Helsinki	World Medical Association	1964
Belmont's Report	National Commission for the protection of human subjects in the biomedical and behavioral research and United States Department of Health, Education and Welfare	1979
Royal Australasian College of Surgeons Code of Ethics[15]	Royal Australasian College of Surgeons	1993

the method and means by which it is to be conducted and the inconveniences, complications and the hazards of the procedure and the likely effects upon the health.

During the coming years, approximately eight more declarations of ethics were published by various international organizations. The first ones were the Declaration of Geneva by the World Medical Association and the International Code of Medical Ethics, which were published in 1948.[16] The Declaration of Helsinki, published in 1964 reemphasized the principle of informed consent for volunteers in biomedical research.

ETHICAL PRINCIPLES FOR MEDICAL RESEARCH AND PRACTICE

The ethical principles for medical research and practice as highlighted by the Belmont report for the protection of human subjects in the biomedical and behavioral research are as described below.[17]

Respect for the Patients

The doctors must show respect for their patients and research subjects by treating them as autonomous individuals and obtaining informed consent before undertaking surgical procedures or any medical or surgical procedure related to research. In the practice of obstetrics and gynecology, the doctor needs to develop respect for the patient as an individual as well as a woman.

Beneficence

This is based on the principle of "avoiding any harm". The doctors need to favor those procedures and treatments, which are likely to benefit the patients and avoid unnecessary harm.

Justice

The doctor should be fair in the process of selecting subjects or the patients. They should be treated fairly in the distribution of benefits and burden.

Other ethical principles for medical research and practice are described below.

The Ethical Confidentiality

Trust is the foundation of physician-patient relationship. This is based on the fact that the patient has the right to privacy, which must be always respected. Patients may disclose their private information to the doctor. This is especially the case in the gynecological practice, where the patients share sensitive information related to intimacy and sexuality with their doctors. Confidentiality, therefore, forms an important aspect of successful therapeutic relationship. According to the code of ethics of American Medical Association (1957), "A physician may not reveal the confidences entrusted to him in the course of medical attendance or the deficiencies he may observe in the character of patients, unless he is required to do so by the law or unless it becomes absolutely necessary to protect the welfare of the individual or the community."[18] The parameters within which the breach of confidentiality would be justified are still controversial. Reporting of sexually transmitted diseases, which may pose to be serious risk to the public health, may be permitted in some US states. In gynecological practice, a variety of complex and difficult situations may arise, where the doctor is faced with the dilemma of whether or not to maintain patient confidentiality. For example, when a woman seeks a medical termination of pregnancy (MTP) or sterilization and requests confidentiality from her partner, the doctor may be faced with a dilemma. In most cases, obligation to patient confidentiality predominates.

Informed Consent

Before undertaking any surgery, it is important for the gynecologist to take informed consent from the patient. Today, the informed consent is required for all operative procedures. The process involves counseling the patient about the various available surgical options so that the patient can select the best surgical procedure out of the various available options. In practice, the informed consent involves informing the patient about the diagnosis, degree of certainty regarding the diagnosis, the surgery that would be recommended in that case and possible alternatives along with their expected outcomes, risks and benefits. The patient outcome, if no therapy is administered, must also be explained to the patient. The consent should be taken well in advance of surgery in a comfortable setting. The patient must be given adequate time to absorb the information, ask any questions if she feels so and then to make an informed decision. Effective communication between the patient and the surgeon is of utmost importance, while counseling the patient regarding various available treatment options. The surgeon may make use of written material (self-explanatory patient leaflets), visual aids (models), websites, etc. to explain the procedure to the patients. The patients must also be informed about the advantages, disadvantages, success and failure rates and complications of the various procedures. The patient must be counseled even regarding the rare complications that are serious and may affect the individual's life. The patient should be given adequate time to interpret and absorb the information presented to her before making the final decision. At no point must it be taken for granted that the patient would be herself able to understand the general risks of surgery, e.g. anesthetic complications.

Elements of Informed Consent

The informed consent requires the following pieces of information: nature of the procedure, rationale of doing the procedure, advantages and disadvantages of doing the procedure and availability of alternatives. If the surgeon encounters an additional pathology at the time of surgery in addition to one for which the informed consent was taken, then the surgeon must first finish the planned surgery and discuss the condition later with the patient. The exception to this rule is the discovery of a life-threatening pathology in which case the surgeon can legally perform surgery in the patient for that condition. The elements of informed consent are as follows:[19]

- Disclosure of information
- Comprehension by the patient
- Voluntary transaction
- Validation.

Disclosure of information: The patients must be explained about their diagnosis and also briefed about the various available treatment options, including no treatment and various medical, surgical and alternative therapies. Risks and benefits of each modality need to be explained in sufficient details so that a reasonable adult patient can understand the situation and make an informed choice.

Comprehension by the patient: The language and the descriptive material, which is used to explain the situation to the patient, must be appropriate to the patient's level of comprehension. The patients must be asked questions in between, to ensure that they understand what they have been told.

Voluntariness: While making a decision, the patient must be free of coercion or constraints and must be able to choose freely. The patient should be mentally competent to be able to make a choice and there must be no evidence of limitation in her ability to understand the information. She must be in a condition to act independently on the basis of information that has been disclosed.

Validation: A written consent form must be given to the patient, which must be duly signed by her. Consent must be taken for each procedure, which is going to be performed even if they are being performed in a single setting. If an additional pathology is discovered at the time of surgery, the surgeon can legally operate on it, only if the condition is life-threatening. On the other hand, if the condition is not life-threatening, then the surgeon must finish the planned surgery and discuss the condition later with the patient.

There are four exceptions to the informed consent:

1. *Emergency situations:* If the relatives are unavailable, the patient is unconscious and is suffering from an emergency life-threatening condition.
2. *Intentional relinquishing by the patient:* Waiver may be given by the patient in case of research projects or exploratory laparotomy.
3. *The patient is mentally incompetent,* i.e. the patient has been declared to be mentally unsound to be able to understand and take decisions appropriately. In this case, the court takes the responsibility for the patient.
4. *Therapeutic privilege:* In case the patient is unconscious or is in the state of confusion and there are no relatives, the physician can act in the patient's benefit without taking her consent.

Surgical Competence as a Moral Commitment

Competence of the surgeon is a moral commitment towards the patient, especially if the surgeon wants to undertake a new procedure. It is essential that the surgeon has been appropriately trained in the clinical sciences and surgical techniques, especially before any new procedure is introduced into clinical medicine.

Ensuring the Appropriate Preoperative Status

The women must be in their optimal preoperative health status before any surgery is undertaken. The following points must be kept in mind:

- The women who smoke must be encouraged to stop smoking at least 24 hours prior to the surgery, in order to reduce the levels of carboxyhemoglobin in their bodies and to minimize the cardiovascular effects of nicotine in the body.[20]

- The women must be screened for sexually transmitted diseases (STDs) before undertaking any pelvic procedure.
- Routine blood tests in order to estimate the patient's hemoglobin levels must be done prior to the procedure.
- Detailed history must be taken and a detailed general physical examination be done.
- The woman must be advised to stop using oral contraceptive pills 1 month prior to the major surgery. In case the patient recently had a myocardial infarction, the surgery must be delayed at least for a period of 3 months.
- All patients undergoing elective surgery must be screened for methicillin-resistant *Staphylococcus aureus* (MRSA).
- Ruling out the presence of pre-existing medical disease: This is important because the morbidity and mortality related to surgery and anesthesia is increased in women with coexisting diseases, such as ischemic heart disease (IHD), hypertension, chronic respiratory diseases, cardiac arrhythmias, etc.

In case there is a presence of concurrent illness, the surgeon must liaise with the anesthetist and other specialists, in order to evaluate the complexity of the patient's situation. In this context, the ASA scoring system (Table 2.2) can prove to be a useful communication tool.[21]

Risk Management

Over recent years, there has been a growing appreciation that a small but significant proportion of patients may experience adverse events, as a result of an error on the part of the health care workers, e.g. errors in the route of administration or dosage of medicines by the nurses. Sometimes, these events may prove to be serious or even life-threatening. Over the past few decades, there has been an increasing trend towards application of principles of risk management in health care organizations. Since small errors can result in particularly disastrous and costly adverse outcomes in both obstetrics and gynecology, it is appropriate to review clinical risk management issues. Risk management involves the ways, in which these errors can be identified and analyzed and subsequently reduced. It involves examining the various procedures, right from the beginning until their end. The various incidents and accidents are analyzed to prevent their occurrence. This is based on the principle that simple system errors can result in some of the most devastating mistakes. The concept of risk management is based on the following strategies:[22]

- Identification, characterization and assessment of potential threats
- Assessment of the vulnerability of critical assets to specific threats
- Determining the risk: This involves assessment of the expected consequences of specific types of attacks on various assets
- Identifying ways to reduce those risks
- Prioritizing risk reduction measures.

An educational and supportive environment, rather than a blame culture, helps in encouraging the reporting of adverse incidents. This encourages the staff to learn from the adverse outcomes. Reduction in the adverse events, which occur in health care institutions helps in improving the overall quality of patient care.

Table 2.2: The American Society of Anesthesiologists (ASA) physical classification system

ASA Classification	Definition
ASA 1	Normal healthy patient
ASA 2	Patient with mild systemic disease which is controlled and does not affect normal activity
ASA 3	Patient with severe systemic disease which limits activity
ASA 4	Patient with severe systemic disease which is incapacitating and a constant threat to life
ASA 5	Moribund patient not expected to survive more than 24 hours with or without surgery

PATIENT COMMUNICATION

In order to communicate effectively, the surgeon needs to develop the art and skill of listening. The surgeon must tell the patient regarding what will be done to her body at the time of surgery and what are the consequences, surgery can have on her life postoperatively. While the patient expresses her feelings, this results in the revelation of her knowledge, fears and biases. The surgeon can help her cope up with them by supplementing her knowledge with the appropriate explanations regarding the anatomy and physiology of her body parts. The usual preoperative, operative and postoperative routines must also be described in detail. The surgeon must also explain the patient about various physical sensations (pain, discomfort, inability to walk, etc.), bandages, incisions, catheters, tubing and medications. Patients own role in her convalescence and recovery must also be defined. The most common complications, which are likely to occur as a result of surgery must be explained to the patient. Before undergoing surgery, the woman may feel lonely, frightened and sick. It is the duty of the surgeon to make her feel more relaxed, calm and peaceful, by allaying all her fears and anxieties. The therapeutic laying on of the surgeon's hands over the patient's shoulders or head may work wonders at time. A healing touch can often comfort the distressed patient when the words may not prove to be adequate.

The patient's family is an important part of her support system. If the patient so desires, the surgeon must involve the patient's family in decision-making process. They should be provided with an adequate amount of information, reassurance, support and attention. If the patient requests the presence of family members, they should be allowed wherever feasible. The surgeon must be available to the patient, in case she wants to contact him/her for further clarification or information.

Verbal Communication

Verbal communication with the patient must be based on the following parameters:

- The doctor must use the vocabulary which the patient understands.
- The doctor must provide appropriate amount of information to the patient, neither too less nor too much that it results in information overload. One of the most difficult questions for the clinicians to answer is, "how much is too much?" The problem is further aggravated due to perceptions regarding litigations.
- The clinicians should make sure that they properly greet the patient before they start taking the history.
- The doctor must ensure that the patient is at ease, by using an appropriate body posture and facial expression.

Besides the patient-doctor communication, the surgeon also needs to pay attention towards the doctor-doctor and doctor-nurse communication, all of which are equally important.

Written Communication

These include maintaining the patient's records and sending letters to other health care professionals.

Clinical Records

Well-maintained clinical records help in maintaining communication with other professionals and in the protection of the patients. They may serve to protect against the future medicolegal litigations. Poor quality records are likely to confuse other health care professionals, thereby endangering the patient's life. Records must be either typed or written in legible handwriting. Preferably, these records must be dated, timed and signed. Concise information must be presented in these records. The physician must not try to present any information, which is not based on evidence. Multidisciplinary team approach must also be practiced and other clinicians may be involved, if the gynecologist feels the requirement.

PSYCHOLOGICAL PREPARATION OF THE PATIENT FOR SURGERY

The surgeon can help prepare the patient psychologically, by providing support in form of reassurance, information and any other form of support to help her deal with the emotional distress related to gynecological surgery. It is not only doctors, but also patients who have certain ethical responsibilities. They need to reveal truth regarding their symptoms, medications, past medical and sexual history, and history of any stressful life event. The patient is likely to react to surgery in the same way she had reacted to that event. Once the surgeon knows the answer, he/she can start the psychological preparation of the patient. Psychological preparation for surgery is supposed to be effective by reducing negative impact of surgery on the quality of life, pain, medication use, behavioral recovery and physiological function. The surgeon should be with the patient at the time of administering anesthesia. Simply holding the patient's hand at the time of administering anesthesia would help her feel safe. Psychosexual rehabilitation may be important after gynecological surgery to help restore her sexual function, sexual identity, body image and self-esteem. Common emotional responses to surgery are given below.

Insecurity

Feelings of insecurity and vulnerability are common among women undergoing surgery. The surgeon can diminish these feelings by ensuring the patient that the surgery is likely to improve the quality of life by providing improvement in the various parameters, such as relief of pain, removal of cancer, improvement of the quality of life, restoration of fertility, etc. If the patient is convinced that she would be better than she is before surgery, she is likely to trust and believe her surgeon and feel less insecure.

Anxiety or Fear

The patient faces fear of unknown at the time of hospitalization. Proper information about the surgery and recovery process would help allay this fear and anxiety. Surgeon is also responsible to ensure that the rest of the hospital staff involved in the surgery also behaves positively with the patient. There is also fear regarding the loss of economic competence for an uncertain length of time. This may be especially important, if the patient is the only earning member of the family.

Regression and Dependency

People who are ill or who undergo surgery tend to regress into a more dependent state. It may be difficult for the family to deal with a woman, who is no longer self-sufficient or is emotionally unstable. This can lead to anger and frustration on part of the relatives and friends.

The prospects of surgery as well as feelings of non-health are likely to contribute to emotional fragility, including the feelings of sadness, depression, tearfulness and irritability. The women are vulnerable to attack on all personal and professional fronts.

Grief and Depression

Grief is a normal, natural reaction to illness or loss of any kind. Grief is essential for emotional healing. By recognizing the various stages of grief, the surgeon is able to help the patient understand, regarding what is happening to her.

Postsurgical depression is also a common finding in patients who have undergone surgery. She may experience the feelings of helplessness, hopelessness and worthlessness. Other symptoms of depression may include midnight-depression, insomnia, nightmares, loss of appetite or excessive eating, lethargy, difficulty in making decisions, psychosomatic symptoms and fatigue.

EVIDENCE-BASED MEDICINE

Traditionally, surgical practice has been experiential and based on the contemporary understanding of basic mechanisms of disease. Surgery was considered to be an art and was largely based on experience. There was a change in this trend with the emergence of "evidence-based medicine" in the 1980s. There is no doubt that the use of evidence-based medicine has been beneficial, but over-reliance on randomized controlled trials and the scientific evidence may not prove to be useful for providing individualized surgical care to the patients. There has been a continuing debate between the practice of "experience" or "evidence-based medicine", while providing care to the patients. The situation is improving, but inevitable tensions remain between the surgeon committed towards providing individualized patient care and the clinical researcher, whose focus is on the results of randomized controlled trials. The ethical principles, which must be kept in surgeon's mind before administering treatment to any patient, include the following: the interests of their patients must always be paramount; any recommendation to a patient must be supported by the best available evidence; before implementing any new intervention or procedure, it must have been properly compared with the currently accepted method(s).

CONCLUSION

Oaths, codes and guidelines for the ethical practice of medicine date back to the Hippocratic Oath of the 4th century BC. Though this oath was largely forgotten at the time of its composition, it achieved a place of prominence in the 18th and 19th centuries as a result of renewed interest in the field of medical ethics. Surgeons were not involved in the Hippocratic Oath or the "Medical Code of Ethics" devised by the American Medical Association (AMA), in 1847. The earliest ethics composition by surgeons was the ACS fellowship pledge, devised by Dr Miles F Porter in 1913. Over the centuries, with the changing medical practice and increased emphasis placed on patient autonomy, managed care and rapidly developing technologies, the long-practiced ethical concepts from the Hippocratic Oath and AMA Code of Medical Ethics have been largely altered. These new forces have caused surgeons to seek greater responsibility in discussing and deciding various bioethical issues. Taking informed consent from the patients prior to surgery ensures that their autonomy is respected. Clinicians are responsible for maintaining their medical and surgical competence. The patient's confidentiality must be protected at each stage. It can be overridden only under exceptional circumstances.

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CHAPTER 3

Anesthesia and Preoperative Care

INTRODUCTION

The main aim of preoperative assessment before anesthesia and surgery is to help improve the final outcome. This is achieved by identifying potential anesthetic difficulties; identifying existing medical conditions; improving safety by assessing and quantifying risk; planning of perioperative care; providing the opportunity for explanation and discussion and by allaying the patient's fear and anxiety. Proper preoperative preparation helps in ensuring the optimal outcome of the operative gynecological procedures. Good preoperative preparation comprises of adequate patient assessment through appropriate clinical history and examination, and preanesthetic evaluation. The clinical examination must include a complete gynecological examination as well as complete evaluation of the pulmonary, cardiovascular, gastrointestinal, urinary, musculoskeletal and neurological systems. Sometimes, the symptoms of gastrointestinal disease can resemble the symptoms related to the diseases of the reproductive tract. In these cases, a proper gastrointestinal tract history and investigations usually help in arriving at the correct diagnosis. At the time of preoperative counseling, the surgeon must ensure that the patients have access to easily understood information. Such information may be conferred to the patient in the form of information booklets or sheets in an appropriate language.

PREOPERATIVE PRINCIPLES IN SURGERY

Confidentiality and Informed Consent

The principles of confidentiality and informed consent have already been discussed in Chapter 2 (Ethics in Surgery).

History and Physical Examination

A concise, but accurate history must be taken from the patient. An accurate menstrual history must be taken from the patient. In case of discrepancy between the menstrual dates and findings of pelvic examination, pregnancy must be ruled out. Additionally, a proper obstetric history, sexual history and a complete urological history must also be taken. This must be followed by complete general physical, gynecological and abdominal examination. The history must be taken in a nonjudgmental, sensitive and thorough manner.[1] Detailed history and clinical vaginal examination forms an important aspect of a normal gynecological check-up.

Importance must be given towards maintenance of patient-physician relationship. It is important for the gynecologist to maintain good communication with the patient in order to elicit proper history and to accurately be able to recognize her problems. The manner of speaking, the words used, the tone of speaking and the body language are important aspects of the patient-physician interaction.[2] Kindness and courtesy must be maintained at all times. These aspects are especially important in case of male gynecologists because the gynecological history entails asking some private and confidential questions from the female patients. Also, the women may be reluctant while telling the history regarding her menstrual cycles to a male gynecologist. It is important for a male gynecologist to take the history and perform the vaginal examination in presence of a third party or a chaperone (a female nurse or the patient's female relative or friend).[3] The clinician must adopt both an empathetic and inquisitive attitude towards the patient. The patient's privacy must be respected at all costs. The gynecologist must refrain from asking personal questions until appropriate patient confidence has been established.[4] The gynecologist needs to listen more and talk less while taking the patient's history.

If any serious condition (e.g. malignancy) is suspected, the diagnosis must not be disclosed to the patient until it has been confirmed by performing investigations. Bad news must be preferably told to the patient when she is being accompanied by someone (relative, friend or spouse). The seriousness and urgency of the situation must be explained without causing undue alarm and fright to the patient. The clinician must never give false reassurance to the patient. Honest advice and opinion must always be provided.[5]

History of Presenting Complaints

Good history taking requires time and patience. Some common gynecological problems with which the patient may present are described below.[6]

Abnormal Menstrual Bleeding

Detailed history for assessing the nature of blood loss needs to be taken from the patient. Some of these questions are described below:

Nature of bleeding: The clinician needs to ask questions to determine the pattern of bleeding, amount of bleeding, the time of bleeding (the days in the menstrual cycle during which the bleeding occurs), bleeding during the intermenstrual intervals (between the episodes of bleeding) and cycle regularity (whether the bleeding pattern is regular or irregular).

Amount of bleeding: Initially the clinician needs to establish whether the woman is having heavy, light or moderate amount of blood loss.

Estimating the quantity of blood loss is a very subjective issue when considering vaginal bleeding. Accurate assessment of the menstrual blood loss may not be possible and best estimates of menstrual blood loss are the only source clinicians have to consider commonly. Some questions which the obstetrician can ask in order to assess the amount of blood loss are as follows:

- Total number of pads or tampons used by the patient during the heaviest days of her bleeding. This can give a rough estimation of the amount of bleeding, though the number of pads used for the same amount of bleeding may vary from woman to woman depending on their hygienic preferences.
- How frequently does she require changing her pads during the day?
- Does she have to use double protection? (e.g. simultaneous use of a tampon and pad, or use of double pad. For the purpose of calculating the amount of blood loss, it can be assumed that an average tampon holds 5 mL and the average pad holds 5–15 mL of blood).
- Does she have to get up in the night to change her protection?
- Is there any history of passage of blood clots?

Normally, the blood lost from the vessels in the endometrial lining forms small clots and this helps in reducing the blood flow. Under normal circumstances, these blood clots are broken down by fibrinolysins, present in the endometrial cavity and the menstrual blood loss is in the form of a fluid. However, in case of very heavy bleeding, the blood is extruded too quickly for it to clot within the uterus. In this situation, the blood clots in the vagina and the menstrual flow includes blood clots.

- Does she stain her bedding or clothes despite of wearing tampons and pads?
- Does she ever experience "flooding" or sudden rushing out of a large quantity of blood?
- Does she have to stay at home or take time off work during the episode of bleeding?
- How long do her periods last?
- Is the amount of bleeding so much as to interfere with the patient's lifestyle?
- Is there constant pain in the lower abdomen during menstrual periods?
- Are the menstrual periods irregular?
- Does she experience tiredness, fatigue or shortness of breath (symptoms of anemia)?
- The type of sanitary protection being used by the patient is also important since the patient may be required to less frequently change the newer absorbent pads in comparison to the homemade cloth-based sanitary protection.

Duration of bleeding: Bleeding occurring for more than 7 days at a stretch can be considered as prolonged.

Pattern of bleeding: Sudden change in the bleeding pattern, e.g. the excessive bleeding at regular intervals which suddenly becomes irregular must be regarded with caution. In these cases, investigations must be undertaken to discover the exact pathology.

Smell: Presence of a foul smelling vaginal discharge points towards the presence of infection or a necrotic malignant growth. Malignant growths often undergo necrosis in the areas of reduced blood supply.

Relation of bleeding to sexual intercourse: Bleeding following sexual intercourse is usually related to the lesions of cervix or vagina. Simple vaginitis (e.g. candidal infection, bacterial vaginosis) may cause intermenstrual bleeding, while gonorrhea and chlamydia may present with heavier bleeding attributed primarily to the copious discharge mixed with the blood. If a woman presents with the history of postcoital bleeding, cervical cancer must be specifically ruled out. The gynecologist must remain vigilant regarding the detection of complaints, which could be indicative of presence of endometrial malignancy, such as sudden change in the bleeding pattern, irregular bleeding, intermenstrual bleeding, postcoital bleeding, dyspareunia, pelvic pain and lower extremity edema, which could be secondary to metastasis.

Abdominal Pain

Pain in the abdomen is one of the most common clinical complaints in medical practice. Besides gastrointestinal pathology, underlying gynecological pathology is also a common cause of pain per abdomen. Gynecological problems like pelvic tuberculosis, pelvic inflammatory disease (PID) and endometriosis may be commonly associated with chronic pain. Acute lower abdominal pain may occur in association with gynecological abnormalities like ectopic pregnancy, torsion or rupture of an ovarian cyst and chocolate cyst. The below-mentioned points need to be asked while taking history of pain.

Exact site of pain: Pain of ovarian or tubal origin is usually felt in the lower abdomen, above the inguinal ligament. On the other hand, the pain of uterine origin is diffusely present in the hypogastric region.

Radiation of pain: Pain of uterine origin is often referred to the inner aspect of the thighs, but does not usually extend beyond the knees. Pain due to appendicitis may initially start in the right iliac region and later radiate to the umbilicus.

Nature of pain: The nature of the pain, whether burning, gnawing, throbbing, aching or excruciating in nature, needs to be determined.

Intensity of pain: The degree of severity of pain, whether mild, moderate or severe also needs to be determined. Pain of severe intensity may interfere with sleep and work.

Aggravating and relieving factors for pain: The history of various relieving and aggravating factors for pain must be taken.

Relationship of other factors with pain: Relationship of pain to other factors such as menstruation (dysmenorrhea), coital activity (dyspareunia), micturition (dysuria), defecation (dyschezia), posture and movement needs to be determined.

Dysmenorrhea or pain associated with menstruation can be of two types: (1) spasmodic and (2) congestive dysmenorrhea. Spasmodic dysmenorrhea usually has no cause and is seen on day 1 or 2 of menstruation. On the other hand, pain due to congestive dysmenorrhea is usually due to some underlying pathology (endometriosis, PID, etc.). This pain may be premenstrual, menstrual or postmenstrual in origin. In case of dysmenorrhea due to PID, the pain improves with menstruation, whereas in case of endometriosis, the pain worsens after menstruation due to ectopic menstruation. Dysmenorrhea during the menstrual periods could be due to fibroids or adenomyosis. Dysmenorrhea during the three phases of menstrual cycle (premenstrual, menstrual and postmenstrual) is typical of endometriosis.

Infertility/Amenorrhea

Duration of infertility/amenorrhea (whether primary or secondary), and history of thyroid dysfunction and galactorrhea need to be asked. In these cases, detailed sexual history, menstrual history and history regarding the patient's lifestyle also needs to be asked.

Hirsutism

Hirsutism refers to increased or excessive growth of hair in women. This is usually related to increased androgen production in the body.

Vaginal Discharge

The color of vaginal discharge, amount of vaginal discharge, duration of the discharge, presence of any odor with the discharge, association of the discharge with menstrual cycles; and presence of other complaints, such as history of constitutional symptoms, vaginal irritation or itching, increased urinary frequency, etc. need to be asked. It is important to ask the patient about certain hygiene practices, which may have an important role in the etiopathogenesis of her problem.

Past Medical History

Past history of medical illnesses such as hypertension, hepatitis, diabetes mellitus, cancer, heart disease, pulmonary disease and thyroid disease needs to be taken. Patient's previous medical and surgical problems may have a bearing on her present complaints. For example, a history of longstanding diabetes could be responsible for development of genital candidiasis and associated pruritus. A patient with previous medical history of severe anemia or cardiovascular heart disease may require special anesthetic preparation (e.g. correction of anemia, or treatment of cardiovascular pathology) before undergoing a major gynecological surgery (e.g. hysterectomy).

Triad of diabetes, hypertension and obesity is associated with an increased risk of endometrial carcinoma. A history of sexually transmitted disease (especially infection with *Chlamydia*) may have a direct bearing on future infertility. Previous history of PID or puerperal sepsis could be responsible for producing gynecological complaints such as menstrual disturbances, lower abdominal pain, congestive dysmenorrhea and infertility. Presence of endocrinological disorders (e.g. thyroid dysfunction) could be responsible for producing menstrual irregularities.

The patient should also be asked about the various medicines she has been consuming. The details of various medicines including their dosage, route of administration, frequency and duration of use need to be asked. The patient must be specifically asked about the various medicines she has been taking, including prescription drugs, over-the-counter (OTC) drugs, herbal drugs and any therapy related to alternative medicine. History of allergy to any medication also needs to be asked.

History of undergoing previous abdominal surgery like cesarean section, removal of appendix, excision of ovarian cyst, myomectomy, etc. may result in the development of pelvic adhesions. These may not only make any subsequent surgery difficult, but also may be the cause of common gynecological problems like pelvic and abdominal pain, infertility, menstrual disturbances and dyspareunia. History of prior gynecologic problems including abnormalities in Pap smear, bleeding problems, sexually transmitted diseases, etc. also need to be taken.

Patients with diabetes, thyroid dysfunction and increased body mas index (BMI) are also at an increased risk during the administration of anesthesia. Therefore, such conditions are discussed below in details.

History of Diabetes

History of diabetes can be associated with significant metabolic derangements in the patient. A proper management of diabetes in the preoperative period helps in preventing complications such as metabolic aberrations, impaired wound healing and increased risk of postoperative infections. Stress of surgery is likely to release counter-regulatory hormones such as glucagon, growth hormone, epinephrine, cortical hormones, etc. which are further likely to exacerbate hyperglycemia. On the other hand, diabetic patients are particularly prone to hypoglycemia because they may be fasting and may not receive certain medications in the perioperative period. Therefore, it becomes important for the surgeon to monitor the patient's blood glucose levels during the perioperative period in order to strike a balance between prevention of both hyperglycemia and hypoglycemia in the postoperative period. In the perioperative period, various medical agents such as insulin with or without hypoglycemic agents may be used in order to achieve control of blood glucose levels. The aim of this treatment is to maintain blood glucose levels in the range of 120–200 mg/dL.

Obesity

Patients with an increased BMI are prone to develop complications such as hypertension, diabetes, atherosclerotic disease, obstructive sleep apnea syndrome, etc. In these cases, apart from a routine preoperative chest X-ray and electrocardiography (ECG), pulmonary function tests and a baseline arterial blood gas analysis may also be essential. Use of narcotics and sedatives must be avoided in these cases and regional anesthesia be used wherever possible.

Thyroid Dysfunction

Since disorders of thyroid function, particularly hyperthyroidism, are likely to affect the cardiovascular system (CVS), the thyroid levels must be controlled by the use of medicines in the preoperative period.

Hematopoietic Dysfunction

In the presence of complications such as easy bruising and episodes of prolonged or excessive bleeding (epistaxis, menorrhagia, bleeding from the gums, etc.), the coagulation profile must be determined. This must comprise of the following tests: bleeding time, clotting time, prothrombin time, activated partial prothrombin time and a platelet count.

Family History

Certain gynecological cancers (e.g. cancer of ovary, uterus and breast) have a genetic predisposition. A woman may be at a high risk of development of such cancers in the future if there is a positive family history of such cancers in her first-degree relatives (especially mother and sister). Menstrual patterns, including age of menarche, frequency and regularity of cycle, associated dysmenorrhea and age of attaining menopause tend to be similar amongst the family members. The common gynecological problems like premature menopause, menorrhagia and premenstrual tension have been observed to run within families. Other medical disorders, like thyroid dysfunction, allergic diathesis and coagulation disorders, which may be responsible for development of gynecological complaints, are often familial in nature.

Marital and Sexual History

Details of the woman's marital life including her age at the time of marriage, how long she has been married and sexual history need to be asked. Details of the woman's sexual history are particularly important. Some such details include her age at the time of first sexual intercourse; her current sexual activities (vaginal, oral, anal and manual); frequency of her sexual intercourses; is she currently seeking a pregnancy; is she presently using any method of contraception, if yes, the type of contraception used; is she or her partner experiencing any sexual dysfunction (frigidity in the woman or impotence or premature ejaculation in the male or problems with libido, arousal, lubrication or orgasm in both males and females); current frequency of her sexual activities; past sexual activities; number of sexual partners (currently and in the past); sexual preferences (heterosexual, homosexual or both); pain at the time of sexual intercourse (dyspareunia), etc.

Obstetric History

Details of every pregnancy conceived irrespective of its ultimate outcome, need to be recorded. Number of previous live births, stillbirths, deaths, miscarriages (both spontaneous and induced), history of recurrent miscarriages if any, medical termination of pregnancies and number of children living at present need to be noted. The age of the youngest and eldest children also needs to be enquired. The mode of delivery of each baby (normal vaginal delivery or cesarean section) and details of any obstetric complications encountered, e.g. puerperal or postabortal sepsis, postpartum hemorrhage (PPH), obstetrical interventions (use of forceps, vacuum, etc.) and other obstetric or gynecological complications (soft tissue injuries such as cervical tears, an incompetent cervical os, genital fistulae, complete perineal tear, genital prolapse, stress urinary incontinence, etc.) and chronic backache also need to be enquired from the patient. Severe degree of PPH and obstetric shock may lead to pituitary necrosis and Sheehan's syndrome or postpartum hypopituitarism. This could be the cause of amenorrhea or hot flushes in a young woman who had recently suffered from massive PPH at the time of delivery. It is a good idea to ask the names of the patients' children at the time of taking history. It helps in reducing patients' anxiety and increasing the confidence in her health care provider.

History of Previous Surgery

The patient should be asked about any surgery she has undergone in the past. The reason for undergoing surgery, particularly of abdominal or pelvic origin, type of incision (laparoscopy or laparotomy) and any history of postoperative complications need to be enquired.

Menstrual History

The menstrual history needs to be taken in details. The following details need to be recorded: age of menarche, date of last menstrual period, cycle length, whether regular or irregular, number of days the bleeding takes place, amount of bleeding (in terms of pads soaked), and presence of any associated symptoms, such as cramps, bloating or headache.

GENERAL PHYSICAL EXAMINATION

General physical examination involves the observation of the patient's general appearance, orientation in time, place and person, nutritional status and patient's demeanor (calm, anxious, or aggressive). The following features need to be observed at the time of general physical examination.[7,8]

Vital Signs

Patient's vital signs such as temperature, blood pressure, pulse, respiratory rate, height and weight need to be taken.

Height and Weight

Height of the patient (in meters) and her weight (in pounds) can be used for calculation of BMI. The classification of the woman as underweight, normal weight and obese has been described in Table 3.1. Calculation of BMI is especially important in women who appear underweight or overweight. Underweight women may commonly suffer from amenorrhea and other menstrual irregularities, whereas overweight women are at an increased risk for endometrial cancer.

Anemia and Dehydration

Excessive blood loss may result in the development of anemia. Excessive loss of body fluids may result in the development of dehydration which causes dryness of mucous membranes and loss of skin turgor.

Table 3.1: Classification of weight according to body mass index (BMI)

Weight for Height Status	Body Mass Index
Very low	< 16.5
Low	16.5–19.8
Normal	19.8–25.9
High	26.0–29.9
Very high	> 30.0

Signs Suggestive of Hyperandrogenemia

Signs suggestive of hyperandrogenemia such as hirsutism (presence of facial hair), deepening of voice, etc. may be related to the presence of androgen secreting tumors or chronic anovulatory states (polycystic ovarian disease).

Blood Pressure

Blood pressure that is persistently greater than or equal to 140 mm Hg (systolic), or greater than or equal to 90 mm Hg (diastolic) is considered as elevated.

Neck Examination

Local examination of the neck may reveal enlargement of thyroid gland or lymph nodes of the neck. Neck examination should also involve palpation of cervical and supraclavicular lymph nodes.

Lymphadenopathy

Lymphadenopathy could be a sign of advanced metastatic disease associated with malignancy. The neck, axilla and groins must also be palpated for the presence of enlarged lymph nodes.

Thyroid Examination

It is important to examine the thyroid gland because menstrual abnormalities may be commonly associated with thyroid dysfunction. While hypothyroidism is commonly associated with oligomenorrhea, hyperthyroidism may be responsible for producing menorrhagia.

Breast Examination

Examination of the breast should be carried out in three positions: (1) with patient's hands on her hips (to accentuate the pectoral muscles), (2) with her arms raised and then (3) in supine position. Both the breasts must be inspected for symmetry, skin or nipple retraction, presence of any obvious growth or mass and skin changes such as dimpling, retraction, crusting or Peau d'orange appearance. Both the breasts must be then palpated bilaterally for the presence of lumps, masses and tenderness. The nipples are assessed for the presence of discharge.

Axillary and supraclavicular regions are palpated for the presence of any lymphadenopathy. The following points need to be particularly observed on examination of breast:

- Breast examination may reveal changes indicative of early pregnancy. This is especially important in cases where pregnancy is not suspected, e.g. in young unmarried girls.
- Staging of breast development: this could be important in women who have yet not attained sexual maturity.
- In all women and especially those above the age of 30 years, breast must be routinely palpated to exclude tumor formation.
- Bilateral milk discharge from the nipples may indicate galactorrhea due to hyperprolactinemia. Ruling out the presence of galactorrhea is especially important in cases that are infertile and suffer from oligomenorrhea or amenorrhea.
- Unilateral bloody nipple discharge could be associated with an intraductal papilloma.

Examination of Back and Spine

Back must be assessed for symmetry, tenderness or masses. Flanks must be assessed for pain on percussion as it could be indicative of renal disease.

SYSTEMIC EXAMINATION

Abdominal Examination

Inspection

The patient must be advised to breathe normally and relax. The examiner must stand on the right side of the patient. The following points need to be noted on inspection of the abdomen: abdominal shape, umbilical eversion or inversion, abdominal enlargement, organomegaly, presence of dilated veins and varicosities, the mobility of abdominal wall with breathing, presence of striae or scar marks over the abdomen and signs of intraperitoneal and retroperitoneal hemorrhage.

Palpation

Normal abdomen should be soft and nontender, with no masses. It is important that the clinician warms his/her hands before palpating the patient's abdomen. The patient should be instructed to flex her hips and knees, which helps in relaxing the abdominal musculature, thereby making palpation easier. If the patient does not relax sufficiently, the clinician may find it difficult to elicit relevant findings during the abdominal examination. Adequate relaxation can be achieved by making the patient comfortable and gaining her confidence. Asking the patient to take slow deep breaths can also help. The clinician must place his/her palm flat over the patient's abdomen.

Palpation must be done gently, while applying pressure by flexing the fingers in unison at the metacarpal-phalangeal joints. The following points must be noted while palpating the abdomen:

- *Tone of abdominal muscles*: Tone of the abdominal muscles can be assessed upon palpation. When muscle tone is increased, there may be resistance to depression of the abdominal wall by the palpating hand. This hypertonia is commonly accompanied with the presence of tenderness. Reduced tone of the abdominal muscles, on the other hand, could be associated with divarication of rectus muscles.
- *Abdominal tenderness*: There must be no tenderness or rebound tenderness present on abdominal palpation. Rebound tenderness refers to pain upon removal of pressure and may be indicative of localized peritonitis or appendicitis. Tenderness must be recorded on a scale of 1-4, where 1 corresponds to mild and 4 to most severe type of pain.
- *Organomegaly*: In the absence of any pathology, most abdominal organs are not palpable in normal people. Palpation of all the abdominal quadrants for the presence of any mass, firmness, irregularity or distention must be performed. The clinician should preferably adopt a systemic approach while palpating the abdomen. The clinician must start from the right upper quadrant and systemically palpate all the quadrants while moving down in a clockwise direction. Though a grossly enlarged organ (especially spleen and liver) can be visualized on inspection of the abdomen, organomegaly can be better appreciated on palpation. The normal edge of liver is sharp, smooth, soft and flexible. The liver can descend for up to 3 cm on deep inspiration. In some normal subjects, its edge can be palpable just below the right costal margin without being enlarged. The normal spleen in a healthy subject is not palpable.
- *Abdominal mass*: If an abdominal mass is felt on abdominal palpation, the following need to be determined: location of the mass and its shape, size and texture, margins of the mass, consistency of the mass, mobility of the mass, whether the mass is unilateral or bilateral mass, tenderness on palpation and whether the mass is intra-abdominal or arising from the abdominal wall.

Auscultation

Auscultation of the abdomen with the help of stethoscope helps the examiner to listen to the normal bowel sounds. When the bowel sounds are not present, the examiner should listen for a period of atleast 3 minutes before reaching the conclusion that the bowel sounds are, in fact, absent.

Cardiovascular System Examination

Routine examination of CVS involves palpation of cardiac impulse and auscultation of the heart at the apex for presence of any sounds, murmurs, clicks, etc. Detailed examination of the CVS is required in cases of past history of cardiovascular disease or complaints suggestive of a possible cardiovascular pathology while taking history. Cardiovascular examination may be important in some patients, where they may be at a risk of myocardial hypoxia at the time of gynecological surgery especially in cases of previous history of cardiovascular diseases. The occurrence of cardiac risk increases in the presence of previous history of myocardial infarction. In order to evaluate the patient's risk of developing cardiac complications during surgery, Goldman's cardiac risk index has been devised (Table 3.2).[9] This is a point system, which classifies the patient's risk for perioperative cardiac morbidity and mortality in terms of points.

If the total score is less than or equal to 5, the risk of cardiac complications is only 1%. If the total adds up to 12, the risk increases to 5%; with the counts up to 25, the risk increases to 11%.

Hypertension

The patients with mild-to-moderate hypertension (systolic BP = 140–150 mm Hg and diastolic BP = 90–110 mm Hg) can proceed to surgery without undergoing any treatment. However, in patients with severe hypertension (systolic BP > 150 mm Hg and diastolic BP > 110 mm Hg), the blood pressure should be first controlled over a period of 6 months before proceeding for the surgery. The antihypertensive medication must be continued until the morning of surgery and started as soon as possible in the postoperative period.

Pulmonary System

Examination of the pulmonary system may be required to detect the presence of wheezes, rales, rhonchi and bronchial breath sounds. Presence of a pulmonary pathology such as chronic obstructive pulmonary disease (COPD) in a patient predisposes her to develop pulmonary complications in the postoperative period.[10] Pulmonary function tests must be performed in the preoperative period to help decide the ventilatory settings in the postoperative period. Use of sedatives and general anesthesia (GA) may result in the development of hypoxia in these patients. Therefore, it is preferable to perform surgery under local or epidural anesthesia in these patients. Application of strategies such as cessation of smoking, use of chest physiotherapy or bronchodilators may help in improving pulmonary function in these patients. This can be attributed to the fact that postoperative complications are more common in patients with history of chronic smoking and COPD.[11] Two most important pulmonary complications such as atelectasis and bronchitis can be prevented by instructing the patient to make use of deep breathing exercises postoperatively.

Table 3.2: Goldman's index of cardiac risk

Cardiovascular Risk Factor	No. of Points
Jugular venous distention (evidence of congestive cardiac failure)	11 points
Recent myocardial infarction in 6 months	10 points
Premature ventricular contractions (5 or more per minute)	7 points
Rhythm other than sinus	7 points
Age above 70 years	5 points
Emergency surgery, aortic valvular stenosis	4 points
Poor medical condition or surgery within the chest or abdomen	3 points

PELVIC EXAMINATION

Pelvic examination forms an important aspect of the gynecological check-up of a woman. If the patient is virginal, the opening of the hymen may be wide enough to allow only one finger or narrow speculum examination. As far as possible a per vaginal examination must be avoided in virginal women.[12] The prerequisites before performing a pelvic examination are described below:

- The patient must be asked to empty her bladder before lying down on the table for the examination. In case of complaints of urinary incontinence, examination must be performed with a full bladder in the lithotomy and erect positions to demonstrate stress incontinence.
- Gloves and instruments, if not disposable, should be sterilized by autoclaving before reuse.
- Since this is an intimate examination, it requires patient's full cooperation. The patient must be described the procedure of pelvic examination and her informed consent be taken before proceeding with the examination.
- Both male and female examiners should be chaperoned by a female assistant.
- A cytological examination (Pap smear) is extremely valuable in detection of cervical and endometrial lesions and must form part of a complete gynecological examination. A recent Pap smear must always be performed before undertaking any pelvic surgery.

Positioning the Patient for Pelvic Examination

Full dorsal position: The full dorsal position with the knees flexed is the most commonly employed position used for gynecological examination in clinical practice. This position allows adequate per speculum and per vaginal examination. This position also enables the clinician to inspect the vagina and cervix for taking vaginal swabs and cervical smears. However, this examination does not allow adequate exposure of the lateral vaginal walls. The examiner stands to the right of the patient. The patient can be made to relax by partly covering her knees and thighs with a sheet.

Lithotomy position: This position involves the use of stirrups to hold the flexed lower limbs and involves the movement of the patient to the edge of table. This position may be uncomfortable and awkward for the patient. Though this position is not commonly used for clinical examination, it is often used at the time of vaginal surgeries and for examination of the patient under anesthesia.

Steps of the Pelvic Examination

Pelvic examination comprises of the following: examination of the external genitalia, a per speculum examination, bimanual vaginal examination and a per rectal examination (if required). These would be described in details below.

Examination of the External Genitalia

The gynecologist examines the external genitalia for the presence of any obvious lesions or signs of inflammation. Examination of external genitalia reveals areas of discoloration, ulceration and redness. Ulcerative areas could be indicative of herpetic infection, vulvar carcinoma, syphilis, etc. Vulvar mass at 5 O'clock or 7 O'clock position may suggest a Bartholin's gland cyst.

Per Speculum Examination

Speculum examination of the vagina and cervix involves inspection of external genitalia, vagina and cervix. Per speculum examination may reveal normal vaginal wall rugosities or smoothness of vaginal epithelium, which could be suggestive of atrophic vaginitis. Presence of masses, vesicles or any other lesions can also be assessed on the per speculum examination.

This examination should ideally precede the bimanual examination. This is primarily because the vaginal discharge can be seen and removed for examination before it gets contaminated with the lubricant used for vaginal examination. Moreover, the cellular debris from the cervix and uterus remains undisturbed and can be obtained for cytological studies at the time of per speculum examination. Also, many superficial vaginal lesions may start bleeding following the vaginal examination and may not allow an optimal per speculum examination.

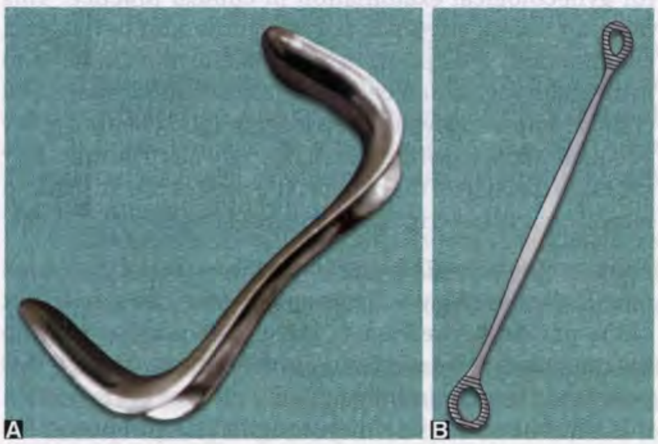
Cervical examination can also be performed using a Sims' vaginal speculum (Fig. 3.1) and an anterior vaginal wall retractor. This speculum allows the assessment of vaginal walls and evaluation of presence of uterine prolapse such as cystocele for rectocele. However, cervical inspection using Sims' speculum is associated with two main disadvantages: the gynecologist needs to bring the patient to the edge of the table. Also, help of an assistant may be required while conducting a per speculum examination using a Sims' speculum.

A self-retaining, bivalve speculum such as Cusco's speculum (Fig. 3.2) also serves as an ideal equipment for vaginal examination. This speculum allows appropriate vaginal exposure so as to ensure adequate vaginal inspection (Fig. 3.3). Presence of cervical lesions (ectropion, polyps, cervical erosions, etc.) can be visualized. Cervical inspection using this speculum also permits the gynecologist to take Pap smear at the time of per speculum examination.

Before inserting Cusco's speculum, the gynecologist must firstly warm and lubricate the speculum by holding it under running tap water. The vaginal introitus must be exposed by spreading the labia from below using the index and middle fingers of the left hand. The Cusco's bivalve speculum must then be inserted at an angle of 45°, pointing slightly downwards. Contact with any anterior structures must be avoided. Once past the introitus, the speculum must be rotated to a horizontal position and insertion must be continued until its handle is almost flush with the perineum. The blades of the speculum are opened up for a distance of approximately 2–3 cm using the thumb lever in such a way that the cervix "falls" in between the blades. The speculum can be secured in its position by using the thumb nut in case of a metal speculum. The speculum must not be moved while it is in a locked position. The cervical and vaginal walls must be observed for the presence of lesions or discharge. Specimens for culture and cytology must also be obtained. While removing the speculum, the speculum must be withdrawn slightly to clear the cervix. As the cervix gets cleared off, the speculum must be loosened and its blades allowed to fall together. The speculum must then be rotated to an angle of 45° and continued to be withdrawn.

Bimanual Vaginal Examination

Following the per speculum examination, a bimanual vaginal examination must be performed. First one and then



Figs 3.1A and B: (A) Sims' speculum; (B) Anterior vaginal wall retractor

Fig. 3.2: Cusco's speculum

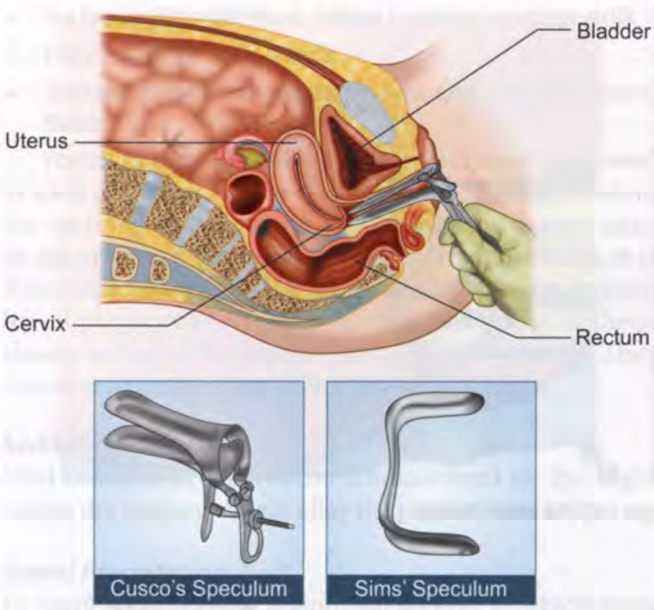


Fig. 3.3: Vaginal inspection using Cusco's speculum

two fingers are inserted into the vaginal introitus following which a bimanual vaginal examination is done. Bimanual vaginal examination is usually more informative than per speculum examination and can be performed in most women.

Procedure: This examination comprises of the following tests:

- A water-based, soluble, nongreasy lubricant must preferably be used. A water-soluble jelly is the best and if it is not available, cetrimide solution must be used.
- The labia are separated with the thumb and index finger of left hand.
- Following this, the two fingers of right hand, first one finger and then the second finger are inserted into the vagina only when the patient relaxes the muscles around the vagina and when it is clear that a two-finger examination would be possible without causing any pain (Figs 3.4A and B).
- Cervical shape, size, position, mobility, consistency and tenderness caused by pressure or movement needs to be assessed. The position and direction of the cervix are the guides to the position of the body of the uterus. If the cervix is pointing in the downwards and backwards direction, the anterior lip of the cervix would be encountered first on the vaginal examination. This indicates the anteverted position of the uterus. On the other hand, if the cervix is pointing in the upwards and forward direction, the posterior lip of cervix would be encountered first on the vaginal examination. This indicates the retroverted position of the uterus. A nonpregnant healthy cervix is usually firm in consistency. The cervix tends to soften during pregnancy. Under normal circumstances, the movement of cervix in any direction must not be painful. However, pain upon moving the cervix (also known as cervical motion tenderness) is a common symptom of PID (salpingo-oophoritis) and ectopic pregnancy.
- In clinical scenario, the vaginal examination is immediately followed by a bimanual examination (Figs 3.5A and B) without removing fingers from the vaginal introitus.
- While the fingers of the examiner's right hand are still inside the vaginal introitus the palm of his/her left hand is placed over the abdomen. The success of bimanual examination primarily depends on the ability of the examiner to use the abdominal hand more often than the vaginal fingers.
- To feel the uterus, the vaginal fingers should move the cervix as far backwards as possible to rotate the fundus downwards and forwards. The abdominal hand is then placed just below the umbilicus and gradually moved lower until the fundus is caught and pressed against the fingers in the anterior fornix.
- The following points are noted on bimanual examination: size of the uterus; its position (anteverted or retroverted); mobility (free mobility, restricted mobility or fixed uterus). If there is a mass felt, its relation to the uterus is noted, like whether the mass is felt separate to the uterus or is it continuous with it. When the mass is felt separate from the uterus, the origin of the mass is most likely from the adnexa or broad ligament. However, if the mass is continuous with the uterus, it probably arises from the uterus, like a fibroid.

Size of the uterus: Bulky uterus corresponds to 6 weeks pregnant size and is slightly larger than the normal. When the uterus appears to be filling all the fornices, it corresponds to 12 weeks size. The in-between size could be between 8 weeks and 10 weeks.

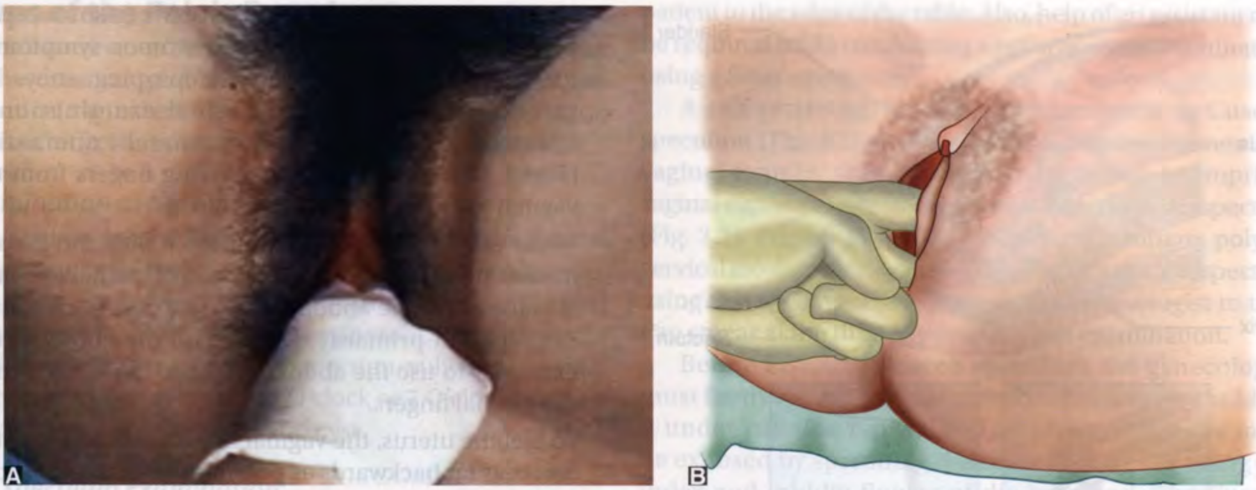
Both the adnexa must then be palpated between the vaginal fingers in the lateral vaginal fornices and the abdominal hand to look for the presence of any mass or abnormality.

Rectal Examination

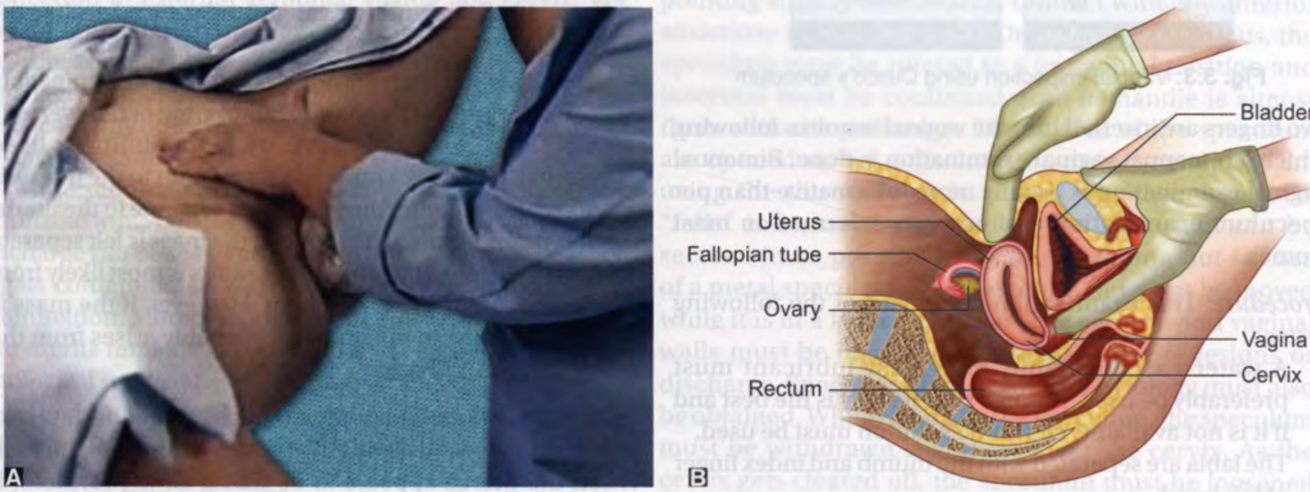
Combined rectal and vaginal examination is done when required. Similar to the bimanual examination, the examiner inserts a lubricated, gloved finger into the rectum to feel for tenderness and masses. Per rectum examination will reveal masses in the posterior pelvis. Presence of nodularity in the pouch of Douglas and tenderness of uterosacral ligaments are signs of endometriosis. Rectal examination also provides information about the competence of anal sphincters and the lesions in the anal canal and rectum. Some practitioners include rectal examination as part of the routine examination, while others do this procedure only in specific cases.

LABORATORY INVESTIGATIONS

Medical and anesthetic problems are identified more efficiently by the taking of a history and by the physical



Figs 3.4A and B: Two finger vaginal examination



Figs 3.5A and B: Bimanual vaginal examination being performed in a patient

examination of patients. No special investigations are required prior to minor surgery in an otherwise healthy patient.[13] Routine investigations, which need to be performed even in otherwise healthy patients are described next. An ECG should be performed on every patient with a cardiac disease or related history but is not indicated for asymptomatic males under the age of 40 years or asymptomatic females under the age of 50 years.

Routine Investigations

The investigations, which are routinely performed include hemoglobin level, hematocrit, total leukocyte count (TLC), differential leukocyte count (DLC), and complete urine analysis. In the presence of underlying or suspected renal or hepatic diseases, kidney function test (KFT) or liver function test (LFT) must be ordered respectively. Baseline electrolyte levels must be done for all patients who would be undergoing extensive pelvic surgery in order to decide postoperative fluid and electrolyte replacement therapy.[14]

Other Investigations

Depending on the particular pathology, other preoperative investigations can be ordered. For example, in case of patients with a gynecological malignancy, a CT scan or MRI may be ordered to evaluate the spread of malignancy. If the renal system or the gastrointestinal system appear to be involved, investigations such as intravenous pyelography or barium enema respectively may help to evaluate the spread of malignancy.

PREOPERATIVE MANAGEMENT

Preoperative Management One Day Prior to Surgery[15]

Fasting

For safety reasons, patients should not eat or drink immediately prior to anesthesia. The Association of Anesthetists of Great Britain and Ireland (AAGBI) recommends the minimum fasting periods based on the American Society of Anesthesiologists (ASA) guidelines:

- Six hours for solid food, infant formula, or other milk
- Four hours for breast milk
- Two hours for clear nonparticulate and noncarbonated fluids.

For all practical purposes, the patient may be allowed to have a light and easily digestible diet, the night before the morning of surgery. After midnight, the patient must be nil per orally and must not eat or drink anything. It is important that the elderly women, who have undergone bowel preparation, children and breastfeeding mothers, should not be left for long periods without hydration. They may require intravenous fluids prior to surgery.

Sedation

Mild sedative drugs may be administered on the night before the surgery to help allay the patient's anxiety.

Bowel Preparation

In women undergoing abdominal surgery in which entry into the bowel is anticipated, complete bowel preparation must be performed by use of laxatives or preoperative enema, either the evening before or on the morning of surgery. Before undertaking an elective major surgery, which is likely to involve the bowel, mechanical cleansing of the large intestines is required. In these cases, cleansing enemas may be given in the early morning to ensure emptying of bowel before the morning of surgery.

Preoperative Antibiotics

Preoperative prophylactic broad spectrum antibiotics are frequently used prior to undertaking gynecological surgery to prevent infection. A single dose of antibiotics immediately prior to the surgery is sufficient for most of the cases. A repeat dose may be required if the surgery is likely to last for longer than 8 hours.[16] The most optimal method of antibiotic administration appears to be IV administration of antibiotics. The antibiotics most commonly used include the new generation cephalosporins (ceftazidime or cefotaxime 2 grams IM/IV) or semisynthetic penicillin or β-lactamase antibiotics, which are usually prescribed 2 hours prior to the surgery.[17] Besides the use of antibiotics, principles such as maintenance of adequate hemostasis and gentle handling of the tissues must be followed. Previously the patients were administered parenteral antibiotics 48–72 hours preoperatively, followed by oral antibiotics for at least 5 days postoperatively. Nowadays, more emphasis is given towards maintenance of asepsis rather than antisepsis. Prophylactic antibiotics are now administered in 1–4 doses at 12-hourly intervals, starting 20 minutes prior to surgery.[18]

Thromboprophylaxis

Adequate prophylactic action must be taken for the prevention of thromboembolism because gynecological surgery may be associated with a high incidence of deep vein thrombosis and pulmonary embolism. The American Academy of Chest Physicians (ACCP) guidelines for thromboprophylaxis are elaborated in Table 3.3.[19]

ROLE OF THE ANESTHETIST

During the preanesthetic check-up performed prior to the surgery, the anesthetist gets the opportunity to discuss with the patient, the choice of anesthetic method in the light of the patient's preferences, his or her clinical state, the surgery itself and the anesthetist's own preferences and special skills. This discussion also helps in highlighting various risks and benefits of different types of anesthesia that can be used. The advantages and complications of each type of anesthetic procedure must be explained to the patient. This is also the time during which the patient can clear all her doubts and even raise questions about any aspect of anesthetic care. During this time, the anesthetist must also gain the patient's consent for the anesthetic procedure. The anesthetists can make use of questionnaires for obtaining basic background information from the patients. These questionnaires may be given to the patient at the surgical outpatient clinic to be completed immediately or taken home for completion and returned by post.

During the preanesthetic check-up, the patient should preferably get an opportunity to talk to the anesthetist, who would be administering the anesthesia. The patient should also have an opportunity to meet other health care professionals, who may be involved in her care. The

Table 3.3: The American Academy of Chest Physicians (ACCP) guidelines for thromboprophylaxis

Risk Stratification	Thromboprophylaxis
Low-risk patients (Those younger than 40 years, with no additional risk factors and duration of surgery is less than 30 minutes)	No need for prophylaxis
Moderate-risk patients (Those aged 40–60 years with no additional risk factors, undergoing surgery of any duration)	Thromboprophylaxis with sequential compression devices (external pneumatic compression devices) or unfractionated heparin 5,000 units BD or low-molecular-weight heparin (e.g. enoxaparin 40 mg daily)
High-risk patients (Those aged 40–60 years with one additional risk factor, such as prior deep vein thrombosis, varicose veins, infection, malignancy, obesity, estrogen therapy or surgery lasting longer than 5 hours)	More frequent heparin dose of 5,000 units TDS
Highest-risk patients Same as the high-risk group, but with more than one risk factor	Combination of both sequential compression devices and heparin

preanesthetic check-up is the perfect time for building the patient's trust and confidence. This trust is likely to play an important role in making the patient feel safe, reassured and relaxed when she sees the doctor again in the operation theater.

The discussion between the anesthetist and the patient must involve the following details: how the patient will get to theater (if inpatient) or when and where she should report on reaching the hospital (if outpatient); what are the things she is likely to experience in the anesthetic room; what time the operation is scheduled; what will be experienced in the recovery room and how the postoperative and postdischarge pain be managed. The patient should be explained about the epidural or patient-controlled analgesia, intravenous lines, oxygen mask, urinary catheters, etc. if these things are likely to be used.

TYPES OF ANESTHESIA

There are a number of options available to women for pain relief during obstetric or gynecologic surgery.[20] Various methods used for obtaining pain relief during labor are enumerated in Table 3.4. Pain medications given intravenously or intramuscularly help to decrease the amount of pain during childbirth or other obstetric procedures. The types of anesthesia used most commonly for the obstetric and gynecological surgeries include GA and regional anesthesia (spinal, epidural or combined spinal and epidural).[21] Among the current methods of obstetric analgesia, regional analgesia (mainly epidural analgesia) is the best because it is most effective and safe. Local anesthesia blocks (pudendal nerve block and paracervical blocks) are also commonly used for minor surgeries. Types of nerve blocks used in various obstetric and gynecological procedures are illustrated in Figure 3.6.

Regional Anesthesia

Regional anesthesia has currently become the most effective means of providing analgesia during labor.[22] The two most commonly used procedures for regional anesthesia are the spinal block (Fig. 3.7A) and epidural block (Fig. 3.7B). Currently, regional anesthesia is the anesthetic agent of

Table 3.4: Methods for labor analgesia

Non pharmacological therapy	Pharmacological therapy	
	Systemic	Regional
♦ Transcutaneous electrical nerve stimulation ♦ Relaxation/breathing techniques ♦ Biofeedback and physical therapies ♦ Hypnosis ♦ Massage ♦ Acupuncture ♦ Hydrotherapy (use of hot or cold packs) ♦ Use of birthing ball (Swiss ball/Bobath ball) ♦ Music therapy	*Inhalational anesthetic agents* ♦ Nitrous oxide ♦ Enflurane ♦ Isoflurane ♦ Desflurane ♦ Sevoflurane *Systemic analgesics* ♦ Opiod analgesics - Pethidine - Morphine - Fentanyl - Sufentanil - Alfentanil - Remifentanil ♦ Tranquilizers/sedatives - Barbiturates - Phenothiazines - Benzodiazepines ♦ Dissociative/amnesic drugs - Ketamine - Scopolamine	♦ Lumbar epidural ♦ Combined spinal epidural analgesia (CSEA) ♦ Continuous spinal analgesia (CSA) ♦ Alternative regional techniques - Lumbar sympathetic block - Pudendal block - Paracervical block

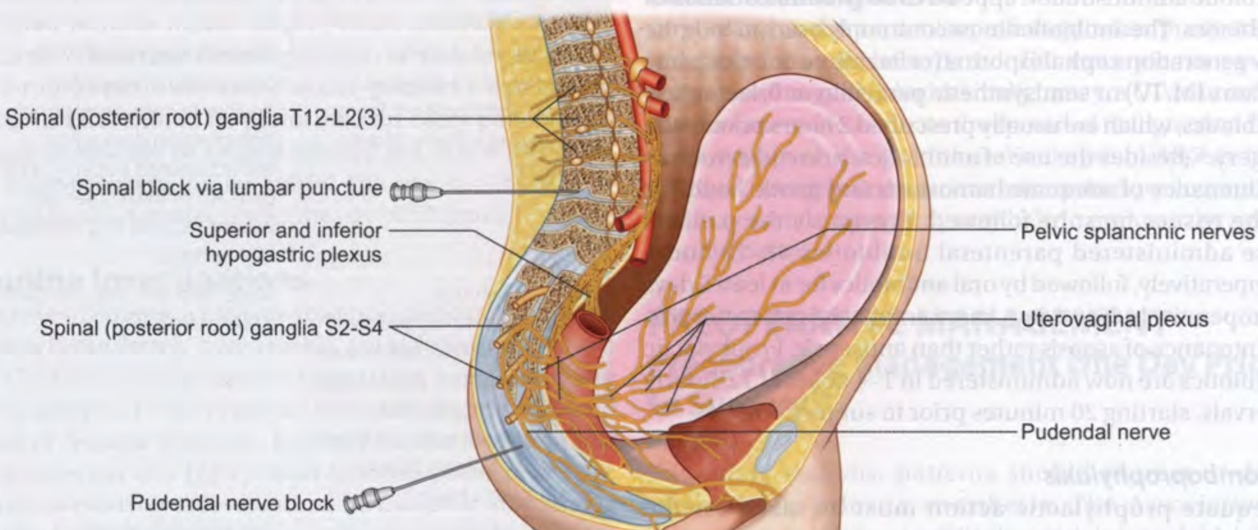
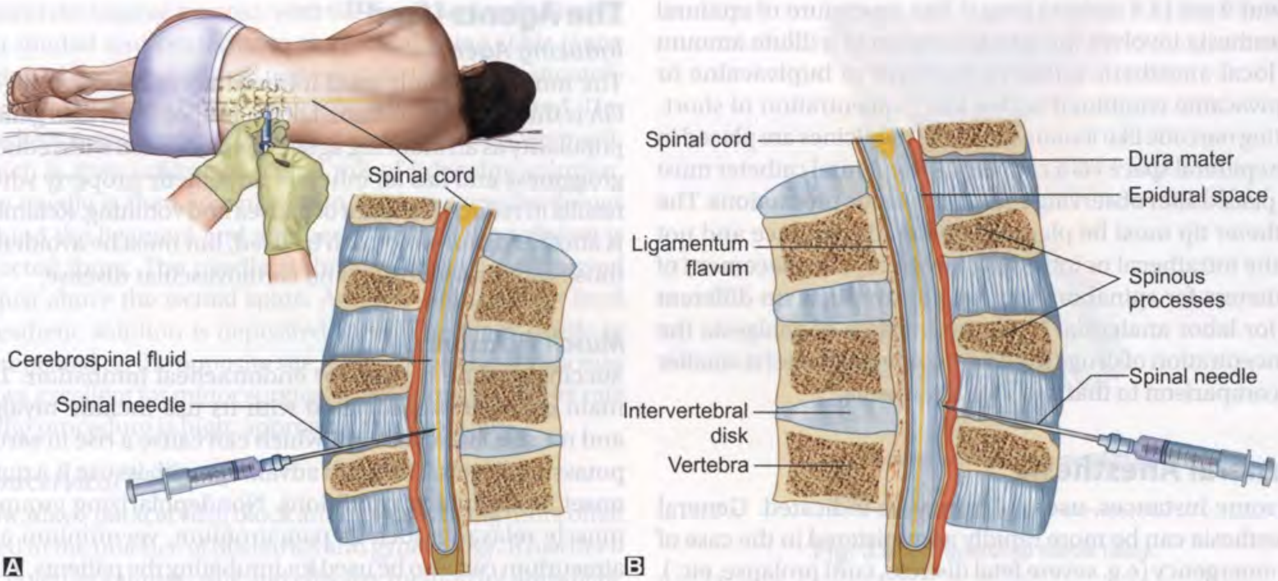


Fig. 3.6: Various types of nerve blocks



Figs 3.7A and B: (A) Spinal block; (B) Epidural block

choice at the time of cesarean delivery. Moreover, it is also used for provision of anesthesia during certain surgical procedures such as cesarean section, tubal ligation, cervical cerclage, and other procedures where the patient is not required to be unconscious during the procedure. The regional anesthesia, especially the epidural analgesia, is also commonly administered for the purpose of pain relief during labor. In epidural analgesia, the pain killer medicines (local anesthetics either in the form of bupivacaine or ropivacaine combined with a low concentration of short-acting narcotics like fentanyl) are instilled inside the epidural space. These can be either administered in the form of bolus doses or continuous infusion by the medical professionals or by the patient herself in the form of patient-controlled epidural analgesia. When the surgeon needs to make a decision regarding the type of anesthesia to be used at the time of cesarean section, the choice between the three methods—spinal, epidural or combined spinal and epidural (CSE), is largely based on the factors such as the time required for performing the anesthetic technique, the rapidity of onset of anesthesia and whether the technique can be used to provide postoperative analgesia. Spinals can be performed in less than 5–10 minutes whereas epidurals and CSEs take a slightly longer time. Both spinals and CSEs have a more rapid onset of adequate anesthesia but epidurals take almost 30 minutes. Hence, for a patient with fetal distress, epidural or CSE anesthesia may not serve as a feasible option. In these cases, either spinal or GA must be used.

The main disadvantage associated with the use of regional anesthesia is that it is contraindicated in patients with coagulopathy or those who are on anticoagulant therapy, those with hypovolemia, those with infection either around the site of injection or systemic sepsis, and those with certain anatomical abnormalities like arteriovenous malformation within the spinal canal.

Use of regional anesthesia can result in complications such as hypotension, spinal headache, convulsions, and peripheral or central neurological damage. Hypotension should be treated by using intravenous fluids and putting the parturient in the left lateral tilt position to avoid the supine hypotension syndrome. When the pregnant patient is in a supine position, compression of the inferior vena cava by the gravid uterus drastically reduces the volume of blood returning to the heart from the lower limbs. Oxygen should also be administered via a nasal prong so as to maintain fetal oxygenation during this period of hypotension. The most effective technique for management of spinal headache is known as "epidural blood patch". This method involves introducing patient's blood into the epidural space.

The main advantage of using regional anesthesia is that it allows the patient to remain awake during the surgery, and also helps in avoiding the risks associated with GA. Use of regional anesthesia at the time of cesarean delivery helps in allowing early contact between mother and child. Anesthesia for cesarean section can be in the form of general or regional anesthesia. There has been a growing trend towards using regional anesthesia due to its higher safety in comparison to the GA. In order to prevent aspiration during GA, most mothers during labor are made to fast. With the growing pressure to liberalize oral intake during labor, the use of regional anesthesia is a more favorable option.

Procedure

The patient's consent must be obtained before the administration of regional anesthesia, either spinal or epidural. The procedure of spinal anesthesia involves injection of a local anesthetic agent into the cerebrospinal fluid in the subarachnoid space (lying between the arachnoid mater and the pia mater, through a fine needle, about 9 cm (3.5 inches) long.[23] The procedure of epidural anesthesia involves the administration of a dilute amount of local anesthetic either in the form of bupivacaine or ropivacaine combined with a low concentration of short-acting narcotic like fentanyl.[24] These medicines are placed in the epidural space via a catheter. The epidural catheter must be placed after observing complete aseptic precautions. The catheter tip must be placed in the epidural space and not in the intrathecal or intravascular space. The placement of catheters for spinal or epidural anesthesia is no different as for labor analgesia. However, in cases of analgesia the concentration of drugs used to provide pain relief is smaller in comparison to that used for anesthesia.[25]

General Anesthesia

In some instances, use of GA may be indicated. General anesthesia can be more rapidly administered in the case of an emergency (e.g. severe fetal distress, cord prolapse, etc.). If the mother has a coagulation disorder or hypotension, GA would be the better alternative to use rather than regional anesthesia. General anesthesia with endotracheal intubation and controlled ventilation helps in providing adequate relaxation of muscles and analgesia, thereby resulting in optimal operative outcomes. The advantage of using GA is that the patient's airways are secured and adequate oxygenation is ensured. The disadvantages include cardiovascular depression, reduced protective reflexes, prolonged psychomotor impairment, and nausea, vomiting and grogginess in the patient.[26] Patients given GA have a higher risk of hypoxia and pulmonary aspiration (in the event of a difficult/failed intubation) especially during an emergency cesarean section, when the patient is likely to be full stomach.

Due to the risk of aspiration when administered in "full stomach", GA for cesarean section usually involves a crash induction. In these cases, an inducing agent along with a rapidly acting muscle relaxant is administered whilst the application of cricoid pressure. Following this, the endotracheal tube is inserted and its cuff inflated.

Anesthesia is continued with oxygen, nitrous oxide and a low concentration of volatile agent like isoflurane together with a longer acting muscle relaxant. Narcotics are not administered until after the delivery of the baby because of their potential for causing fetal distress.

Preanesthetic Medications

The drugs used for preanesthetic medication commonly include, an anxiolytic (to allay anxiety the night before surgery); antiemetic (to reduce nausea and vomiting); H2 blockers (to reduce the pH and volume of gastric secretions) and glycopyrolate/atropine to reduce the amount of gastric secretions. Analgesic drugs such as nonsteroidal anti-inflammatory drugs (NSAIDs) and opioids, etc. can also be used.

The Agents Used[27]

Inducing Agent

The most commonly used intravenous inducing agent for GA is thiopentone sodium. Lately, propofol has also gained popularity as an inducing agent. It is associated with reduced grogginess and has an inherent antiemetic property which results in reduced amount of nausea and vomiting. Ketamine is another agent which can be used, but must be avoided in those with hypertension and cardiovascular disease.

Muscle Relaxants

Succinylcholine is used for endotracheal intubation. The main drawbacks associated with its use include myalgia and muscle fasciculations, which can cause a rise in serum potassium levels. The main advantage with its use is a quick onset of intubating conditions. Nondepolarizing group of muscle relaxants such as pancuronium, vecuronium and atracurium can also be used for intubating the patients. They are free from the drawbacks of succinylcholine and also help in providing relaxation during the entire course of surgery.

Local Anesthesia

Some common minor obstetrical and gynecological procedures can be performed under local anesthesia.[28] Local anesthesia can be administered either in the form of a pudendal or a paracervical block. The two main complications associated with the use of local anesthetics are systemic toxicity and delayed hemorrhage (especially if combined with adrenaline). The patient must be observed for at least 2 hours prior to discharge.

Pudendal Block

The pudendal nerve, which is derived from the 2nd, 3rd and 4th sacral nerve is blocked with local anesthetic administered using a special needle introduced via a needle guide (Fig. 3.8). With the patient in the lithotomy position, a 22-gauge needle, having a length of 15 cm is placed through the transducer,

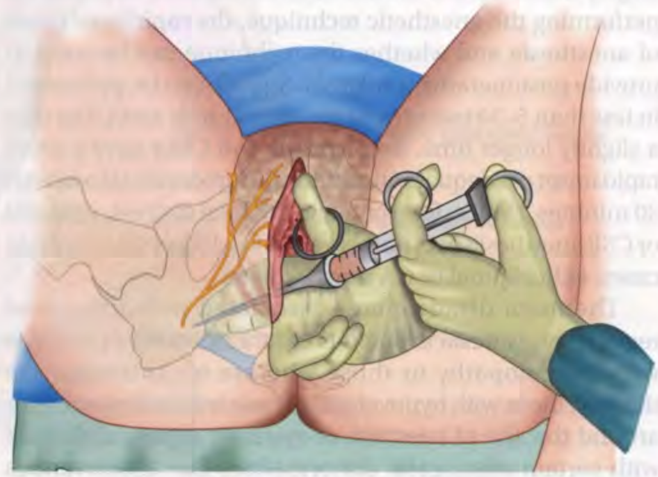


Fig. 3.8: Pudendal nerve block

against the vaginal mucosa, with the tip of the needle aiming just medial and posterior to the ischial spine. This is the region where the pudendal nerve is most likely to be situated. Approximately 1 mL of 1% lidocaine solution is injected. The needle is next advanced through the sacrospinous ligament, which is then infiltrated with 3 mL of lidocaine solution. The needle is then advanced into the loose areolar tissues behind the ligament and another 3–5 mL of the solution is injected there. The needle is then withdrawn and moved to just above the ischial spine. Another 10 mL of the local anesthetic solution is deposited there. The block needs to be repeated on the opposite site. Though the anesthesia may prove excellent for minor surgical procedures, the failure rate of the procedure is high, approaching almost 50%.

Paracervical Block

Nowadays, paracervical block anesthesia is being more often used in the practice of obstetrics and gynecology. It has been accepted as a simple, safe and effective method for anesthetic administration. This block helps in preventing transmission through the paracervical plexus bilaterally. Though this block helps in providing complete relief against the pain of the first stage of labor, additional anesthesia is required at the time of delivery. This is an ideal method of anesthetic administration for dilatation and curettage. Paracervical block can also be used in other minor procedures such as cervical repair, conization and Shirodkar or Wurm operations.

However, the main disadvantage associated with its use is the high incidence of fetal bradycardia along with the several reports of fetal deaths. With the gaining popularity of epidural and spinal anesthesia, the use of paracervical blocks has greatly declined.

Procedure: The block comprises of the following steps (Fig. 3.9):[29]

- The woman is placed in a modified lithotomy position.
- The block is performed with the patient in bed under sterile drapes but without surgical preparation.
- The cervicovaginal fornix is located with the examining finger.
- The guide is placed at the 5 O'clock and 7 O'clock positions after sweeping the guide away from the cervix in order to place the needle in the posterior lateral fornix. A 3- or 4-inch 21-gauge needle is adequate for use in most of the cases.
- The needle is then inserted through the guide, and approximately 5–10 mL of the local anesthetic solution (1% solution of lidocaine hydrochloride with epinephrine 1:1,000,000) is injected through the lateral vaginal fornix on both sides.

PREOPERATIVE PRINCIPLES PRIOR TO SURGERY

Before undertaking any gynecological surgery, the surgeon must be well-versed with the abdominal and pelvic

Fig. 3.9: Paracervical nerve block

anatomy. In case of distorted anatomy, all attempts must be made to restore the normal anatomy as far as possible. The preoperative preparation just prior to the surgery comprises of the following steps:

- The bladder is catheterized
- The patient is anesthetized
- A careful bimanual examination is performed under anesthesia so that the surgeon can obtain valuable information, which may otherwise not be possible
- The vulva, vagina and perineum must then be cleaned and scrubbed with a sterile sponge soaked in savlon and then followed by povidone-iodine solution. Particular attention must be paid towards cleaning the umbilicus at the end. The abdominal area to be surgically prepared extends superiorly from the inferior limit of the rib cage and inferiorly uptill the mid thighs. The lateral margins of the skin preparation extend to the anterior iliac crest and the anterior axillary line.

INTRAOPERATIVE CARE PRINCIPLES

Some of the important things which must be kept in the mind at the time of surgery include the following:

- Surgery must be done along the lines of tissue planes
- Tissues must be handled gently
- Adequate access to the operation field and good source of light are important prerequisites before undertaking any surgery
- Use of appropriate retractors and bowel packing helps in obtaining adequate access
- Maintenance of asepsis is an important principle, which must be kept in mind at the time of surgery.

Principles of Asepsis

Asepsis may be defined as prevention of the exposure of the incision site with microorganisms, thereby preventing the risk of development of infection. Three important principles which are required for achieving asepsis are reduction of time, trauma and trash.[22]

Time: The time duration during which the surgical procedure is performed is an important factor. The longer the procedure, greater would be the possibility of infection and contamination.

Trauma: Trauma to the tissues as a result of rough handling, drying and desiccation of tissues upon exposure to room temperature, creation of excessive dead space, use of implants or foreign bodies or nonoptimal temperature is likely to contribute to infection.

Trash: Trash refers to the contamination of tissues by bacteria or foreign bodies.

- Hand washing for 3-5 minutes prior to any surgical procedure is important for the maintenance of asepsis.

Precautions to be taken at the time of surgery to minimize the tissue harm are as follows:[23]

Gentle handling of the tissues: Prolonged surgical time results in drying of the tissues and compromises blood flow through them. Tissues damaged by crushing, drying, excessive use of sutures or other surgical implants serve as the nidus of infection.

Surgeon must carry out meticulous dissection: Proper hemostasis must be obtained. If electrocautery is being used, it must be switched off immediately, when not in use. Use of toothed or crushing instruments must be avoided as far as possible.

Appropriate suturing techniques: The surgeon must make use of appropriate suturing techniques. Sutures must be placed as close to the tissue edge as possible. In order to prevent the obstruction of blood flow, the sutures must be placed no more than 1 cm from the edge. Sutures should be tightened enough to oppose the tissue edges. If the sutures are tighter, they are likely to further obstruct the blood supply, resulting in dehiscence. All the dead space between the tissues must be removed at the time of closure.

Among the various steps taken to maintain asepsis, use of preoperative shaving has not been observed to alter the rate of wound infection. Use of a single dose of antibiotics preoperatively helps in preventing wound infection or septicemia. Prolonged course of antibiotics or unnecessary use of antibiotics must be avoided to prevent the development of antibiotic resistance. Antimicrobial prophylaxis against infective endocarditis (IE) is not recommended in patients undergoing urological, gynecological and obstetric procedures where infection is not already present. If infection is present, then patients at high risk of IE should receive antibiotics against the organisms responsible for causing IE.

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4
CHAPTER

Postoperative Care, Surgical Asepsis and Antibiotic Prophylaxis

INTRODUCTION

Postoperative care begins immediately after the surgery when the patient is shifted from the operation theater into the recovery room. Postoperative care continues throughout the recovery period, even after the patient is discharged home. Critical concerns during the postoperative period include airway clearance, pain control, mental status examination and wound healing. Other important concerns in this period include prevention of various surgery-related complications such as blood pressure (BP) variability (hypotension or hypertension), urinary retention, constipation and deep venous thrombosis.[1] Various postoperative considerations are dependent on the presence of underlying medical conditions. For example, in patients with diabetes, blood glucose levels need to be monitored every 1–4 hourly until patients become conscious and responsive. The patients, in whom the surgery is performed under general anesthesia, must be extubated before leaving the operating room. Patients should not be shifted from the operation theater to the recovery room until they can clear and protect their airways.[2] The intubated patients with normal lungs and trachea may have a mild cough for 24 hours after extubation. In patients with a previous history of bronchitis or smoking, postextubation coughing is likely to last longer. Hypoxic dyspnea is treated with oxygen. Nonhypoxic dyspnea may be treated with anxiolytics or analgesics. Controlling the pain is an important aspect of postoperative management. Opioids are typically the first-line choice and can be given orally or parenterally. The patients may be briefly confused when they come out of anesthesia. The first 72 hours after the surgery is the most critical period for the patient. During this period, precise monitoring of the patient's cardiovascular, renal and respiratory system provides valuable information regarding the patient's postoperative status. Due to the extreme importance of postoperative care, this chapter would be briefly discussing the major concerns in the postoperative care of patients who have undergone gynecological or obstetric surgery.

POSTOPERATIVE CARE

No standard postoperative orders can be followed for each patient. They need to be customized according to the individual patient's needs and requirements. It is important that each patient must be evaluated before being transferred to the recovery room. The frequency of checking patient's vitals must be based on the severity of the patient's condition. All patients must be evaluated on the evening of surgery and appropriate documentation recorded in their chart. This should include thorough evaluation of the vital signs, catheter drainage (nasogastric, peritoneal and Foley's), evaluation of the pulmonary status and performance of an abdominal examination. Postoperative care can be divided into three phases, discussed below.

Immediate Postoperative Care

This involves the period immediately following surgery when the patient is still in the operation theater. The parameters such as ABC (airway, breathing and circulation) must be monitored soon after the surgery. The patient must be eventually shifted to the recovery area. The patients' vitals should have stabilized when the patient is shifted to the recovery area. It is important that each patient must be evaluated before being transferred from the recovery room. If the patient does not appear ready for transfer, efforts must be made to stabilize the patient or to transfer her to the ICU.

Early Postoperative Care

This involves the period after the patient is shifted from the recovery area to the ward, until the time of discharge from the hospital. The care in the ward can be summarized by acronym SOAP, which can be described as follows:

S: Subjective: How does the patient feel?

O: Objective: Assessment of objective parameters such as BP, temperature and fluid balance

A: Assessment: Physical examination

P: Plan: Plan of care for the next 24 hours

Initially, the patient's pulse and BP must be recorded after every 15 minutes and thereafter every 30 minutes. Features such as tachycardia (> 100/minute), falling BP, pallor, gasping for breath, etc. may indicate internal or external blood loss. Patient's temperature must be recorded at least twice daily. The rise of temperature by 37–38°C in the first 36 hours after surgery could be related to pyrogen release, caused due to massive intraperitoneal hemorrhage or trauma. In cases of suspected infection, the following investigations need to be performed: urine culture and sensitivity, culture and sensitivity of pus from wound, and vaginal swab culture and sensitivity. Chest X-ray may indicate atelectasis or patchy lung consolidation or pleural effusion. Presence of calf tenderness could be indicative of phlebothrombosis. In lactating mothers there could be breast engorgement, mastitis or breast abscess formation. In cases of urinary tract infection (UTI), fever is associated with rigor, increased frequency of micturition and dysuria. The presence of pelvic hematoma, abscess or infection must be ruled out on clinical examination.

Medications

The use of analgesic medications is particularly important during this period. Adequate analgesia must be prescribed. These may include oral medicines such as paracetamol and nonsteroidal anti-inflammatory drugs (NSAIDs), patient controlled analgesia (PCA), opioids, epidural analgesia, etc. In case, the patient complains about nausea, she should be administered antiemetic medications. The type of medicine, the route of administration and the dosage needs to be specified. The other medications which must be prescribed include antibiotics and prophylactic therapy for deep vein thrombosis (DVT).

Fluid and Electrolyte Balance

Maintenance of fluid balance is important during this phase. The nursing care professionals must be instructed to inform the surgeon in case the urinary output becomes less than 30 cc per hour. Average fluid intake for a healthy person is about 750 mL in the form of food and 1,500 mL in the form of fluid. Insensible loss of about 1-1.5 liters occurs everyday in the form of breathing and sweating. Urinary excretion is about 1,500 mL per day and loss through stools is about 150-200 mL per day. The fluid loss through vomitus and drainage via drains also needs to be taken into account. Proper fluid balance, therefore, needs to be maintained in order to avoid fluid and electrolyte imbalance. Most gynecological patients can tolerate up to 2,500 mL of fluid intake per day. Daily requirements for sodium and potassium are 1 Mmol/kg. If the patient is on IV fluids, serum electrolyte levels must be checked every 24–48 hours. Central venous pressure (CVP) monitoring may be required if maintenance of fluid balance appears to be difficult. Colloids or whole blood should be used for volume expansion in surgical patients.

As a result of surgical trauma, increased amount of potassium may be excreted in the urine. In case of poor muscle tone and lethargy, K^+ deficiency must be replaced. Protein catabolism is accelerated due to surgical trauma resulting in an increased urea excretion. If 100 g of glucose can be administered by oral or IV route, protein loss can be spared.

Nutrition and Dietary Requirements

Patient who had uncomplicated surgery may be given a regular diet on the first postoperative day if the bowel sounds are present; abdominal examination reveals no distention and the patient is no longer nauseated from anesthesia. In case the bowel sounds are absent or abdominal distention is present, the patient can be started on IV fluids or kept nil per orally (NPO) depending upon the other clinical findings.

Late Postoperative Care

This involves the period after which the patient is discharged home and comprises of the following components, as given below.

Wound Care

The surgeon must individualize care of each wound, but the sterile dressing placed in the operating room is generally left intact for 24 hours unless signs of infection (e.g. increasing pain, erythema and drainage) develop. After 24 hours, the site should be checked twice a day, if possible, for signs of infection. If they occur, wound exploration and drainage of abscesses, systemic antibiotics, or both may be required. Topical antibiotics are usually not helpful. A drain tube, if present, must be monitored for quantity and quality of the fluid collected. Sutures, skin staples, and other closures are usually left in place for 7 days or longer depending on the site and the type of surgery.

Requirement for Hormone Replacement Therapy

Estrogen deficiency may occur in patients who have undergone bilateral oophorectomy at the time of surgery. In those cases, hormone replacement therapy may be administered.

Prophylactic oophorectomy is sometimes performed in women approaching menopause due to the likely risk of developing ovarian malignancy in the future. Some of the complications as a result of bilateral ovary removal include vasomotor symptoms, osteoporosis, genitourinary atrophy, etc. Ideally the patients should have been counseled about these adverse effects prior to the surgery. Moreover, the benefits and risks of using hormone replacement therapy (HRT) posthysterectomy should also have been explained.

Physical Activity

The patient should be encouraged to ambulate as early as possible in the postoperative period in order to reduce the risk of development of venous thromboembolism (VTE).

POSTOPERATIVE COMPLICATIONS

The events occurring at the time of surgery and anesthesia can result in postoperative complications, which can alter the outcome of surgery and result in significant operative morbidity and mortality. Some such complications are described next.

Hemorrhage

The minimum hemoglobin level at the time of surgery must be about 10 g/dL. In patients with severe anemia prior to the surgery, blood must be transfused. In the patients with mild anemia, blood must be kept arranged, even though the actual transfusion may not be required. Elective surgery is usually not performed until the patient's hemoglobin levels have been built up.[3] Therefore, blood transfusions are rarely required as a result of anemia in the patient. Nevertheless, intraoperative blood transfusion may be required in the circumstances where there is excessive blood loss at the time of surgery. This may result in hemodynamic instability, poor intravascular volume and a state of collapse. Blood transfusion is usually life saving in the cases of shock. It helps in increasing the oxygen carrying capacity of blood by the addition of red blood cells, restoration of blood volume and the raising of plasma proteins in the blood. It also helps in the provision of the coagulation factors. While awaiting blood transfusion, fluids such as Ringer's lactate or plasma expanders such as hemaccel or hetastarch can be used. Additionally, some precautions may be observed at the time of surgery. The surgery must be performed carefully, quickly and gently in order to minimize blood loss and tissue damage. The ligatures on the pedicles should be properly secured. The evaluation of blood loss at the time of surgery can be made by calculating the number of soaked sponges, weights of wet swabs and variation in the pulse and BP. In case of extensive surgery such as Wertheim's, blood transfusion may be required in the theater.

Primary Hemorrhage

Primary hemorrhage due to arterial blood loss may occur at the time of surgery due to slipping of ligatures and retraction of vessels in it. Double ligatures must therefore be tied and an unduly thick pedicle in single suture be avoided. Transfixation of sutures may also be helpful. The loss of venous blood is usually in the form of an ooze from an ill-defined area of dissection around a mass or adhesion. This is usually encountered in case of pelvic floor surgery. To prevent this, the dissection should be blunt and preferably in the line of cleavage. If required, tight compression or vaginal packing may be done. In case of retractable internal hemorrhage, internal iliac ligation may be required.

Reactionary hemorrhage: Reactionary hemorrhage is a type of prolonged primary hemorrhage, which does not occur immediately as it is originally masked by the hypotensive effect of drug or anesthesia. However, when the blood pressure reverts to normal, vasodilatation occurs and oozing begins.

Secondary Hemorrhage

It usually occurs on 7–10th postoperative day. The usual cause is the sepsis, which erodes the blood vessels and bleeding starts from the infected granulation tissues. The hemorrhage may begin as dirty discharge and dark clots, which proceed to fresh red profuse bleeding. This may eventually result in hemodynamic instability and shock. Broad-spectrum intravenous antibiotics must be started in these cases. Since the use of sutures would be ineffective due to the presence of infected tissues, tight compression helps in achieving hemostasis in these cases. This helps in tiding over the emergency until the sepsis settles.

Postoperative Febrile Morbidity

The common cause of fever is a high metabolic rate that occurs due to the stress of a surgical procedure. Other causes of fever may include pneumonia, UTIs and wound infections. Precautionary steps such as incentive spirometry, deep breathing exercises and periodic coughing can help to reduce the risk of pneumonia.

Pulmonary Complications

Upper respiratory tract infections such as acute bronchitis or pneumonitis must be treated prior to elective surgery, especially if planned under general anesthesia. Most important pulmonary complications after pelvic or abdominal surgery include atelectasis, pneumonia and pulmonary thromboembolic diseases. Some of the risk factors for the development of postoperative pulmonary complications in gynecological surgery patients include those with age greater than 60 years, cancer, congestive cardiac failure, smoking within 8 weeks of surgery, upper abdominal incision, vertical incision and length of incision greater than 20 cm.[4] Some of the pulmonary complications are described next. Complications such as lung abscesses, pleurisy and empyema are rare as a result of improved anesthesia techniques and prophylactic antibiotic cover.

Atelectasis: The diagnosis of atelectasis is based on the following parameters: impaired oxygenation, unexplained temperature of more than 38°C and chest radiography showing the evidence of volume loss or new airspace opacity.[5] Risk factors for development of atelectasis include advanced age, obesity, intraperitoneal sepsis, prolonged anesthesia time, nasogastric tube placement and smoking. Steps which can be taken to prevent the occurrence of atelectasis include: cessation of smoking, 8 weeks prior to the elective surgery; deep breathing exercises; mobilization; adequate analgesia (epidural or patient controlled analgesia) and selective gastric compression. Chest physiotherapy is usually not recommended as it is associated with numerous disadvantages such as exhaustion, pain in the chest, bronchospasm and transient hypoxemia.[6] Moreover, it has not been shown to be superior over deep breathing exercises in the prevention of atelectasis.[7]

Postoperative pneumonia: Hospital-acquired pneumonia develops 48 hours or more after hospital admission and is caused by an organism that was not incubating at the time of hospitalization. Common pathogens which are responsible for causing hospital-acquired pneumonias can include *Streptococcus pneumoniae*, methicillin-sensitive *Staphylococcus aureus*, *Haemophilus influenzae*, *Escherichia coli*, *Klebseilla pneumoniae*, *Enterobacter* species, etc. Some interventions to reduce the risk for the hospital-acquired pneumonia include strict adherence to infection control procedures, early removal of invasive devices (e.g. catheters), semirecumbent positioning of the patient, restriction of acid suppression therapy, restrictive red blood cell transfusion strategy and the strict control of hyperglycemia. Procedures for control of infection include use of alcohol-based hand disinfection and appropriate barrier precautions.

Postoperative bronchitis: Postoperative bronchitis may present with dyspnea and persistent cough with expectoration.

Mendelson syndrome: This may result from the inhalation of regurgitated gastric contents during the time of anesthesia. It may present in the form of acute respiratory distress with cyanosis due to bronchospasm and pulmonary edema. This may lead to hypotension and cardiovascular collapse, which may even prove to be fatal.

Lung collapse: This may occur due to the blockage of the alveoli with tenacious mucous plugs. It may present with dyspnea, chest constriction, cyanosis of varying degrees and fever with resultant tachycardia. The chest on the affected side has restricted movements with reduced air entry. The trachea and the mediastinum may be displaced ipsilaterally and the diagnosis may be confirmed on chest X-ray. Though chest physiotherapy does not prove to be effective, deep breathing exercises may prove to be effective.

Urinary Tract Complications

Urinary Infection

It may commonly occur after vaginal surgery, prolonged or intermittent repeated catheterization, bladder surgery or elective gynecological cancer surgery. Aseptic precautions must be observed while performing urethral catheterization to prevent the occurrence of infections. Poor voiding after surgery or extensive bladder dissection may result in an increased residual volume in the bladder causing cystitis. This may present as hypogastric pain, increased frequency of micturition, dysuria, etc. In these cases, urine routine and microscopy, and urine culture and sensitivity must be performed. Rarely, the infection may ascend high up in the urinary tract to cause acute pyelonephritis. The patient may be acutely ill having high fever with rigors, vomiting and anorexia. The pain is localized to the loin and the renal angle may be tender to palpation.

Urinary Retention

Urinary retention may commonly occur after surgery. Causes include use of anticholinergics or opioids, immobility and decreased oral intake. Patients must be monitored for urinary retention. Straight catheterization is typically necessary for patients who have a distended bladder and are uncomfortable or who have not urinated for 6–8 hours after surgery.

Gastrointestinal Complications

Slight postoperative nausea and vomiting due to the use of anesthetic agents is common problem amongst postoperative patients. Two other common gastrointestinal complications include postoperative ileus and postoperative intestinal obstruction. Excessive vomiting may result from paralytic ileus. This could be as a result of pelvic hematoma, peritonitis, bladder/rectal injury or hypokalemia. It initially may contain only gastric content; later on it becomes bilious and lastly may become offensive and dark colored and may contain fecal matter. Vomiting is usually effortless and is associated with a fall in BP and electrolyte imbalance. The causative factor must be treated vigorously. Use of bowel stimulants such as enema is strictly prohibited until the condition has reversed and bowel sounds have reappeared.

Postoperative Ileus

Postoperative ileus can be considered as an inevitable consequence of abdominal surgery. Paralytic ileus is a form of nonmechanical intestinal obstruction, which occurs due to reduced peristaltic activity of the intestines. It is important to differentiate between postoperative ileus and postoperative obstruction. In case of postoperative ileus there is discomfort from distention, but crampy pains are not present. In case of postoperative obstruction, cramping progressively increases in severity. Postoperative ileus occurs 48–72 hours of the surgery, while in case of intestinal obstruction; the onset may be delayed for up to 5–7 days after surgery. There may be nausea, vomiting and distention in both the cases. While bowel sound may be absent or hypoactive in case of postoperative ileus, high pitched bowel sounds and borborygmi with peristaltic rushes may be present in case of postoperative obstruction. In paralytic ileus, abdominal radiography shows presence of distended loops of small and large bowel. Gas is usually present in the colon. On the other hand, in postoperative obstruction, abdominal radiographs may show single or multiple loops of distended bowel (usually small bowel) with air-fluid levels. In case of postoperative paralytic ileus, treatment is mainly conservative with the use of nasogastric suction, enemas and cholinergic stimulations. However, in case of postoperative obstruction, the mainstay of treatment is surgical. In the initial stages, conservative management with nasogastric decompression may be done. Serial monitoring of the white blood cell count and differential count is an important method for differentiating between bowel obstruction and paralytic ileus.

Intestinal Obstruction

Mechanical intestinal obstruction is suspected when the patient has severe colicky abdominal pain and visible peristalsis with loud and exaggerated bowel sounds in the area of gut proximal to the site of obstruction. There may be some abdominal distention and vomiting of gastric or bilious contents. This condition requires immediate surgical intervention.

Venous Thrombotic Events

One of the most common postoperative complication is the venous thrombotic events such as DVT and pulmonary embolism (PE). PE can be considered as one of the most important causes of postoperative mortality.[8] DVT is also associated with considerable morbidity and mortality. PE may be characterized by rapid onset of respiratory distress, hypotension, chest pain and cardiac arrhythmias. The major sites of thrombus formation are soleal venous sinuses of the calf and venous arcade, which join the posterior tibial and peroneal veins draining the soleal muscle.[9] Due to confluence of large veins in this area, the local stasis is marked. This results in formation of large friable thrombus, which grows rapidly and has minimal intimal anchorage. Once the thrombus is dislodged, it may rapidly embolize via the inferior vena cava to reach the cardiopulmonary sites. Presence of thrombus along with accompanying inflammation of the blood vessels may result in the development of DVT. This may be associated with a small, but persistent rise in the temperature and pulse rate on the third postoperative day, aches or pain in the lower limbs and calf tenderness. The flexion and extension of the ankle joints may elicit pain (i.e. Homan's sign positive). Duplex ultrasonography of the calf muscle blood flow helps in establishing the diagnosis.[10,11] In cases where the clot embolizes, if the clot is small, it can produce symptoms such as slight chest pain, moderate cyanosis, dyspnea or pleural effusion with blood-stained sputum. If the clot is large, it may result in symptoms such as intense pain in the chest, acute dyspnea, cyanosis, tachycardia and shock. Massive clots can prove to be fatal, resulting in profuse hemoptysis, gasping and collapse.

Various factors, which are thought to lead to postoperative thrombosis, are venous stasis, changes in the blood constituents, and impaired function of the vessel wall. Venous stasis can be considered as the most important factor in the genesis of postoperative thrombosis. Venous stasis in the pelvis and lower extremity promotes the adhesion of the platelets to the endothelial cells lining the vessels, which encourage the development of the thrombus. Another factor which could be responsible for producing venous stasis during the prolonged surgery is the use of tight packing of the intestines in the upper abdomen resulting in the obstruction of the underlying vena cava. Various risk factors for development of venous thrombosis are enumerated in Table 4.1.[12]

Doppler ultrasound has become the most widely used investigation for the diagnosis of DVT. It helps in measuring blood flow velocity through the major blood vessels. In the presence of thrombosis, reduced signal is produced. Color enhancement can be used for identifying arteries (red) and veins (blue). This technique helps in identification of DVT in the iliac, femoral or popliteal veins.

Prevention

Prevention is the most important tool in the treatment of VTE. Some of the preventive measures which can be taken to reduce the risk of embolism include preoperative and postoperative prophylaxis with unfractionated heparin (UFH) or low-molecular-weight heparin (LMWH) and concomitant use of embolic stockings or intermittent pneumatic compression stockings.[13,14] Early mobilization in

Table 4.1: Risk factors for venous thrombosis

Age ♦ < 40 years (major surgery) ♦ 60 years (non-major surgery)
Obesity ♦ Moderate obesity: 75–90 kg or > 20% above the ideal weight ♦ Morbid obesity: 115 kg or > 30% above the ideal weight with reduced fibrinolysins and immobility
Immobility ♦ Preoperative immobility: Prolonged hospitalization, venous stasis ♦ Intraoperative immobility: Prolonged operative time, loss of pump action of the calf muscles, compression of vena cava ♦ Postoperative immobility: Prolonged periods of confinement to the bed, venous stasis
Trauma ♦ Damage to the walls of the pelvic veins ♦ Radical pelvic surgery/malignancy: Release of tissue thromboplastins
Activation of factor X ♦ Prior radiation therapy, diabetes mellitus ♦ Reduced fibrinolysin: radiation, medical disease, cardiac disease, heart failure, severe varicose veins, previous venous thrombosis

the postoperative period encourages the muscle pumping function of the legs, thereby reducing venous stasis.

Unfractionated heparin: The mainstay of prophylactic treatment had been low-dose UFH. Since it does not affect activated partial thromboplastin time (APTT), it does not cause any increase in postoperative bleeding. The main effect of low-dose heparin is exerted via antithrombin through factor Xa, as well as directly on thrombin. The commonly used dosage is 5,000 IU, 2 hours before surgery and then 5,000 IU every 12 hourly for the next 5 days. For the high-risk patients, the dosage must be used at every 8 hourly intervals. There is a risk of heparin induced thrombocytopenia and requires monitoring of APTT when used for treatment.

Warfarin: Warfarin can be used for the long-term treatment and prevention of VTE. Due to its teratogenic action, it is contraindicated in pregnancy. It requires anticoagulation monitoring and is associated with a high risk of bleeding.[15]

Low-molecular-weight heparin: They have now become the mainstay of prophylactic treatment and have replaced all other forms of the drug therapy. These drugs have a longer half-life than UFH and are therefore much more biopredictable.[16,17] They have a much more reliable pharmacokinetic profile. LMWH mainly act by inhibiting factor Xa and have very little activity against thrombin. They have a much longer half-life than UFH and measurement of APTT does not reflect its anticoagulation state. The main advantage of LMWH is that they are associated with a lower incidence of heparin-induced thrombocytopenia and postoperative bleeding.

Inferior vena caval filters: Inferior vena caval filters help in trapping large emboli. These can be used for the prevention of pulmonary embolism when anticoagulation therapy fails or is contraindicated. It can be used prior to pulmonary embolectomy or pulmonary endarterectomy.

External pneumatic leg compression: They are used as a prophylactic agent for DVT. They help in preventing venous stasis and stimulate the fibrinolytic system.[17-20]

Treatment

The initial treatment of venous thrombosis still involves the use of UFH, although LMWH is also approved for the treatment of VTE. The most commonly used regimen involves administering a loading dose of 80 U/kg to a maximum of 10,000 units. They are maintained on a constant infusion rate of 18 units/kg. Measurement of APTT or factor Xa assay must be done 4-6 hours after the initiation of therapy.

Postoperative Infection

In the majority of cases, the cause of pelvic and abdominal wound infection is the bacteria found amongst the endogenous microflora of the lower genital tract. Other risk factors include the patient's age, socioeconomic status, type of surgery, site of incision, duration of surgery, use of implants, obesity, presence of concurrent comorbid conditions such as diabetes mellitus, history of surgery, radiotherapy, chemotherapy, prolonged hospitalization or use of inappropriate antibiotic prophylaxis. Common postoperative infections include the following:

- Pelvic infections such as pelvic cellulitis, vaginal cuff hematoma and/or abscess, pelvic vein thrombosis, postoperative adnexal abscess, cellulitis, osteomyelitis pubis, incisional wound infection and cystitis. In case of pelvic cellulitis, the patients present with fever on 2nd–5th postoperative days after hysterectomy. Other findings may include abdominal tenderness, peritoneal signs or postoperative ileus. Induration may be present on pelvic examination. Also, no fluctuant mass is present in the majority of cases. However, in case of vaginal cuff hematoma and/or abscess, there may be purulent discharge and/or a fluctuant mass may be palpated at the vaginal cuff.

  Presence of postoperative febrile morbidity, not responding to antimicrobial therapy is suggestive of septic pelvic thrombophlebitis. In these cases, usually there is no evidence of abscess on pelvic examination or investigations such as CT or ultrasonography. Full heparin anticoagulation must be administered to the patient for about a week. Response may be observed within 24–48 hours of the start of therapy.

  In case of adnexal abscesses, the patient presents with fever and abdominal pain. There may be a tender palpable adnexal mass on pelvic examination.
- Nonpelvic infections may include infections such as pneumonia, bacteremia, pyelonephritis, etc.
- The most commonly used antibiotics for the treatment of postoperative infections include semisynthetic penicillins, cephalosporins (third generation) or aminoglycosides in combination with clindamycin or one of new large spectrum penicillin (third generation, e.g. carbenicillin and ticarcillin and fourth generation, e.g. piperacillin).

Prevention

Steps, which can be taken to reduce the incidence of postoperative infection, are as follows:

- Prophylactic antibiotics 30 minutes prior to the incision or at the time of induction of anesthesia[21]
- Use of meticulous surgical techniques at the time of surgery
- Ensuring adequate hemostasis at the time of surgery. Drains must not be used as an alternative against good hemostasis
- Judicious use of cautery at the time of surgery
- Gentle handling of the tissues
- Sterilization of the operation theater and high level disinfection of the instruments.

Wound Infection at the Incision Site

The wound infections could be of two types: (1) early onset wound infections or (2) late onset wound infections. Early onset wound infections are caused by group β-hemolytic streptococci and respond to high doses of parenteral penicillin. Late onset wound infections, on the other hand, become apparent by 5th–7th postoperative day. There may be a single high spike of the fever in the afternoon or early morning. Treatment consists of drainage, irrigation, dressing and systemic antibiotics. Continuing wound sepsis may result in development of burst abdomen by second postoperative week. This may be associated with the peeping out of the gut and omentum through the incision line. The treatment for burst abdomen includes emergency single-layered closure along with resuturing. The various factors which may influence wound healing include malnourishment, anemia, chronic diseases, diabetes, malignancy, sepsis and massive corticosteroid therapy. Incisional hernia may occur due to the herniation of abdominal contents, usually gut and omentum through a gap in the rectus sheath as a result of partial or complete wound dehiscence. The treatment comprises of repair of hernia and strengthening with inlay or sublay of prosthetic mesh as an elective procedure at a later date.

Cystitis

This may occur if appropriate precautions are not taken at the time of urethral catheterization or in cases where the urinary output is less than 2,500 mL in 24 hours. The presentation is in the form of fever with chills and rigors, and pain and tenderness over the hypogastrium. Urine culture and sensitivity must be done and antibiotics started appropriately.

POSTOPERATIVE ANALGESIA

Satisfactory postoperative pain management is an important component of patient care. Pain is a subjective experience, which may be defined as "an unpleasant sensory and emotional experience associated with actual or potential tissue damage." Since the sensation of pain can be influenced by many physiological and psychological factors, management of pain is a complex process and would be discussed in details in this section.

Effects of Postoperative Pain

Besides being the major cause of discomfort, pain in the postoperative period can affect the different organ systems resulting in the development of postoperative complications such as atelectasis, sputum retention and hypoxemia; myocardial ischemia, tachycardia and dysrhythmia; decreased gastric emptying, reduced gut motility and constipation; urinary retention; hyperglycemia and metabolic acidosis; increased protein catabolism; complications related to reduced mobility such as difficulty in getting out of bed, physiotherapy, and changing of dressing, etc. resulting in impaired wound healing, development of pressure sores and increased risk of DVT; and psychological complications such as anxiety and fatigue. Both pharmacological and nonpharmacological treatment modalities are now available for postoperative pain control. The pain medications can be administered by various routes including intramuscular, subcutaneous, intravenous, oral, rectal or transdermal.[22] For control of postoperative pain, analgesic medications can be either administered in the form of continuous infusions of opioids and/or NSAIDs; patient-controlled administration of opioids and/or NSAIDs; and intermittent boluses and/or continuous infusion of epidural or intrathecal opioids.

Nonpharmacological Methods

Nonpharmacological methods of pain relief comprise of the methods such as relaxation therapy, hypnosis, cold or heat massage, splinting of wounds, transcutaneous electrical nerve stimulation (TENS), etc. Preoperative explanation and patient education plays an important role in preparing the patient prior to surgery and helps in reducing the pain perception.

Pharmacological Management

Oral NSAIDs form the first line of management for mild-to-moderate pain. For patients who cannot tolerate NSAIDs or who require stronger dosage of analgesic, combinations of paracetamol and opioids are the next best choice. For more severe pain, injectable opioids may be required. For high-risk surgery, spinals and epidurals using combinations of local anesthetic and opioid analgesics may help in reducing the morbidity related to the pain of surgery.[23]

Nonsteroidal Antiinflammatory Agents

These form the first line of pharmacological management for mild-to-moderate postoperative pain. NSAIDs act by inhibiting the enzyme cyclooxygenase, which helps in reducing the production of inflammatory mediators such as prostaglandin, prostacyclin and thromboxane at the site of tissue injury. Their use can produce certain side effects such as gastric irritation and peptic ulceration; impairment of renal function and platelet dysfunction; exacerbation of aspirin-induced asthma, poor bone or wound healing, etc. Furthermore, NSAIDs may not appear as an adequate analgesic agent for severe pain. They appear to best work in conjunction with other agents. For example, administration of ketorolac helps in reducing the requirements of morphine by nearly 50% in patients recovering from abdominal surgery. NSAIDs can be administered either via oral or parenteral route. At times, NSAIDs can also be administered via alternative routes such as per rectal route.

Paracetamol: Paracetamol (acetaminophen) is the most commonly used NSAID, which also has a weak antiinflammatory activity. It can be administered both by oral or rectal routes. It is usually prescribed on an "as and when required" basis. In comparison to other NSAIDs (especially aspirin), paracetamol does not stimulate respiration or affect the acid-base balance or has an effect on cellular metabolism. In normal dosage, paracetamol is usually safe and well-tolerated. However, it has the potential to cause paracetamol poisoning in large doses (> 150 mg/kg body weight in an adult). Dosage greater than 250 mg/kg body weight can even prove to be fatal. Overdose of paracetamol may result in hepatic necrosis. Paracetamol is often prescribed in combination with other weak opiates.

Opiates

The most commonly used opiate drugs are diamorphine, morphine and pethidine. Pethidine has only about 10% the analgesic potency of morphine. They act on μ receptors in brain and spinal cord. The main side effect of opiates is their potential to cause respiratory depression. The action of opiate drugs on μ1 receptors is responsible for analgesic action, whereas their action on μ2 receptors is responsible for respiratory depression. Use of opiates can produce side effects such as sedation, nausea and vomiting, vasodilatation and myocardial depression, pruritus, delayed gastric emptying, constipation, urinary retention, etc.

Opiates can be administered by oral route, subcutaneous, intramuscular or intravenous, and epidural or spinal route. Opiates can also be used for patient-controlled analgesia, where the patient determines her own analgesic requirement all by herself. Opioids, which can be administered by oral route include, dihydrocodeine, oxycodone, codeine, tramadol and morphine. Opioids such as morphine sulfate and meperidine hydrochloride (pethidine) can be administered by the intramuscular, subcutaneous or IV routes.[24] However, the main disadvantage of administering intramuscular injections is that it can be extremely painful. On the other hand, use of subcutaneous injections may help in providing effective pain relief. Moreover, the injection is less painful and the effect lasts longer.

Patient-Controlled Analgesia

Patient-controlled analgesia is a mechanism of drug delivery in which the analgesic medicine (e.g. pethidine) is delivered intravenously. The drug is released in the blood only when the patient feels the need of a painkiller medicine and pushes the button of the pump. The physician, however, can determine the dosage of this intermittent injection. Moreover, the physician can also determine the minimal length of time that must elapse between two consecutive doses as well as the amount of drug that can be injected in a specified period of time (1-4 hours).

Opioid drugs can also be administered by epidural or intrathecal route. This can help reduce the dosage of opioids required for adequate pain relief, especially if administered in association with local anesthetics. While using the epidural route, a catheter can be used to maintain analgesia in the postoperative period.

CONCLUSION

The postoperative care of the patient starts right after the surgery and continues even after the patient is discharged home until the patient achieves an adequate health status. At the time of discharge, the patient should be given a discharge sheet which adequately summarizes all the postoperative instructions which the patient must observe. The patient should be given instructions regarding various activities, such as when to return to work; when to resume social activities, driving and sexual intercourse and when to appear for follow-up visits for detection of potential complications and providing on-going treatment.

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CHAPTER 5

Surgical Practices: Incisions, Wound Healing and Suture Materials

INTRODUCTION

The success of a gynecologic procedure performed through an abdominal incision depends on careful selection of the incision site and proper closure of the wound. The surgeon needs to consider multiple factors before making an abdominal incision. These factors include the disease process, body habitus, operative exposure, previous scars, cosmesis and the need for quick entry into the abdominal cavity. Since giving an accurate incision is the most important factor to ensure the adequate exposure of the operative field, types of incisions in the abdominal wall and their closure, would be discussed in detail in this chapter. Improper incision often causes inadequate exposure, which may result in complications such as hemorrhage, injury to the bladder, colon, etc. Location of the incision is particularly important in cases of gynecological malignancy because these patients may often require additional procedures such as colostomy, urinary diversion, or extraperitoneal lymph node dissection.

TYPES OF SURGICAL INCISIONS

The incision should be given in such a way so as to minimize the damage to the tissues. Preferably, a scalpel should be used at the time of making an incision, and the fewest possible strokes must be given. The type of incision to be given is decided by the surgeon based on the following parameters: required speed of surgery, potential difficulties with hemostasis, amount of exposure required, cosmetic concerns, the history of previous surgery and presence of previous incisions, and the patient's overall nutrition and health.[1] Characteristics of various types of abdominal incisions are described in Table 5.1.[2] Midline skin incision is rarely used nowadays.[3] The paramedian incision has been replaced by a Pfannenstiel incision, wherever it is possible. The Pfannenstiel incision has now become one of the most frequently used incision in both obstetrics and gynecology. Previously, the skin was closed with interrupted and subcuticular sutures. However, nowadays most surgeons prefer to use disposable staples.[4] Besides, there has been development of newer surgical skills in the field of microsurgery, minimal invasive surgery, cryosurgery, laser surgery and most recently the computerized robotic surgery.

Transverse Incisions

Nowadays, the transverse incisions are more commonly employed and are associated with the best cosmetic results.

Table 5.1: Characteristics of lower abdominal incisions

Incisions	Pfannenstiel	Cherney	Maylard	Vertical
Pelvic exposure	Least extensive	Extensive	Most extensive	Extensive
Upper abdomen exposure	None	Least extensive	Extensive	Most extensive
Hemorrhage	Moderate	Moderate	Maximal	Minimal
Hernia formation	Minimal	Minimal	Moderate	Maximum
Risk of evisceration	Minimal	Minimal	Moderate	Maximum
Speed	Minimal	Moderate	Minimal	Maximum speed

Moreover, these incisions are much stronger in comparison to the midline incisions. They are less painful and associated with reduced postoperative discomfort. The rate of wound evisceration and hernia formation is also less common with the transverse incisions. Transverse incisions are, however, associated with certain disadvantages such as being a time-consuming procedure, more hemorrhage, formation of potential spaces and hematomas, and limited area for surgical exploration. Nerve injury, which can result in paresthesia of the overlying skin, is more frequent in a transverse incision compared with a midline incision.

Pfannenstiel Incision

This type of incision can be considered as the gynecological incision having the best wound security.[5] Though the cosmetic results are excellent, the exposure is limited. This incision should not be used in patients with extensive gynecological malignancy or nonmalignant conditions such as widespread endometriosis requiring extensive exposure or in case of extensive pelvic hemorrhage. This type of incision must also not be used in cases where speed is required for entering the abdomen.

Technique

- The slightly curved skin incision is made transversely, approximately 4 cm above the superior border of the pubis, and is carried through the skin and subcutaneous fat to the level of rectus fascia. The incision is usually made 1–2 finger breadths above the pubic crest. An incision length of 10–15 cm is sufficient. Increasing the length of the skin incision to more than 14 cm is usually not useful in improving the amount of exposure.
- The rectus sheath is incised transversely with the help of a scalpel or electrocautery (Fig. 5.1A). Once a small incision has been made in the rectus sheath, rest of the fascia is incised in a curvilinear manner, 1–2 cm lateral to the rectus sheath using a curved scissors or electrocautery.
- The upper edge of the fascia is grasped with two Kocher clamps on either side of the midline. The rectus muscle is then dissected free from the fascia (Fig. 5.1B). Next, the lower edge of the rectus fascial edge is grasped with Kocher clamps. Electrocautery or blunt dissection with the scissors can be used to dissect the rectus muscles and the pyramidalis muscle from the fascia. The rectus muscles are then separated in the midline by spreading the points of a hemostat between the muscles until the transversalis fascia is encountered.
- The peritoneum is opened and incised vertically (Fig. 5.1C). The entry must be made at the superior extent of exposure, in order to minimize the risk of perforating the urinary bladder.

Closure of the Pfannenstiel Incision

The peritoneum does not need to be closed separately as re-epithelialization occurs within 48 hours. Closure of the peritoneum does not add to the strength of the incision. Regardless of whether the peritoneum is closed or not, the rectus muscles should be thoroughly irrigated with water or saline, and any bleeding areas should be cauterized or ligated. Bleeding from small perforating vessels through the rectus muscle is the most common source of subfascial hematoma. The rectus fascia is approximated with delayed absorbable sutures.

Advantages

The Pfannenstiel incision is associated with the following advantages:

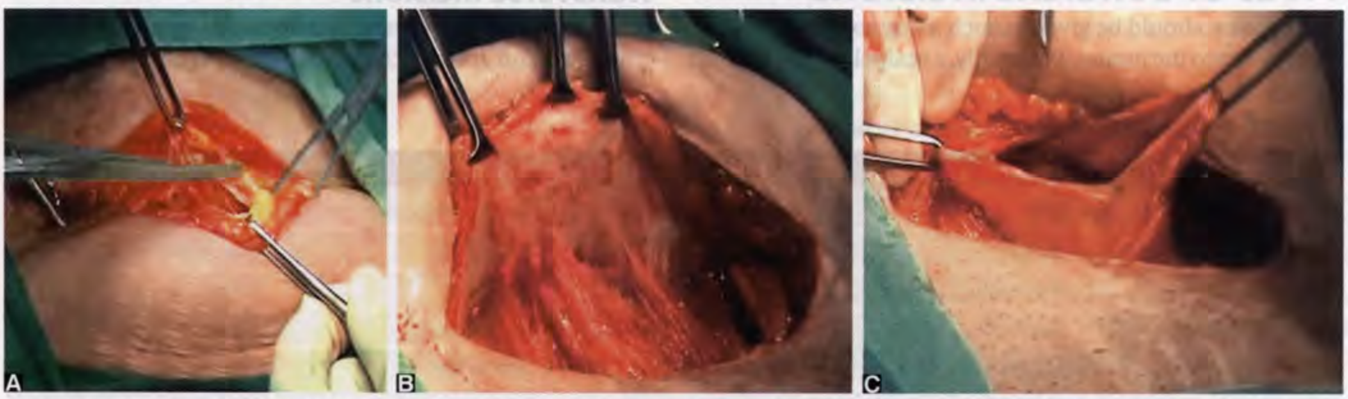
Good exposure to the central pelvis but limited exposure to the lateral pelvis and upper abdomen: The Pfannenstiel incision results in good exposure to the central pelvis but provides limited exposure to the lateral pelvis and upper abdomen. As a result, this incision cannot be used for a radical hysterectomy and pelvic lymph node dissection, unless the patient is very thin.

Excellent postoperative strength and good cosmetic results: The Pfannenstiel incision is associated with an excellent postoperative strength and good cosmesis.

Disadvantages

The incision is associated with the following disadvantages:

Limited exposure of the lateral pelvis and upper abdomen: Due to the limited exposure, the usefulness of this incision for gynecologic cancer surgery is largely limited.



Figs 5.1A to C: Pfannenstiel incision: (A) Fascial incision; (B) Separation of the rectus muscle; (C) Vertical incision of peritoneum

Increased risk of hemorrhage: There is an increased risk of hematoma or seroma formation due to the large extent of dissection required, and greater operating time.

Cherney Incision

Technique

Unlike the Pfannenstiel incision, wherein the rectus muscles are separated, in the Cherney incision, these muscles are detached from their insertion over the pubic bone (Figs 5.2A and B).[6] It begins with a low transverse incision of the abdominal skin and rectus sheath similar to the Pfannenstiel incision. The sheath is then elevated off the rectus abdominis muscle inferior to the fascial incision until the pubic bone is reached. However, the fascia need not be dissected in superior direction. The pyramidalis muscle can be left attached to the rectus sheath. This helps in minimizing unnecessary bleeding. Next, the rectus muscles are severed approximately 0.5 cm above their insertion from the pubic bone, using electrocautery. The peritoneum is then opened after retracting the rectus muscles.

Closure

While closing the Cherney incision, the peritoneum needs to be closed first. Then, the cut ends of the rectus muscle are attached to the distal end of the anterior rectus sheath using interrupted two-three, nonabsorbable sutures. The rectus muscle is usually not fixed to the pubis symphysis because of the risk of development of osteomyelitis. However, if delayed healing is anticipated, permanent sutures may be employed. The re-establishment of the muscle attachments is important because it helps in attaining excellent postoperative strength. Next, the fascia is closed with two running, continuous, delayed-absorbable sutures.

Advantage

Cherney transverse incision allows excellent surgical exposure to the space of Retzius and the pelvic sidewall.

Disadvantage

This incision involves the detachment of the rectus abdominis muscle.

Maylard Incision

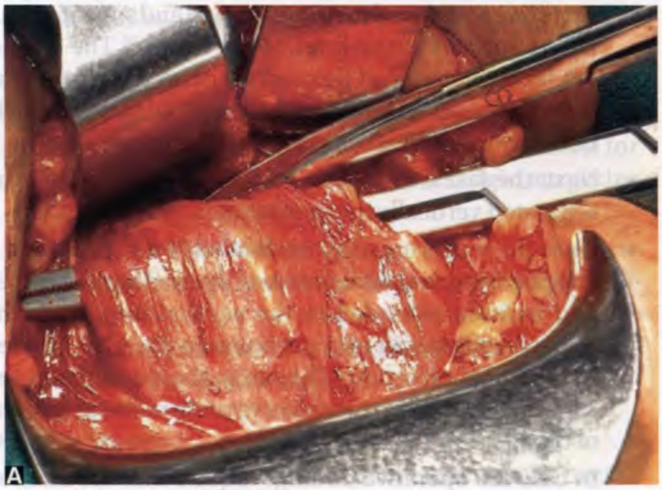
This muscle cutting incision, first devised by Maylard helps in providing adequate exposure of the pelvic sidewalls.[7] As a result, this incision is used for radical pelvic surgery including radical hysterectomy with pelvic lymph node dissection and pelvic exenteration for cervical cancer and cytoreductive surgery for ovarian cancer.[8] This incision usually refers to a subumbilical transverse incision.

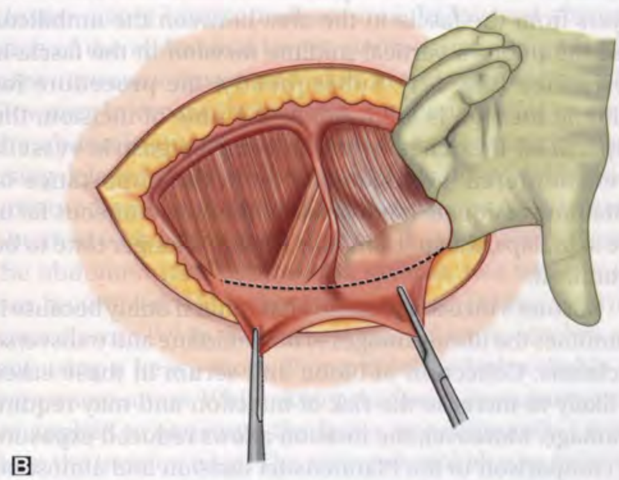
Technique

The skin incision is made approximately at the level of the anterior superior iliac spine, about 3–8 cm superior to the pubis symphysis. It is extended about 5 cm medial to the iliac spine. Skin, subcutaneous tissue, and rectus sheath are divided transversely as described previously for the Pfannenstiel incision. The incision is usually extended past the lateral border of the rectus muscle. However, instead of separating the rectus muscles and fascia, the rectus muscles are cut transversely (Figs 5.3A and B). Most surgeons prefer to ligate the deep inferior epigastric vessels before transecting the muscles. However, all the surgeons do not make use of this practice. In order to make the incision safely, the muscle must be elevated off the peritoneum with the hand or using some retractor. To complete the incision, the transversalis fascia and peritoneum are incised transversely.

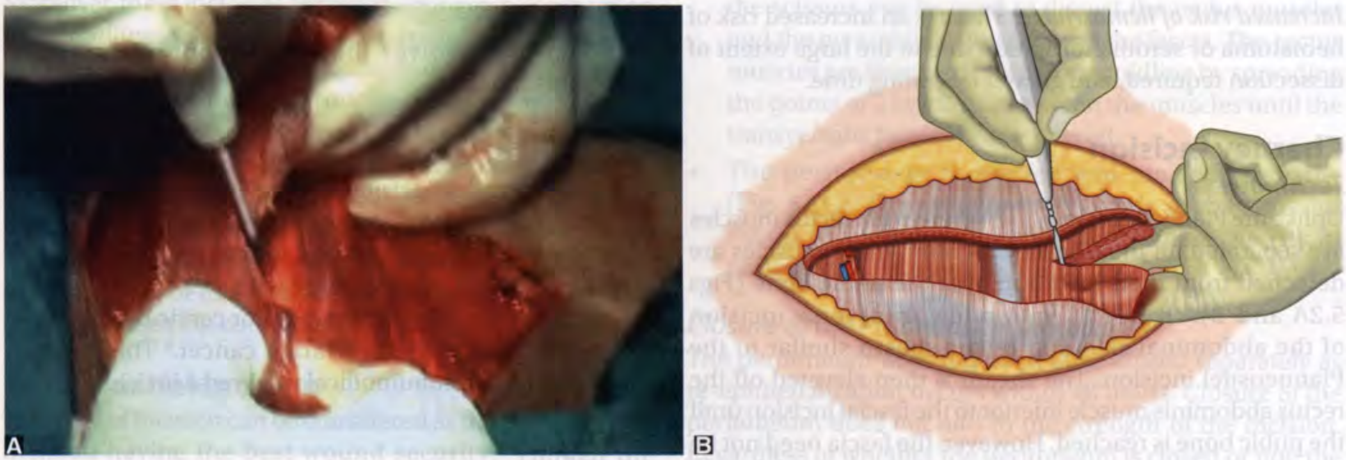
Closure of the Maylard Incision

To facilitate closure of a Maylard incision, firstly the peritoneum is closed with an absorbable suture. Next, each inferior epigastric vessel is ligated. The cut edges of the rectus muscles are irrigated with water and inspected for the presence of any bleeding points. Once adequate hemostasis





Figs 5.2A and B: Cherney incision: (A) Identification of rectus muscle prior to their attachment; (B) Diagram showing transection of the tendons of rectus muscle



Figs 5.3A and B: Maylard incision: transection of the rectus muscle

has been ensured, the fascia and underlying rectus muscle can be closed with a monofilament absorbable suture.

Advantages

- Provision of extensive pelvic exposure
- Can be used at any level of the abdomen.

Disadvantages

- This incision requires more time to accomplish
- Can be associated with potential blood loss in comparison to the other incisions.

Küstner Incision

This incision is sometimes also known as the modified Pfannenstiel incision. This comprises of two incisions: first a transverse incision through the skin and subcutaneous fat, which is followed by a vertical incision of the rectus fascia along the midline. The transverse skin incision is similar to that of Pfannenstiel incision. This curved incision begins below the anterior superior iliac spine and extends just below the pubic hairline through the subcutaneous fat down to the anterior sheath of the rectus muscle. Following sufficient dissection to separate the subcutaneous tissue layers from the fascia in the area between the umbilicus and the pubis, a vertical midline incision in the fascia is performed (Fig. 5.4). Subsequently, the procedure for midline incision is followed. At the time of incision, the superficial branches of the inferior epigastric vessels, if encountered, are ligated. Due to the importance of obtaining adequate hemostasis in the subcutaneous fat of the skin flaps, the incision may require a longer time to be produced.

Küstner's incision presently has limited utility because it combines the disadvantages of both midline and transverse incisions. Collection of blood and serum in these cases is likely to increase the risk of infection and may require drainage. Moreover, the incision allows reduced exposure in comparison to the Pfannenstiel incision and almost no extensibility. It was initially developed to reduce the risk of evisceration. However, it has not been observed to reduce the incidence of herniation in comparison to that of the midline incisions.

Vertical Incision

Several types of vertical abdominal incisions have been used in gynecologic surgery, including midline, and paramedian incisions. A midline incision is the type of vertical incision, commonly used at the time of gynecologic oncology surgery. The midline or paramedian vertical incision can be considered as the simplest of abdominal incisions, which can be given speedily. They are likely to provide excellent exposure as they can be easily extended and provide rapid entry into the abdominal cavity.[9] They are also associated with the least amount of blood loss. However, their use is associated with potential problems such as an increased rate of infection and the possibility of nerve damage and atrophy of the rectus muscle.

Technique (Figs 5.5A and B)

- In the lower abdomen, the incision is made from just above the pubis to below the umbilicus in the midline. For a midline abdominal incision, the skin and subcutaneous fat are incised to the level of the fascia.[10] The scalpel or electrocautery can be used to incise this tissue. The subcutaneous fat should not be dissected from the fascia because this creates unnecessary dead space.
- Next, the fascia is incised, and the rectus muscles are separated vertically in the midline.
- Once the rectus muscles are divided, the peritoneum is grasped between two hemostats, opened with a scalpel, and incision extended in the vertical direction. The transversalis fascia and peritoneum are also opened in a vertical direction. The entry should begin at the superior extent of the incision to prevent the possibility of bladder injury.
- In case the operative findings require that the incision be extended above the umbilicus, the surgeon must

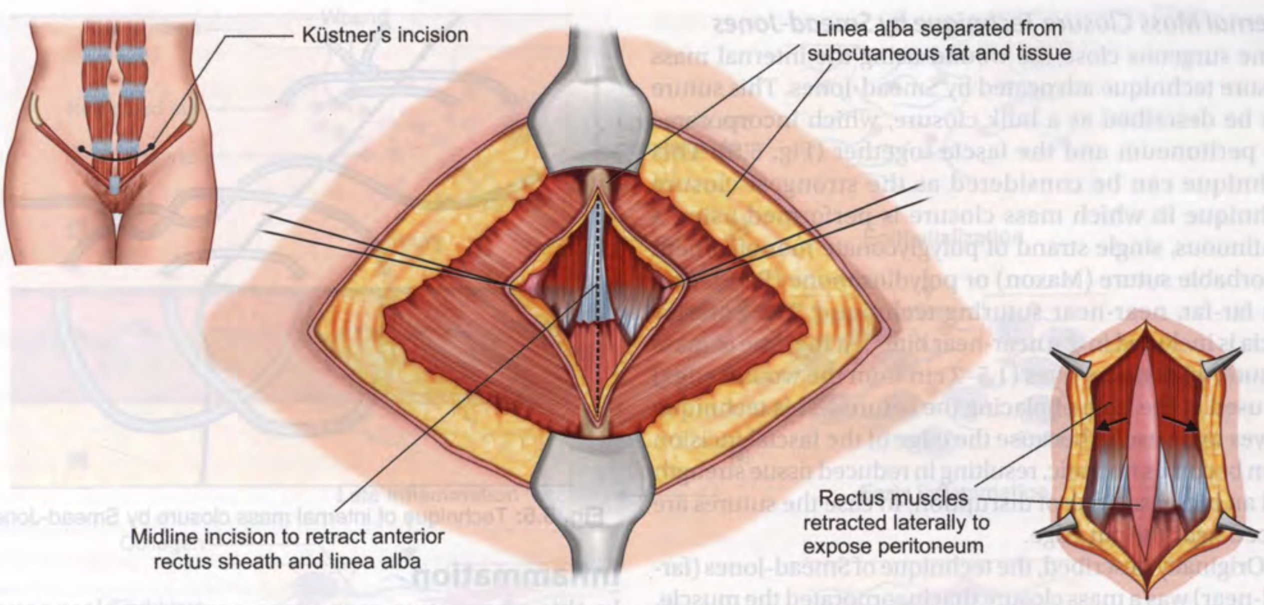
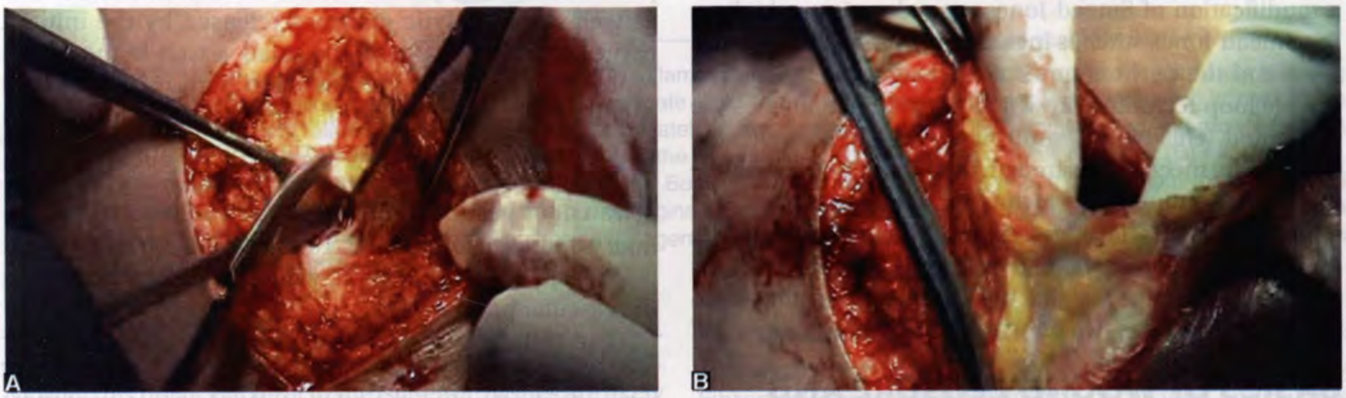


Fig. 5.4: Küstner's incision



Figs 5.5A and B: Vertical incision: (A) Fascial incision; (B) Peritoneal incision

avoid cutting through the umbilicus. Involvement of the umbilicus may result in an increased risk of postoperative wound infections due to bacterial colonization of the umbilicus.

Advantages

The advantages of the midline incision are as follows:

- A versatile vertical incision, which can be used for performing various types of gynecologic surgeries including cancer surgery
- Easy to give this incision
- Allows quick entry into the abdominal cavity with little blood loss
- Can be easily extended in length depending upon the findings at the time of surgery.

Disadvantages

- An increased risk of wound dehiscence and hernia formation.

Technique of Closure

Layered Closure

Previously, the method of choice for closure was layered closure using interrupted sutures. In layered closure, each of the abdominal layers: peritoneum, rectus fascia, subcutaneous tissue and skin are closed separately. However in recent times, most surgeons prefer to close the abdominal wall with continuous running stitches using delayed absorbable sutures. The rates of dehiscence obtained with continuous sutures are same as those obtained with interrupted sutures closures. While closing the abdomen with continuous sutures, two techniques can be utilized: (1) layered closure and (2) the internal mass closure.[11-13] In the internal mass closure, stitches are put using a heavy monofilament delayed-absorbable or permanent suture. While closing the fascia, the sutures must be applied to penetrate the fascia, approximately 1.5 cm from the incision edge. The suture should also include the underlying muscle and peritoneum.

Internal Mass Closure Technique by Smead-Jones

Some surgeons close the wound using the internal mass closure technique advocated by Smead-Jones. This suture can be described as a bulk closure, which incorporates the peritoneum and the fascia together (Fig. 5.6). This technique can be considered as the strongest closure technique in which mass closure is performed using a continuous, single strand of polyglyconate monofilament absorbable suture (Maxon) or polydioxanone (PDS). This is a far-far, near-near suturing technique. The anterior fascia is included in the near-near bite.[14] At the time of mass closure, wide tissue bites (1.5–2 cm from the wound edge) are used at the time of placing the sutures. This technique proves to be useful because the edge of the fascial incision often becomes necrotic, resulting in reduced tissue strength and an increased risk of disruption, in case the sutures are placed near the cut edge.

Originally described, the technique of Smead-Jones (far-and-near) was a mass closure that incorporated the muscle, fascia and peritoneum of the abdominal wall. This closure, incorporating all layers, is extremely strong. However, now a modification of Smead-Jones procedure is used where the Smead-Jones stitches include only the musculofascial layer and the peritoneum is closed separately. This is a double loop technique in which far and near stitches are alternated. This type of suturing technique is associated with greater mechanical strength than continuous or simple interrupted sutures. This technique is commonly used for approximating fascial edges, especially in patients who are at risk for fascial disruption or infection. This suture gains its strength from the fact that before tearing out, it needs to rupture the tissue at two points rather than just one.

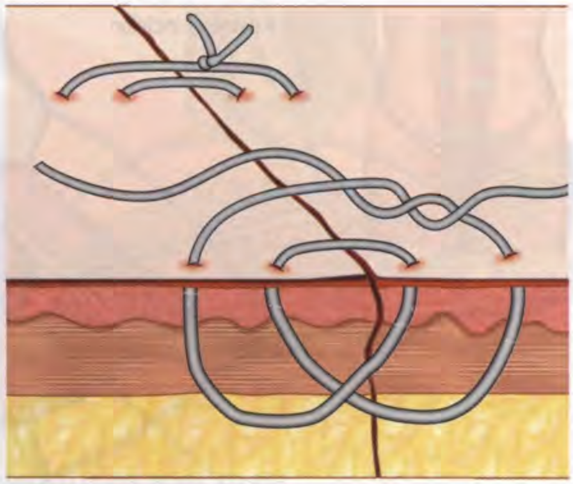


Fig. 5.6: Technique of internal mass closure by Smead-Jones

BASICS OF WOUND CLOSURE AND HEALING

Understanding of the fundamental process of wound healing is important for the surgeon in order to best create and close an abdominal incision. The wound-healing process is a balance between the amount of damage done to the tissues at the time of surgery and the ability of the body to decontaminate and repair it. It is the duty of the surgeon to maintain this balance in order to minimize the rate of wound infection and dehiscence. Proper understanding of the wound healing helps in minimizing the postoperative wound complications. The wound healing comprises of five distinct phases (Figs 5.7A to F):[15-17]

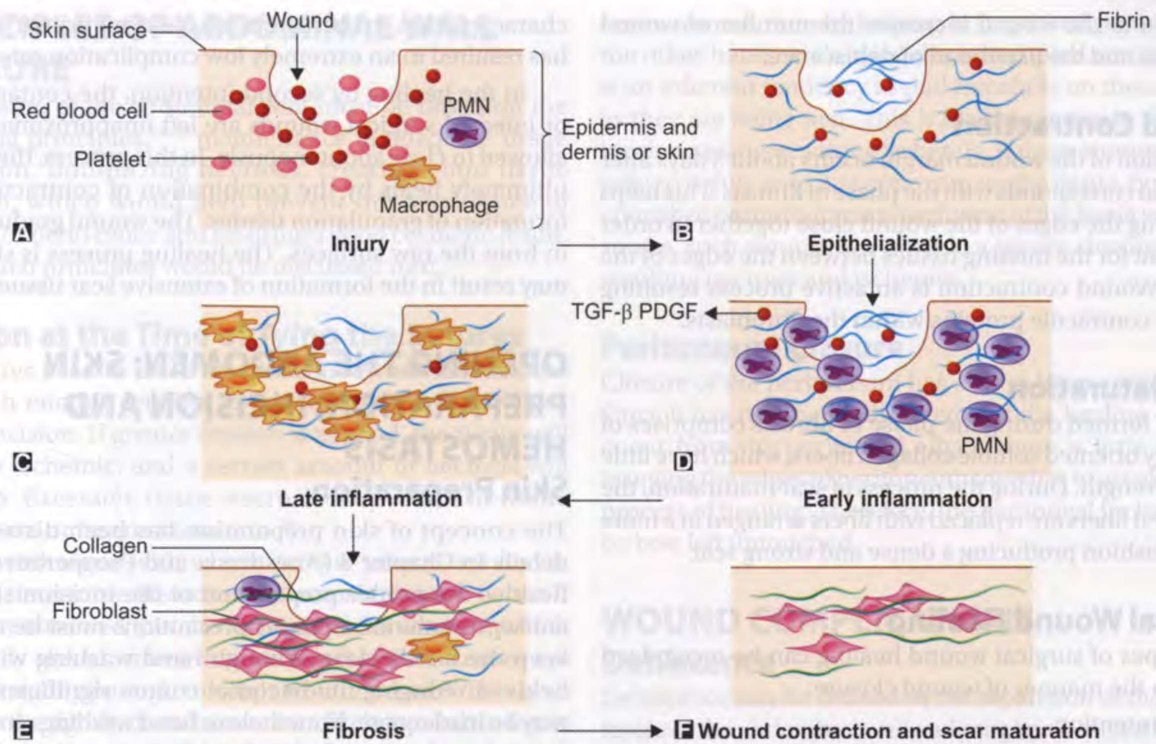
1. Inflammation
2. Epithelialization
3. Fibrosis
4. Wound contraction
5. Scar maturation.

These phases may not occur in a strict sequence and there is often an overlap. These phases occur both in cases where the wound is made with a surgical scalpel or in cases of a traumatic wound.

Inflammation

In this phase, two responses occur simultaneously: (1) vascular and (2) a cellular response. The vascular phase is initiated by amines such as histamine and kinins as well as proteolytic enzymes released by the injured tissues. During this phase, the small vessels in the region of the injury become permeable to both molecular and cellular mediators of the inflammatory response, which help in eliminating the bacteria through the process of opsonization, phagocytosis and direct cellular cytotoxicity. A transient vasoconstriction occurs immediately after injury and lasts for about 5–10 minutes. Vasoconstriction is followed by vasodilatation, which causes an increase in the vascular permeability.

The cellular response is caused by the migration of polymorphonuclear neutrophils (PMNs) into the area of injury. In the first few days, there is the dominance of PMN cells, while in the later stages of the inflammatory process, there is dominance of monocytes, which transform into macrophages. The macrophages phagocytize the bacteria, foreign bodies and the necrotic debris. The PMNs and wandering tissue macrophages begin their work of digesting damaged tissue, killing bacteria, and synthesizing the chemotactic factors that guide wound repair. These cells lay the groundwork for the later appearance of the fibroblasts, which would help reestablish wound strength. Although these cells are capable of limited activity in an anaerobic environment, their proper function in the wound depends upon the oxygen supply to the tissues. This is usually dependent on adequate perfusion of the adjacent tissues. The surgeon can ensure this by avoiding unnecessary damage to the tissues at the time of surgery. The death of the PMNs releases intracellular enzymes and debris into the wound. These become part of the wound exudate and form pus. While pus can develop even in the absence of infection, the healing is further impaired in the presence of infection. After the formation of the necrotic tissues, actual repair (healing) must begin from the healthy, uninjured tissues



Figs 5.7A to F: The phases of cutaneous wound healing: (A) Inflammation: extravasation of vasoactive amines immediately following cutaneous injury; (B) Coagulation then occurs as platelets aggregate with fibrin, which is deposited in the wound following its conversion from fibrinogen; (C) Platelets release several factors, including platelet-derived growth factor (PDGF) and transforming growth factor β (TGF-β), which attracts polymorphonuclear leukocytes (PMNs) to the wound, signaling the beginning of inflammation; (D) After 48 hours, macrophages replace PMNs as the principal inflammatory cell. Both PMNs and macrophages remove debris from the wound and reorganize the extracellular matrix; (E) The proliferation phase begins at about 72 hours as fibroblasts, recruited to the wound by growth factors released by inflammatory cells, begin to synthesize collagen; (F) Collagen cross linking and reorganization occurs for months after injury in the remodeling phase of repair

behind the area of damage. Before the healing can begin, the dead necrotic debris should have been removed. During this delay, bacteria in the ischemic tissues are likely to proliferate, further delaying repair, and increasing the likelihood of infection. Injury to the tissues at the time of surgery can occur as a result of electrocautery, abrasion or desiccation of tissues. The more of these damaging elements are present, the more amount of necrotic tissue would be present, which requires to be eliminated before healing can begin. All these factors are likely to increase the risk of wound infection.

Epithelialization

Replacement of dead/damaged cells occurs through the process of epithelialization. This occurs by the migration and subsequent maturation of immature epithelial cells from the deeper basal layers of the surrounding areas. Epithelialization results in the production of water-tight seal within 24 hours of injury. Initially this is thin and poorly attached to the underlying surface, making it prone to injury even with minor trauma. Over a period of few days, differentiation and maturation of the migrated cells along with the process of fibrosis helps in the formation of a strong scar.[18]

Fibroplasia

This is the process by which the wound regains its strength. Fibroplasia results in the formation of collagen, which adds to the strength of the healed wound. The process of fibrosis begins with the differentiation of the mesenchymal cells into fibroblasts. Fibroblasts and fibrin strands then migrate into the wound, resulting in an increased strength of the wound. Over the site of injury, fibroblasts proliferate and manufacture glycoproteins and mucopolysaccharides. This forms the ground substance of the connective tissues. After production of the ground substance, tropocollagen or the basic building block of collagen is synthesized. It is only after 4–5 days of injury that enough collagen is produced in order to cause an increase in the wound tensile strength. Initially, when the collagen is synthesized by the fibroblasts by about second day of injury, it appears as an amorphous gel devoid of strength. Maximum collagen synthesis occurs around the fifth day. Collagen synthesis is dependent on the presence of factors such as oxygen, vitamin C and amino acid precursors. Deficiency of these factors in the wound can inhibit healing, resulting in an increased incidence of wound dehiscence. Adequate perfusion at the site of injury is another important factor involved in promoting wound healing. Damage to tissue that impairs the delivery of oxygen to the wound increases the number of wound infections and the likelihood of dehiscence.

Wound Contraction

Contraction of the wound margin occurs about 5 days after injury and corresponds with the phase of fibrosis. This helps in bringing the edges of the wound close together in order to account for the missing tissues between the edges of the wound. Wound contraction is an active process resulting from the contractile proteins within the fibroblasts.

Scar Maturation

The scar formed during the phase of fibrosis comprises of randomly oriented soluble collagen fibers, which have little tensile strength. During the process of scar maturation, the disordered fibers are replaced with fibers arranged in a more orderly fashion producing a dense and strong scar.

Surgical Wound Healing

Three types of surgical wound healing can be recognized based on the manner of wound closure:

1. First intention
2. Second intention
3. Third intention.

The desired mode of healing for the surgical incisions is healing by the first intention. This occurs when the wound layers are reapproximated after injury. The proper apposition of the tissue layers allows healing to occur in a minimum period of time with no separation of the wound edges and minimum formation of the scar tissue. Primary closure of the skin and subcutaneous tissues is defined as closure at the time of the initial operation, and secondary closure indicates closure after granulation tissue has formed either with suturing or spontaneously as healing by secondary intention.[19]

A delayed primary closure is one in which the subcutaneous tissue and skin are not closed at the time of initial surgery, but covered by a sterile dressing and then closed some days later (usually on the fourth day), but before the formation of granulation tissue. Delayed primary closure is also known as healing by third intention. Sutures can be placed during the original operation and left to be tied later, or the wound can be sutured under local anesthesia in the patient's room.[20,21] During this time, the body's immune response has had a chance to clean the wound, and microscopic capillary formation has begun, creating excellent oxygenation of the wound edge.[22] Closure of the wound on the fourth day greatly decreases the chance of infection, allowing patients to avoid the potentially serious problem of sepsis associated with wound infection. This approach is most helpful during treatment of pelvic infection, especially in patients with poor healing characteristics. In these patients, delayed primary closure has resulted in an extremely low complication rate.

In the healing by second intention, the contaminated or infected surgical wounds are left unapproximated and allowed to close spontaneously. In this process, the wound ultimately heals by the combination of contraction and formation of granulation tissues. The wound gradually fills in from the raw surfaces. The healing process is slow and may result in the formation of extensive scar tissue.

OPENING THE ABDOMEN: SKIN PREPARATION, INCISION AND HEMOSTASIS

Skin Preparation

The concept of skin preparation has been discussed in details in Chapter 3 (Anesthesia and Preoperative Care). Besides the proper preparation of the incision site with antiseptic solutions, proper precautions must be taken to keep the hands clean. Though hand washing with soap helps in reducing the bacterial counts significantly, this may be inadequate. Nonetheless, hand washing remains an important element of preoperative preparation because it helps in removing gross contaminants and dirt.

Numerous antiseptic solutions are available for scrubbing. Alcohol has been shown to be an excellent choice due to its immediate and broad spectrum activity against Gram-positive and Gram-negative organisms. A 1-minute scrub with alcohol has been shown to be as effective, as a 4- to 7-minute scrub with other antiseptics. A 70% solution of alcohol is most commonly used for scrubbing.[23] Since alcohol is a highly flammable substance, the surgeons must take special precautions at the time of using electrocautery or laser. Other antiseptic solutions commonly used for scrubbing include the iodophors (betadine), hexachlorophene, and chlorhexidine gluconate.

Use of Drains

Use of drains for the purpose of wound drainage has always been controversial. Use of drains is recommended in cases where diffuse oozing persists or wound contamination is greater than normal. The main disadvantage of using a surgical drain is that being a foreign body, it has the potential to increase wound infection. Furthermore, it can provide access for bacteria to enter the wound, even after its closure. Therefore, the use of drains is only recommended in situations where there is a sufficient risk of hematoma or seroma formation, e.g. in case of a massively obese patient. The best choice is a closed suction drain brought out through a separate stab incision. This is associated with the lower rates of infections in comparison to the other options such as bringing out the drain through the same incision.

PRINCIPLES OF ABDOMINAL WALL CLOSURE

The closure of the abdominal wall must be based on the following principles:[24-28] maintenance of adequate tissue perfusion, minimizing necrosis, creating good tissue strength, which would help prevent the occurrence of hernias or dehiscence and assuring a good cosmetic result. Some such principles would be discussed next.

Tension at the Time of Tying the Sutures

All sutures used to close the musculofascial wall must be tied with enough tension to just approximate the edges of the incision. If greater tension is applied, the tissue will become ischemic, and a certain amount of necrosis will develop. Excessive tissue necrosis may result in tissue dehiscence or hernia formation.[29]

The technique with which various sutures are tied is likely to determine the extent of necrosis that will occur. It has been observed that the strength of the wounds, which are tightly closed, is less than those where the sutures are tied just tightly enough to coapt wound edges.[30] This is so because the tightly closed sutures are likely to result in tissue ischemia and necrosis. Therefore, before choosing the type of sutures, it should be ensured that they are not so tightly placed as to cause tissue ischemia or necrosis.

Suture Placement

Another element that is important to ensure adequate wound strength is the distance between the wound edges and the site of suture placement. The collagenases, which are produced as a result of the inflammatory process and help in the removal of the necrotic debris, usually extend for a region, approximately 1.5 cm from the edge. Secondly, there is a purely mechanical factor: the farther away from the skin edge the sutures are placed, more force would be required to pull them out; these sutures are more secure. Therefore, sutures should be placed at least 1-1.5 cm from the wound edge. In patients at increased risk of wound disruption, sutures should be placed 2 cm from the edge.

Choice of Closure

The two basic techniques, which can be used to suture the wound edges together are the running and the interrupted closure techniques.[28,30] The main advantage with the running sutures is that they can be speedily applied because knots need to be tied at only two or three points. However, in the past, this method of closure was considered to be weak because disruption of any portion of the suture was likely to open the entire wound. The main advantage with the interrupted and figure-of-eight sutures is that even if one knot breaks or is insecurely tied, the whole incision would not come apart.

More recently, it has been shown that unlocked running stitches help in evenly distributing the tension along the entire wound, thereby helping in improved perfusion. On the other hand, while tying the interrupted stitches, there is an inherent tendency to pull forcefully on these sutures as they are being tied. This is likely to increase the tissue tension and the resulting ischemia. If these sutures are tied only so tightly as to just approximate the tissue, but loosely enough to permit adequate perfusion of the fascia within the suture, such sutures can provide a secure closure without resulting necrosis and ischemia.

Peritoneum Closure

Closure of the peritoneum has always been controversial. Since it has now been observed that the healing does not occur from the peritoneal edges, there is little sense in bringing the edges of peritoneum together to accelerate the process of healing. Therefore, the peritoneal incision must be best left untouched.

WOUND COMPLICATIONS

Dehiscence

Dehiscence can be defined as the separation of the sutured layers of the abdominal wall and may be classified as partial or complete. In the case of a partial dehiscence, one or more, but not all of the sutured layers disintegrate. This is sometimes also known as wound disruption and most commonly occurs between 2 to 12 days after surgery.[31] The most common cause of dehiscence is the sutures pulling through the fascia. Complete dehiscence, on the other hand, is characterized by the separation of all the abdominal layers, resulting in exposure of the peritoneal cavity. This is also sometimes termed as evisceration or burst abdomen. This complication is currently thought to occur in less than 1% of the cases.

Some of the risk factors for dehiscence are listed in Table 5.2. The main factor which is likely to affect the risk of dehiscence is the inherent strength of abdominal wall tissues.[32] Besides these other factors, which may influence the risk of dehiscence include factors such as age (> 60 years), sex (males are at an increased risk), metabolic disease (uremia, diabetes and vitamin C deficiency), presence of malignancy, etc.

Wound dehiscence usually occurs at the points of insertion of the sutures into the tissue. This indicates that dehiscence is typically dependent on the way the sutures are anchored in the tissue. The most secure way of closing the abdomen is closing the musculofascial layers separately and placing the retention sutures through all layers of the abdominal wall, including the skin. There is no place for catgut sutures in fascial closure. Absorbable sutures, such as polyglycolic acid (Dexon) and polyglactic acid (Vicryl), have been found to produce results comparable to permanent sutures, such as prolene, in healthy patients undergoing elective surgery who are at no unusual risk for dehiscence.[33] In patients at risk for dehiscence, permanent sutures are usually required.

Since the occurrence of dehiscence can be associated with considerable morbidity and mortality, diagnosis and treatment should be prompt. The most common complaint in the patients with dehiscence is that of a profuse serosanguineous discharge from the wound. In case of evisceration, intestines can be seen protruding through the area of disruption. If this is the case, the intestines should be covered with saline-moistened gauze and an urgent surgery undertaken in order to close the incision in the operating theater. Once the patient is in the operating room, the wound must be cleansed carefully and thoroughly. Debridement of the subcutaneous tissue and fascia should be carried out as necessary. In these cases, the method of wound closure is important; method of mass closure is employed in most of the cases.

Wound Infection

Wound infection has been reported to occur in 2–4% of all clean abdominal incisions and up to 35% of all grossly contaminated incisions. Clean incisions can be considered as those incisions which are initiated on aseptically prepared skin without entering a contaminated viscus or encountering infection. A wound can be considered to be contaminated, if an infected genitourinary tract is entered or there is an occurrence of gross gastrointestinal spillage. Infection is often initiated by direct inoculum of bacteria into the wound from the patient's or surgeon's skin and is further aggravated by the presence of necrotic tissue. Therefore, proper aseptic preparation of both the patient's operative site and surgeon is essential in order to ensure the lowest possible rate of infection. This has been described in details in Chapter 3 (Anesthesia and Preoperative Care).

Copious irrigation of wound with nonirritating physiologic solutions also helps in significantly reducing the chances of wound contamination. Another approach of dealing with a contaminated wound is delayed primary closure which has been described previously.

Table 5.2: Risk factors for dehiscence

Systemic Factors
• Malnutrition (Hypoproteinemia, chronic anemia, vitamin C deficiency)
• Advanced age
• Obesity
• Infection
Increased Stress on Wound
• Chronic coughing
• Paralytic ileus with gastrointestinal distention
• Ascites
Metabolic Disease
• Uremia
• Diabetes
• Vitamin C deficiency
Previous History of Medical Disease or Medication
• Previous radiation therapy
• Malignancy
• Chemotherapy
• Systemic steroids
Intraoperative Technique
• Infection or hematoma formation
• Pressure necrosis
• Improper wound closure technique
• Type of incision given by the surgeon
• Suture type
• Closure technique

SUTURES

A suture is any strand of material used to approximate tissue or ligate vessels. Various materials have been used as sutures throughout history. The various qualities, which must be taken into consideration before choosing a particular suture material, include physical properties of the various suture materials such as tensile strength, security of the knot that has been tied, nonallergenic properties of the suture material, etc. and healing characteristics of the tissues. Though, the ideal suture has yet not been created, broadly, the various types of suture materials can be of two types: (1) absorbable and (2) nonabsorbable (Table 5.3 and Figs 5.8A to G). The characteristics of various absorbable and nonabsorbable sutures are described in Table 5.4.

Whether absorbable or nonabsorbable, based on the number of strands used in these sutures they can be of two types: (1) monofilament sutures and (2) multifilament sutures. Monofilament suture materials comprise of a single smooth strand (e.g. silk and mersilene in case of nonabsorbable sutures and polyglyconate and polydioxanone in case of absorbable sutures).[34,35] On the other hand, the multifilament suture materials comprise of multiple fibers woven together. Some examples of nonabsorbable multifilament suture materials are nylon and prolene, whereas the absorbable multifilament fibers

Table 5.3: Different types of sutures

Absorbable Sutures	
Natural	**Synthetic**
Catgut • Plain • Chromic	Polyglactin 910 (Vicryl) • Uncoated • Coated Polyglycolic acid (Dexon) Poliglecaprone (Monocryl) Polydioxanone (PDS) (Quill) Polyglyconate (Maxon)
Nonabsorbable Sutures	
Natural	**Synthetic**
• Silk • Cotton • Stainless-steel wire (Flexon)	• Nylon (Dermalon, Surgilon) • Polypropylene (Prolene, Novafil) • Braided synthetics (Mersilene, Ethibond)

Figs 5.8A to G: Different types of absorbable suture materials: (A) Chromic catgut; (B) Dexon; (C) Maxon; (D) Monocryl; (E) Plain catgut; (F) Vicryl; (G) Polydioxanone monofilament

are Vicryl and Dexon.[36] Monofilament materials are often preferred for skin closure because they are associated with reduced tissue reaction, are less traumatic and may be associated with a reduced rate of infection. This is despite the fact that more number of knots are required with monofilament fibers. Comparison between monofilament and multifilament suture material has been described later in the text.

Absorbable Sutures

Today, sutures are classified based on their absorptive properties. Absorbable sutures are prepared from the collagen of animals or synthetic polymers. These sutures are removed from the body by enzymatic action or hydrolysis. These sutures lose most of their tensile strength before 60 days. The absorbable sutures can be of two types: (1) natural and (2) synthetic sutures.[37] The ability of the suture to retain tensile strength dictates where the suture should be used in wound closure. The loss of tensile strength must not be correlated with the rate of absorption. Some sutures can maintain adequate tensile strength until wound healing is occurring, followed by rapid absorption. On the other hand, some sutures may lose tensile strength rapidly and undergo slow absorption. All absorbable sutures eventually completely dissolve. Absorbable sutures have some limitations. For example, in patients with fever, infection, poor nutritional status, or conditions associated with excessive moisture (e.g. ascites), absorption of absorbable suture may occur at an accelerated rate resulting in the premature attenuation of tensile strength.[38]

Natural Absorbable Sutures

The most commonly used natural absorbable sutures are plain catgut and chromic catgut.[39]

Table 5.4: Characteristics of various nonabsorbable and absorbable sutures

Nonabsorbable Sutures			
	Configuration	Tensile Strength	Knot Security
Silk	Braided	Good	Good
Nylon	Monofilament	High	Fair
Prolene	Monofilament	Good	Poor
Mersilene	Braided, synthetic	High	Good
Ethibond	Braided, coated	High	Fair
Stainless steel wire	Monofilament	High	Good
Novafil	Monofilament	High	Poor
Absorbable Sutures			
Gut (Plain)	Twisted	Poor	Poor
Chromic (gut)	Twisted	Poor	Poor
Dexon	Braided	Good	Good
Vicryl	Braided	Good	Fair
Polydioxanone II (PDS II)	Monofilament	Good	Poor
Monocryl	Monofilament	Fair	Good

Plain Catgut

Plain catgut is composed of purified strands of collagen obtained from the submucosa of the animals. The catgut was originally obtained from the sheep intestines. The term, "catgut" is derived from the Arabic term "kitgut", which is referred to the strings of musical instrument known as kit. Being a foreign protein, the plain catgut elicits a marked inflammatory response in the tissues. It is rapidly degraded by the proteolytic enzymes released by the white blood cells (WBCs). This causes the suture to lose more than 70% of its tensile strength in 7 days and is totally digested within 70 days.[40] Plain catgut is used in tissues where the strength is required for short periods of time.

Chromic Catgut

Chromic catgut is formed by treating catgut with chromic acid salts, which bind to the antigen sites in the collagen. The resulting sutures elicit less inflammatory response and are subsequently more resistant to degradation. Chromic catgut maintains more than half of its strength at 7–10 days.[41] It is very useful in the tissues where long-term strength is not required such as serosal, visceral or vaginal tissues. The sutures should not be used in the skin because the inflammatory response can cause scarring and the sutures often serve as a nidus of infection. Since natural absorbable sutures are degraded by proteolytic enzymes released by the inflammatory cells, these sutures lose strength more rapidly in the infected tissues.

Synthetic Absorbable Sutures

Polyglycolic Acid and Polyglactin 910

Polyglycolic acid (Dexon) is a copolymer of glycolic acid while polyglactin 910 (Vicryl) is a copolymer of lactic acid and glycolic acid. Sutures of polyglycolic acid and polyglactin are composed of braided filaments (multifilament) because the monofilament suture would be too stiff for general surgical use due to the inherent rigidity of these polymers.

The two sutures have similar biological properties. Breakdown is by hydrolysis rather than digestion by proteolytic enzymes. The result is a minimal inflammatory reaction and a constant absorption rate. Polyglactin 910 and polyglycolic acid are frequently used to ligate pedicles during a hysterectomy. These sutures can be used to close fascia of a transverse incision in a healthy patient. However, most surgeons prefer to use monofilament sutures for closing the fascia of a transverse incision. There is no loss of tensile strength in the first 7–10 days after using these sutures. About 50–60% of tensile strength remains after 14 days; 20–30% after 21 days and almost no tensile strength at 28 days.[41] The initial tensile strength of both these sutures is significantly greater than the catgut sutures of equal size. Tensile strength of the synthetic absorbable sutures is almost equal to the tensile strength of the catgut sutures, one size larger.[42] However, one major disadvantage of these sutures is that they are not as easy to handle as the catgut sutures. To help solve this problem, the manufacturers have tried to improve the handling qualities of their products by offering various types of surface coatings or using finer and more tightly woven filaments. Although these refinements have helped in improving the handling characteristics, they have also increased the tendency of the knots to slip. These sutures can be used in most situations where chromic catgut would be used and have replaced catgut almost entirely for many surgeons. Since they retain their tensile strength longer than natural absorbable sutures, they are acceptable for fascial closure in patients at low risk for fascial dehiscence.[43]

Polyglyconate and Polydioxanone

A new class of polymers polyglyconate (Maxon) and polydioxanone (PDS) allow the production of pliable monofilament sutures.[44] The initial tensile strength of these monofilament sutures is comparable to that of multifilament absorbable sutures. These sutures undergo absorption at a much slower rate. Thus, the tensile strength of these sutures is maintained for a much longer period of time. Due to their delayed absorption profile, both these monofilament sutures are excellent choices for fascial closure. Moreover, the inflammatory response of these sutures is minimal. An additional advantage of these monofilament sutures is that they lack the interstices which could serve as the nidus for bacterial infection. Thus, use of these sutures is associated with minimal amount of chronic inflammation. Since these sutures are composed of only one fiber, care must be taken to ensure that the strand is not inadvertently damaged by any instrument, needles or other sharp-edged materials.

Poliglecaprone 25

Poliglecaprone 25 (Monocryl) is an absorbable suture that retains 50% of its tensile strength after 2 weeks. First introduced in 1993, Monocryl has an absorption pattern, which is highly uniform and predicable. Similar to other synthetic absorbable sutures, Monocryl is absorbed by hydrolysis and does not induce inflammatory response of the catgut. This monofilament suture retains about 50–60% of its original tensile strength at 7 days postoperatively and about 20–30% of its original tensile strength at 14 days. Almost all the tensile strength is lost by 21 days. Although the tensile strength of this suture is similar to that of chromic catgut and it actually maintains its tensile strength longer than chromic catgut, it is not recommended by the manufacturer for use of fascial closure or any other tissue in which approximation under stress is required.

Nonabsorbable Sutures

Nonabsorbable sutures are made up of materials that cannot be readily broken down in the body, either due to enzymatic activity or hydrolysis. However, these sutures are not completely resistant to absorption. Over time, these sutures also lose their tensile strength and are eventually completely absorbed or digested. The commonly used nonabsorbable sutures are of three types (Figs 5.9A to D):

1. *Class I*: Composed of silk or synthetic fibers
2. *Class II*: Composed of cotton or linen fibers or coated natural or synthetic fibers, with the coating forming a casting of significant thickness, but not contributing appreciably to their strength
3. *Class III*: Composed of monofilament or multifilament metal wires.

The natural nonabsorbable sutures include silk, cotton and stainless-steel wire (Flexon). The synthetic nonabsorbable sutures include nylon (Dermalon, Surgilon); polypropylene (Prolene, Novafil) and braided synthetics (Dacron, Tevdek). Nonabsorbable sutures help in maintaining tensile strength over long periods of time. The disadvantages of these sutures include pain, presence of palpable sutures and formation of sinuses.

Silk Sutures

Silk sutures are derived from animal proteins and can be considered as a type of delayed absorbable sutures. They lose nearly half of their tensile strength after 1 year of implantation and cannot be found after 2 years. It can produce great amount of inflammatory response and is a type of multifilament fiber. Due to the presence of capillary action in these fibers, it is unsuitable for use in tissues which have a high potential for infection. Unlike silk, which loses its tensile strength in the presence of moisture, cotton sutures become stronger by 10% in the presence of moisture.

Nylon Sutures

Nylon sutures are available both in the form of polyfilament sutures (Nurolon, Surgilon) as well as monofilament fibers (Dermalon, Ethicon). Though monofilament nylon fibers have a greater tensile strength than the braided nylon fibers, polyfilament fibers are associated with better knot security in comparison to the monofilament fibers. Monofilament fibers incite reduced inflammatory reaction and are less prone to infection in comparison to the polyfilament fibers. However, nylon being a relatively inert material is likely to produce minimal tissue reaction in comparison to other nonabsorbable synthetic sutures.

Polyester

The polyester fibers are produced only in braided forms. These sutures can have various types of coatings. The uncoated polyester fibers (Mersilene/Dacron) are associated with better knot security. Presence of coating can improve the handling qualities of the polyester fibers. The knot security of uncoated polyester sutures is better than that of the coated polyester fibers.

Polypropylene

Polypropylene sutures are monofilament sutures composed of linear hydrocarbon polymers. It has the least tissue reactivity amongst all the nonabsorbable sutures. It is associated with good knot security in comparison with other monofilament nonabsorbable sutures. Nowadays, metal sutures are rarely utilized for gynecological surgery.

Monofilament versus Multifilament Sutures

Comparison between monofilament and multifilament sutures has been described in Table 5.5.

SURGICAL NEEDLES

Surgical needles can come in various shapes as shown in Figure 5.10. The body of the needle is available in different shapes: straight, half-curved, curved or compound. Obstetricians and gynecologists rarely use straight needles, except in cases where skin closure is required. Half-curved

Figs 5.9A to D: Different types of nonabsorbable sutures: (A) Prolene; (B) Mersilene; (C) Ethibond; (D) Silk sutures

needles are often used for skin closure in laparoscopic suturing. Curved needles are available in various curvatures with three-eighths of the circle being the curvature, which is most commonly used at the time of gynecological surgery. The surgical needles have three components: eye, body and the point (Fig. 5.11A). Figure 5.11B shows the correct way of holding a curved surgical needle. A curved surgical needle must be held by the needle holder at about two-thirds distance from the needle point (tip). Various tissue structures which can be sutured using different needle shapes are listed in Table 5.6.

Table 5.5: Comparison between monofilament and multifilament sutures

Monofilament Sutures		Multifilament Sutures	
Advantages	**Disadvantages**	**Advantages**	**Disadvantages**
♦ Smooth surface ♦ Less tissue trauma ♦ No bacterial infestation (reduced chances of infection) ♦ No capillarity ♦ Better cosmetic results	♦ Poor handling and knotting ♦ Poor knot burial ♦ Poor stretch properties	♦ Good strength ♦ Soft and pliable ♦ Good handling and knotting properties	♦ Higher chances of infection due to bacterial infestation ♦ Capillary action ♦ Increased tissue trauma

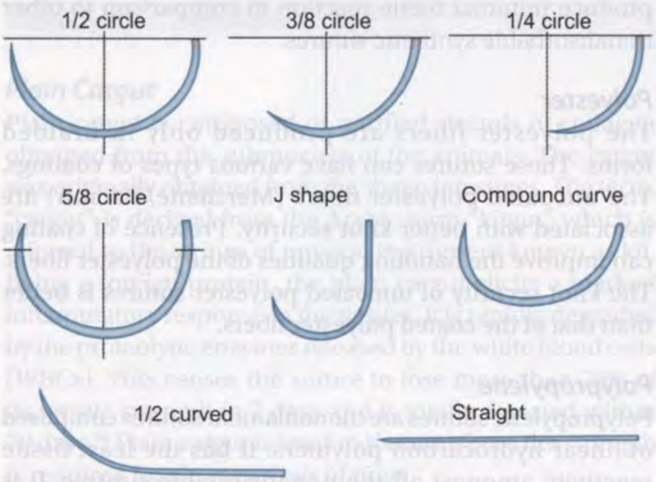


Fig. 5.10: Different types of needle shapes

Eye of the Needle

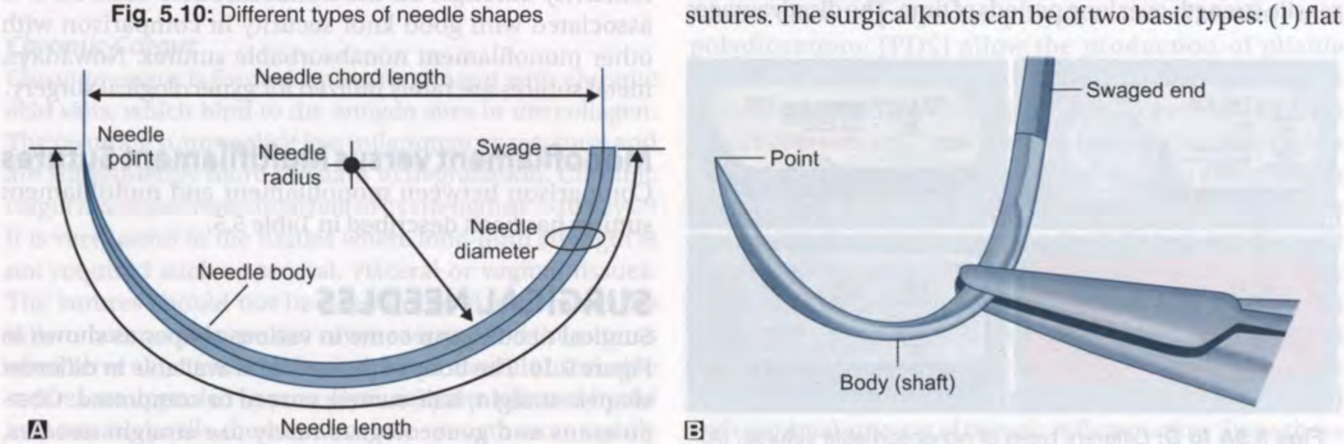
Eye of the needle is the point of attachment of the suture. The eye of the needle can be of three types: (1) closed, (2) French or (3) swaged. Closed eye of the needle is similar to that of the household sewing needle. French eye of the needle is the slit having ridges, which helps in grasping the sutures. The swaged needle is an eyeless needle in which the suture is mechanically attached to the needle end in the form of a continuous unit.

Point of the Needle

It begins at the widest part of the body of the needle and extends up to the extreme tip. The needle points can be of two types: cutting point and the tapered point (Fig. 5.12). Tapered points needles are commonly used in friable tissues, which are likely to be easily perforated such as bowel and peritoneum. Taper needles gradually taper to a point. A cross section taken anywhere along the shaft would show a round shaft as shown in Figure 5.12. Cutting points can be of two types: (1) conventional and (2) reverse. The tip of the conventional cutting needle is triangular in shape and the apex forms a cutting surface which enables penetration of tough tissues such as skin. The conventional cutting point needles have a sharp edge on the inside of the curve. In the reverse cutting needles, the sharp edge is on the outer curve of the needle. The reverse cutting needles are similar to the conventional cutting needles except that their sharp edge is on the outside of the outer curve, rather than being on the inside of the curve. This helps in reducing the likelihood of the sutures pulling through the tissues.

SURGICAL KNOTS

Whether the surgical knot is tied properly or not acts as the deciding point for the overall tensile strength of the surgical sutures. The surgical knots can be of two basic types: (1) flat



Figs 5.11A and B: (A) Characteristics of a curved surgical needle; (B) Correct way of holding a curved surgical needle

Table 5.6: Various structures which can be sutured using different needle shapes

Needle Shape	Structure which can be Sutured
¼ circle	♦ Eye ♦ Microsurgery
3/8 circle	♦ Dura ♦ Eye ♦ Fascia ♦ Nerves
½ circle	♦ Muscle ♦ Eye ♦ Skin ♦ Peritoneum
5/8 circle	♦ Cardiovascular surgery ♦ Oral surgery ♦ Pelvis ♦ Urogenital tract
Straight	♦ Nasal cavity ♦ Nerve ♦ Skin ♦ Tendon
J-shaped	♦ Laparoscopy
Compound	♦ Eye (anterior segment)

knots and (2) the sliding knots. Flat knots can be of three types (Fig. 5.13): (a) square knot, (b) surgeon's knot and (c) granny's knot and would be described in details next in the text.[45] Sliding knots, also known as the slip knots can be identical, nonidentical and parallel.[46] Sliding knots are usually created when unequal tension is applied to the strands and may be useful in situations when tying a flat square knot is difficult and cumbersome (e.g. in deep pelvis or in vagina). Sliding knots are associated with a higher failure rate than the flat knots.

Square Knot

In a flat square knot, the first throw is forehanded and the second throw is backhanded. After the two throws are applied, the suture strands are pulled with equal tension in the opposite direction in the same plane (Figs 5.14A to D).

Granny's Knot

Successive throws are identical in a Granny's knot, i.e. the first step is repeated twice. Therefore, the successive throws mirror each other in this case. Granny's knot is thereby less secure than a square knot.

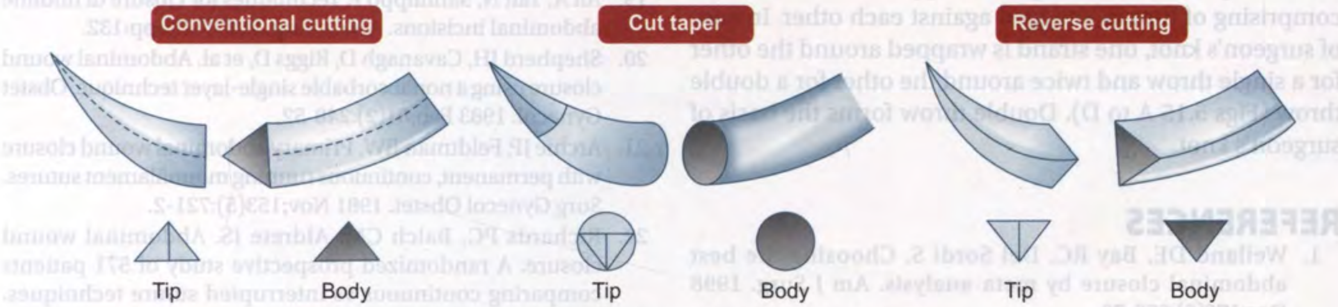


Fig. 5.12: Different types of needle points

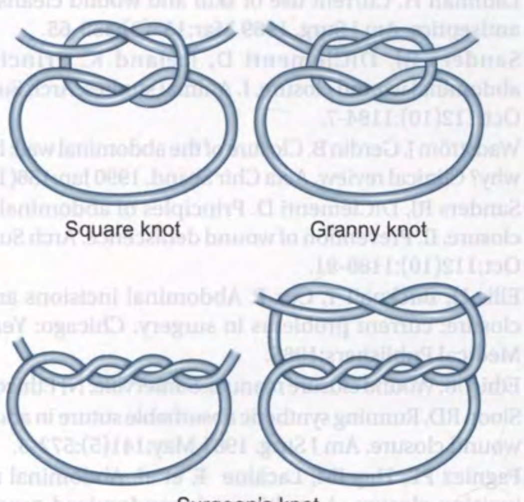
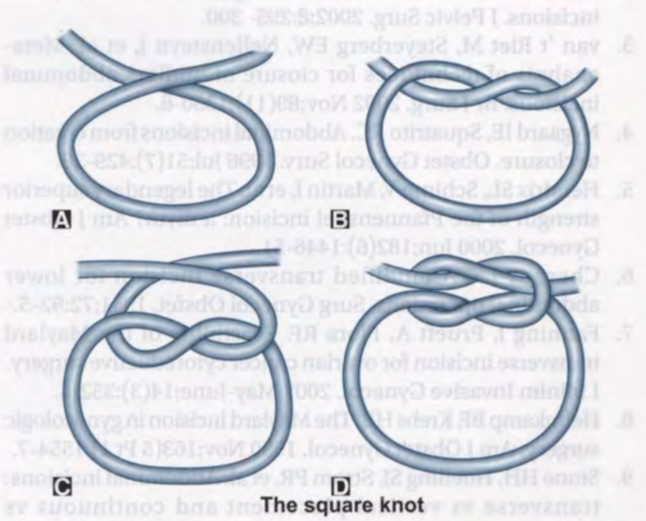
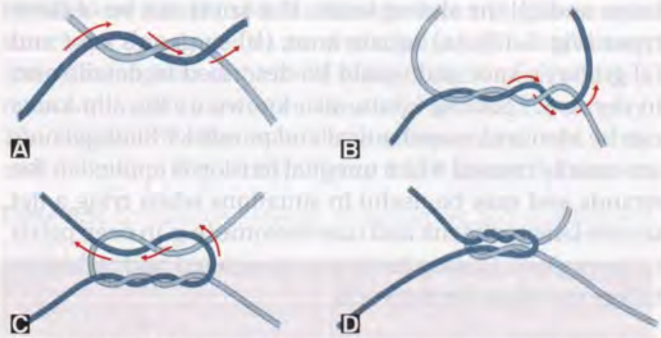


Fig. 5.13: Different types of surgical knots



Figs 5.14A to D: Steps for tying a square knot: (A and B) Right end of the cord is crossed over the left end, and brought around once; (C) Left end of the cord is crossed over the right end of the cord once; (D) The two ends of the knot are pulled until the knot becomes tight and secure



Figs 5.15A to D: Steps for tying a surgical knot: (A and B) Left end of the cord is crossed over the right end, brought around once and then twice; (C) Right end of the cord is crossed over the left end of the cord once; (D) The two ends of the knot are pulled until the knot becomes tight and secure

Surgeon's Knot

Surgeon's knot is same as a square knot except that the first throw is a double one. Due to this, the surgeon's knot is more secure than a square knot. It is sometimes often reinforced by a third single throw. A surgical knot consists of a loop, which helps in maintaining tissue apposition and a knot, comprising of throws snugged against each other. In case of surgeon's knot, one strand is wrapped around the other for a single throw and twice around the other for a double throw (Figs 5.15 A to D). Double throw forms the basis of surgeon's knot.

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SECTION 2

Operative Obstetrics

6

CHAPTER

Prenatal Diagnostic Procedures

INTRODUCTION

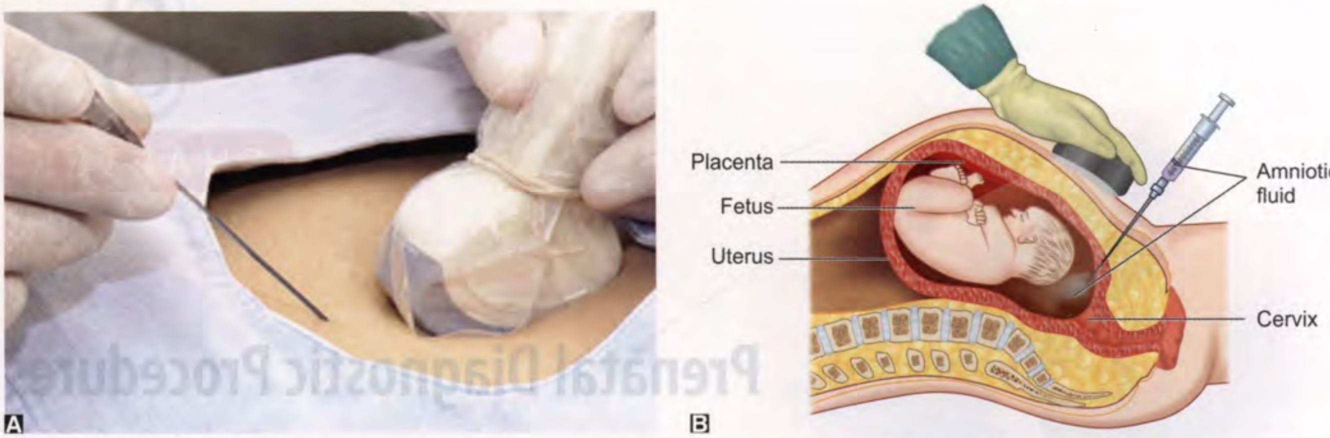
Prenatal testing aims at detecting various anomalies such as structural, chromosomal and genetic disorders in the fetus or the embryo before its birth, while it is still in utero. Some of these anomalies include neural tube defects, chromosomal anomalies, genetic disorders (cystic fibrosis, Tay-Sachs disease, thalassemia, sickle cell anemia, etc.) and other anomalies such as spina bifida, cleft lip, etc. Prenatal diagnostic procedures can be divided into two categories: (1) invasive and (2) noninvasive procedures. Common noninvasive procedures include ultrasound examination and maternal serum screens (e.g. alpha-fetoprotein levels in the serum). The invasive tests include procedures such as amniocentesis, chorionic villus biopsy and cordocentesis. All the three procedures help in providing fetal cells which can be used for determining fetal karyotype. All these three procedures would be discussed in this chapter. Prenatal diagnostic testing done for fetal karyotyping to identify babies with Down's syndrome most commonly involves amniocentesis at 16–20 weeks of gestation, or chorionic villus sampling (CVS) at 10–12 weeks of gestation.[1,2] The prenatal diagnosis of Down's syndrome by amniocentesis was first reported in 1968[3] and the procedure of CVS was first described later, in the same year.[4] The advantage of the invasive tests over the noninvasive ones is that these tests help in obtaining fetal tissue which would assist in the diagnosis of various chromosomal and genetic disorders of the fetus with the help of various cytogenic, molecular or biochemical tests. Fetal blood sample obtained through cordocentesis helps in detection of various hematological abnormalities and infections. The choice regarding the exact procedure to be performed is usually based on the period of gestation. CVS is performed at 10–12 weeks, amniocentesis at 16–20 weeks and cordocentesis between 18 to 24 weeks of gestation. Karyotype evaluation of fetal cells can be done with the help of tests such as FISH (fluorescence in situ hybridization), chromosomal banding, comparative genomic hybridization (CGH) or array CGH.

It is important to inform the patient at the time of counseling, before undertaking any of these prenatal diagnostic cytogenic tests that even if the results of amniocentesis or CVS report gives finding of normal fetal karyotype and amniotic fluid alpha-fetoprotein levels are within normal limits, it does not guarantee the birth of a normal newborn. This is so as there are many types of birth defects and mental retardation cases which might be associated with a normal karyotype. Thus, these defects would be missed on amniocentesis or CVS.

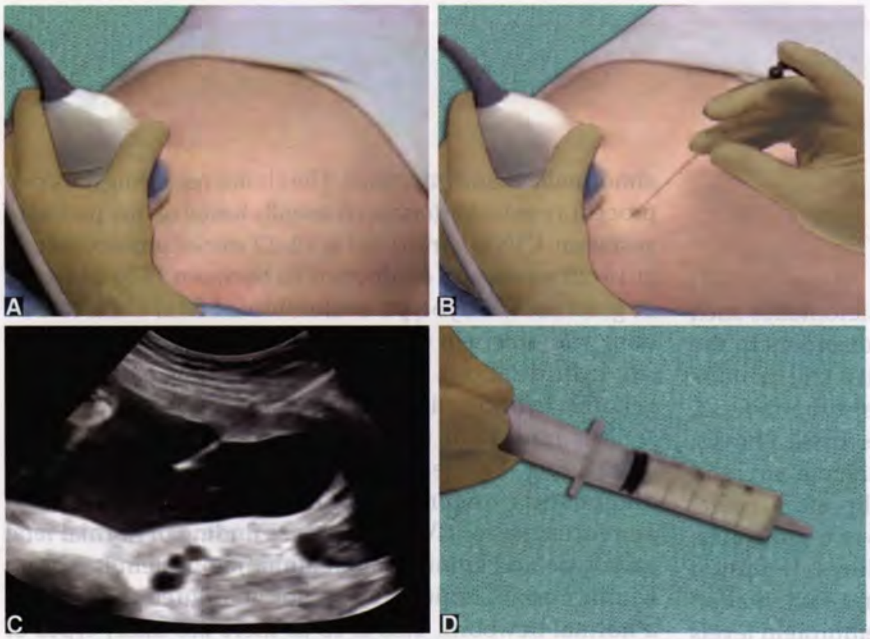
OVERVIEW OF SURGERY

Amniocentesis

Amniocentesis is a prenatal diagnostic procedure which involves the use of ultrasound-guided, needle-insertion technique for aspiration and sampling of amniotic fluid.[3] The procedure of amniocentesis has been demonstrated in Figures 6.1 and 6.2. The procedure of amniocentesis, when performed initially in 1968 was a "blind" one, involving the palpation of the outline of the uterus and insertion of a needle into the selected spot, with the aim that it would reach the amniotic fluid surrounding the fetus. Amniocytes, obtained from the amniotic fluid are used for cytogenetic and molecular genetics studies. Also, alpha-fetoprotein



Figs 6.1A and B: (A) Procedure of amniocentesis; (B) Diagrammatic representation of the procedure of amniocentesis



Figs 6.2A to D: Step-by-step demonstration of the procedure of amniocentesis: (A) Placing the ultrasound probe over the abdomen; (B) Needle insertion under ultrasound guidance; (C) Ultrasound showing needle tip inside a pocket of amniotic fluid; (D) Syringe containing amniotic fluid

levels of amniotic fluid can be determined. Biochemical analysis of amniotic fluid helps in assessment of pulmonary maturity, diagnosis of open neural tube defects and for the assessment of various viral and bacterial infections. Nowadays, this procedure is performed under "ultrasound guidance", in which the uterine contents and the position of the placenta are visualized prior to amniocentesis.

Amniocentesis has proven to be a safe and effective technique for prenatal diagnosis and can be performed after approximately 11 weeks of gestation. However, it is usually performed between 15 to 17 weeks of gestation when the ratio of viable to nonviable cells in the amniotic fluid is the greatest and sufficient amount of amniotic fluid (up to 200–250 mL) is present. Approximately 15–20 mL of amniotic fluid is aspirated out. At times, amniocentesis may be performed in the early second trimester (prior to 15 weeks). This helps in providing prenatal diagnosis at an early period of gestation so that if the woman elects to undergo medical termination of pregnancy (MTP) after abnormal results, it can be done easily. However, early amniocentesis may be technically difficult because of reduced amniotic fluid volume. Since the number of amniocytes is fewer at this stage, a longer time may be required to grow an adequate number of cells. Moreover, early amniocentesis performed in the early second trimester has not been shown to be a safe procedure by many research trials. In a randomized controlled trial by "The Canadian Early and Mid-trimester Amniocentesis Trial (CEMAT) group", it was shown that early amniocentesis, at 11–14 weeks of gestation, was associated with higher fetal loss rate and increased risk of fetal anomalies (especially talipes equinovarus) when compared with the other procedures.[4] Royal College of Obstetricians and Gynaecologists (RCOG) has recommended that an early amniocentesis should be undertaken only in exceptional circumstances after the mother has been made fully aware of the potential complications.[5]

Amniocentesis in the third trimester can be carried out for a number of indications, including late karyotyping, amniotic fluid optical density assessments for rhesus disease, amniotic fluid insulin measurements, lung maturity studies (measurement of components of pulmonary surfactant) and detection of indices of suspected preterm labor or rupture of the membranes (amniotic fluid fibronectin levels).[6] Amniocentesis in the third trimester is performed under continuous ultrasound guidance. Third-trimester amniocentesis does not appear to be associated with significant risk of emergency delivery. Compared with midtrimester procedures, third-trimester amniocentesis, when performed under continuous ultrasound guidance is associated with a high success rate and a low risk of complications.[7]

Chorion Villus Biopsy

Chorionic villus sampling is a prenatal diagnostic technique in which a sample of fetal chorionic tissue is obtained from the chorion frondosum (future placenta) between 10 to 14 weeks of gestation. A larger amount of fetal DNA is obtained through CVS in comparison to amniocentesis. With the introduction of first-trimester screening programs there has been a decline in the rate of CVS especially amongst women more than 35 years of age. CVS is performed either with the help of a catheter inserted transcervically (transcervical CVS) or a needle inserted transabdominally (transabdominal CVS) under ultrasound guidance. The third type of CVS procedure (transvaginal CVS) is rarely done nowadays.

The decision regarding whether CVS is to be performed transabdominally or transcervically is usually made by the obstetrician based on the placental localization. Fundal placenta or that located within upper two-thirds of the uterine walls is better approached with transabdominal route as compared to transcervical route. On the other hand, placenta located in the lower one-third of the uterine walls is better approached by transcervical route. Majority of CVS procedures are performed by transabdominal route. Since this procedure can be performed during the first trimester, it helps in providing better options for safely terminating a pregnancy. While CVS is commonly performed between 10 to 12 weeks, it can also be performed as early as 6–9 weeks of gestation. However, in order to minimize the teratogenic effects of CVS, it is usually performed 10 weeks onwards.

Cordocentesis

Cordocentesis, also sometimes called percutaneous umbilical cord blood sampling (PUBS), was performed for the first time in 1974 for diagnosis of hemoglobinopathies. It is a diagnostic test which aims at detection of fetal anomalies (e.g. blood disorders like hemolytic anemia, etc.) through direct examination of fetal blood. This test is used for the chromosomal analysis when the period of gestation is so advanced that the tests such as amniocentesis and chorion villus biopsy cannot be carried out. Cordocentesis is usually performed during 18–24 weeks of pregnancy. In cases of fetal anemia, such as Rh-negative immunized women, and cases of nonimmune hydrops, the procedure of cordocentesis helps in estimating the fetal hemoglobin and hematocrit levels. It can be used for the diagnosis of hematological disorders such as thrombocytopenia; diagnosis of congenital infections such as rubella, cytomegalovirus (CMV), toxoplasmosis, etc. and for fetal blood gas analysis. This procedure can also be used for therapeutic purposes such as intrauterine transfusion, drug therapy (in cases of fetal arrhythmias) and for stem cell transplantation.

AIMS OF SURGERY

- Amniocentesis involves transabdominal aspiration of amniotic fluid, which contains fetal cells.
- Chorionic villus sampling involves aspiration of fetal placental tissue by aspiration of chorion villi from chorion frondosum either through the transabdominal or transcervical route. Since the cells of chorionic villi are same as the fetal cells, cytogenic analysis of the villus cells gives information identical to that of the fetal cells.
- Cordocentesis is a diagnostic test which aims at detection of fetal anomalies through direct examination of fetal blood, late in pregnancy when other tests cannot be used.

INDICATIONS

The indications for various prenatal diagnostic tests are as follows:

- Advanced maternal age of more than 35 years
- Family history of genetic disorders/chromosomal anomalies (Thalassemia/hemophilia/Duchenne muscular dystrophy, etc.)
- History of recurrent miscarriages or stillbirths
- Ultrasound examination showing the presence of congenital anomalies
- Abnormal results of maternal biochemical screening
- Early onset intrauterine growth restriction (IUGR) or oligohydramnios of severe degree
- Maternal congenital infections
- Exposure to teratogens
- Amniocentesis in late pregnancy (after 32 weeks) is done for the assessment of fetal lung maturity.

PREOPERATIVE PREPARATION

Preoperative preparation for all the three procedures is more or less the same and is described below.

- *Informed consent:* The procedure should be performed only after the woman has given informed consent.

Before performing the procedure, the obstetrician must counsel the patient regarding the procedure, indications, advantages, disadvantages and the risks involved to the patient and her baby.

- *Determination of maternal blood group:* Maternal blood group including Rh factor needs to be determined before performing the procedure. If the mother is Rh-negative, she should be administered Rh-immune globulins in order to prevent fetal isoimmunization.
- *Preprocedure ultrasound evaluation:* A comprehensive preprocedure ultrasound examination needs to be performed in order to determine the gestational age, number of gestational sacs, placental localization, and to rule out multifetal pregnancy or presence of fetal congenital anomalies. Nowadays, various prenatal diagnostic procedures are usually performed under the "ultrasound guidance", in which the uterine contents and the position of the placenta are visualized prior to the insertion of needle/catheter and a suitable point on the mother's abdomen for the needle insertion is marked before performing the particular procedure.
- *Aseptic technique:* Strict asepsis should be maintained at the time of the procedure. After cleaning and draping, the patient is placed in the lithotomy position.
- *Local anesthesia:* Though local anesthesia is commonly used, there is little evidence regarding the benefit of the use of local anesthesia or analgesic drugs prior to the procedure.[8]
- *Cervicovaginal cultures:* Cervicovaginal cultures must be obtained prior to transcervical CVS in order to rule out infection with pathogens such as gonorrhea, chlamydia, group B streptococcus, etc. In case of infection, appropriate antibiotics must be administered.
- *Extra preoperative steps in case of cordocentesis:* The following preoperative steps are those, which may be required in cases undergoing cordocentesis:
  - *Antenatal glucocorticoids:* Glucocorticoids may be administered at least 24 hours prior to cordocentesis in fetuses between 24 to 34 weeks of gestation in order to enhance fetal lung maturity, in case this has not been previously documented.
  - *Intravenous access:* An intravenous line must be secured in the patient so that she can be administered analgesics, antibiotics, and fluids, as required. This may also be required to prepare the patient in the anticipation of procedure-related complications requiring an emergent cesarean delivery.
  - *Antibiotic prophylaxis:* Broad spectrum antibiotic prophylaxis can be administered 30–60 minutes prior to the procedure in order to minimize the risk of intra-amniotic infection, which may sometimes occur after the procedure in case strict asepsis was not maintained during the procedure.
  - *Maternal local anesthesia and sedation:* Local anesthesia can be optionally used in case of diagnostic procedures. However, it is usually required in cases of therapeutic procedures (e.g. transfusions) to reduce the patient discomfort associated with an increased duration of needle insertion. Maternal sedation is generally not required either for diagnostic or therapeutic procedures.
  - *Fetal paralytic drugs:* Restriction of fetal movement is usually not required in cases of diagnostic procedures. However, it may be required in cases of prolonged procedures (e.g. fetal transfusion) where fetal movement is likely to dislodge the needle. In these cases, atracurium (0.4 mg/kg) may be administered intramuscularly in order to produce fetal paralysis for up to an hour, at the same time producing minimal fetal cardiovascular effects.

SURGICAL STEPS

AMNIOCENTESIS

Following the preoperative preparation, the ultrasound probe is placed over the abdomen and the needle is inserted through the marked point. Previously, the visualization of amniotic fluid pocket was done under the ultrasound guidance prior to the needle insertion. The ultrasound probe was removed at the time of needle insertion. However, nowadays at most of the tertiary centers, the amniocentesis needle is inserted under "continuous ultrasound control" by using the real-time ultrasound equipment. Continuous visualization of the amniocentesis needle through real-time ultrasound examination has greatly helped in reducing the risk of blood-staining of liquor from 2.4% to 0.8%.[9-12] The current RCOG recommendations are that amniocentesis must be performed under "continuous ultrasound control" in order to avoid "bloody taps", because the presence of blood interferes with amniocyte culture.[6]

- Once the ultrasound examination is complete, sterile preparation of maternal abdomen is done. Since nowadays, the amniocentesis is performed under ultrasonic guidance, the best practice to maintain asepsis during the procedure of amniocentesis is to enclose the ultrasound probe in a sterile bag and to use separate sterile gel for the probe.
- The ultrasound scanning during the procedure is usually performed by the same person inserting the needle. While inserting the needle, the obstetrician must try as much as possible to avoid passing through the placenta. However, a transplacental approach has been shown to be safe and appropriate, if it provides easy access to a pool of amniotic fluid.[13-15] Care must be taken to avoid cord insertion. All research studies have emphasized the need to place the needle through the thinnest available part of the placenta. The RCOG has recommended that the outer diameter of the amniocentesis needle used should not be wider than 20 gauge (0.9 mm) and it must be inserted in two rapid, successive steps.[6] A spinal

needle having a standard length of 8.9 cm (excluding the hub) is commonly used. Longer needles having a length of 15 cm are also sometimes used. Before the insertion of amniocentesis needle, the area selected for needle insertion should be visualized with color Doppler to exclude the presence of placental or uterine blood vessels. The point of needle insertion is usually chosen as an area, which shows the presence of a large pocket of amniotic fluid, away from the fetus. Insertion through the placenta must be avoided and the needle tip must be kept away from the fetal face and cord.

- On entering the amniotic fluid pocket, the stylet is withdrawn. This causes the amniotic fluid to come out freely through the needle hub. Sometimes, instead of connecting the syringe directly to the needle, a plastic connecting tube is then attached to the needle hub at one end and to a 10 cc plastic syringe at the other end. Presence of the connecting tube helps in preventing abrupt, jerky motion of the needle, thereby preventing fetal needle-related injuries.[7]
- A 2-mL syringe is connected to the needle hub. Initial 1–2 mL of fluid which is withdrawn is usually discarded due to the possibility of contamination with blood.
- Approximately 15–20 mL of amniotic fluid is then obtained and transferred to the transportation tubes.
- The two samples of 10 mL each are taken in two separate aliquots and sent to the laboratory for cytogenic analysis and alpha-fetoprotein determination, respectively.
- Since the amount of amniotic fluid increases with the increasing period of gestation, a rule of thumb commonly employed for removing an appropriate amount of amniotic fluid is to take a volume (in mL) which is equivalent to the gestational age in weeks (e.g. 17 mL at 17 weeks of gestation).

CHORIONIC VILLUS SAMPLING

There is consensus that CVS, both transabdominal and transcervical, have to be performed under continuous ultrasound control.[5] The two procedures differ from each other in terms of the method of villous aspiration.

Transcervical CVS

- The procedure of transcervical CVS is shown in Figure 6.3. After the cervix and vagina have been cleaned with an antiseptic solution, a sterile polythene catheter 26 cm long, with an outer diameter of 1.5 mm and a soft stainless steel obturator is inserted inside the endocervical canal so that it lies parallel to the chorion frondosum.
- Once the tip of the catheter is in the desirable position, the obturator of the catheter is removed.
- Then a 20 mL syringe containing small amount of culture medium is connected to the catheter. The catheter is moved back and forth couple of times, while negative suction pressure is applied to suck in the placental tissue.

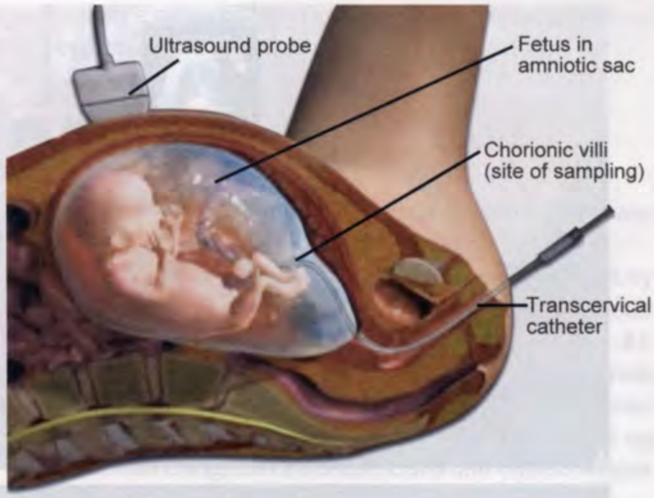


Fig. 6.3: Procedure for transcervical chorionic villus sampling (CVS)

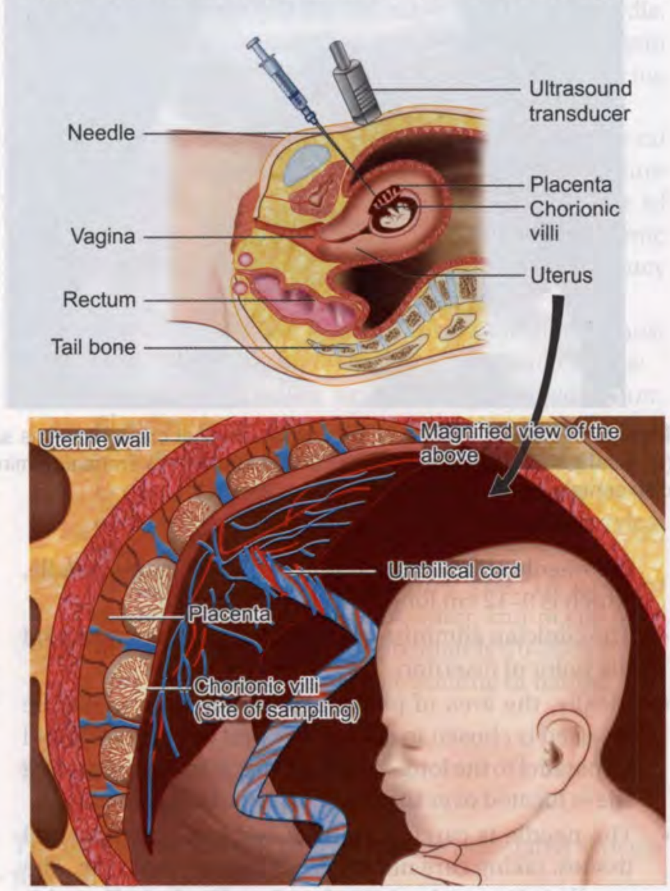


Fig. 6.4: Diagrammatic representation of the procedure of transabdominal chorionic villus sampling (CVS)

- The sample of tissue obtained, is sent to the laboratory for cytogenic analysis.

Transabdominal CVS

- The procedure of transabdominal ultrasound is demonstrated in Figures 6.4 and 6.5. Under ultrasound guidance, the surgeon visualizes the area from where

Figs 6.5A to D: Procedure for transabdominal chorionic villus sampling (CVS): (A) Visualization of placenta using the ultrasound; (B) Insertion of needle under ultrasound guidance; (C) Transabdominal ultrasound showing needle in the region of chorionic villi; (D) Petri dish containing chorionic villus tissues

the needle will be punctured. An 18–20 gauge needle, which is 9–12 cm long, with a stylet is used.

- The clinician administers local anesthetic agent around the point of insertion.
- Ideally, the area of placenta where needle would be inserted is chosen in such a way that the needle would be parallel to the long-axis of the placenta. The sampling site is located over the thickest part of the placenta.
- The needle is carefully introduced into the placental tissues, taking care not to pierce the amniotic sac. The needle is inserted using a free-hand technique and is slowly moved back and forth a number of times along the chorion frondosum.
- A 20-mL syringe containing 1–2 mL of the culture media is attached to the needle, through which the placental tissue is aspirated after application of negative suction pressure. The syringe should fit snugly over the needle in order to create an adequate amount of vacuum.
- The needle is rotated several times in order to loosen the villi. Up and down movements are made along the length of placenta about 3–4 times. Villi are slowly aspirated out. Villi with culture medium in the syringe are flushed into a Petri dish and examined.
- The aspirated tissue is then sent to the laboratory for analysis. The tissue that gets contaminated with blood, decidua or mucus should be discarded. Irrespective of the route of CVS, the sample must be taken in a strictly sterile container.

CORDOCENTESIS

The procedure of cordocentesis involves the following steps (Fig. 6.6):

- A thin needle (20–22 gauge) must be inserted through the abdomen and uterine walls into the umbilical cord under ultrasound guidance. Placental origin of the cord is the best site for cordocentesis. If this site is not accessible, then a full loop of cord can be selected for the puncture. Fetal side of cord should preferably be avoided. Length of the needle is decided on the basis of distance from the skin to the site of puncture.

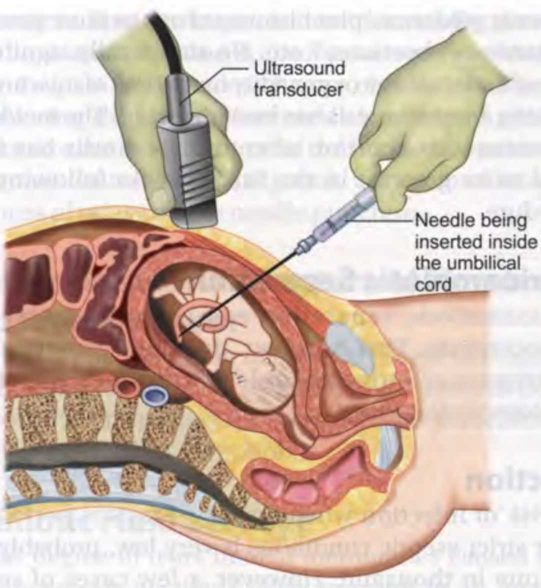


Fig. 6.6: The procedure of cordocentesis

- *Sampling site:* The first step in sampling the umbilical cord is to identify a fixed segment of the cord, preferably where the cord inserts into the placenta. Doppler color flow ultrasound can be used for confirming the placental cord insertion site. The abdominal insertion site of cord is not chosen because it is likely to become unstable, in case the fetus moves. The main drawback of using the placental insertion site is the possibility of contamination by maternal blood. It is easier and safer to sample the umbilical vein in comparison to the umbilical artery. Moreover, sampling of the umbilical artery is associated with an increased risk of bradycardia and prolonged postprocedural bleeding.

The procedure of cordocentesis is easiest when the placenta is anterior; however, this may be associated with an increased risk of fetomaternal hemorrhage (FMH) and fetal loss in case the placenta is penetrated. These complications are less likely to occur in case the placenta is posterior. However, in these cases, the fetus may obstruct access to the target portion of the cord. In these cases, manipulation of the maternal abdomen to move the fetus may help in providing better access to the sampling site.

- When the needle tip reaches the cord, a sharp and quick puncture is made over the wall to achieve penetration into the vessel. Tip of the needle can be visualized inside the vessel lumen.
- The stylet is withdrawn; syringe attached and approximately 2–4 mL of fetal blood is aspirated. After the blood has been obtained, the needle is withdrawn.
- *Blood sample:* Upon entering the umbilical cord, the stylet is removed and fetal blood is withdrawn into a syringe attached to the hub of the needle. The syringe may be preloaded with a small amount of anticoagulant. Proper positioning of the needle can be confirmed by injection of physiological saline solution into the cord. Presence of turbulent flow along the vessel confirms correct needle positioning.

POSTOPERATIVE CARE

The postoperative steps for all the three procedures are more or less the same and involve the following:

- *Administration of anti-Rh immunoglobulins:* Any invasive procedure like amniocentesis, CVS, etc. should be followed by administration of anti-Rh immunoglobulins. Except for first-trimester abortion where the dose required is 50 µg, in all other situations the dose of Rh immunoglobulins required is 300 µg [American Congress of Obstetricians and Gynecologists (ACOG)].[16]
- *Postprocedural ultrasound examination:* At the completion of the procedure and removal of the needle, an ultrasound examination must be performed again to check for fetal heart rate and to ensure well-being of the baby.
- *Confirmation of fetal well-being:* Electronic fetal monitoring must be performed after the procedure in order to ensure the fetal well-being. Presence of fetal bradycardia or late decelerations on electronic fetal monitoring may be an indication for emergency cesarean section.
- *Signs of complications:* Postoperatively, the patient must be observed for the following signs of complications:
  - *Excessive bleeding or discharge per vaginum:* Bleeding is more common following transcervical CVS in comparison to the transabdominal one.
  - *Fever:* Fever is more common following transabdominal CVS in comparison to the transcervical one.
  - *Bleeding from the puncture site:* In case of cordocentesis, transient bleeding can occur from the puncture site in approximately 10–20% cases. This bleeding is usually self-limiting in nature.

ADVANTAGES

The prenatal diagnostic procedures are associated with the following advantages:

- Enable timely medical or surgical treatment of a condition.
- Give the parents a chance to abort the diseased or abnormal fetuses. CVS helps in providing information about the fetus at an early gestational age. This enables the couple in making appropriate reproductive decisions.
- Give the parents a chance to prepare themselves psychologically, socially, financially and medically for a baby with a particular health problem or disability or to an increased likelihood of stillbirths.

DISADVANTAGES

Some contraindications for CVS are listed in Table 6.1.

COMPLICATIONS

AMNIOCENTESIS

Amniocentesis is a commonly performed invasive procedure. Though it is associated with a low complication rate, when performed under ultrasonic guidance, the patients need to be counseled regarding the possibility of a few likely complications. Some of these include, fetal miscarriage, risk of infection, leaking per vaginum, etc. These would be described below in detail.

Miscarriage

One of the most important concerns to both mother and the clinician is the risk of pregnancy loss related to the invasiveness of the procedure. Different studies have shown different rates for spontaneous abortions, with the rates varying from 0.5% to 1% in most cases.[17-21] According to the RCOG guidelines, the rate of miscarriage associated with amniocentesis is approximately 0.5–1% above the normal risk for spontaneous miscarriage among the general population.[5]

Some of the factors tend to increase the risk of spontaneous abortion following amniocentesis. These include, increased levels of maternal serum alpha-fetoprotein (MSAFP) before amniocentesis, perforation of the placenta during amniocentesis, withdrawal of discolored amniotic fluid, avoiding concurrent use of ultrasonic guidance,[7] past histories of one or more previous spontaneous abortions,[22] etc. No statistically significant effect of maternal age or gravidity on the risk of miscarriage following amniocentesis has been detected. The incidence of spontaneous abortion after amniocentesis has been found to be greatest in the first 3 weeks following the procedure.

Table 6.1: Contraindications for chorionic villus sampling (CVS)

Absolute Contraindications for Transcervical CVS
• Vaginismus • Cervical stenosis • Cervical myomas • Cervical infection • Myomas present in lower uterine segment, which obstruct access to the placenta in the fundus • Severe anteflexion or retroflexion of the uterus that renders the placenta inaccessible to the intracervical catheter
Absolute Contraindications for Transabdominal CVS
• Extreme uterine retroflexion with loops of intestine present between the abdominal wall and uterus • Fetal position obstructing access to a placenta attached on the posterior wall of the uterus
Relative Contraindications for CVS (Both Transabdominal and Transcervical)
• Maternal Rh isoimmunization • Presence of an intrauterine device

Chorioamniotic Separation

Chorioamniotic separation can occur as a result of amniocentesis. This however, does not usually affect the pregnancy outcome unless it extends for entire chorioamniotic surface.

Infection

The risk of infection when amniocentesis is performed under strict aseptic conditions is very low, probably less than one in thousand. However, a few cases of severe sepsis resulting in maternal death, have been reported following amniocentesis. Infection can be caused by inadvertent puncture of the bowel, skin contaminants or organisms present on the ultrasound probe or gel.[23] The infection due to presence of skin contaminants or due to organisms present on the ultrasound probe can be avoided by following standard practices for maintaining asepsis. As mentioned previously, the best practice recommended by RCOG for maintaining asepsis during the procedure of amniocentesis is to enclose the ultrasound probe in a sterile bag and to use separate sterile gel for the probe.[5]

Rare Injuries

Rarely, severe injury can result from the amniocentesis procedure, including hemorrhage, gangrenous limbs, pneumothorax, ocular trauma, cardiac tamponade, peripheral nerve damage, fistula formation, intracranial abnormalities, bowel abnormalities, fetal cutaneous scarring, laceration of various internal organs, fetal demise, etc.[18]

Fetal Cutaneous Scarring

The incidence of fetal cutaneous scarring secondary to amniocentesis is estimated to be approximately 1–3%.[24] However, the actual rate is probably higher, since these marks are often inconspicuous at birth and infants are seldom examined thoroughly for needle puncture scars at that time. The frequency of fetal cutaneous scarring significantly increases when women undergo multiple attempts at amniocentesis during a given pregnancy.[25] The areas of cutaneous trauma may be overlying the areas of serious internal injury. Needle injury can result in multiple scars at several locations particularly the extremities, abdomen, back, buttocks and neck. Some scars are linear, possibly resulting from a tangential path taken by the needle, and some are circular. Though inexperienced surgeons while performing amniocentesis are more likely to result in fetal puncture, sometimes needle punctures may be unavoidable due to abrupt movements of the fetus. Over the past few decades, the use of real-time ultrasonic monitoring during amniocentesis has helped clinicians determine the exact position of the fetus while performing the amniocentesis. This has greatly helped in reducing the chances of injury due to needle puncture.

Preterm Premature Rupture of Membranes and Preterm Labor

The risk for development of preterm premature rupture of membranes (PPROM) is 3% and that for preterm delivery is about 8%. The procedure, however, is not associated with an increased risk of abruption.

Amniotic Fluid Leakage

Minor degree of tears in fetal membranes caused by the amniocentesis needle is likely to result in an increased risk of leaking per vaginum related to amniotic fluid leakage. This is most likely to occur in the first 6 weeks following amniocentesis. However, this does not result in any significant increase in the rate of vaginal bleeding. Rupture of the fetal membranes is common, but can be a potentially serious complication of amniocentesis. Quintero has described a technique to seal the defect present in fetal membranes in which intra-amniotic injection of platelets and cryoprecipitate (amniopatch or blood patch) is used for the treatment of amniocentesis induced premature rupture of membranes.[26] The technique is simple and does not require knowledge about the exact location of the defect.[27] However, the appropriate dose of platelets and cryoprecipitate yet needs to be established.

Vertical Transmission

There have been reports of mother-to infant-transmission of viral infections such as hepatitis, CMV, toxoplasmosis, human immunodeficiency virus (HIV), etc. related to the procedure of amniocentesis.[28,29] The highest risk of transmission is related to HIV infection. The risk appears lowest amongst women receiving highly active antiretroviral therapy (HAART).

CHORIONIC VILLUS SAMPLING

Some of the complications associated with the procedure of CVS are listed below:

- *Fetal loss/miscarriage:* The most serious complication, occurring as a result of CVS is fetal damage or loss. CVS may be associated with a pregnancy loss rate of 0.7–2%, which is higher than that associated with amniocentesis. CVS can be considered to be less safe than second-trimester amniocentesis, and the additional risk seems to be limited to transcervical CVS.
- Mild transient cramps
- Bleeding per vaginum
- Infection
- Rupture of membranes
- *Vertical transmission of maternal infection:* There is also a risk of vertical transmission of maternal infection such as hepatitis, HIV, etc.
- *Failure to obtain an adequate sample:* The failure rate of CVS is dependent upon the operator experience. At the first attempt, the success rate is estimated to be about 80% and at the time of second attempt it is 90%. More than two attempts for a particular procedure at the time of same sitting are usually not recommended.
- *Fetal defects:* CVS, performed before 10 completed weeks of pregnancy, has been found to be associated with fetal defects like oromandibular facial defects, limb hypoplasia, isolated limb disruption defects, etc.[30] In order to reduce the incidence of these defects the RCOG has recommended that CVS should not be performed before 10 completed weeks of gestation.[5] This risk appears to be very low (1 in 3,000) when CVS is performed after 10 weeks gestational age.
- *Fetomaternal hemorrhage:* FMH has been recognized and may occur due to an increase in MSAFP levels following CVS. FMH has been suggested as one cause of fetal loss after CVS. This is particularly so in cases where the level of MSAFP is very high or continues to rise after CVS.

CORDOCENTESIS

Cordocentesis is mainly associated with fetal complications, some of which can be even fatal.[31] These may include life-threatening complications such as bleeding, bradycardia and infection. Maternal complications unrelated to the pregnancy are unlikely to occur.

- *Hemorrhage:* Bleeding from the puncture site is the most common complication of cordocentesis, occurring in about 20–30% of cases. Puncture of the umbilical artery is associated with a significantly longer duration of bleeding in comparison to venipuncture. Fetuses with defects in platelet number or function are particularly at a significant risk for developing potentially fatal bleeding from the puncture site. A transfusion of 15–20 mL of platelet concentrate helps in increasing the fetal platelet count by 70,000 to 90,000, which is adequate for preventing bleeding from the cord puncture site. If continued bleeding is noted from the puncture site, management either comprises of immediate delivery, if considered safe based on gestational age, or attempts must be made for the restoration of fetal volume.
- *Cord hematoma:* Cord hematoma is usually asymptomatic, but can be associated with a transient or prolonged sudden fetal bradycardia. Expectant management is recommended in the presence of reassuring fetal heart rate monitoring and a nonexpanding hematoma. However, delivery is indicated if signs of nonreassuring fetal status persist.

- *Fetomaternal hemorrhage:* A significant fetomaternal transfusion occurs in approximately 40% of cases. These fetomaternal bleeds may be defined by either greater than 50% increase in MSAFP concentration in blood following the procedure or presence of greater than 1 mL of FMH as calculated by Kleihauer-Betke staining of the maternal blood.

  Fetomaternal hemorrhage is more common with an anterior than a posterior placenta, with procedures lasting longer than 3 minutes, and with those requiring two or more needle insertions. The main consequence of a small FMH is an increase in maternal antibody titers when the procedure is performed in cases of red blood cell isoimmunization.
- *Bradycardia:* Transient fetal bradycardia has been reported in 5–10% of fetuses. Most cases resolve without intervention within 5 minutes. This complication occurs due to a vasovagal response caused by local vasospasm.
- *Infection:* The procedure may be associated with the maternal risk for the development of chorioamnionitis.
- *Failure rate:* Cordocentesis may be associated with a failure rate of 9%.
- *Fetal loss:* The procedure has been found to be associated with an overall risk of fetal loss of 1.4% before 28 weeks of gestation, and an additional 1.4% risk of perinatal death after 28 weeks. This loss rate is significantly greater than that related to amniocentesis.
- *Vertical transmission of infection:* There is a risk for vertical transmission of infection in women with chronic hepatitis or infection with the HIV undergoing cordocentesis.

DISCUSSION

AMNIOCENTESIS VERSUS CVS

It is important for the obstetrician to know the differences between amniocentesis and CVS. They can use this information to counsel their patients. If the patient chooses to undergo first-trimester CVS over second-trimester amniocentesis, it helps in facilitating the earlier prenatal diagnosis of various genetic and cytogenetic disorders in the fetus. This, therefore, helps in earlier termination of affected pregnancies. Many times the patient may want to know the risks of pregnancy loss associated with amniocentesis versus that associated with CVS in order to decide the option between the two. The obstetrician usually takes the final decision regarding the particular invasive test which a patient would undergo, including the possibility of pregnancy termination, in the face of such information. If the risk of a pregnancy loss due to one procedure is greater than the other, choosing between the two on the basis of timing becomes a challenging decision. The obstetricians are required to balance the risks of the two procedures with their preferences for the timing of information. CVS would provide the information sooner and allow for an earlier, safer termination of pregnancy, if so desired.

Although CVS in general is thought to be more invasive and associated with higher rate of fetal loss, various studies performed till date have presented with conflicting results. Though a few studies have shown almost identical rate of miscarriage after CVS compared with amniocentesis, most randomized control trials indicate that the rate of miscarriage following CVS is higher in comparison to the second-trimester amniocentesis.[32-35] A fetal mortality rate of 0.5–1.0% is associated with this procedure. Chorionic villus sampling (by any route) in comparison with second-trimester amniocentesis has been found to show an excess pregnancy loss rate of 3%.[32] The comparison between the two types of CVS procedures shows that transabdominal and transcervical CVS are equally safe procedures for first-trimester diagnosis of fetal abnormalities.[36]

TRANSABDOMINAL VERSUS TRANSVAGINAL ROUTE OF CVS

Both the routes have comparable results and are performed between 10 to 12 weeks. Transcervical CVS is associated with a higher risk of ascending infection. Risk of threatened abortion and vaginal bleeding are more frequent with the transcervical route. The transcervical CVS has also been found to be associated with poor sampling efficacy in comparison to transabdominal route. Transcervical approach is usually opted in cases where the placenta is posterior and approach through the anterior route may not seem to be feasible.

PRENATAL DIAGNOSTIC PROCEDURES IN MULTIFETAL GESTATION

Amniocentesis

In case of multifetal gestation, a multineedle technique is most commonly adopted where a separate procedure is performed on each sac using separate and sequential insertion of a new needle for each amniotic cavity. The multineedle technique has not been found to be associated with an increased risk of adverse outcomes in comparison to the single needle technique.[37]

With the multineedle technique, amniotic fluid is aspirated from one sac and 2–3 mL of indigo carmine dye is injected prior to withdrawal of the needle. Methylene blue dye is usually not used due to the risk of methemoglobinemia and small bowel atresia in the neonate and the staining of skin. Amniocentesis is subsequently performed in the other sac by inserting a new needle and aspirating amniotic fluid. If the amniotic fluid sample is free of dye, it confirms that a different sac has been sampled. If triplets or higher order gestations are present, the dye indigo carmine is commonly injected into the second sac, once clear fluid has been aspirated from it. Following this, a third needle is inserted into the third sac and so forth until each sac has been sampled. Withdrawal of clear fluid confirms that a new sac has been successfully entered, whereas the aspiration of blue-tinged fluid indicates that a previously tapped sac has been re-entered by the needle.

Aspiration of both twin sacs using a single needle insertion into the uterus is an alternative technique which is used by some obstetricians because this technique is associated with reduced maternal discomfort in comparison to the multineedle technique. In this technique, the needle is inserted into the more anterior sac. Following the aspiration of fluid from the first sac, the needle is advanced under ultrasound guidance through the dividing membrane into the second sac. In this technique, no dye is used for confirmation of the origin of the fluid.

Chorionic Villus Sampling

In case of multifetal gestation, it is important for the obstetrician to determine the chorionicity (monochorionic from dichorionic placentas) before proceeding for the CVS because this knowledge will help determine the number of samples which need to be taken. An ultrasound examination can be used for evaluating the chorionicity.

In case of multifetal gestation, CVS can be performed by a transabdominal, transcervical or a combined transabdominal, transcervical approach.[38] In case of the combined approach, transabdominal route is adopted for one twin and transcervical route is adopted for the other. Only a single sample is required in the presence of monochorionic twins. In case of dichorionic twins if there are two separate placentas, two separate needle insertions are usually required. Combined transabdominal and transcervical approach may be required in some cases to avoid twin-twin contamination, e.g. in a case where one placenta is anterior and the other is posterior.

Cordocentesis

It may be difficult to locate an optimal site for cordocentesis in case of multifetal gestation. Moreover with multiple fetuses, the risk of complications is increased, as well. Studies have reported a fetal loss rate of 8–12% in twin gestations undergoing fetal blood sampling.[39,40]

CONCLUSION

One of the most devastating experiences for the obstetrician is to have a patient unknowingly give birth to a child suffering from Down's syndrome while the patient had been under their obstetric care all through the antenatal period. Both noninvasive and invasive techniques for prenatal diagnosis of Down's syndrome are available. The noninvasive screening tests comprise of estimation of certain biochemical markers. In the first trimester, the biochemical markers like β-hCG and pregnancy associated plasma protein-A (PAPP-A) are mainly used. In the second trimester, the biochemical screening tests mainly involve the use of triple test (α-fetoprotein, β-hCG, and unconjugated estriol) and quadruple test (α-fetoprotein, β-hCG, unconjugated estriol and inhibin A levels). Presently, screening of maternal serum to identify fetuses with Down's syndrome is routinely being offered during the second trimester of pregnancy. More recently, ultrasound features in the form of structural (major) and nonstructural (minor/soft markers) are being used to predict this risk. Presently nuchal thickness is the single most predictive sonographic marker for identification of fetuses at risk of Down's syndrome. The measurement of nuchal thickness is performed in the first trimester when the crown-rump length is about 45–85 mm.

Positive result on noninvasive tests is followed by performance of invasive tests, which involve the cytogenic analysis of fetal tissue. The two types of invasive tests commonly used are amniocentesis and CVS. Amniocentesis is commonly performed in the second trimester, whereas CVS is mainly performed in the first trimester. Amniocentesis involves transabdominal aspiration of amniotic fluid which contains fetal cells. CVS involves aspiration of fetal placental tissue by aspiration of chorion villi from chorion frondosum either through the transabdominal or transcervical route. In comparison to amniocentesis, CVS is associated with higher rate of fetal loss. Also, CVS is associated with a greater risk of sampling and technical failures in comparison to amniocentesis. Recently, much research has been done regarding the use of first-trimester screening. First-trimester screening would help in providing option for earlier termination of pregnancy and identification of fetuses with a high risk of development of Down's syndrome at an early stage. However, as yet first-trimester screening is not considered to be a safer option in comparison to second-trimester screening. Future research in the form of well designed, randomized controlled trials to establish and improve the safety and efficacy of first-trimester screening procedures needs to be done.

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CHAPTER 7

Forceps Delivery

INTRODUCTION

Operative delivery can be of two types: (1) abdominal method (cesarean section) and (2) vaginal-assisted delivery (forceps delivery or vacuum extraction). Over the past 10–15 years, the rate of cesarean delivery has increased, while that of instrumental vaginal delivery has fallen. The present trend is towards increasing use of vacuum delivery and this method is rapidly replacing forceps as the predominant method for instrumental vaginal delivery.

OVERVIEW OF SURGERY

Vaginal instrumental delivery involves the use of either forceps or vacuum to facilitate the delivery of fetal head. Both the types of assisted vaginal deliveries aid the delivery of fetal head through application of manual traction (forceps) or suction force (vacuum cup). Although, the most important function of forceps is application of traction, they also prove useful for rotating the fetal head, particularly those lying in the occiput transverse or occipitoposterior positions. The force produced by the forceps on fetal skull is a complex function of the strength of pull and compression exerted by the forceps and friction produced by maternal tissues. It is impossible to determine the exact amount of force exerted by the forceps for an individual patient.

AIMS OF SURGERY

Assisted vaginal delivery using the forceps or vacuum is commonly used for maternal reasons, such as cutting short the second stage of labor, when maternal efforts fail to effect delivery (e.g. maternal exhaustion) or for maternal benefit (cardiac disease, severe preeclampsia, etc.). It can also be used for fetal reasons, such as presence of nonreassuring fetal heart tones on cardiotocography (ACOG, 2001).[1] While forceps are usually used for speeding up the delivery, occasionally they can also be used for slowing down delivery, e.g. while delivering the after-coming head of the breech. Therefore, it is of utmost importance that the clinicians involved in maternal care are well-acquainted with the technique of performing an operative vaginal delivery either using forceps or vacuum. Since it is important for the obstetricians to be conversant with both the techniques, the same would be described in details, forceps-assisted delivery in this chapter and vacuum-assisted delivery in the next chapter (Chapter 8). However, none of these methods, neither vacuum nor forceps, is 100% perfect, because each method is associated with its own advantages and disadvantages. While the use of forceps is associated with an increased risk of injuries to the woman's genital tract, vacuum usage is associated with an increased risk of fetal scalp injuries, such as neonatal cephalohematoma or subgaleal hematoma.

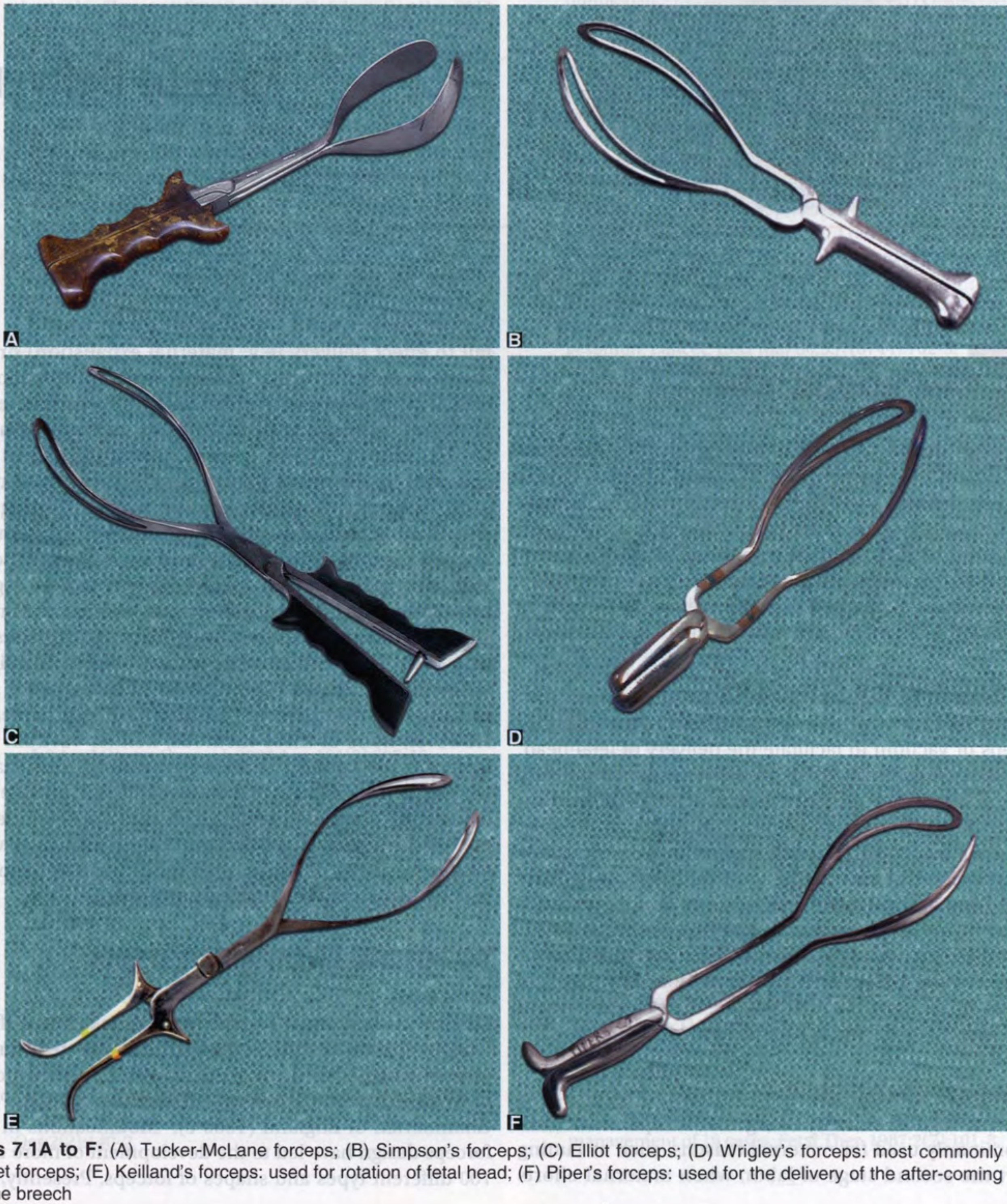
SURGICAL EQUIPMENT USED

Forceps

Forceps are instruments which help in the delivery of the fetus, by applying traction to the fetal head. The credit for the invention of the precursor of the modern forceps, which is presently used for the delivery of live infants, goes to Peter Chamberlen of England (1600 c).[2] Modifications in the forceps design have led to the development of more than 700 different types and shapes of forceps. Presently, the use of forceps has decreased to a great extent in the clinical practice due to an improvement in the fetal monitoring and surveillance techniques. Many different types of forceps are being used at different centers (Figs 7.1A to F). Wrigley's forceps are most commonly used for forceps delivery (Fig. 7.1D), whereas Keilland's forceps are commonly used for the rotation of fetal head (Fig. 7.1E). Another type of forceps commonly used are the Piper's forceps (Fig. 7.1F), which are used for the delivery of the after-coming head in cases of breech vaginal deliveries. Use of Piper's forceps helps in reducing traction on the fetal neck during breech vaginal delivery.

Different Types of Forceps

Different types of forceps commonly used in the clinical setup are shown in Figures 7.1A to F and are described next:



Figs 7.1A to F: (A) Tucker-McLane forceps; (B) Simpson's forceps; (C) Elliot forceps; (D) Wrigley's forceps: most commonly used outlet forceps; (E) Keilland's forceps: used for rotation of fetal head; (F) Piper's forceps: used for the delivery of the after-coming head of the breech

Tucker-McLane forceps: They have narrow overlapping shanks and solid blades with shorter and rounder cephalic curve. This is an instrument of choice for application to round unmolded heads, commonly seen amongst multiparous women.

Simpson's forceps: They have parallel separated shanks. Blades have long, tapered cephalic curve. It acts as an instrument of choice for application to long molded heads as is commonly seen in nulliparous women.

Elliot forceps: They have ample of pelvic curve in the blades which are fenestrated and have an English-style lock.

Wrigley's forceps: Wrigley's forceps are designed for use when the head is on the perineum and local anesthesia is being used. It is a short light instrument, having pelvic and cephalic curves and an English lock.

Kielland's forceps: The Kielland's forceps were introduced in 1915 by Dr Christian Kielland.[3] This forceps was originally designed to facilitate rotation and extraction of the fetal head, arrested in the deep transverse or occipitoposterior position. In order to achieve this objective, this instrument has been designed with several significant modifications, which help in differentiating it from the classic forceps. Some of these are as follows:

- The blades of Keilland's forceps have only a slight pelvic curve. The minimal pelvic curve of the blades enables the operator to safely rotate the forceps blade inside the vaginal canal.
- The shanks of the forceps blades are overlapping and joined by a sliding lock in comparison to the English lock, which is present in most classical forceps.
- The knobs on the finger grips of the forceps handle help in identifying the anterior surface of the instrument.

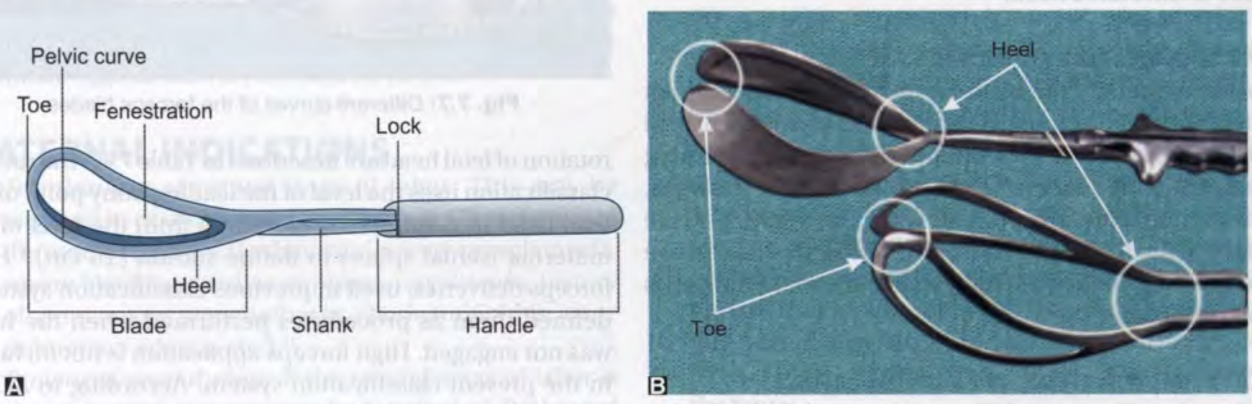
Piper's forceps: Piper's forceps was introduced by Dr Edmund B Piper in 1924.[3] This forceps was designed to facilitate delivery of the after-coming fetal head in breech deliveries. Piper's forceps (Fig. 7.1F) have long shanks with a backward curve. This causes the handles to fall below the level of the blades, which help the surgeon to directly apply the forceps blades to the baby's after-coming head, without the necessity of elevating the baby's body above the horizontal.

Parts of Forceps

Forceps are composed of two branches, each of which has four major components: blades, shank, lock and handle (Figs 7.2A and B). Each of these is described as follows:

- *Blades:* The blades help in grasping the fetus and have two curves, the pelvic curve and the cephalic curve. While the pelvic curve corresponds to the axis of birth canal, the cephalic curve conforms to the shape of fetal head. The forceps blades may be fenestrated or solid (Fig. 7.3), with the fenestrations providing firmer grip of the fetal head.
- *Shanks:* The shanks connect the blades to the handles and provide the length of the device. They could be either parallel (as in Wrigley's forceps) or crossing (as in Tucker-McLane forceps) (Fig. 7.4).
- *Lock:* The lock is the articulation between the shanks. Many different types have been designed (Fig. 7.5). The English type of lock is more common type, where a socket is located on the shank at the junction with the handle. This fits into a socket located similarly over the opposite shank. Another type of lock is the sliding type of lock, which may be present in some forceps such as Kielland's forceps.
- *Handles:* The handles are where the operator holds the device and applies traction to the fetal head. The handles may be fenestrated at times to allow a firmer hold over the fetal head (Fig. 7.6).

The forceps blades have two curves, i.e. the cephalic curve and the pelvic curve (Fig. 7.7). The cephalic curve is adapted to provide a good application to the fetal head. In cephalic application, the forceps blades are applied along the sides of the head, grasping the biparietal diameter in between the widest part of the blades. The long axis of the blades corresponds more or less to the occipitomental plane



Figs 7.2A and B: Different components of a forceps

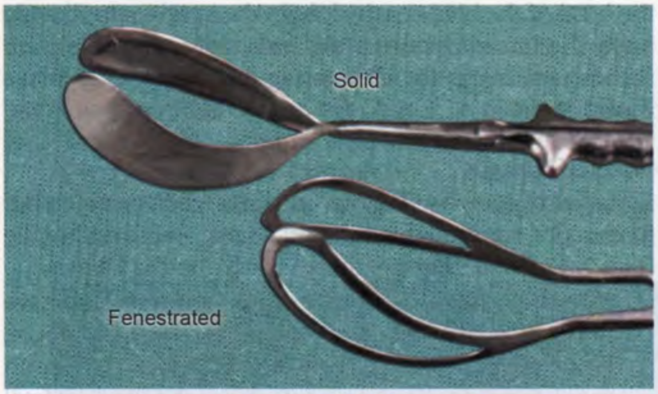


Fig. 7.3: Different types of forceps blades

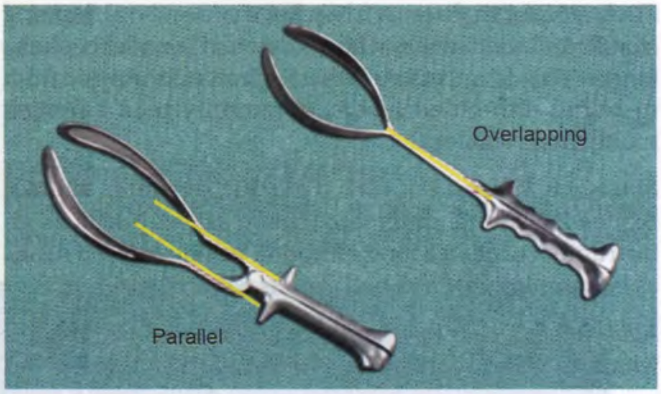


Fig. 7.4: Different types of shanks

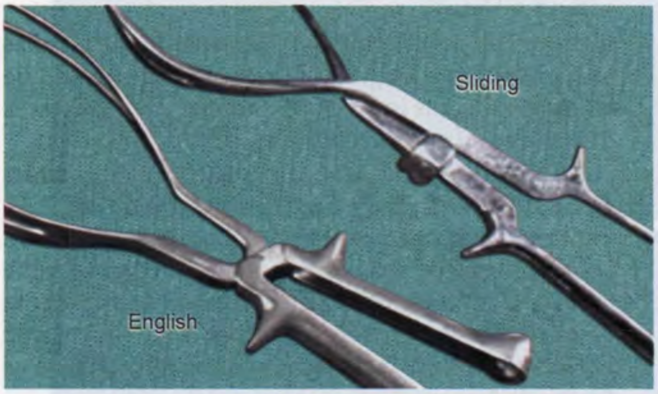


Fig. 7.5: Different types of locks

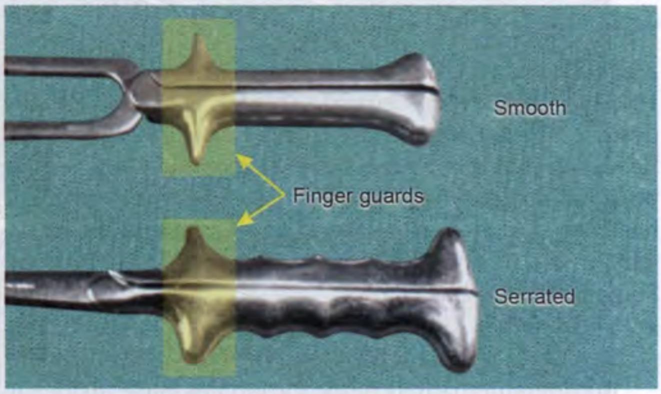


Fig. 7.6: Different types of handles

of the fetal head. Since this method of application results in negligible compression effect on the cranium, this method of application is favored over pelvic method of application. On the other hand, the pelvic curve conforms to the axis of birth canal and allows the blades to fit in with the curve of the birth canal. Pelvic application consists of application of forceps blades along the sides of lateral pelvic wall, ignoring the position of fetal head. Therefore, this type of application can result in serious compression on the cranium, especially in case of unrotated head.

Identification of the Forceps Blades

In order to identify the blade of the forceps, whether left or right, the blades must be articulated and then placed in front of the pelvis with the tip of the blades pointing upwards and the concave side of the pelvic curve forwards. In this position, the forceps blade which corresponds to the left side of the maternal pelvis is the left blade and the one which corresponds to the right side of the maternal pelvis is the right blade.

ACOG Criteria for Types of Forceps Deliveries

The American Congress of Obstetricians and Gynecologists (ACOG) criteria for classification of instrumental delivery (both forceps and vacuum) according to the station and

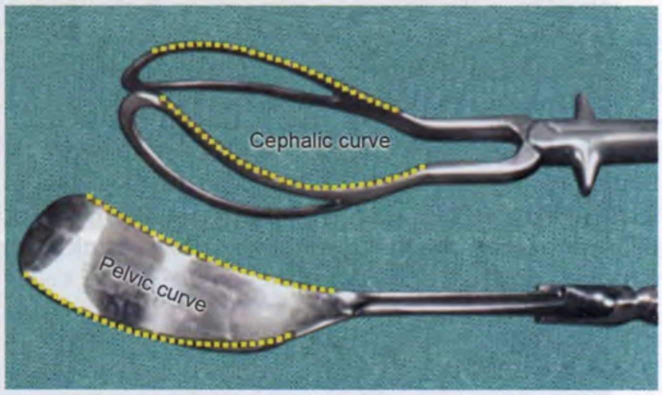


Fig. 7.7: Different curves of the forceps blades

rotation of fetal head are described in Table 7.1.[4] The revised classification uses the level of the leading bony point of the fetal head in centimeters, measured from the level of the maternal ischial spines to define station (±5 cm).[1] High forceps deliveries, used in previous classification systems, defined them as procedures performed when the head was not engaged. High forceps application is not included in the present classification system. According to ACOG (1994) and the Society of Obstetricians and Gynaecologists of Canada (SOGC) (2005), "high forceps deliveries are not recommended in modern obstetric practice."[1,5,6]

Table 7.1: The American Congress of Obstetricians and Gynecologists (ACOG) criteria for classification of instrumental delivery

Procedure	Criteria
Outlet forceps	• The fetal scalp is visible at the introitus, without separating the labia
	• The fetal skull has reached the pelvic floor
	• The sagittal suture is in anteroposterior diameter or right or left occiput anterior or posterior position
	• The fetal head is at or on the perineum
	• The rotation does not exceed 45°
Low forceps	• Leading point of fetal skull is at station ≥ +2 and not on the pelvic floor • The degree of rotation does not matter. It could be either: – Rotation is 45° or less (left or right occiput anterior to occiput anterior or left or right occiput posterior to occiput posterior) – Rotation is 45° or more
Mid pelvic	Station is above +2 cm, but the head is engaged
High pelvic application	Not included in the classification system

Source: Adapted from Reference 4

Application of the forceps when the head is not "engaged" is known as "high forceps". In our setup, only low forceps and outlet forceps are used and mid forceps are usually replaced by cesarean section.

INDICATIONS

Indications for operative vaginal deliveries are identical for forceps and vacuum extractors. No indication for operative vaginal delivery is absolute and largely depends upon the skill and preference of the operator. Many times the surgeon may prefer a cesarean section rather than a difficult forceps delivery. The use of midforceps delivery in modern obstetric practice still remains controversial.[7,8] Many obstetricians favor the use of cesarean delivery over difficult midforceps application. The various maternal and fetal indications for operative vaginal delivery are described below.[9,10]

MATERNAL INDICATIONS

- *Termination of second stage of labor:* This may be required in case of conditions which are threatening to the mother (maternal exhaustion, severe preeclampsia, severe bleeding, cardiac or pulmonary disease, history of spontaneous pneumothorax, chorioamnionitis, acute pulmonary edema, etc.).[11]
- *Prolonged second stage:* If the second stage of labor is too prolonged, it requires to be terminated. Prolonged second stage of labor has been described by Friedman, as nulliparous women, who fail to deliver after 3 hours with and 2 hours without regional anesthesia.[12] It also includes multiparous women, who fail to deliver even after 2 hours with or 1 hour without regional anesthesia. Prolonged second stage of labor may be related to inadequate uterine contractions, ineffective maternal efforts, malrotation of fetal head (e.g. occipitoposterior position), perineal rigidity, epidural analgesia, etc.[13]

FETAL INDICATIONS

- Suspicion of immediate or potential fetal compromise in the second stage of labor, in the form of nonreassuring fetal heart sounds on continuous cardiotocographic machine (CTG) trace (particularly fetal heart decelerations with reduced or absent variability). This may be related to conditions, such as fetal umbilical cord prolapse, premature separation of placenta, etc.
- In the hands of an experienced surgeon, fetal malpositions, such as the after-coming head in breech vaginal delivery and occipitoposterior positions can be considered as indications for forceps delivery.[14]

Presently, there is no evidence regarding the beneficial use of prophylactic forceps application in an otherwise normal term labor and delivery.

PREOPERATIVE PREPARATION

Prerequisites for Forceps Delivery

Before the application of forceps, it is important for the surgeon to review the indications for operative vaginal delivery and confirm the presence of all the prerequisites for forceps application. Prerequisites for forceps delivery include the following:[15]

- *Maternal verbal consent:* Maternal verbal consent should be obtained prior to the application of forceps. However, in some circumstances it may not be possible to take the maternal consent, especially if the procedure needs to be performed as an emergency or if the mother is sedated. In these cases, consent may be taken from the patient's partner or relatives. If a forceps delivery has been planned in advance (i.e. for maternal medical indications), it is possible to counsel the patient and take her consent prior to the onset of active labor.
- *Assessment of the maternal pelvis:* The maternal pelvis must be adequately assessed before proceeding with a forceps delivery. The type of pelvis (i.e. gynecoid, android, anthropoid or platypoid) and adequacy of the pelvis for delivery of the baby must be clinically assessed prior to undertaking delivery. It should be emphasized that adequate pelvic size depends not just on the pelvic assessment, but also on the size and presentation of the fetus.
- *Engagement of the fetal head:* The fetal head must be engaged before application of forceps. Engagement of

the fetal head implies that the largest diameter of the fetal presenting part (biparietal diameter in case of cephalic presentation) has passed through the pelvic inlet. Engagement of the fetal presenting part is of great importance, as it helps in ruling out fetopelvic disproportion.

- *The presentation, position and station of the presenting part:* The presentation, position and station of the fetal presenting part must be reconfirmed just before the procedure. The fetus must present as vertex or face with the chin anterior. The station of the fetal head must be at or below the zero station. If the leading part of the fetal head is at the zero station or below, the fetal head is said to be engaged. This implies that the biparietal plane of the fetal head has passed through the pelvic inlet. However, in the presence of excessive molding or caput formation, engagement may not have taken place, even if the head appears to be at zero station. In these cases, the obstetricians can improve their clinical estimate of engagement by using the abdominal palpation, to estimate how much of the fetal head is above the upper level of the pubic symphysis. A recently engaged fetal head may be two-fifths palpable per abdominally. The presence of the sagittal sutures in the anteroposterior diameter of the pelvic outlet must be also confirmed before application of forceps. Determination of fetal position by examination of sagittal sutures and fontanels is possible when the head is low in the pelvis. However, when the head is at a higher station, an absolute determination of the position of fetal head may not be possible. In these cases, fetal position can be determined by locating the fetal ear. Forceps are applied across the ears to the mandibular region.
- *Cervical dilatation and effacement:* The cervix must be fully dilated and effaced. If the forceps are applied before complete cervical dilatation and effacement has been attained, the procedure may produce severe maternal lacerations and hemorrhage.
- *Status of the membranes:* The fetal membranes must have ruptured prior to the application of forceps.
- *Bladder to be emptied:* The bladder should be emptied in preparation for forceps operative deliveries, regardless of the type of anesthesia used. Except for the cases where the fetal head is on the perineum, the bladder should be emptied with the help of a catheter.
- *The woman's position:* The laboring woman, in whom forceps have to be applied, should be preferably placed in the "lithotomy position". However, some practitioners prefer to use the left lateral position instead. After placement in the proper position, the woman must be adequately cleaned and draped, while observing aseptic precautions in order to minimize the chances of maternal infection.
- *Adequate analgesia:* The patient must be administered adequate analgesia prior to the application of forceps. The decision regarding the type of anesthesia to be used should be made before initiating the delivery. An adequate level of anesthesia is an important prerequisite before forceps application. Attempts to undertake the instrumental delivery without adequate anesthesia may be extremely painful for the mother and may end up in failure. While some surgeons use only local infiltration of anesthesia to the perineal body prior to forceps application, others may prefer to use pudendal block anesthesia augmented with intravenous sedation. In some cases, adequate anesthesia may also be obtained using regional or general anesthesia. Regional anesthesia using epidural or spinal block is more commonly used, while general anesthesia is usually reserved for very complicated situations.
- *Operator's competence and facilities for operative delivery:* Adequate facilities for cesarean section should be available in case the delivery by forceps fails. Operator's skill, training and competence in the use of forceps, play an important role in the eventual success of the procedure. The operator should not only be competent in the use of the forceps, but he/she should be promptly able to recognize and manage potential complications. It is very important for the operator to know when he/she must abandon the attempts at forceps delivery and resort to cesarean section.

Contraindications for Forceps Application

The following are the contraindications for forceps-assisted vaginal deliveries:

- Any contraindication for normal vaginal delivery (a total placenta previa, cephalopelvic disproportion, etc.)
- Refusal of the patient to give verbal consent for the procedure
- Cervix is not fully dilated or effaced
- Inability to determine the fetal presentation or position of fetal head
- Inadequate pelvic size or cephalopelvic disproportion
- Previous unsuccessful attempts of vacuum extraction (relative contraindication)
- Absence of adequate anesthesia/analgesia
- Setup with inadequate facilities and support staff
- Inexperienced operator.

In general, evaluation of the patient for forceps delivery is purely clinical and no laboratory or imaging evaluations are required.

SURGICAL STEPS

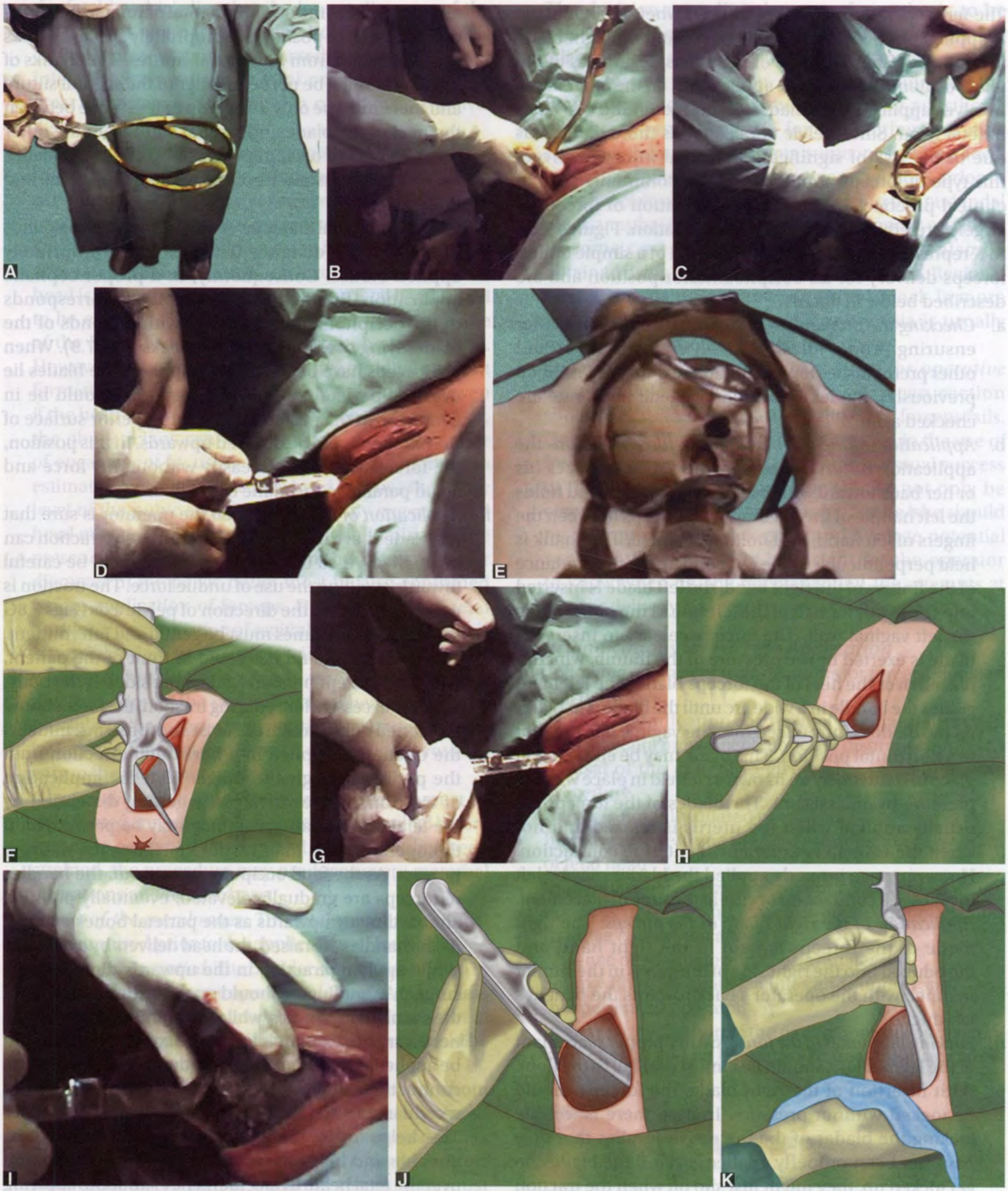
APPLICATION OF THE FORCEPS[2-4]

The success of instrumental vaginal delivery using forceps largely depends upon the technique of forceps application. Knowledge regarding the exact position of the fetal head is of utmost importance before the application of forceps.

The term "pelvic application" is used when the left blade is applied on the left side of the pelvis and the right blade is applied on the right side of the pelvis, regardless of the fetal position. The "cephalic application", on the other hand, involves application of blades of forceps on the two sides of fetal head. Since pelvic application is more dangerous due to the risk of significant maternal injury involved, this type of forceps application is not commonly used in clinical practice. The cephalic application of forceps is largely preferred over the pelvic application. Figures 7.8A to K represent a pictorial demonstration of a simple outlet-forceps delivery for an occipitoanterior position and are described below in details:

a. *Checking the prerequisites for forceps application*: After ensuring proper anesthesia, an empty bladder and other prerequisites for forceps application (as described previously), the fetal position and fetal heart rate are checked again.
b. *Application of the left blade of the forceps*: Before the application of forceps blades, the surgeon places his or her back towards the maternal right thigh and holds the left handle of the left branch of forceps between the fingers of left hand, as if holding a pencil. The shank is held perpendicular to the floor and under the guidance of the fingers of the right hand, the left blade is inserted into the posterior half of the left side of the pelvis along the left vaginal wall. The force necessary to insert the blade is exerted by the pressure of the thumb, which is placed over the heel of the forceps blade. The left hand guides the handle in a wide arc until the blade is in place. As the blade is introduced into the vagina, it is brought to a horizontal position. This blade may be either left in place to stand freely on its own or is held in place without pressure by an assistant. The blades of the forceps are usually applied when the uterus is relaxed and not when the woman is experiencing uterine contraction. However, once properly applied the blades may be left in place, if a contraction occurs at the time of placement.
c. *Application of the right blade of the forceps*: The right blade of the forceps is held in the right hand and introduced into the right side of the pelvis in the similar manner, with the operator's back towards the patient's left thigh.
d. *Locking the blades of the forceps*: After proper placement of the left blade, it should lie almost parallel to the floor. With insertion of the right blade, the forceps should be locked without pressure. In case there is trouble locking the blades of the forceps, it implies that they have not been properly applied. Even if the blades do get locked up, they might just slip off when the traction is applied. Therefore, before locking the forceps blades and application of traction, it is important to check, if the blades have been properly applied or not.
e. *Checking the proper application of the forceps*: The forceps blades must be applied directly to the sides of fetal head along the occipitomental diameter. In case of occiput anterior position, appropriately applied blades are equidistant from the sagittal sutures. The shanks of the blades must be perpendicular to the sagittal suture and there must be only a fingertip or less space between the heel of the blade and sagittal suture. On the other hand, in case of occipitoposterior position, the blades would be equidistant from the midline of the face and brow.

   The biparietal diameter of the fetal head corresponds to the greatest distance between the appropriately applied blades. Consequently, in a proper cephalic application, the long axis of the blades corresponds to the occipitomental diameter, with the ends of the blades lying over the posterior cheeks (Fig. 7.9). When the forceps have been correctly applied, the blades lie over the parietal eminence, the shank should be in contact with the perineum and the superior surface of the handle should be directed upwards. In this position, the forceps should lock easily without any force and stand parallel to the plane of the floor.
f. *Application of traction*: When the operator is sure that the blades have been placed appropriately, traction can be applied. At all times, the surgeon should be careful towards avoiding the use of undue force. The traction is usually applied in the direction of pelvic axis (Figs 7.8G and H) and at all times must be gentle and intermittent. The operator should be seated in front of the patient, with elbows kept pressed against the sides of the body. To avoid excessive force during traction, the force should be exerted only through the wrist and forearms. Initially, the traction is applied in a horizontal direction until the perineum begins to bulge. With the application of traction, as the vulva starts getting distended by the fetal occiput, an episiotomy may be performed, if the operator feels that it would facilitate the delivery process. As the fetal occiput emerges out, the handles of forceps are gradually elevated, eventually pointing almost directly upwards as the parietal bones emerge. As the handles are raised, the head delivers by extension. While applying traction in the upwards direction, the surgeon's four fingers should grasp the upper surface of the shanks and handles, while the thumbs must exert the necessary force on their lower surface. Traction should be applied intermittently, synchronous with the uterine contractions and the fetal head should be allowed to recede inside during the periods of uterine relaxation. This helps in simulating normal delivery as much as possible and helps in preventing undue compression over the fetal head. In an emergency situation, applying continuous traction may be necessary until the fetal head delivers. The safe limit for the amount of traction to be applied, in order to accomplish safe fetal head descent has been considered to be about 45 pounds in primiparas and 30 pounds in multiparas.[2,3]



Figs 7.8A to K: (A) Assembly of the blades of forceps prior to application; (B) Application of left blade of forceps; (C) Application of right blade of forceps; (D) Locking the blades of the forceps; (E) Demonstration of correct application of the forceps blades over the fetal skull; (F) A median or a mediolateral episiotomy may be performed at this time. A left mediolateral episiotomy is performed in this case; (G) Application of horizontal traction with the operator seated; (H) Diagram showing application of traction in horizontal direction until the perineum begins to bulge; (I) As the fetal occiput bulges out, the traction is applied in the upward direction; (J) Diagram showing application of traction in the upward direction with the bulging of occiput; (K) Following the distention of vulvar outlet by the fetal head, the branches of forceps are disarticulated and delivery of rest of the head is completed by modified Ritgen's maneuver

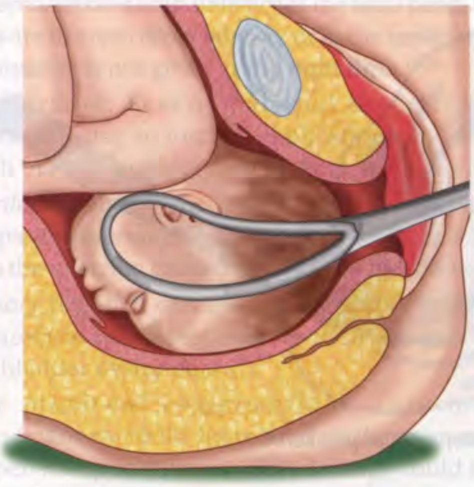


Fig. 7.9: Correct application of the forceps blades in a proper cephalic application

Though there is no fixed limit for the number of traction attempts to be applied before abandoning the procedure, in case there is no descent of the fetal head, abdominal delivery should be considered following three unsuccessful attempts at the forceps. Once the vulva has been distended by the fetal head, we prefer to remove the forceps blades and complete the delivery of fetal head by modified Ritgen's maneuver. Some clinicians prefer to keep the forceps blades in place, while the fetal head is emerging out. We do not use this practice because we believe that this practice increases the total fetal dimension, thereby increasing the likelihood of causing injury to the vulvar outlet.

g. *Episiotomy*: With the application of traction, as the vulva is distended by the fetal occiput, an episiotomy may be performed, if the operator feels that it would facilitate the delivery of fetal head. In our setup, an episiotomy is usually performed in all cases of forceps deliveries. With the application of metallic blades of forceps, less opportunity exists for the maternal tissues to stretch. Therefore, we believe that performance of an episiotomy would help in allowing a more rapid delivery, even though it may result in an increased blood loss at times. The utility of episiotomy in preventing short- and long-term maternal injury is controversial.

POSTOPERATIVE CARE

POSTDELIVERY EXAMINATION

Following forceps delivery, thorough examination of both the mother and the newborn is advisable.

Maternal Examination

The mother's external genitalia must be carefully examined, in order to rule out the presence of any cervical, vaginal, perineal and paraurethral lacerations or tears. In case of the presence of significant maternal vulvar edema, measures such as perineal ice application and pain killers may prove to be useful. A postoperative hemogram should be obtained in patients who experience excessive bleeding. Before discharging patients who had undergone forceps delivery, pelvic and rectal examinations must be performed in order to exclude any bleeding and presence of entities, such as pelvic hematoma, rectal tears, misplaced sutures, unrecognized lacerations, etc.

Neonatal Examination

The newborn must be examined for lacerations, bruising and other injuries over the scalp and face.

Follow-Up

In case no forceps-related complications are found at the time of discharge, the mother should be asked to come for a follow-up postpartum examination within 4–6 weeks, where the usual protocol for postpartum care, including a thorough pelvic examination must be performed.

ADVANTAGES

The use of forceps helps in avoiding abdominal cesarean delivery. It may be especially useful in cases of prolonged second stage of labor or in cases where the obstetrician wants to cut short the second stage of labor due to maternal condition. Other applications of the forceps, besides when the fetal head is in occiput anterior position, are described below.

OTHER APPLICATIONS OF FORCEPS

Delivery of the Head in the Occipitoposterior Position

The blades are applied in such a way that they correctly grip the fetal head and are equidistant from the midline of the face and brow. The toes of the blade curve towards the mouth rather than facing towards the ears. Traction is first applied in downward/backward direction until the forehead emerges under the pubic symphysis. The handles are then gradually elevated so that the occiput is flexed and it emerges over the perineum. With the emergence of occiput, the handles are depressed to deliver the face and forehead, thereby completing face-to-pubis delivery (Fig. 7.10).

If the head is deep transverse arrest, in experienced hands, rotation by Kielland's forceps is a better option in comparison to manual rotation or delivery by cesarean section.

Application of Piper's Forceps in Breech Presentation

In cases of breech presentation, the safest method of delivering the after-coming head, once it has entered the

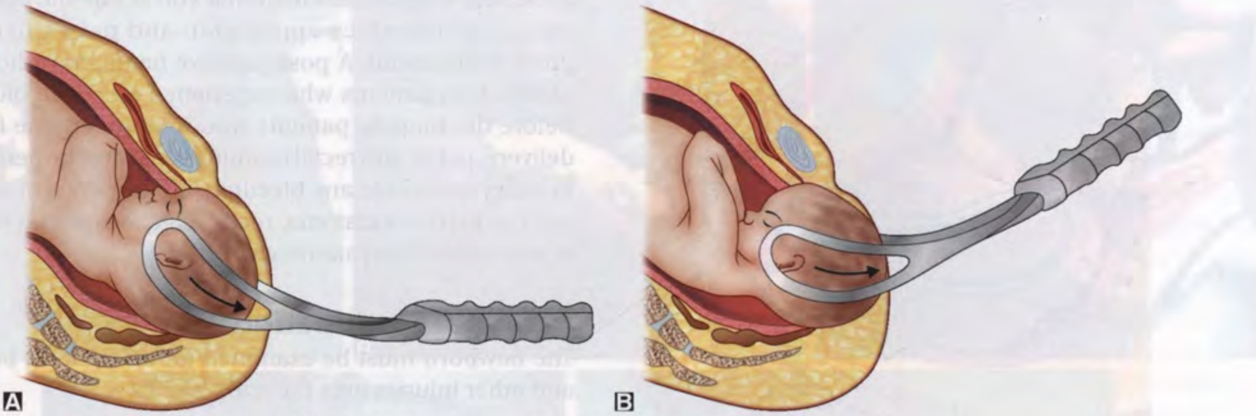
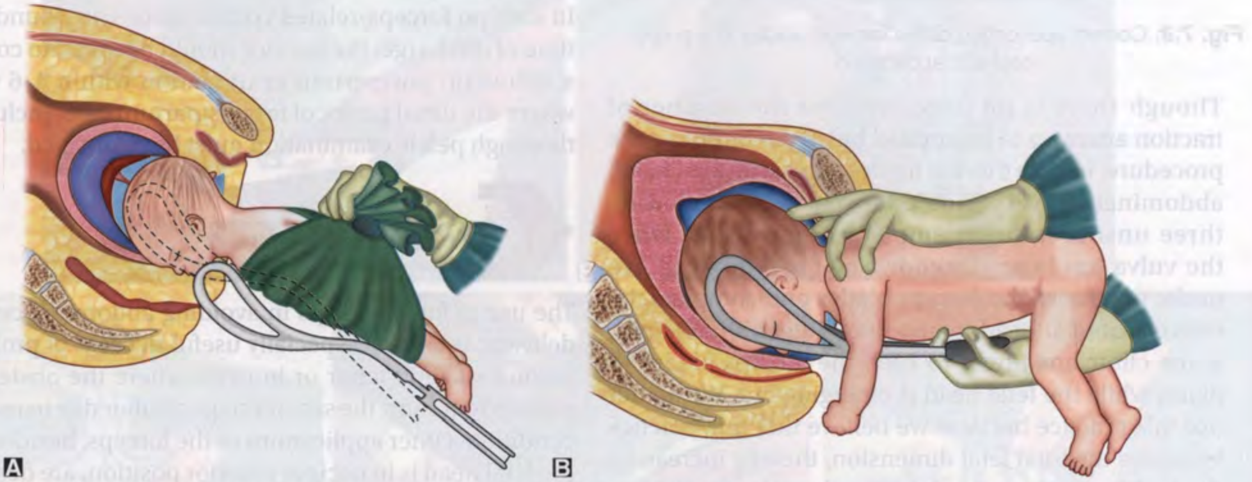


Fig. 7.10: Application of forceps in occipitoposterior position



Figs 7.11A and B: (A) Application of Piper's forceps on the after-coming head of the breech; (B) Application of the downwards traction to deliver the fetal head

pelvis, is by application of the Piper's forceps (Figs 7.10A and B).

Procedure

In cases of breech vaginal delivery, if the Mauriceau-Smellie-Veit or Burns-Marshall maneuvers fail to deliver the head easily, Piper's forceps should be promptly applied. The steps for forceps application are as follows:

1. Prior to the application of forceps, the infant should be supported by an assistant, and the operator should sit on a low stool for the forceps insertion.
2. After checking the prerequisites for forceps application, the left blade is applied directly to the right side of the baby's face (Fig. 7.11A). The opposite blade is then applied and the forceps locked.
3. A deep episiotomy should be performed, to prevent damage to the vagina and perineum.
4. After rechecking for the prerequisites for forceps application, the head is delivered by downward traction (Fig. 7.11B). Once the face appears at the introitus, the forceps handles are elevated to flex and deliver the rest of the head by flexion.

Application of Forceps in Face Presentation

In a face presentation (mento-anterior) the forceps may be applied directly. Mento-posterior face positions must be rotated prior to application of forceps.

COMPLICATIONS

The use of forceps has been found to be associated with long-term maternal and fetal morbidity. Midforceps application is associated with higher rates of maternal and neonatal morbidity in comparison to outlet forceps or low-forceps application.

MATERNAL COMPLICATIONS

- *Injury to the maternal tissues:* Even with use by an experienced surgeon, forceps deliveries may be associated with an increased risk of perineal tears and lacerations (both vaginal and cervical).[15] This could be related to the more rapid and extensive stretching of the maternal tissues with delivery of the fetal head. Perineal tears are likely to especially occur in the cases, where the episiotomy is not given at the right time.[16-18]

- *Hemorrhage:* Severe maternal tissue injury and lacerations due to forceps application can sometimes result in extensive bleeding and maternal hemorrhage.
- *Febrile morbidity*: This could be the manifestation of postpartum uterine infection and pelvic cellulitis, resulting from the infection caused by trauma to the tissues.
- *Urinary retention and bladder dysfunction*: Damage to the urethral sphincters may result in urinary retention and bladder dysfunction.
- *Late maternal complications*: Late maternal complications could be related to damage caused to the pelvic support tissues. This damage could manifest in the form of genitourinary fistulae or pelvic organ prolapse. Injury caused by forceps may in the long term result in the development of fecal incontinence due to damage to the rectal sphincter function or urinary incontinence due to damage to the urethral sphincters.[19-21]

INJURIES TO BABY

Fetal injury: Various fetal injuries which can be caused by the application of forceps, include cephalohematoma, facial nerve injury, depressed skull fractures, intracranial bleeding, shoulder dystocia, etc.[22-25] Additionally, cerebral palsy and subtly lower IQ (2.5 points) levels have also been described in infants delivered by forceps.

DISCUSSION

Over the past two decades, the use of vacuum extraction and forceps delivery has been declining both in low- and high-income countries. At the same time, there has been an increase in the rates of cesarean delivery.[26] The objection to the use of forceps mainly includes the presence of a high rate of complications associated with its use. Forceps delivery is likely to cause potential harm both to the mother and the infant. In fact, some medical schools no longer train their junior doctors in the skills to perform instrumental delivery. At most places, the art of performing instrumental delivery is largely restricted to specialists and consultants. The art of instrumental delivery, especially vacuum extraction, needs to be taught to practitioners, such as midwives, nurse practitioners, resident doctors and general physicians, so that it can be useful to provide emergency obstetric care at the periphery.[27] This allows women to give birth closer to home in midlevel facilities, when hospitals may not be easily accessible or in cases of emergency, when facilities for cesarean delivery are not available. Use of forceps delivery helps in potentially reducing the risks associated with cesarean delivery and overall costs of obstetric care.

- As discussed previously, vacuum delivery is presently being favored over forceps delivery. A comparison between the two has been discussed in chapter 8. Another important concept which would be discussed in this section is failed forceps delivery, i.e. when consecutive attempts at traction by forceps are unable to achieve delivery.

VACUUM VERSUS FORCEPS

Detailed discussion of the technique of vacuum delivery has been done in Chapter 8 (Vacuum Delivery). The technique of vacuum application is easier to learn and quicker to apply in comparison to forceps application. Vacuum application is also associated with fewer chances of maternal trauma, discomfort and injuries, thereby resulting in lower maternal morbidity in comparison to forceps delivery. While vacuum application is associated with fewer chances of maternal injuries, the incidence of fetal craniofacial injuries retinal hemorrhages and transient lateral rectus palsy is comparatively higher.[28] Overall, vacuum application is associated with higher rate of successful vaginal delivery.

FAILED FORCEPS

This is a term implying that an attempt to deliver with forceps had been unsuccessful. If the surgeon is not sure regarding whether the attempt at forceps delivery would be successful or not, the attempt is considered to be a trial of forceps delivery. The patient undergoing trial of forceps must be delivered in a setup, well equipped with facilities for an emergency cesarean delivery, in case the need arises. In case the satisfactory application of the forceps cannot be achieved or there is no descent of fetal head even after three attempts of traction application through forceps, the procedure must be abandoned and delivery accomplished with the help of vacuum extraction or cesarean section. Some of the causes of failed forceps are as follows:

- Unsuspected cephalopelvic disproportion
- Misdiagnosis of the position of the head
- Incomplete dilation of the cervix
- Outlet contraction (very rare in an otherwise normal pelvis).

CONCLUSION

Over the years, the use of forceps to facilitate delivery has been advocated in order to avoid abdominal (cesarean) delivery. Even though the rate of cesarean delivery has increased, while that of instrumental vaginal delivery has fallen over the past decade, the American College of Obstetricians and Gynecology (2001) recommends forceps delivery as an acceptable and safe option for delivery.[1] However, presently there has been a decline in the rate of forceps delivery. This has resulted in a decline in the level of experience and training of the young obstetricians in the skill of operative vaginal delivery. The complete obstetrician must be well trained and capable of using all of the modalities of vaginal deliveries, both instrumental (forceps and vacuum) and spontaneous vaginal, in order to ensure a safe maternal and fetal outcome. It is, therefore, important for all obstetricians to be proficient in the knowledge of using both forms of instrumental vaginal delivery, forceps and vacuum extractors, as well as in performing spontaneous deliveries and cesarean sections.

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CHAPTER 8

Vacuum Delivery

INTRODUCTION

Vacuum application is emerging as an important procedure for assisted vaginal delivery. Vacuum delivery has been rapidly replacing forceps as the more predominant method of instrumental vaginal delivery.[1] The term "ventouse" is derived from a French word meaning a soft cup. This device is known as vacuum extractor in the USA, while it is referred to as ventouse in Europe.[2]

OVERVIEW OF SURGERY

The increasing interest in the use of vacuum extractor can be largely considered due to the fact that it is relatively safer for both the mother and infant in comparison to forceps delivery. Suction force by the vacuum creates an artificial caput or chignon within the cup. This helps in the firm hold of vacuum cup and allows adequate traction.

The original vacuum extractor was designed by Sir John Young in Edinburgh in 1849.[3] Soon after, Malmström developed the prototype of the modern vacuum extractor in Sweden.[4] The Malmström extractor consisted of a metal cup with a flat plate inside it and a chain attached to the plate. The chain was placed inside a rubber tube, which was necessary to develop the vacuum, and was attached to a traction bar. Traction is applied to the vacuum cup by the chain and plate.[5] The metal cup comes in four sizes and it is recommended that the largest cup possible should be used for delivery.

It was not until 1973, when Kobayashi developed the soft silastic cup in the USA.[6,7] The silastic cup has many advantages over the metal cup. Compared with metal-cup vacuum extractors, soft-cup devices are easier to use and cause fewer neonatal scalp injuries.[8-11] The chance of injury to the fetal scalp is relatively less because the vacuum can be developed quickly and, therefore, can be released between contractions.[9] However, the major disadvantage associated with the use of vacuum extractors is that they are likely to detach more frequently in comparison to the metallic cups, which detach less frequently.[10,11]

AIMS OF SURGERY

Today, more and more obstetricians are showing preference towards the use of silastic vacuum extractor as an alternative to delivery, when the fetal head is stuck up in the midpelvis rather than proceeding directly with cesarean section.[12] While forceps is an instrument which helps in the delivery of fetal head through transmission of the mechanical force to the base of skull, ventouse is an instrument, which assists in delivery by creating a vacuum between it and the fetal scalp. The pulling force in case of vacuum extraction helps in dragging the cranium.[13]

SURGICAL EQUIPMENT USED

Types of Vacuum Devices

Originally, vacuum devices as invented by Malmström had a rigid metal cup with a separate suction catheter attached laterally and connected to a foot- or hand-operated pedal. The instrument as devised by Malmström comprised of three parts: (1) suction cup, (2) vacuum generator and (3) traction tubing device (Fig. 8.1).

Nowadays, besides the rigid cups (made of metal); flexible or soft cup (made of plastic, silicone or silastic material) and semi-rigid cups are also available (Figs 8.2A to D). Table 8.1[14] lists different types of vacuum delivery suction-cup devices. Metallic cups are preferred over flexible cups in case of occipitoposterior positions and difficult occipitoanterior positions. Soft/semi-rigid vacuum cups may be available in different shapes: mushroom-shaped and bell-funnel shaped. Mushroom-shaped devices are associated with a lower failure rate in comparison to the bell-shaped devices. Examples of different types of cups include soft or rigid anterior cups and rigid posterior cups. Posterior cups are flatter, which allow for better placement at the flexure point on the fetal head, which is usually much further back in the sacral hollow during occipitoposterior presentation.

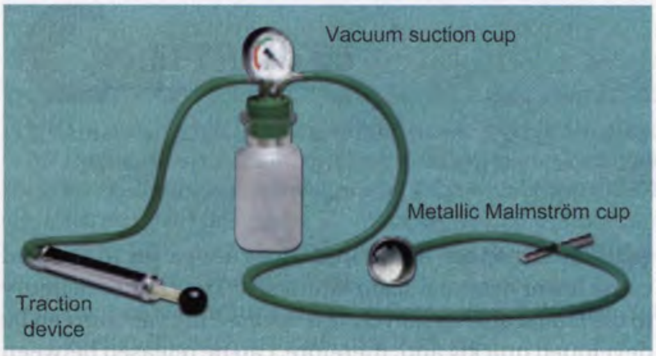


Fig. 8.1: Vacuum device, having a rigid metal cup, as invented by Malmström

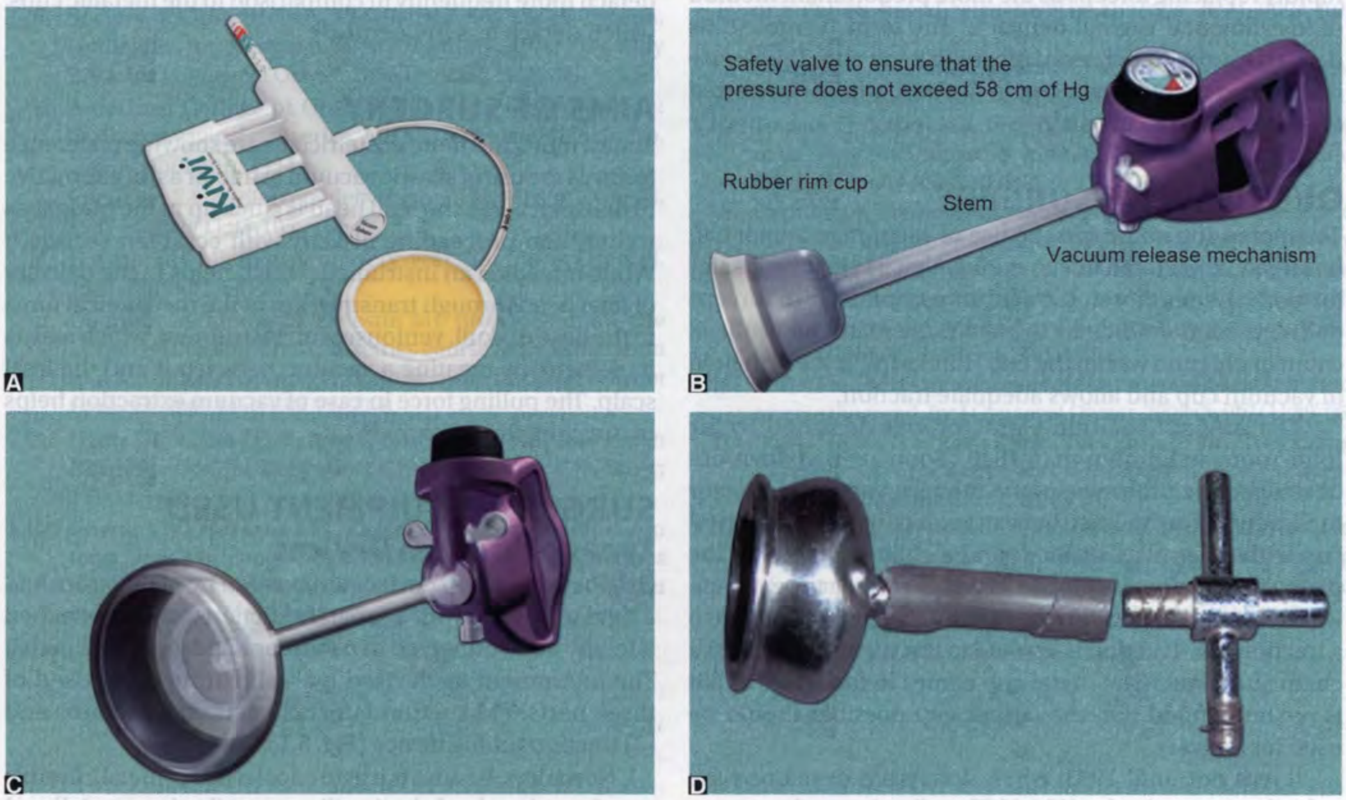
Most of the newer devices use hand-pump suction, which requires an assistant or can be used by the obstetrician (herself or himself)[15] (Figs 8.2A to C). In the United States, these hand-held devices are intended for single use and are disposable.

INDICATIONS

The classification, indications and contraindications for vacuum delivery are almost the same as that utilized for forceps delivery. However unlike the forceps, vacuum extractors cannot be used in cases of face presentation or after-coming head of breech.[16] The vacuum must never be applied to an unengaged head, i.e. above zero station.[17]

Indications for vacuum application are more or less similar to that of forceps and include the following:[18,19]

- As an alternative to forceps operation (e.g. occipito-transverse or occipitoposterior position)
- Shortening of the second stage of labor for maternal benefit (e.g. maternal exhaustion)
- Delay in descent of the head in the second stage of labor (e.g. case of the second baby of twins)
- *Prolonged second stage of labor*: This has been defined by Friedman[20] as a lack of continuing progress for 3 hours in nulliparous women, with the use of regional anesthesia and 2 hours without its use or a lack of continuing



Figs 8.2A to D: Various types of suction cup devices for various vacuum extractor devices: (A) Hand-held vacuum device Kiwi OmniCup with soft silastic cup; (B) MitySoft Bell cup; (C) M-style mushroom cup; (D) Metal cup

Table 8.1: Types of vacuum delivery suction-cup devices

Name	Size	Material
Soft cups (silicone or plastic)		
Gentle Vac	60	Soft rubber
Kiwi ProCup	65	Soft plastic
Mityvac Bel	60	Soft silicone
Secure Cup	63	Rubber
Silc Cup	50–60	Silicone rubber
Soft Cup	60	Soft polyethylene
Tender Touch	60	Soft silicone
Vac-U-Nate	65	Soft silicone
Rigid "anterior" cups (plastic or metal)		
Flex Cup	60 mm	Polyurethane
Kiwi OmniCup	50 mm	Rigid plastic
Malmström	40–60 mm	Metal
Mityvac "M" Style	50 mm	Rigid polyethylene
Rigid "posterior" cups (plastic or metal)		
Bird posterior cup	40–60 mm	Metal
Kiwi OmniCup	50 mm	Rigid plastic
Mityvac "M" Select	50 mm	Rigid polyethylene

Source: Adapted from Reference 14

progress for 1 hour without regional anesthetics, or 2 hours with regional anesthetics in multiparous women
- Nonreassuring fetal heart tones or other suspicion of immediate or potential fetal compromise.

PREREQUISITES FOR VACUUM DELIVERY

Before application of vacuum, the obstetrician must ensure that the some prerequisites as required before application of forceps are fulfilled. These have been previously described in Chapter 7 on forceps delivery.

CONTRAINDICATIONS FOR THE USE OF VACUUM FOR OPERATIVE VAGINAL DELIVERY

Absolute Contraindications

Some absolute contraindications for the use of vacuum for operative vaginal delivery are as follows:[21]
- Cephalopelvic disproportion
- Non-engagement of fetal head or presence of the head at a high station
- Operator inexperience.

Relative Contraindications

Some relative contraindications to vacuum delivery are as follows:
- *Fetal prematurity*: Gestational age less than 34 weeks has been considered as a relative contraindication to fetal delivery, due to an increased risk for intracranial hemorrhage[22]
- Known fetal conditions that affect the bone or disorders of fetal bone mineralization
- Fetal coagulation defects or active bleeding disorders
- Noncephalic or facial presentation
- Fetal macrosomia.

PREOPERATIVE PREPARATION

The preoperative preparation is the same as that required for forceps delivery (see Chapter 7) and comprises of obtaining maternal consent, performing a complete vaginal examination and ensuring adequate analgesia.

SURGICAL STEPS

The actual steps of vacuum extraction in case of occipitoanterior position are shown in Figures 8.3A to D, while those in case of occipitoposterior position are shown in Figures 8.4A and B. These steps are described below in details.

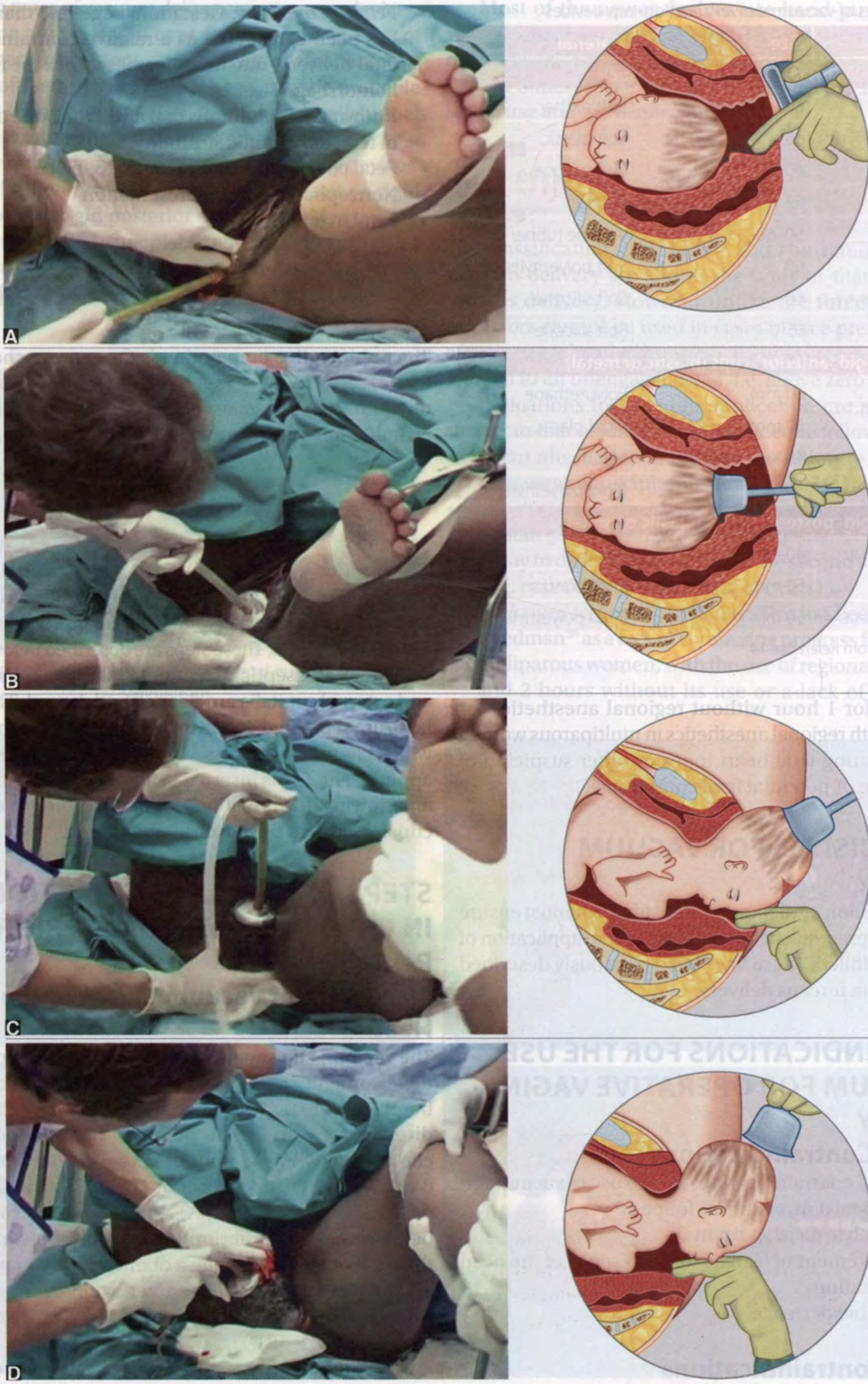
Under all aseptic precautions, the patient's perineum and external genitalia are cleaned and draped. The patient's labia are separated, following which the vacuum (soft) cup, which has been compressed and folded, prior to insertion, is applied. The cup is inserted gently by pressing it in inwards and downwards direction, so that the inferior edge of the cup lies close to the posterior fourchette.

STEPS OF VACUUM EXTRACTION IN CASE OF OCCIPITOANTERIOR POSITION

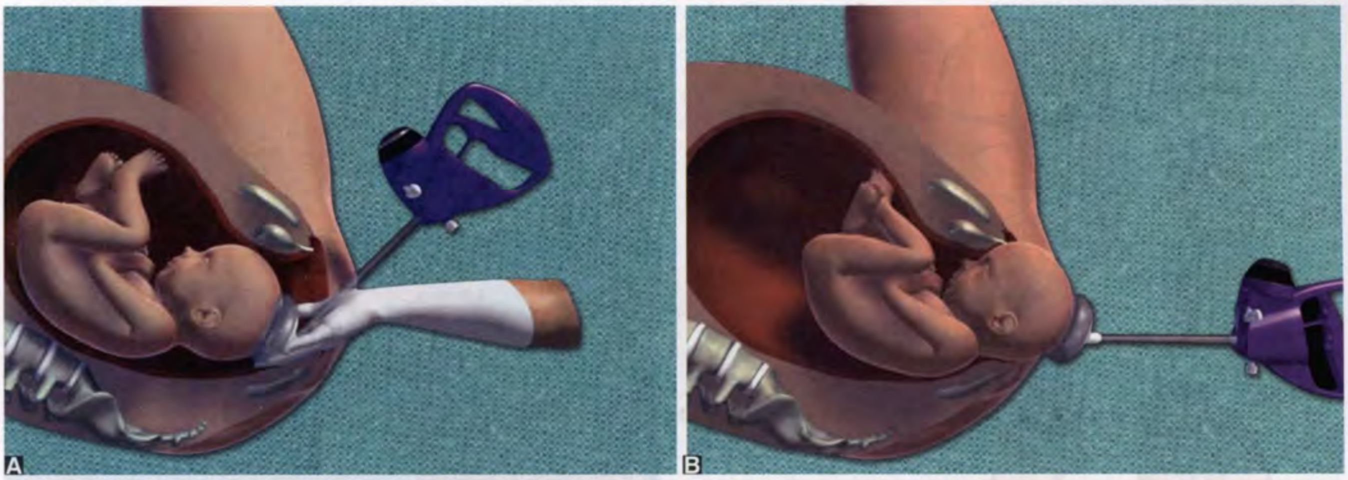
Placement of Vacuum Cup over the Fetal Head

The vacuum cup should be so positioned as to prevent the deflexion and asyncylitism of fetal head. The cup should be placed in such a way that the center of the cup lies directly over the flexion point or the pivot point which can be defined as a point over the sagittal suture, about 6 cm behind the anterior fontanel or 3 cm in front of the posterior fontanel (Fig. 8.5A). As a general rule, the cup must be placed as far posteriorly as possible. This implies that the edge of the cup having a diameter of 5–7 cm would be approximately 3 cm from the anterior fontanel and would lie over the posterior fontanel. This is known as the application distance (Fig. 8.5B).

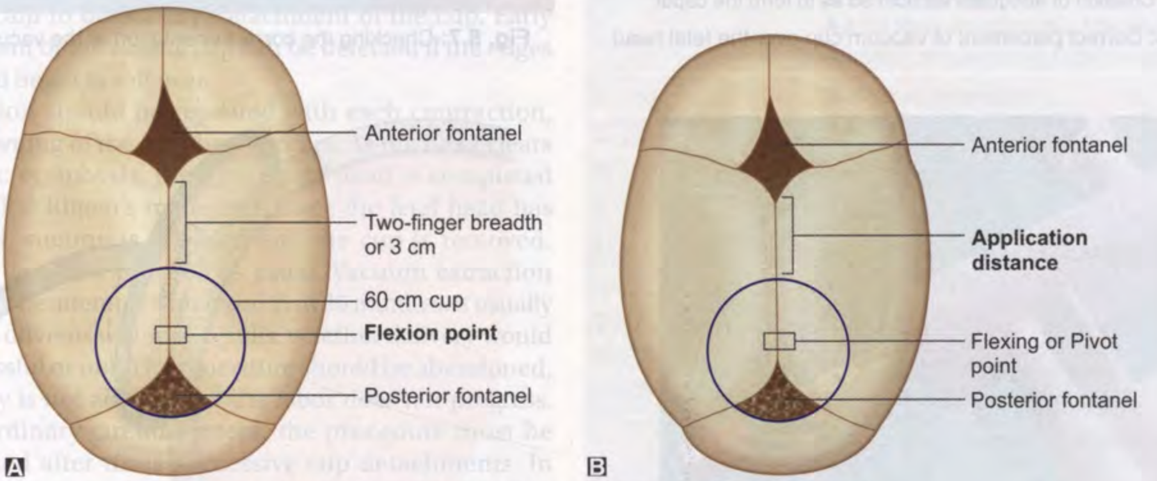
Four different types of cup applications are possible: (1) flexing median, (2) flexing paramedian, (3) deflexing median and (4) deflexing paramedian. In the flexing median



Figs 8.3A to D: (A) Insertion of the vacuum cup into the vagina; (B) Application of the vacuum cup over the fetal head; (C) Creation of vacuum suction; (D) Application of traction to facilitate the delivery of fetal head



Figs 8.4A and B: Steps of vacuum extraction in case of occipitoposterior position: (A) Application of the vacuum cup over the fetal head which is in the occipitoposterior position; (B) Extraction of the fetal head



Figs 8.5A and B: (A) Flexion point; (B) Application distance

type of cup application, the center of cup lies over the flexion point. This positioning helps in maintaining flexion of the fetal head and avoids traction over the anterior fontanel (Fig. 8.6). If the cup is placed anteriorly on the fetal cranium near the anterior fontanel rather than over the occiput, this may result in undue extension of the cervical spine. Similarly, if the cup is asymmetrically placed in relation to the sagittal suture, it is likely to worsen asyncylitism.

While positioning the cup, the obstetrician must be careful that no maternal soft tissues get trapped between the vacuum cup and fetal head. Moreover, the cup should not be twisted because this is likely to result in lacerations or injury to the fetal head. In order to prevent the entrapment of maternal tissues within the vacuum cup, the full circumference of the vacuum cup must be palpated, both before and after the vacuum has been created, as well as prior to the application of traction.

While applying the vacuum cup, the knob on the metal cup or the ridge on the silastic cup should be in line with the posterior fontanel (Fig. 8.7).

Creation of Vacuum Suction

Once the cup has been properly placed, vacuum must be created. The obstetrician must place the fingers of one hand against the suction cup and grasp the handle of the instrument with the other hand, following which the vacuum is applied. In order to achieve effective traction, a pressure of at least 0.6–0.8 kg/cm^2 must be created. The pressure must be gradually created, by increasing suction by 0.2 kg/cm^2 every 2 minutes. With the use of soft cups, it is possible to create negative pressure of 0.8 kg/cm^2 over as little as 1 minute. For the Kiwi Omnicup, the pressure should correspond to the green area on the pressure gauge (Fig. 8.8). Prior to the application of traction, an episiotomy may be performed. With the vacuum extractor, a midline or mediolateral episiotomy is adequate and a pudendal nerve block serves as an optimal form of anesthesia.

Force of Traction

When using a metal cup or a Kiwi Omnicup for vacuum extraction, a chignon (Fig. 8.9) needs to form before traction

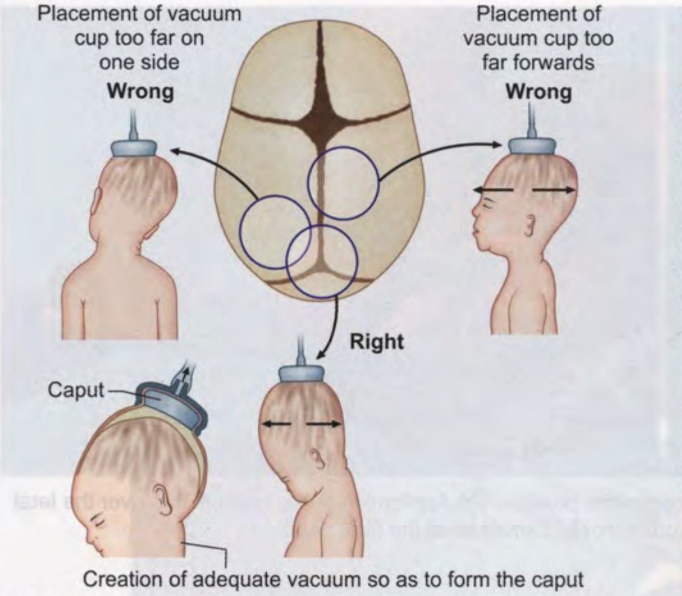


Fig. 8.6: Correct placement of vacuum cup over the fetal head

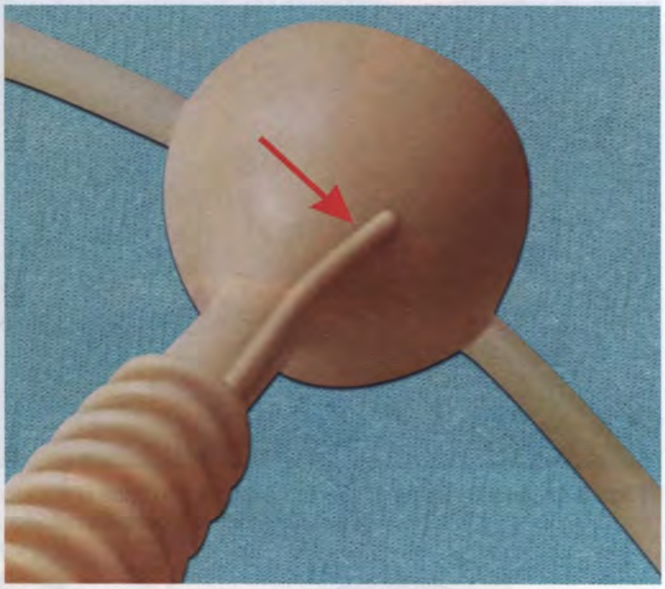


Fig. 8.7: Checking the correct orientation of the vacuum cup

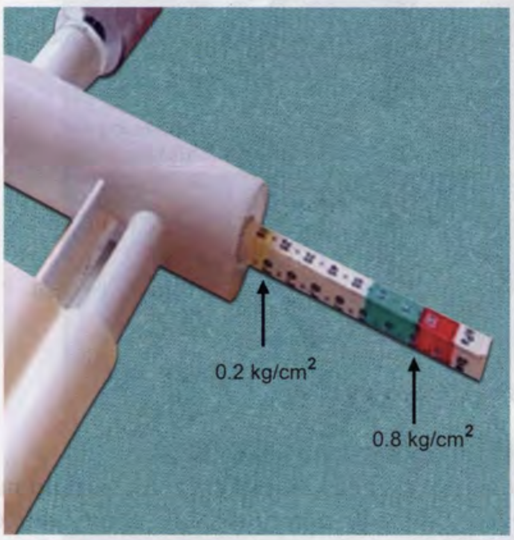


Fig. 8.8: Creating appropriate pressure in the Kiwi OmniCup vacuum device

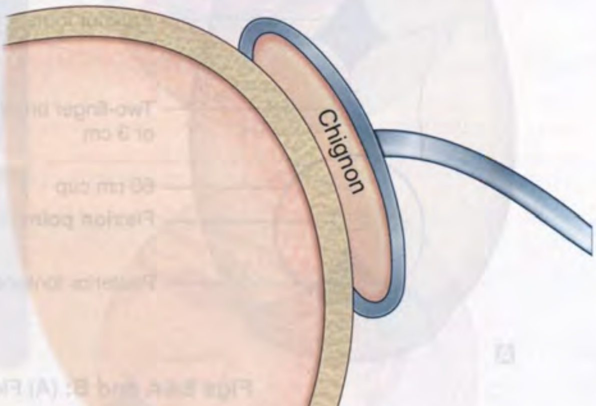
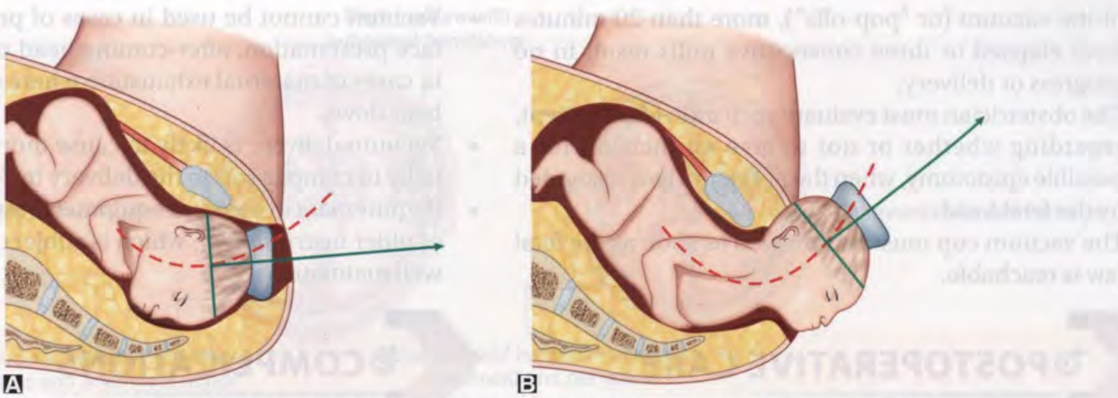


Fig. 8.9: Chignon created over the fetal scalp

is applied and this would take 1–2 minutes. "Chignon" is a French word meaning a large coil or lump of hair (bun) at the back. In obstetrics, chignon refers to a swelling over the scalp (artificial caput succedaneum) that develops inside the cup when vacuum is induced and is the means by which the cup adheres to the scalp. It is observed immediately after the removal of cup from the scalp. However, it rapidly decreases in size 1 hour after birth to become a diffuse swelling. It usually disappears over a period of 1–2 days.

As soon as the vacuum has been built up and the operator has checked that no vaginal tissue is trapped inside the silastic cup, traction should be applied with each uterine contraction in line of pelvic axis (Figs 8.10A and B). Initially, the traction must be applied in the direction perpendicular to the base of cup, i.e. in the downward direction. Once crowning of the head occurs, the direction must be changed to downwards and forwards in relation to the maternal position.

The patient is encouraged to push at the same time, so that a minimum amount of traction is required to complete the delivery. More than three good attempts of pulling are usually not recommended. Delivery should be achieved within three contractions. Descent should, however, be achieved with each contraction. The procedure should be discontinued if unintended cup detachments or "pop-ups" of the cup occur three times or if extraction is not achieved within 15–20 minutes of initiation. In case the cup gets dislodged, it should be reapplied only after careful



Figs 8.10A and B: Direction of application of traction with the help of vacuum cup device

inspection of fetal scalp for any injury. In order to prevent "pop-offs" during traction, the obstetrician must keep a thumb on the anterior part of the cup and index finger on the scalp to detect any detachment of the cup. Early detachment of the silastic cup can be detected if the edges of the cup begin to roll over.

Traction should be repeated with each contraction, until crowning of the fetal head occurs. As the head clears the pubic symphysis, the delivery of head is completed by modified Ritgen's maneuver. Once the fetal head has delivered, suction is released and the cup is removed. Delivery can then proceed as usual. Vacuum extraction should not be attempted for more than 20 minutes. It usually becomes obvious within 6–8 pulls, whether delivery would be successful or not. The procedure should be abandoned, if delivery is not achieved or the labor does not progress. Under ordinary circumstances, the procedure must be abandoned after three successive cup detachments. In these cases, forceps delivery or abdominal delivery must be considered. The procedure should also be stopped, if there appears any evidence of maternal or fetal trauma.

Using the "ABCDEFGHIJ" Mnemonic

The steps performed in vacuum extraction can be described using the mnemonic "ABCDEFGHIJ".[23] This acronym has been reviewed in Table 8.2.

A: Prior to delivery, the obstetrician should **a**ddress the patient and discuss the risks and benefits of operative vaginal delivery. At the time of delivery, extra **a**ssistance is required. This includes nursing care professionals, midwives, anesthetists, pediatricians and neonatal resuscitation team. Adequate **a**nalgesics should be administered before carrying out vacuum delivery. Though pudendal anesthesia suffices in most of the cases, regional anesthesia may be sometimes required for vacuum delivery.

B: The **b**ladder should be emptied prior to the application of vacuum in order to avoid risk of injury.

C: Prior to the application of vacuum, the **c**ervix should be completely dilated.

Table 8.2: Using the mnemonic "ABCDEFGHIJ" for vacuum extraction

Letter of acronym	Interpretation
A	**A**ddressing the patient **A**sk for help: assistants must be present **A**nalgesic requirements to be taken care of
B	**B**ladder to be empty
C	**C**omplete cervical dilation
D	**D**etermination of fetal position
E	**E**quipment to be checked and kept ready
F	**F**lexion point: vacuum cup to be placed at the flexion point
G	**G**entle traction
H	**H**alting the procedure
I	**I**ncision for episiotomy
J	Remove the vacuum cup when the **j**aw is reachable

D: The position of the fetal head should be **d**etermined prior to vacuum application.

E: The vacuum **e**quipment should be checked by the obstetrician, to ensure adequate suction.

F: The center of the cup should be placed at the **f**lexion point, which can be defined as a point over the sagittal suture, approximately 3 cm in front of the posterior fontanel and approximately 6 cm from the anterior fontanel. The placement of cup over the flexion point is important, as it helps in maximizing traction and minimizing detachment of the cup.

G: The obstetrician must apply **g**entle traction and increase the force of vacuum suction with the manometer at the recommended range. While some obstetricians prefer to lower the force of suction between contractions to decrease rates of scalp injury, others prefer to maintain continuous suction, especially in cases where rapid fetal delivery is required, e.g. in cases of nonreassuring fetal heart tones.

H: It is important for the obstetrician to know when to **h**alt the procedure for instrumental delivery. Use of vacuum should be **h**alted, when there are three disengagements of the vacuum (or "pop-offs"), more than 20 minutes have elapsed or three consecutive pulls result in no progress or delivery.

I: The obstetrician must evaluate each individual patient, regarding whether or not to give an incision for a possible episiotomy, when the perineum gets distended by the fetal head.

J: The vacuum cup must be removed as soon as the fetal jaw is reachable.

POSTOPERATIVE CARE

The postoperative steps for vacuum delivery are same as that of forceps delivery. It must involve the inspection of maternal tissues (cervix, vagina, vulva and paraurethral tissues) for the presence of any tears, lacerations, injury, etc. The newly delivered infant must be also carefully examined for the presence of any injuries.

ADVANTAGES

Similar to forceps delivery, the use of vacuum helps in avoiding the need of abdominal delivery (cesarean section). The use of vacuum extractor is supposed to have many advantages, some of which are listed in Table 8.3. The modern, soft, silastic vacuum cup, which can be used nowadays can be safely applied to the fetal scalp without much chances of causing injury or fetal scalp trauma. Also, the vacuum can be built up and released in between contractions, thereby further reducing the chances of fetal head injury.

One of the major advantages of vacuum extractor is that when traction is too great, the cup dislodges or pops off. This acts as a safety feature of the vacuum device. The vacuum cup has a traction limit of 23 lbs, which is much less than that with forceps delivery and therefore can be considered as an additional safety factor. However, during vacuum extraction, patient's active participation is essential. Therefore, ventouse delivery can be considered more physiological than the forceps delivery.

DISADVANTAGES

Some of the disadvantages associated with vacuum delivery are as described next.

Table 8.3: Advantages of vacuum delivery

♦ No extensive training and experience required
♦ No risks related to extensive traction
♦ Clear cut rules for application
♦ Rotation of baby's head occurs spontaneously
♦ Reduced maternal injury in comparison to forceps delivery
♦ Safety factor

- Vacuum cannot be used in cases of preterm delivery, face presentation, after-coming head of the breech or in cases of maternal exhaustion where she is unable to bear down
- Vacuum delivery is likely to cause more trauma to the baby in comparison to the delivery by forceps
- Requirement of complex equipment (especially in cases of older instruments), which is subject to failure if not well maintained.

COMPLICATIONS

Some of the complications for vacuum application have been described below.

NEONATAL INJURY

Use of vacuum can result in development of injuries, such as scalp lacerations, bruising, subgaleal hematomas, cephalohematomas, intracranial hemorrhage (Figs 8.11 and 8.12), neonatal jaundice, subconjunctival hemorrhage, clavicular fracture, shoulder dystocia, injury of sixth and seventh cranial nerves, Erb's palsy, retinal hemorrhage and fetal death.[24-27] Signs and symptoms of serious intracranial injury in a neonate include apnea, bradycardia, bulging fontanels, convulsions, irritability, lethargy and poor feeding.[28] Various neonatal injuries, which can occur as a result of vacuum application are described below.

Cephalohematomas (Fig. 8.12A)

Vacuum deliveries are associated with higher chances of development of neonatal cephalohematoma, in comparison with forceps delivery. The resolution of cephalohematomas can result in the development of hyperbilirubinemia over long term. In case of cephalohematoma, bleeding occurs beneath the periosteum, between the skull and the periosteum. As a result, the boggy swelling associated with cephalohematoma is limited by the suture lines in contrast to the subgaleal hematomas, which are not limited by the suture lines.

Subgaleal or Subaponeurotic Hematomas (Fig. 8.12B)

Subgaleal hematoma occurs as a result of bleeding in the potential space between the skull periosteum and epicranial aponeurosis. Since the collection occurs above the periosteum, it can cross the suture lines. Subgaleal hematoma must be suspected in case of boggy scalp swelling, swelling crossing the suture lines and an expanding head circumference.[29-32] The diffuse head swelling shifts with repositioning and indents on palpation. Swelling is not limited by suture lines (unlike in the cases of cephalohematoma). The infants may also have signs of hypovolemia (hypotension, pallor, tachycardia, tachypnea and a falling hematocrit).

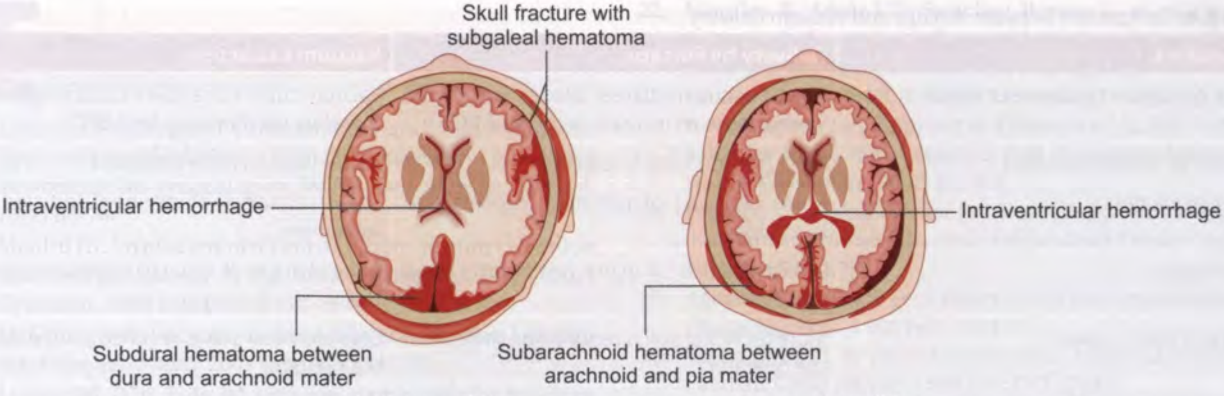
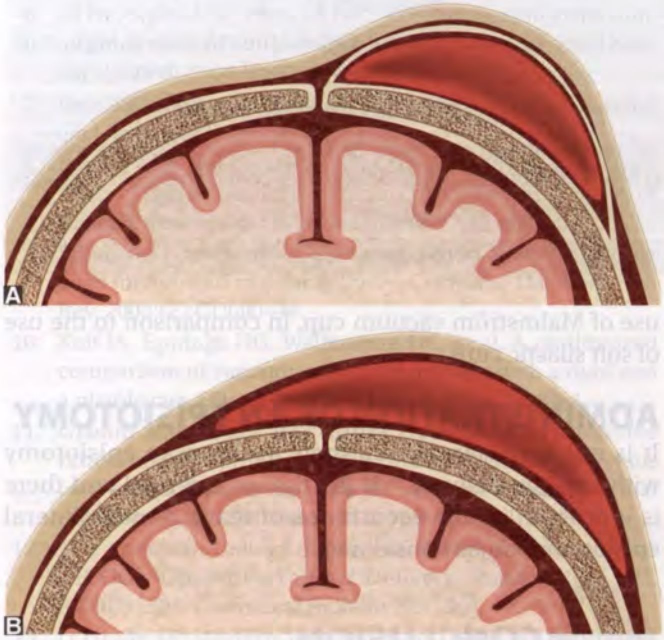


Fig. 8.11: Various types of fetal injuries which can occur as a result of vacuum application



Figs 8.12A and B: (A) Cephalohematoma; (B) Subgaleal hematoma

Intracranial Hemorrhage

These can be of various types, depending upon the location of the blood collection. Epidural hematoma occurs in the potential space between the dura mater and the skull. Subdural hematoma occurs in the potential space between the dura mater and arachnoid mater. Subarachnoid hemorrhage occurs in the subarachnoid space between the arachnoid mater and pia mater.

Shoulder Dystocia

Operative vaginal delivery is a risk factor for shoulder dystocia and it occurs more commonly with vacuum delivery, in comparison to the forceps delivery. The incidence of shoulder dystocia increases in cases of fetal macrosomia.

Retinal Hemorrhage

These usually resolve within several weeks and are unlikely to be associated with long-term morbidity.

Transient Neonatal Lateral Rectus Palsy

Since this usually resolves spontaneously, it is unlikely to have much clinical importance.

DISCUSSION

Vacuum extractors have replaced forceps for many situations, in which instrumental vaginal delivery is required, in order to avoid abdominal cesarean delivery. These devices are usually employed in cases of nonprogress of fetal head in the second stage of labor or for a nonreassuring fetal heart tracing. Vacuum extraction is associated with a higher rate of neonatal injury, in comparison to the forceps delivery. In comparison with metal-cup vacuum extractors, soft-cup devices are easier to use and are associated with fewer neonatal scalp injuries. However, the soft cups are likely to detach more frequently. The comparison between forceps and vacuum delivery is described next.

FORCEPS VERSUS VACUUM[33-40]

The "ventouse" delivery is considered to be more physiological and similar to normal vaginal delivery, in comparison to the forceps delivery. The comparison between vacuum and forceps delivery has been tabulated in Table 8.4 and illustrated in Figure 8.13. Theoretically, the use of vacuum extractor has several advantages over obstetric forceps. The use of vacuum helps in avoiding the insertion of space-occupying steel blades within the vagina. On the other hand, with a forceps delivery the fetal biparietal diameter is increased by the thickness of each forceps blade. Unlike forceps, the vacuum cup takes up minimal space in a mother's birth canal and, therefore, it is less likely to result in accidental maternal injuries.

Additionally, with the use of vacuum extractor, there is no requirement for precise rotation of fetal head prior to the application of the vacuum cup. Thus, the vacuum can be used, even if the obstetrician is unsure about the exact fetal position. Since the vacuum extractor helps in the application

Table 8.4: Comparison between forceps and vacuum delivery

Parameters	Delivery by Forceps	Vacuum Extraction
Effect on biparietal diameter (BPD) of fetal head	Space-occupying steel blades within the vagina cause an increase in the fetal BPD	Vacuum cup is not a space occupying device, therefore no change in fetal BPD
Amount of traction required	More traction force is required	Lesser traction force is needed
Maternal injuries	More chances of perineal injuries and lacerations	Lower chances of perineal injuries and lacerations
Fetal injuries	Lesser chances of injury to the fetal scalp and brain	More chances of injury to the fetal scalp and brain
Technical skill required	More technical skill is required on the part of the operator	Less technical skill is required on the part of the operator
Application in case of unrotated fetal head or occipitoposterior position	Must not be applied in cases of unrotated fetal head or occipitoposterior position	Can be applied in cases of unrotated fetal head or occipitoposterior position
Cervical dilation	Must be applied only in cases of fully dilated cervix	Can be applied even through incompletely dilated cervix
Safety feature	Not present	Present (When the traction is high, cup dislodges or pops off on its own)
Autorotation of fetal head	Cannot occur	Can occur along with traction
Use in other fetal presentations	Can be used in cases of mento-anterior position and after-coming head of the breech	Cannot be used in cases of mento-anterior position and after-coming head of the breech
Failure rate	Lower	Higher
Maternal morbidity	Higher	Lower

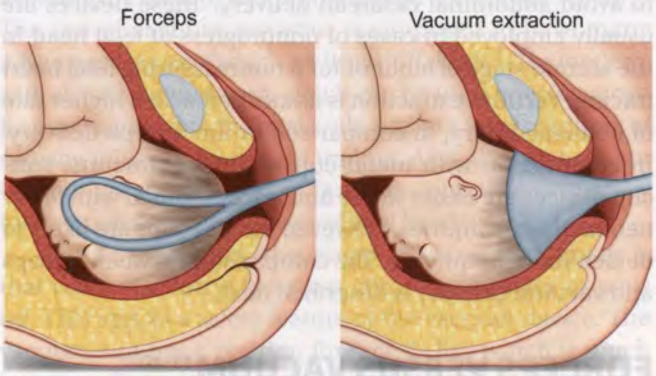


Fig. 8.13: Comparison between forceps and vacuum delivery

of traction only, therefore, even if the occiput is not directly anterior or the head is in an unrotated position, it is most likely to rotate, when it reaches the perineum, similar to the case of spontaneous vaginal delivery. Moreover, even if the fetal head is deflexed, vacuum extraction often helps in flexing it.

Vacuum application is associated with a much reduced maternal trauma. The amount of traction applied to the fetal head remains uncontrollable with forceps delivery, but it can be controlled with the use of a vacuum extractor. As a result, a high incidence of third- and fourth-degree maternal lacerations is associated with the use of forceps. However, use of vacuum is likely to result in serious fetal complications, including significant cranial injuries. An increased incidence of cephalohematomas and retinal hemorrhages has also been noted after vacuum deliveries. The incidence of fetal injuries is likely to be higher with the use of Malmström vacuum cup, in comparison to the use of soft silastic cups.

ADMINISTRATION OF AN EPISIOTOMY

It is not necessary to routinely perform an episiotomy with vacuum delivery.[41] If the tissues feel rigid and there is a probability for occurrence of tears, a mediolateral episiotomy can be considered.

CONCLUSION

From the above discussion, it is apparent that the use of silastic vacuum extractor is gaining popularity in various parts of the world. However, the procedure must be performed by an experienced obstetrician and it must be immediately abandoned, if it does not proceed smoothly or the cup dislodges more than three times. The obstetrician must consider vacuum extraction as a trial. There should be a progressive descent of fetal head with each traction attempt. If there is no clear evidence regarding the descent of fetal head, an alternative delivery approach must be considered. Delivery by vacuum extractor is being considered less traumatic for the mother, in comparison to the forceps delivery. Moreover, complications to the fetus may be minimized, if the physician recognizes contraindications to the use of vacuum extraction and follows the procedure correctly. Although a simple procedure, it still demands proper knowledge of the indications, careful use of technique, meticulous care and most importantly operator experience.

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CHAPTER 9

Normal Labor Room Procedures

INTRODUCTION

It is of prime importance for the obstetricians and gynecologists to be acquainted with the surgical procedures performed in the labor room. These may not be the major surgical procedures because most major surgical procedures would be performed in the operating room under general anesthesia. Most of the common labor room procedures have been described in individual chapters, e.g. forceps delivery (Chapter 7), vacuum delivery (Chapter 8), medical termination of pregnancy (Chapter 11), McDonald's procedure for cervical incompetence (Chapter 12), surgical interventions for control of postpartum hemorrhage (Chapter 13), repair of perineal injuries (Chapter 14), manual removal of placenta (Chapter 15), shoulder dystocia (Chapter 16), etc. "Episiotomy" and "induction of labor" are the labor room procedures that are discussed in this chapter.

EPISIOTOMY

An episiotomy is a surgical incision given through the perineum (Fig. 9.1) in order to enlarge the vaginal introitus for assisting the process of childbirth. Episiotomy is one of the most commonly performed surgical procedures in the United States. In general, episiotomy is less common in Europe than in the United States. However, the prevalence of episiotomy has reduced gradually over the past few years. This is primarily due to the controversy related to the efficacy and safety of the procedure. Although episiotomy is commonly performed in our setup, there is no strong medical evidence supporting its use. Episiotomy can be considered as one of the most controversial operations in obstetric practice. Giving an episiotomy is one of the ways of preventing the pelvic floor muscles against the harm caused by the genital tract trauma during the process of childbirth. The muscles of the pelvic floor form the major support system on which the uterus and vagina rest, related anteriorly to bladder and urethra, and posteriorly to rectum and anal canal. As a result, pelvic floor dysfunction can result in problems such as uterine organ prolapse, urinary incontinence, bowel incontinence, sexual dissatisfaction, etc.

Overview of Surgery

Episiotomy is a surgical incision, which is believed to guard the muscles of the pelvic floor by protecting them against stretching related to childbirth and delivery. Seven different types of episiotomies depending upon the direction of the surgical incisions have been described in the literature (Fig. 9.2): (1) the midline episiotomy, (2) modified median episiotomy, (3) "J"-shaped episiotomy, (4) mediolateral

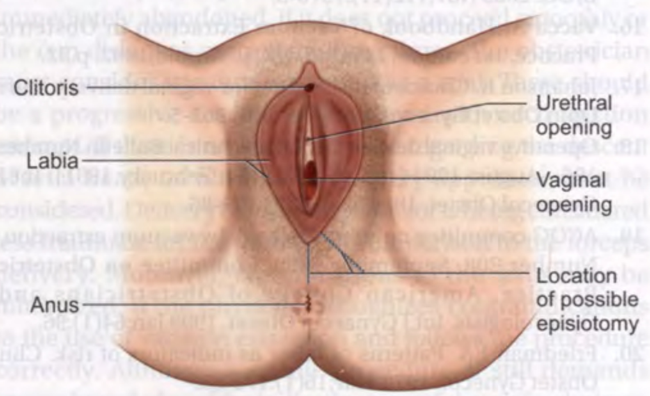


Fig. 9.1: Normal anatomy of the perineum

episiotomy, (5) lateral episiotomy, (6) radical lateral (Schuchardt incision), and (7) anterior episiotomy.[1,2] However, out of these only midline, mediolateral or lateral episiotomies are commonly used in the clinical practice. The midline episiotomy extends medially in the midline, directly from the lowermost edge of the vaginal opening towards the anus and is most commonly performed type of incision in the United States and Canada.[3] The mediolateral episiotomy, on the other hand, begins in the midline and is directed laterally, either towards the right or the left. While repairing the episiotomy incision, utmost importance must be given towards the maintenance of hemostasis and anatomical restoration without excessive suturing. Different types of episiotomies and their characteristics are described in Table 9.1.[2]

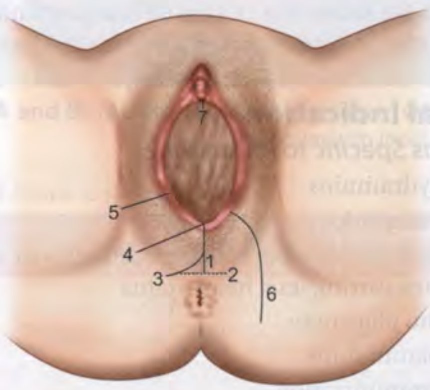


Fig. 9.2: Direction of giving different types of episiotomies: (1) Median episiotomy; (2) Modified median episiotomy; (3) "J-shaped" episiotomy; (4) Mediolateral episiotomy; (5) Lateral episiotomy; (6) Radical lateral (Schuchardt incision); (7) Anterior episiotomy

Aims of Surgery

Episiotomy is believed to confer protection to the woman by substituting a ragged laceration with a straight surgical incision, thereby protecting the pelvic floor against trauma and injury related to childbirth.[4,5] However, presently the evidence regarding the benefits of episiotomy in protecting the integrity of pelvic muscles as riddled with conflicting results. Despite this, episiotomy is one of the most commonly performed procedures in the obstetric practice.[6]

INDUCTION OF LABOR

Induction of labor can be defined as commencement of uterine contractions before the spontaneous onset of labor with or without ruptured membranes. It is indicated when the benefits of delivery to the mother or fetus outweigh the benefits of continuing the pregnancy. Induction of labor comprises of cervical ripening (in case of an unfavorable cervix) and labor augmentation. While cervical ripening aims at making the cervix soft and pliable, augmentation refers to stimulation of spontaneous contractions which may be considered inadequate due to failed cervical dilation or fetal descent.[7] Dilatation and effacement of cervix associated with cervical ripening and labor augmentation ultimately results in delivery of the baby. Cervical ripening is a complex process, primarily occurring under the influence

Table 9.1: Different types of episiotomies

S. No.	Type of Episiotomy	Characteristics
1.	Median (midline, medial) episiotomy	The incision begins at the posterior fourchette and runs along the midline through the central tendon of the perineal body. The incision extends to nearly half of the length of the perineum
2.	Modified median episiotomy (inverted "T"-shaped incision)	This incision is similar to the median episiotomy incision, except the addition of two transverse incisions in opposite directions just above the expected location of the anal sphincter. The two transverse incisions are perpendicular to the midline and measure about 2.5 cm in total length. The use of this modification is claimed to reduce the occurrence of injuries to the anal sphincters
3.	"J"-shaped episiotomy	This episiotomy begins with a midline incision and is then gently curved in a lateral direction to avoid the anus
4.	Mediolateral episiotomy	This is the most frequently used type of episiotomy in Europe. This incision begins in the midline and is directed laterally and downwards away from the rectum
5.	Lateral episiotomy	This incision begins in the vaginal introitus 1 or 2 cm lateral to the midline and is directed downwards towards the ischial tuberosity
6.	Radical lateral (Schuchardt incision)	Radical lateral episiotomy is often considered to be a nonobstetrical incision because it is usually performed at the beginning of radical vaginal hysterectomy or trachelectomy to allow easy access to the parametrium or to facilitate the extraction of a neglected vaginal pessary. Very rarely, this incision may be used to facilitate childbirth in case of complicated deliveries (large head, difficult breech or for correction of shoulder dystocia). This is a fully extended episiotomy, which begins as a deep incision into one vaginal sulcus and is curved downwards and laterally away and around the rectum
7.	Anterior episiotomy	The anterior episiotomy or deinfibulation involves incision of the scar associated with some degrees of female genital mutilation. This incision is usually performed during delivery on women who have had female infibulation performed previously

Source: Adapted from Reference 2

of prostaglandins whereby prostaglandins cause the breakdown of the cervical proteoglycan ground substance, scattering of the collagen fibers, an increase in the content of substances such as elastase, glycosaminoglycan, dermatan sulfate and hyaluronic acid levels in the cervix.[8] Induction of labor must be considered only when vaginal delivery appears to be an appropriate route of delivery and no contraindications for the vaginal route are present.

INDICATIONS

EPISIOTOMY

Previously, it was believed that an episiotomy must routinely be performed at the time of vaginal delivery, especially in the primigravidas. However, according to the current recommendations by the American Congress of Obstetricians and Gynecologists (ACOG, 2006), an episiotomy must only be performed in the situations where it is required.[9] Some of the conditions in which an episiotomy is indicated are as follows:

- As a prophylactic method to spare the strain on the pelvic floor muscles when it becomes apparent that natural vaginal delivery may cause straining of the pelvic floor muscles resulting in second- or third-degree perineal tears.
- Rigidity of perineal muscles, which is responsible for causing an arrest in the natural progress of labor. An episiotomy must be performed if, at the time of normal vaginal delivery, the tissues around the vaginal opening begin to tear or do not seem to be stretching enough to allow the baby to be delivered.
- Prevention of neonatal injuries in case of premature infant, having a soft cranium or macrosomic infant, which may be at a risk of shoulder dystocia.
- To prevent complete perineal tears in cases where the perineum is short.
- In cases where instrumental vaginal delivery is indicated.
- *Shoulder dystocia*: Although the performance of episiotomy does not resolve the problem of shoulder dystocia, it does allow the operator more room to perform maneuvers to free shoulder from the pelvis.
- Breech vaginal delivery.
- In cases where a woman has undergone female genital mutilation, a midline or a mediolateral episiotomy may be indicated.
- When the patient is actively pushing, but rapid delivery is still required due to fetal distress (prolonged late decelerations or fetal bradycardia).
- Episiotomy may also be at times given in cases of extremely premature babies in order to prevent compression of fetal head.
- Episiotomy may be given in cases of high-risk pregnancy to shorten the duration of the second stage of labor. This may help prevent undue bearing down efforts on the part of the mother in cases where she is suffering from medical disorders such as preeclampsia, heart disease, etc.

INDUCTION OF LABOR

Induction of labor is indicated only in those situations where it becomes apparent that both the mother and the fetus would be associated with a higher likelihood of better outcome if the fetal birth is expedited.[10] Before taking the decision for induction of labor, the obstetrician must weigh the benefits of labor induction against the potential maternal and fetal risks. Though there are no absolute indications for induction of labor, some common clinical indications for the induction of labor are discussed below.

Maternal Indications

Indications Specific to Pregnancy

- Oligohydramnios
- Polyhydramnios
- Ruptured membranes with preeclampsia or eclampsia or nonreassuring fetal heart status
- Abruptio placentae
- Chorioamnionitis
- Rh isoimmunization.

Maternal Diseases

- Diabetes mellitus
- Renal disease
- Chronic pulmonary disease
- Chronic hypertension.

Fetal Indications

- Postmaturity
- Intrauterine growth restriction
- Premature rupture of membranes (PROM)
- Fetus with congenital anomalies
- Intrauterine fetal death.

PREOPERATIVE PREPARATION

EPISIOTOMY

Under all aseptic precautions after cleaning and draping the perineum, the proposed site of repair is infiltrated with 10 mL of 1% lignocaine solution (Figs 9.3A and B).

Anesthesia in the form of nerve blocks or local injections of anesthetic drug is given if the patient has not received regional anesthesia (e.g. epidural anesthesia) for the delivery. If proper visualization of lower genital tract does not appear to be possible, it may be necessary to take the woman to theater for examination under anesthesia.

Figs 9.3A and B: (A) Infiltration of the perineum with local anesthesia before giving a mediolateral episiotomy; (B) Infiltration of the perineum with local anesthesia before giving a median episiotomy

Table 9.2: Bishop's score (modified)

Score	Dilation (cm)	Effacement (%)	Station of the Presenting Part	Cervical Consistency	Position of Cervix
0	Closed	0–30	– 3	Firm	Posterior
1	1–2	40–50	– 2	Medium	Mid position
2	3–4	60–70	– 1, 0	Soft	Anterior
3	> 5	> 80	+ 1, + 2	–	–

While performing the repair of the episiotomy incision, vaginal or cervical tears, the patient must be placed in lithotomy position, with a good source of light from behind. The obstetrician must ensure that adequate assistance and instruments are also available in order to provide adequate exposure of the genital tract.

INDUCTION OF LABOR

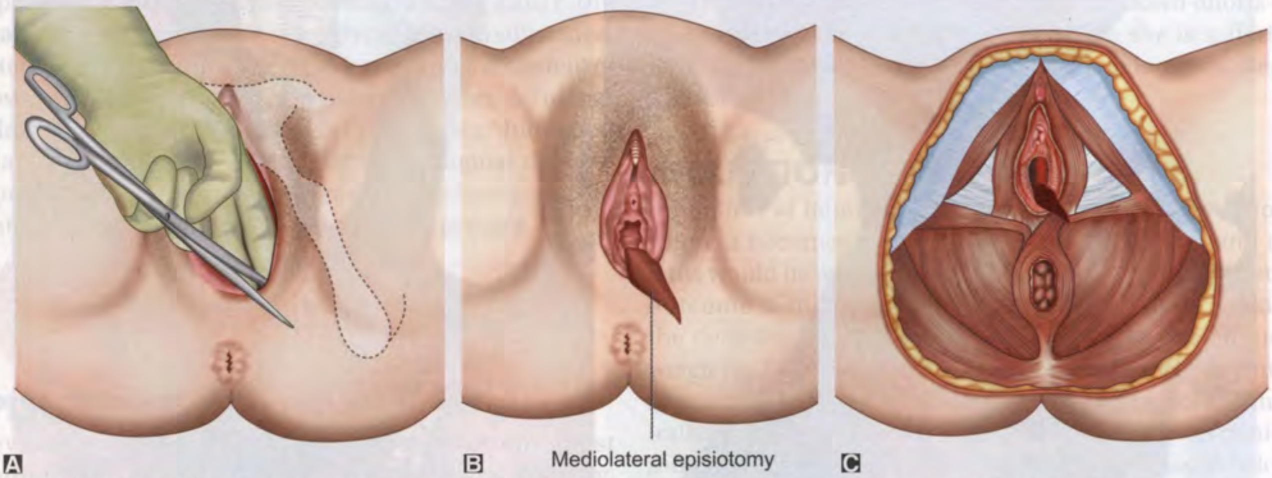
Prior to the induction of labor, following steps must be performed:

- *Patient counseling:* Before induction of labor is undertaken, the patient must be carefully counseled. She should be explained about the reason for induction, end points of the process, requirement for lower segment cesarean section (LSCS) in case the induction fails, options of mode of delivery, neonatal outcomes and complications, etc. All relevant information should be made available to the woman and she should be helped to be able to make an informed choice regarding her care or treatment plan.
- *Evaluation of the state of cervix:* This is done by calculation of the Bishop's score (Table 9.2). A maximum score of 13 is possible with this scoring system. Labor is most likely to commence spontaneously with a score of 9 or more, whereas lower scores (especially those < 5) may require cervical ripening and/or augmentation with oxytocin.[11]
- *Ultrasound assessment of gestational age:* This would help to prevent induction in premature babies.
- *Assessment of fetal lung maturity:* This may not be required in case where induction is medically indicated and the risk of continuing the pregnancy is greater than the risk of delivering a baby before lung maturity has been attained.

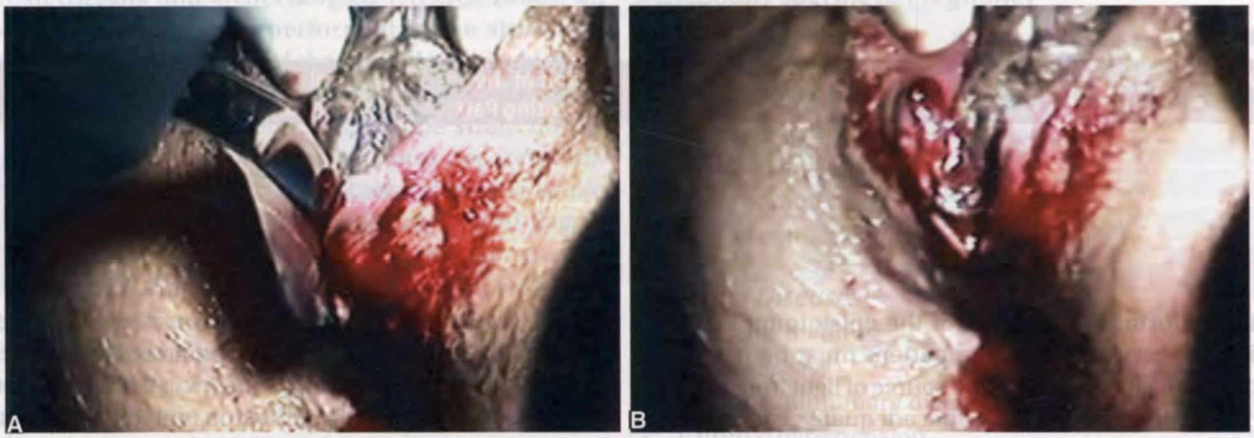
SURGICAL STEPS

REPAIR OF AN EPISIOTOMY

- The steps of surgery while performing a mediolateral episiotomy or a midline episiotomy are illustrated in Figures 9.4 and 9.5. Two fingers of the clinician's left hand are placed between the fetal presenting part and the posterior vaginal wall.
- The incision is made using a curved scissors at the point when the woman is experiencing uterine contractions; the perineum is being stretched by the maternal presenting part and is at its thinnest.
- The cut should be made starting from the center of fourchette extending laterally either to the right or left. This type of episiotomy is known as the mediolateral type of episiotomy which is most commonly performed in our setup. In many centers, a median episiotomy is performed extending from the center of fourchette towards the anus.



Figs 9.4A to C: (A) The procedure of giving a mediolateral episiotomy; (B) Cut in the skin after giving a mediolateral episiotomy; (C) Cut in the perineal muscles after giving a mediolateral episiotomy

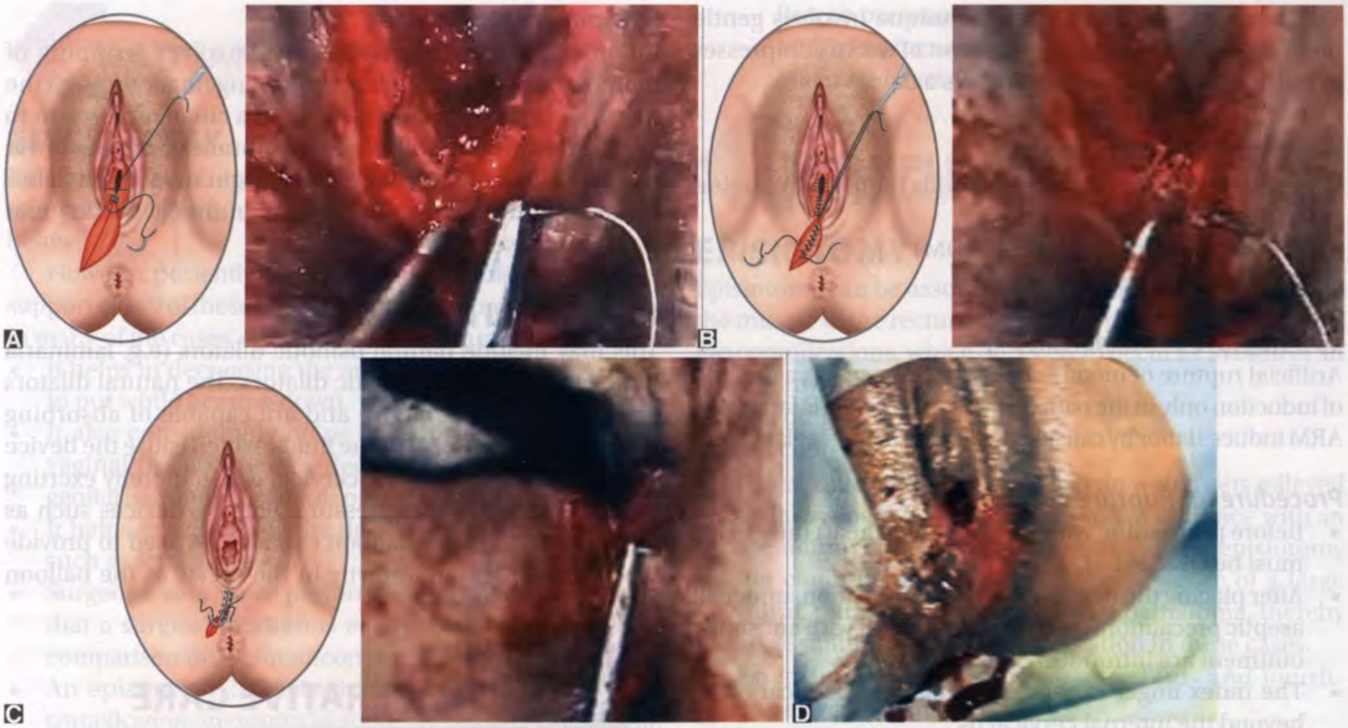


Figs 9.5A and B: The procedure of performing a midline episiotomy: (A) Performing a midline episiotomy; (B) Distention of the perineum by fetal head after performing a midline episiotomy

- The structures which are cut while performing the episiotomy include: posterior vaginal wall; superficial and deep transverse perineal muscles; bulbospongiosus and part of levator ani muscle; fascia covering these muscles; transverse perineal branches of pudendal nerves and vessels and subcutaneous tissues and skin.
- Following the delivery of the baby after the placenta has been expelled, the episiotomy incision is repaired. In case of presence of vaginal tears or lacerations, their repair is also performed essentially in the same manner as that of the episiotomy in order to achieve hemostasis and to obliterate the dead space.
- Prior to the repair of an episiotomy incision or a perineal or a cervical tear, the patient is placed in a lithotomy position with a good source of light, illuminating the area of incision. The area to be repaired must be cleaned with an antiseptic solution. The surgeon must examine the cervix, the vaginal walls, the vulvar outlet and paraurethral areas for any suspected injuries or tears, which also need to be repaired. The repair of an episiotomy or vaginal lacerations (tears) is performed in three layers (Figs 9.6A to C): the first layer comprising of the vaginal mucosa and submucosal tissues; the second layer comprising of the perineal muscles and the third layer comprising of the skin and subcutaneous tissues. The vaginal mucosa is repaired using continuous sutures with 2-0 or 3-0 chromic catgut sutures. The first vaginal suture is placed just above or at the apex of the incision. After closing the vaginal incision and reapproximating the cut margins of the hymenal ring, the sutures are tied and cut. Next, the fascia and the muscles of incised perineum are reapproximated with interrupted sutures of 2-0 or 3-0 chromic catgut. Lastly, the skin is closed using interrupted stitches with silk or subcuticular stitches.

INDUCTION OF LABOR

Methods for induction of labor comprise of both methods for cervical ripening as well as augmentation of labor. Methods of cervical ripening include pharmacological



Figs 9.6A to D: Repair of an episiotomy incision: (A) Vaginal mucosa being repaired using continuous stitches; (B) Muscle layer being repaired using interrupted stitches; (C) Skin being repaired using interrupted matrix sutures; (D) Appearance of perineum following the repair of episiotomy

methods, nonpharmacological methods and use of mechanical cervical dilators.[12]

Pharmacological Methods

Medical methods for labor induction commonly comprise of prostaglandins [dinoprostone (PGE2), or misoprostol (PGE1)] and/or oxytocin.

Dinoprostone

Dinoprostone helps in cervical ripening and is available in the form of gel (Prepidil or Cerviprime) or a vaginal insert (Cervidil). Prepidil comprises of 0.5 mg of dinoprostone in a 2.5 mL syringe.[13] The gel is injected intracervically every 6 hours for up to three doses in a 24-hour period. Cervidil, on the other hand, is a vaginal insert containing 10 mg of dinoprostone. The main advantage of Cervidil is that it can be immediately removed in case it causes hyperstimulation.

Misoprostol

Misoprostol (Cytotec) is a synthetic PGE1 analog. This drug has not been currently approved by the United States Food and Drug Administration (US FDA) for cervical ripening or induction of labor. Misoprostol, however, has been approved for the prevention of peptic ulcers. Use of misoprostol for cervical ripening is an off-label use, which is still considered controversial by some clinicians. However, its use is recommended by the ACOG. A dose of 25 mg is placed transvaginally at every 3 hourly intervals for a maximum of 4 doses or it may be prescribed in the oral dosage of 50 mg orally at every 4 hourly intervals.[14] Also, presently the available evidence supports the intravaginal or oral use of 25–50 µg of PGE1 for cervical ripening/induction of labor. The same dosage can be repeated after 4–6 hours, if required.

Oxytocin

Oxytocin is a uterotonic agent which stimulates uterine contractions and is used for both induction and augmentation of labor. It can be started in low dosage regimens of 0.5–1.5 mU/minute or the high dosage regimen of 4.5–6.0 mU/minute, with incremental increases of 1.0–2.0 mU/minute at every 15–40 minutes.[15] If an intrauterine pressure catheter is in place, measurement of intrauterine pressure ranging between 180 Montevideo units/period and 200 Montevideo units/period is an indicator of adequate oxytocin dosing.

Other Pharmacological Methods for Induction of Labor

Mifepristone (Mifeprex) is an antiprogesterone agent, which is able to stimulate the uterine contractions.[16] Isosorbide mononitrate is another agent which can be used for cervical ripening without stimulating uterine activity.

Breast massage and nipple stimulation is a nonpharmacologic method which is thought to stimulate uterine contractions by facilitating the release of oxytocin from the posterior pituitary gland.

The most commonly used technique involves gentle massage of the breasts or application of warm compresses to the breasts for 1 hour, three times a day.

Surgical Management

Various nonpharmacological methods for labor induction comprise of the following:

- Low rupture of membranes (ROM)
- Stripping of membranes.

Low Rupture of Membranes

Artificial rupture of membranes (ARM) is used as a method of induction only in the patients where the cervix is favorable. ARM induces labor by causing the release of prostaglandins.[17]

Procedure for Rupture of Membranes

- Before proceeding with ARM, the fetal heart rate (FHR) must be checked
- After placing the woman in lithotomy position, under all aseptic precautions, two fingers smeared with antiseptic ointment are introduced inside the vagina
- The index finger is passed through the cervical canal beyond the internal cervical os
- Using the index and the middle fingers, the fetal membranes are swept free from the lower uterine segment as far as can be reached with fingers
- While the fingers are still in the cervical canal, with the palmar surface upward, a long Kocher's forceps with closed blades is introduced along the palmar aspect of the fingers up to the membranes
- The blades of the Kocher's forceps are opened to grasp the membranes and tear it using twisting movements (Fig. 9.7)
- When the membranes rupture, there is a visible gush of amniotic fluid
- The color of the escaping liquor must be noted. Meconium-stained liquor is suggestive of fetal distress
- If the head is not engaged, an assistant must push the head to fix it to the brim in order to prevent cord prolapse.

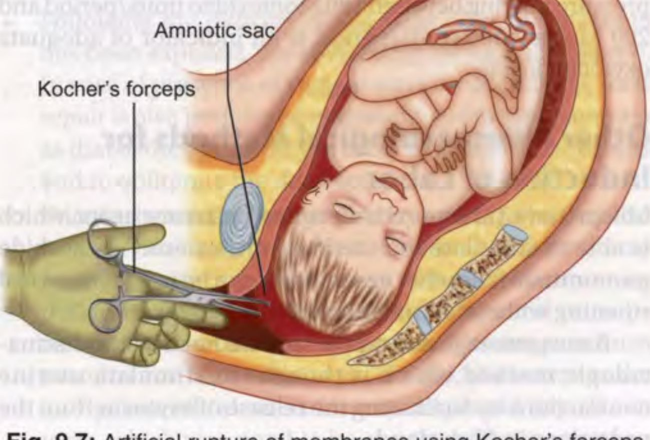


Fig. 9.7: Artificial rupture of membranes using Kocher's forceps

Stripping of Membranes

As the name implies, the process involves stripping of membranes by inserting the examining finger through the internal cervical os and moving it in a circular direction to detach the inferior pole of the membranes from the lower uterine segment. The process is thought to augment labor by causing the release of prostaglandins (PGF 2α) and phospholipase A2.

Mechanical Methods

This may include natural osmotic dilators (e.g. laminaria tents) and synthetic osmotic dilators. The natural dilators are hygroscopic in nature and are capable of absorbing endocervical and local tissue fluids, which cause the device to enlarge within the endocervical canal, thereby exerting controlled mechanical pressure. Balloon devices such as 24/26-French Foley's balloon can also be used to provide mechanical pressure directly in the cervix as the balloon is inflated.

POSTOPERATIVE CARE

CARE OF AN EPISIOTOMY

- If infection is suspected, combinations of broad spectrum antibiotics can be administered
- Application of an ice-pack over the stitches may help in reducing inflammation in the area, thereby reducing pain and swelling
- Regular use of warm sitz bath is also helpful in reducing pain and inflammation over the site of incision.
- The patient must be advised to ambulate around as much as possible and regularly perform the pelvic floor exercises in order to stimulate circulation and speed up the process of healing.
- Use of pain killers, such as paracetamol, may help in providing pain relief.

INDUCTION OF LABOR

- Color of liquor and cervical status following ROM is observed
- The clinician must detect cord prolapse, if present
- Quality of FHR must be assessed following ROM. In case the FHR is less than 100 beats/min or more than 180 beats/min, fetal distress must be suspected
- Fetal electrode may be applied in high-risk cases in order to assess the fetal heart status
- A sterile vulvar pad is applied
- Prophylactic antibiotics may be administered in case delivery is not anticipated within 18 hours
- If good labor is not established 1 hour after ARM, oxytocin infusion must be started. In case of the presence of severe maternal disease (e.g. sepsis, eclampsia, etc.), oxytocin infusion must begin at the same time as ARM.

ADVANTAGES

EPISIOTOMY

Episiotomy is performed with the intention of conferring many advantages. Some of these advantages are enumerated below.

However, presently there is no strong medical evidence in support of any of these benefits. In fact, it is now believed that in many of the cases, episiotomies can actually cause harm.

- It helps in decreasing the amount of effort mother has to put while bearing down.
- It also considerably helps in reducing trauma to the vaginal tissues, thereby decreasing the occurrence of genital tract injuries such as perineal tears and lacerations.
- It helps in expediting the delivery of the baby in cases such as fetal distress.
- Surgeons who favor performing an episiotomy argue that a surgical incision is easier to repair and heal in comparison to a spontaneous irregular or extensive tear.
- An episiotomy is likely to be associated with fewer complications in comparison to a laceration or vaginal tear.
- An episiotomy by preventing undue stretching of the pelvic floor muscles is thought to provide protection against pelvic floor relaxation, which could predispose to the development of future cystoceles, rectoceles, uterine prolapse, urinary incontinence, etc.

INDUCTION OF LABOR

Advantages of amniotomy or ROM are as follows:

- The process of ARM by providing extensive contact between the fetal presenting part and the cervix, encourages release of endogenous prostaglandins, thereby augmenting labor and shortening its duration
- The escape of liquor at the time of ARM provides the opportunity for early detection of meconium-stained liquor amnii and the possibility of fetal distress, thereby instigating closer observation of fetal well-being.

DISADVANTAGES

INDUCTION OF LABOR

Contraindications to induction of labor are similar to that for spontaneous labor and vaginal delivery. Some of the absolute contraindications for induction of labor include:

- Transverse lie
- Vasa previa, placenta previa
- Previous cesarean delivery/scarred uterus (especially with the involvement of uterine cavity).
- Certain relative contraindications for induction of labor are as follows:
  - Previous LSCS
  - Breech presentation
  - Multiple pregnancy
  - Maternal heart disease.

COMPLICATIONS

EPISIOTOMY

Episiotomy can be associated with extensions or tears into the muscle of the rectum or even the rectum itself. Some of the complications, which are likely to occur as a result of an episiotomy, are as follows:

- Bleeding
- Infection
- *Pain:* While a slight amount of pain which gets relieved on taking pain killers is a common occurrence with an episiotomy, persistent severe pain at the episiotomy site could be an indicator of the presence of a large vulvar, paravaginal or ischiorectal hematoma, thereby necessitating a thorough exploration in these cases.
- Extension of the episiotomy into third- and fourth-degree vaginal lacerations
- Longer healing times
- Increased discomfort/sexual dysfunction when intercourse is resumed
- Swelling
- Unsatisfactory anatomic results (e.g. skin tags, asymmetric introitus, fistula formation, narrowing of introitus, etc.)
- Possible increased risk of development of perineal lacerations in the subsequent deliveries.

INDUCTION OF LABOR

Induction of labor, in general, can be associated with the following complications:

- Uterine hyperstimulation (with oxytocin and misoprostol), may result in uteroplacental hypoperfusion and FHR deceleration
- Prostaglandins may produce tachysystole, which may be controlled with terbutaline
- Maternal systemic effects, such as fever, vomiting and diarrhea, may be infrequently observed
- Failure of induction
- Uterine atony and postpartum hemorrhage
- Increased rate of cesarean delivery
- Chorioamnionitis
- Oxytocin may be responsible for producing water intoxication.

Complications associated with ARM are as follows:

- Reduction in amniotic fluid may result in cord compression and/or head compression
- The intensity of pains may increase to undesirable levels, adversely affecting the fetus

- There may be a danger of cord prolapse and/or limb prolapse
- Predisposition to a premature separation of the placenta
- The risk of ascending infection, which further increases with the passage of time
- The obstetrician is compelled to accomplish delivery within a reasonable period of time.

Complications associated with sweeping and stretching of membranes include risk of infection, bleeding, accidental rupture of the membranes and discomfort to the patient.

DISCUSSION

EPISIOTOMY

Role of Episiotomy

In the past few years, especially in the 1970s, it was a common practice to give an episiotomy to almost all women, especially the primigravidas. However, the use of episiotomy has considerably decreased over the past few years. Initially, it was believed that the use of an episiotomy would be associated with reduced amount of postoperative pain and better healing in comparison to a laceration. This fact, however, proved wrong over a period of time. The present evidence regarding the safety and efficacy of episiotomy has presented with conflicting views. Another unproven benefit of episiotomy is that its use would be associated with reduced incidence of pelvic relaxation, cystocele, rectocele and urinary incontinence.

A systematic review by Hartman et al. does not support the fact that traditional use of routine episiotomy provides any maternal benefit against genital tract injuries.[18] A few trials have shown that the routine use of episiotomy can result in an increased incidence of anal sphincter and rectal tears. There is increasing evidence that the median episiotomy is not effective for preventing pelvic relaxation and is associated with higher rates of obstetric anal sphincter injury.[19-22]

Surgical repair and postoperative healing of midline episiotomy is better in comparison to a mediolateral one. A midline episiotomy is also associated with better anatomical results, minimal postoperative pain, reduced blood loss and dyspareunia. Midline episiotomy is considered to be more superior to the mediolateral episiotomy except for the issue that it is more commonly associated with third- and fourth-degree extensions. Shiono et al. concluded from their study that a mediolateral episiotomy incision was preferable to a midline one as the latter was associated with an increased risk of lacerations, especially third- and fourth-degree lacerations, some of which may result in the development of rectovaginal fistula in the long run.[23] This can result in significant morbidity. However, Sartore et al. have shown that even a mediolateral episiotomy does not protect against development of urinary and anal incontinence or genital prolapse, post delivery.[24] They also observed that a mediolateral episiotomy was associated with lower pelvic floor muscle strength, more dyspareunia and perineal pain compared with the practice of giving no episiotomy. Also, even the mediolateral episiotomy incisions can be associated with other complications including increased pain, less satisfactory cosmetic result, painful intercourse, etc. Presently, the evidence regarding the choice between a midline or mediolateral episiotomy is rather limited.

In fact, outcomes with routine practice of episiotomy can be considered worse since some proportion of women who would otherwise have normal vaginal delivery without accompanying muscle damage or laceration, would instead have a surgical incision. Moreover, outcomes with episiotomy can be worse in some cases, resulting in complications like painful intercourse and extension of the episiotomy into the sphincter or rectum. Evidence regarding long-term sequel is fair to poor. There is limited data regarding the protective effect of episiotomy in prevention of fecal and urinary incontinence, pelvic floor relaxation or impaired sexual function. Fair to good evidence suggests that immediate maternal outcomes from routine episiotomy are not better than those from restrictive use; in fact they have been often observed to be worse.

From the above discussion, it appears that an episiotomy must not be routinely performed. The procedure must be used only for selective indications such as shoulder dystocia, breech delivery, instrumental delivery (forceps or vacuum extraction), occipitoposterior position and in cases where it appears obvious that failure to perform an episiotomy would result in extensive perineal tears and lacerations.

Timing of an Episiotomy

If performed too early, an episiotomy may result in considerable amount of bleeding. If performed too late, it may not be able to prevent the lacerations. The episiotomy must be performed when the fetal head distends the vaginal introitus by 3–4 cm. When used with forceps application, episiotomy must be performed following the application of the blades.

Episiotomy is performed with the intention of conferring protection to the woman's genital tract by substituting a ragged laceration with a straight surgical incision, thereby protecting the pelvic floor against trauma and injury related to childbirth.

Prevention of an Episiotomy

Episiotomies are not always necessary, and some preventative measures can be practiced by the patient in order to reduce the risk related to the performance of an episiotomy incision.[25-31] Some of these measures are as follows:

- Good nutrition, which would help in keeping the perineal skin healthy and supple. This is important because healthy skin is likely to stretch more easily at the time of fetal delivery

- Kegel exercises for the muscles of the pelvic floor
- Prenatal perineal massage
- Controlled pushing during the second stage of labor
- Warm compresses, perineal massage and support during delivery.

INDUCTION OF LABOR

Oxytocin versus Prostaglandins for Induction of Labor

Oxytocin is the most commonly used drug all over the world to augment labor. Intracervical application of dinoprostone (PGE2, 0.5 mg gel), anyway had been the gold standard for cervical ripening. It still remains the gold standard for cervical ripening. Since 1975, prostaglandins (PGE2) have also been used for induction of labor. The labor induced by prostaglandins is likely to have a shorter interval between ROM and delivery in comparison to that induced with oxytocin and ROM, especially in cases where the cervix is ripe.[32] However, in cases where the cervix is unripe, prostaglandins are more successful than oxytocin in inducing labor. The most commonly used prostaglandin regimen for induction of labor comprises of oral administration of two tablets of PGE2 (0.5 mg each) every hour until labor is established.[33] This is followed by the administration of one tablet orally every hour to augment labor.

Misoprostol (PGE1) is also nowadays commonly being used for induction of labor. The most commonly followed regimen comprises of vaginal administration of 25 μg misoprostol every 4–6 hours. Vaginal route is more effective than the intracervical or oral route. Hundred micrograms of oral or 25 μg of vaginal misoprostol has been found to be similar in efficacy to intravenous oxytocin for labor induction. In comparison to the PGE2 analogs, PGE1 analogs are cheaper, can be stored at room temperature and are easy to administer. PGE1 is a more effective method of cervical ripening than either intravaginal or intracervical PGE2 or oxytocin. PGE1 in comparison to PGE2 has been found to be associated with an increased incidence of hyperstimulation.[34] The safety issues concerning the use of vaginal misoprostol are presently unclear and it has yet not got FDA approval for its use as an inducing agent. Misoprostol overdosage, however, can be associated with complications such as tachysystole, uterine hyperstimulation, which may be associated with birth asphyxia and/or rupture uterus. Another complication, which may occur, is meconium-stained liquor (resulting in meconium aspiration).

Use of prostaglandins over oxytocin for induction of labor facilitates ambulation, the labor contractions are less painful and the risk of postpartum hemorrhage is lower in comparison with oxytocin. Moreover, there is no danger of fluid overload and neonatal jaundice as observed with oxytocin. However, it is possible to control the augmented labor while using oxytocin infusion with the help of continuous monitoring of the uterine activity and FHR. The rate of infusion is controlled by the healthcare provider and can be stopped, reduced or increased at any moment whenever the need arises. On the other hand, the induction of labor cannot be controlled while using prostaglandins. Once a prostaglandin tablet has been consumed orally or the prostaglandin gel has been instilled, the effect of the drug cannot be as reversed unlike in case of oxytocin.

Use of prostaglandins is favored over oxytocin in cases where labor is induced in either nulliparous or multiparous women with intact membranes, regardless of the fact whether the cervix is favorable or not. However, if the membranes have ruptured, both prostaglandins or oxytocin may be used as both of them are equally effective in such cases.

CONCLUSION

An obstetrician must be familiar with the two procedures commonly performed in the labor room: (1) administration of an episiotomy and (2) induction of labor.

Although the procedure of episiotomy was originally invented to reduce the risk of the genital tract injuries and lacerations, the exact benefit of the procedure still remains controversial. According to the recommendations of ACOG (2006), an episiotomy should not be considered routine and only be performed if deemed necessary. An episiotomy does help in enlarging the size of the pelvic soft tissue outlet, which may help in facilitating the delivery of a macrosomic or breech infant. Also, in case fetal distress is suspected, administration of an episiotomy may help in reducing the time of fetal expulsion. If a shoulder dystocia is anticipated, it may be sensible to intentionally administer an episiotomy to generate more space for performing obstetric maneuvers required to relieve the dystocia. Therefore, presently the use of an episiotomy should be only restricted to the situations where there is likely to be a high risk of severe lacerations or there is a requirement for rapid delivery of the fetus. The women must be advised to exercise their pelvic muscles through Kegel exercises, which can help prevent the requirement for an episiotomy. Moreover, episiotomy is a controlled surgical incision which helps in preventing the occurrence of a spontaneous, large, irregular laceration of the perineum. It is usually easier to repair a controlled surgical incision in comparison to a spontaneous laceration. This is likely to result in the better restoration of surgical anatomy, thereby resulting in fewer long-term complications.

Induction of labor helps in expediting the process of vaginal delivery. Induction and augmentation of labor appear to be the two parts of the same continuum, merging imperceptibly into one another. Induced labors are associated with higher rates of operative interference and an increased demand for pain relief. It can be done by using both medical and surgical methods. However, any induced labor must be carefully monitored. It is especially important for the obstetrician not to leave any patient with induced labor unattended. All induced labors must be monitored with the help of a partogram. Continuous electronic fetal monitoring is not essential. In case of suspicious/pathological findings on cardiotocography, oxytocin infusion must be decreased or discontinued. In suspected or confirmed cases of acute fetal compromise, the delivery should be accomplished as soon as possible (preferably within 30 minutes).

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CHAPTER 10

Cesarean Section

INTRODUCTION

OVERVIEW OF SURGERY

Cesarean section is a surgical procedure commonly used in the obstetric practice. In this procedure, the fetal delivery is attained through an incision made over the abdomen and uterus, after 28 weeks of pregnancy.[1] If the removal of fetus is done before 28 weeks of pregnancy, the procedure is known as hysterotomy. Presently, there has been a considerable rise in the rate of cesarean deliveries.

AIMS OF SURGERY

Abdominal delivery through a cesarean section is usually performed when a vaginal delivery is likely to put the baby's or mother's life or health at risk.

INDICATIONS

Indications for cesarean section are listed in Table 10.1.[2]

PREOPERATIVE PREPARATION

The steps discussed below should be taken for preoperative preparation.

Assessment of Fetal Pulmonary Maturity

A planned cesarean delivery must be scheduled at or after 39 completed weeks of gestation.

Table 10.1: Indications for primary cesarean delivery

Common Indications
♦ Failure to progress during labor or dystocia (18%)
♦ Nonreassuring fetal status (32%)
♦ Fetal malpresentation (19%)
♦ Suspected macrosomia (5,000 g in women without diabetes; 4,500 g in women with diabetes) (10%)
♦ Preeclampsia (10%)
♦ Maternal request (8%)
Less Common Indications
♦ Abnormal placentation (e.g. placenta previa, vasa previa, placenta accreta)
♦ Multiple gestation (with first fetus in noncephalic presentation)
♦ Fetal bleeding diathesis
♦ Cord presentation or cord prolapse
♦ Maternal infection (e.g. herpes simplex or human immunodeficiency virus)

Source: Adapted from Reference 2

Empty Stomach

In order to prevent the risk of aspiration of gastric contents at the time of administration of anesthesia, the patient should be nil per mouth for at least 12 hours before undertaking a cesarean section. In case the patient is full stomach, she should be administered H_2 receptor blocker (ranitidine 150 mg) and an antiemetic (metoclopramide 10 mg) at least 2 hours prior to the surgery.

Patient Position

The patient is placed with 15° lateral tilt on the operating table, in order to reduce the chances of hypotension.

Anesthesia

While cesarean section can be performed both under general or regional anesthesia, nowadays regional anesthesia is favored.[3] Spinal and epidural anesthesia have become the most commonly used forms of regional anesthesia in the recent years. Regional anesthesia is safer and is associated with significantly lower maternal and neonatal morbidity, in comparison to general anesthesia. Women who are having a cesarean section under regional anesthesia should be offered intravenous ephedrine or phenylephrine and volume preloading with crystalloids or colloids, in order to reduce the risk of hypotension occurring at the time of surgery. Before cleaning and draping the patient, it is a good practice to check the fetal lie, presentation, position and fetal heart sounds once again. Foley's or plain rubber catheter must be inserted, following which the cleaning and draping of the abdomen is done.

Antibiotic Prophylaxis

Preoperative antibiotic prophylaxis is recommended 0–60 minutes prior to giving the incision. Single dose of a narrow spectrum antibiotic (cefazolin) 2 g (for a patient < 120 kg) is usually preferred. There is no evidence regarding the beneficial effect of multiple doses or broad spectrum antibiotics.

Thromboprophylaxis

Mechanical thromboprophylaxis is recommended for all women undergoing cesarean delivery. For women who are at a high risk of thromboembolism, a combination of mechanical and pharmacological thromboprophylaxis is suggested until the woman starts ambulating after the surgery. Pharmacological treatment (where required) is begun 6–12 hours following the surgery.

Preparation of the Skin

The area around the proposed incision site must be washed with antiseptic soap solution (e.g. savlon and/or betadine solution). Antiseptic skin cleansing before surgery is thought to reduce the risk of postoperative wound infections. The antiseptic solution must be applied at least three times over the incision site, using a high-level disinfected sponge holding forceps and cotton or gauze swab. The surgeon must begin at the proposed incision site and move outwards in a circular motion away from the incision site. After reaching the edge of the sterile field, the previous swab must be discarded and new swab must be used. At the end, the inner aspects of thighs and umbilicus must be swabbed.

The surgeon must keep his/her arms and elbows high and surgical gown away from the surgical field. The woman must be draped using sterile drapes immediately after the area of surgery has been adequately prepared, in order to avoid contamination. If the drape has a window, it should be placed directly over the incision site.

The woman's pubic hair must not be shaved, as this may increase the risk of wound infection. The hair may be trimmed, if necessary.

SURGICAL STEPS

The essential steps in a cesarean delivery are summarized in Table 10.2 and Figures 10.1A to I and are described next in details.

Giving an Abdominal Skin Incision

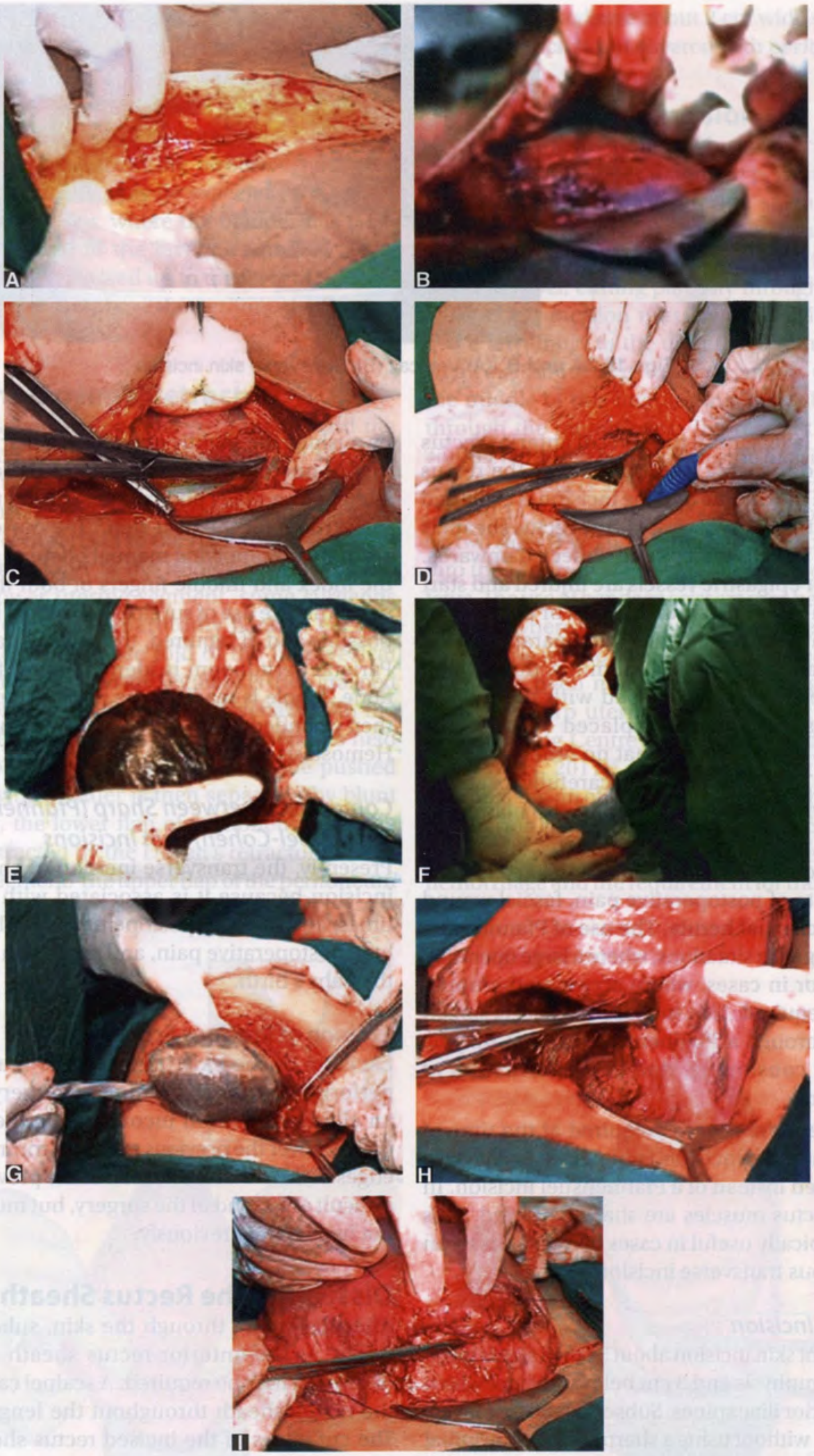
A vertical or transverse incision can be given over the skin (Fig. 10.2). The vertical skin incision can be either given in the midline or paramedian location, extending just above the pubic symphysis to just below the umbilicus. Previously, vertical skin incision at the time of cesarean section was favored, as it was supposed to provide far more superior access to the surgical field in comparison to the transverse incision. Also, the vertical incision showed potential for extension at the time of surgery. However, it was associated with poor cosmetic results and an increased risk of wound dehiscence and hernia formation. Therefore, nowadays, transverse incision is mainly favored due to better cosmetic effect, reduced postoperative pain and improved patient recovery. Two types of transverse incisions are mainly used, while performing cesarean section: (1) the sharp (Pfannenstiel) type and (2) the blunt (Joel-Cohen) type.[4,5]

Sharp Pfannenstiel Transverse Incision

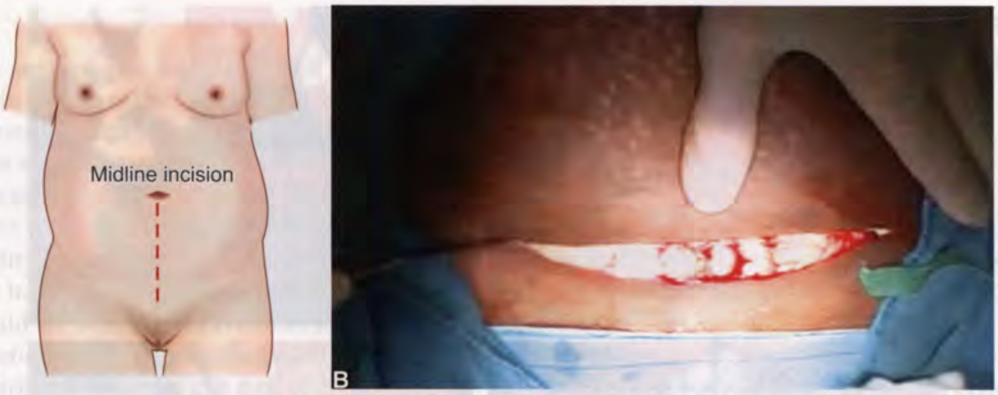
In this type, a slightly curved, transverse skin incision is made at the level of pubic hairline, about an inch above the pubic symphysis and is extended somewhat beyond the lateral borders of rectus abdominis muscle. The

Table 10.2: Summary of the essential steps in a cesarean delivery

• Use of a sharp Pfannenstiel transverse lower abdominal skin incision (or Joel-Cohen incision)
• Blunt extension of the uterine incision
• Manual removal of the placenta at the time of cesarean delivery must not be done
• Controlled cord traction for removal of the placenta or waiting for spontaneous expulsion of placenta
• Routine use of forceps to deliver baby's head must not be employed
• The uterine incision must be closed with two suture layers
• Neither the visceral nor the parietal peritoneum needs to be sutured
• Routine closure of subcutaneous space is not required unless the thickness of fat is greater than 2 cm
• Regular use of superficial wound drains is not required
• Early skin-to-skin contact between the mother and baby must be encouraged



Figs 10.1A to I: Steps of cesarean delivery: (A) Giving an incision over the abdomen and dissecting out different layers of skin; (B) Application of Doyen's retractor after dissection of parietal peritoneum; (C) Incision of visceral peritoneum; (D) Giving a uterine incision; (E) Delivery of fetal head; (F) Delivery of the entire baby out of the uterine cavity; (G) Delivery of the placenta; (H) Clamping the uterine angles with Green-Armytage clamps; (I) Stitching the uterine cavity



Figs 10.2A and B: (A) Vertical; (B) Transverse skin incision

subsequent tissue layers, until the level of anterior rectus sheath, are opened by using a sharp scalpel. The rectus sheath is incised in the middle and the incision is extended on both sides with the help of scissors. The rectus sheath is held on both sides, by Allis forceps and dissected upwards. In case the superior epigastric vessels are injured and start bleeding, they can either be suture ligated or coagulated with the help of diathermy. Following the separation of the muscles, pyramidalis and rectus abdominis, the parietal peritoneum is identified and grasped with the help of two artery forceps. An incision is placed between the two artery forceps after ensuring that no other structure has been grasped. The incision is then carefully extended upwards and downwards, to ensure that the bladder is not injured.

Pfannenstiel incision is associated with better cosmetic results, reduced rate of postoperative pain, fascial wound dehiscence and incisional hernia. The use of Pfannenstiel incision is discouraged in situations, where a large operating space is required or in cases, where access to the upper abdomen may be required. Also, in cases of repeat cesarean section, re-entry through a Pfannenstiel incision may be difficult and time consuming, due to the formation of adhesions and scars.

In cases, where more room is required at the time of surgery, but a transverse incision is preferred, a Maylard incision may be used instead of a Pfannenstiel incision. In these cases, the rectus muscles are sharply divided. This incision may be typically useful in cases of repeat cesarean section with previous transverse incision.

Joel-Cohen Blunt Incision

In this type, a straight skin incision about 3 cm in size is given above the pubic symphysis and 3 cm below the line, which joins anterior superior iliac spines. Subsequent tissue layers are opened bluntly, without using a sharp scalpel. The initial cut is given only through the cutis. In the midline, which is free from large blood vessels, the cut is deepened to meet the fascia. A small transverse opening is made in the fascia with the scissors. The rest of the fascia is then opened transversely, by pushing the slightly open tip of a pair of straight scissors, first in one direction and then in the other. The fascia is stretched caudally and cranially, using the index fingers to make room for the next step.[6] The muscle and fat tissue is separated by applying manual bilateral skin traction, using the index and middle fingers of both the surgeon and his assistant. The use of surgical knife must be avoided as far as possible and, if required, the scissors can be used instead. Parietal peritoneum is identified and finger dissection is done. A hole is made in the parietal peritoneum, which is then extended by the pull of surgeon and his/her assistant. Hemostasis is achieved with the help of diathermy.

Comparison between Sharp (Pfannenstiel) versus Blunt (Joel-Cohen) Skin Incisions

Presently, the transverse incision of choice is Joel-Cohen incision because it is associated with shorter operating times, and reduced postoperative febrile morbidity, blood loss, postoperative pain, and time from skin incision up to the baby's birth.[7]

Excision of Previous Scar

Excision of the existing previous scar must always be performed at the beginning of surgery, by either giving an elliptical incision incorporating the scar or giving an incision over the previous scar with trimming of the fibrosed edges of the wound. Excision of the previous scar is usually difficult at the end of the surgery, but must be done, if it has not been done previously.

Dissecting the Rectus Sheath

After dissecting through the skin, subcutaneous fat and fascia, as the anterior rectus sheath is reached, sharp dissection may be required. A scalpel can be used to incise the rectus sheath throughout the length of the incision. The cut edges of the incised rectus sheath are held with the help of Allis forceps and then carefully separated out from the underlying rectus muscle and pyramidalis. These muscles are then separated with the help of blunt and sharp dissection, to expose transversalis fascia and peritoneum.

Opening the Peritoneum

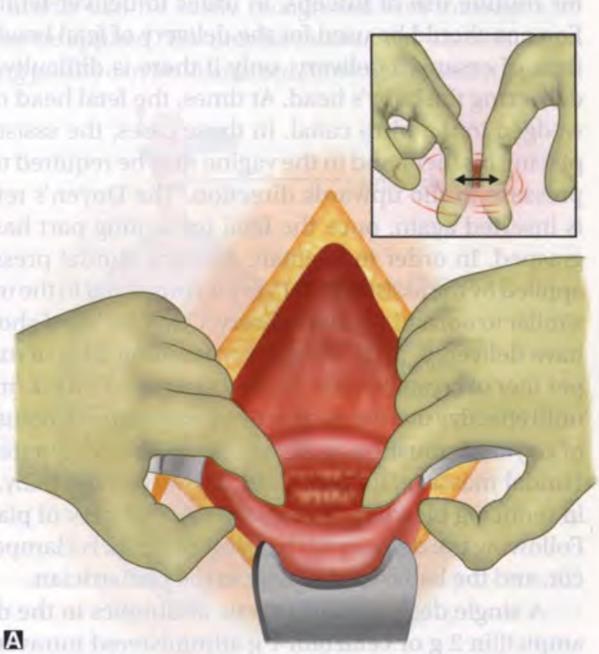
The transversalis fascia and peritoneal fat are dissected carefully to reach the underlying peritoneum. After placing two hemostats about 2 cm apart to hold the peritoneum, it is carefully opened. The layers of peritoneum are carefully examined to be sure that omentum, bowel or bladder is not lying adjacent to it. This may be especially important in cases of obstructed labor, where the bladder has been pushed cephalad almost to the level of umbilicus. The peritoneum is superiorly incised up to the level of incision and inferiorly to a point just above the peritoneal reflection over the bladder.

Insertion of the Doyen's Retractor

Following the dissection of parietal peritoneum and the identification of the lower uterine segment, the surgeon must then check, if the uterus is dextrorotated, by identifying the round ligaments. In the dextrorotated uterus, the left round ligament in comparison to the right round ligament may be anterior and closer to the midline. Following the identification of lower uterine segment, some surgeons prefer to put a moistened laparotomy pack in each of the paracolic gutters. The loose fold of the uterovesical peritoneum over the lower uterine segment is then grasped with the help of forceps and incised transversely with the help of scissors. The lower flap of the peritoneum is held with artery forceps and the loose areolar tissue pushed down. The underlying bladder is then separated by blunt dissection. Finally, the lower flap of peritoneum and the areolar tissue is retracted by the Doyen's retractor to clear the lower uterine segment. The upper flap of the peritoneum is pushed up to leave about 2 cm wide strip on the uterine surface, which is not covered with peritoneum.

Giving a Uterine Incision

An incision is made in the lower uterine segment about 1 cm below the upper margin of peritoneal reflection. The incision over the lower uterine segment is given about 2–3 cm above the bladder base. While making an incision in the uterus, a curvilinear mark of about 10 cm length is made by the scalpel, cutting partially through the myometrium. The uterine incision must be gently given, taking care to avoid any injury to the underlying fetus. Following this, a small cut (about 3 cm in size) is made, using the scalpel in the middle of this incision mark, reaching up to, but not through the membranes. The rest of the incision can be completed either by stretching the incision, using the tips of two index fingers along both the sides of the incision mark (Fig. 10.3A) or using bandage scissors, to extend the incision on two sides (Fig. 10.3B). The bandage scissors is introduced into the uterus over the two fingers, in order to protect the fetus. The use of bandage scissors may be especially required in cases, where the lower uterine segment is thickened and the uterine incision cannot be extended using the fingers. There has been much controversy regarding, whether a blunt or sharp uterine incision must be used. National Collaborating Centre for Women's and Children's Health (NCCWCH, 2011)[8] recommends that blunt rather than sharp extension of the uterine incision should be used when the uterine segment is well formed because it is supposed to reduce amount of blood loss, incidence of postpartum hemorrhage and the requirement for transfusion at the time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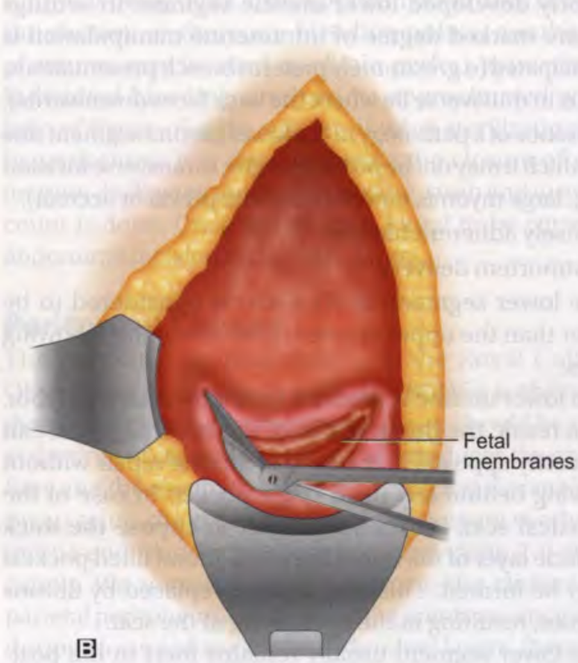


B

Figs 10.3A and B: (A) Extension of the uterine incision by manual stretching, using the index fingers; (B) Extension of the uterine incision with the help of scissors of cesarean section. If the lower uterine segment is very thin, injury to the fetus can be avoided, by using the handle of the scalpel or a hemostat (an artery forceps) to open the uterus. The uterine incision must be large enough so as to allow the delivery of the head and trunk without the risk of extension of the incision laterally into the uterine vessels. One must remember that in patients with advanced second stage of labor, the lower uterine segment may be excessively stretched. In these cases, it may be required to place the incision relatively higher, in order to avoid the extension towards the vagina. In case the surgeon feels that lateral extension of the uterine incision is a possibility, he/she can use several alternatives, such as making a J-shaped, U-shaped or a T-shaped incision. As the fetal membranes bulge out through the uterine incision, they are ruptured. The amniotic fluid, which is released following the rupture of membranes is sucked with the help of a suction machine.

Location of the Uterine Incision

Lower segment uterine scar or the upper segment uterine scar: While in the past, a vertical incision (classical) was commonly used, this was associated with a high risk of scar rupture during future pregnancies. There are two types of vertical incisions: (1) low vertical (limited to the lower uterine segment) and (2) the classical vertical (extending up to the uterine fundus). The low vertical incision appears to be as safe and strong as the low transverse incision.[9]

The classical incision is rarely performed at or near-term because it is associated with a high rate of scar rupture in future pregnancies. As a result, lower segment transverse incisions are nowadays preferred. Indications for considering a vertical uterine incision are as follows:

- Poorly developed lower uterine segment in settings where marked degree of intrauterine manipulation is anticipated (e.g. extremely preterm breech presentations, fetus in transverse lie where the back faces downwards).
- Presence of a pathology in the lower uterine segment due to which it may not be possible to give a transverse incision (e.g. large myoma, anterior placenta previa or accreta).
- Densely adherent bladder.
- Postmortem delivery.

The lower segment uterine scar is considered to be sounder than the upper segment scar due to the following reasons:

- The lower uterine segment is thinned out during labor. As a result, the thin margins of the lower segment can be easily apposed at the time of uterine repair without leaving behind any dead space pocket. In case of the classical scar, it may be difficult to appose the thick muscle layer of the upper segment. Blood filled pockets may be formed. This may be later replaced by fibrous tissues, resulting in the weakening of the scar.
- The lower segment usually remains inert in the post-partum period. On the other hand, the upper segment undergoes rapid contractions and retractions, resulting in the loosening of the uterine sutures. This can result in imperfect healing and further weakening of the uterine scar.
- When the uterus stretches in the future pregnancy, the stretch is along the line of the scar in the case of the lower segment scar, whereas in cases of vertical scar, the uterus stretches in the direction perpendicular to the scar, thereby resulting in the scar weakness.

Chances of the placental implantation in the area of the scar at the time of the future pregnancy are highly unlikely in the case of the lower segment scar. However, in case of the classical scar the placental tissue is quite likely to implant in the area of the scar at the time of future pregnancy. Penetration and the invasion of the scar by the placental trophoblasts are likely to produce further weakening of the scar.

As a result of the previously mentioned reasons, the lower segment scar is much stronger as compared to the upper segment scar and is unlikely to give way during subsequent pregnancies. Lower segment scar may rupture occasionally at the time of labor. On the other hand, upper segment scar is weak and may rupture, both during the antenatal period and at the time of labor.

Delivery of the Infant

In case of cephalic presentation, once the fetal presenting part (head) becomes visible through the uterine incision, the surgeon places his/her right hand below the fetal presenting part and grasps it. In case of cephalic presentation the fetal head is then elevated gently, using the palms and fingers of the hand. Delivery of the fetal head should be in the same way as during the normal vaginal delivery. There is no need for routine use of forceps, in order to deliver fetal head. Forceps should be used for the delivery of fetal head at the time of cesarean delivery, only if there is difficulty, while delivering the baby's head. At times, the fetal head may be wedged in the birth canal. In these cases, the assistant by placing his/her hand in the vagina may be required to exert pressure in the upwards direction. The Doyen's retractor is inserted again, once the fetal presenting part has been grasped. In order to facilitate delivery, fundal pressure is applied by the assistant. Delivery is completed in the manner similar to normal vaginal delivery. Once the baby' shoulders have delivered, an IV infusion containing 20 U of oxytocin per liter of crystalloids is infused at a rate of 10 mL/minute, until effective uterine contractions are obtained. Bolus doses of oxytocin must be avoided due to risk of hypotension. Fundal massage, following the delivery of the baby, helps in reducing bleeding and hastens the delivery of placenta. Following the delivery of the baby, the cord is clamped and cut, and the baby handed over to the pediatrician.

A single dose of prophylactic antibiotics in the dose of ampicillin 2 g or cefazolin 1 g administered intravenously after the cord is clamped and cut (if not previously administered at the time of giving the incision), helps in providing adequate prophylaxis. No additional benefit has been demonstrated with the use of multiple dose antibiotic regimens. If the woman shows signs of infection, e.g. fever, urinary tract infections, sepsis, etc., antibiotics must be continued until the woman becomes free of fever for at least 48 hours.

Placental Removal

At the time of cesarean section, the placenta should be removed, using controlled cord traction (Fig. 10.4) or awaiting spontaneous expulsion and not manual removal as this reduces the risk of endometritis.[10] Following the delivery of the placenta, the remnant bits of membranes and decidua are removed using a sponge-holding forceps. The cut edges of the uterine incision are then identified and grasped with the help of Green-Armytage clamps. The uterine angles are usually grasped with Allis forceps. Additionally, some surgeons practice routine dilatation of internal os, in order to allow better drainage of lochia postdelivery.[11] We routinely do not use this practice. Prior to the closure of uterine incision, it is a good practice to inspect the adnexa (both the tubes and ovaries).

Closing the Uterine Incision

The main controversies related to the closure of the uterine incision are whether the closure should be in the form of a single-layered or a double-layered closure and whether the uterus should be exteriorized or not at the time of closure. Before repair of the uterine incision, some surgeons prefer to exteriorize the uterus in order to improve exposure and facilitate closure of uterine incision. Moreover, uterine exteriorization has some inherent advantages. A relaxed atonic uterus can be easily recognized and massage can therefore be applied. The uterine incision, its extension and bleeding points can be visualized more easily and repaired.

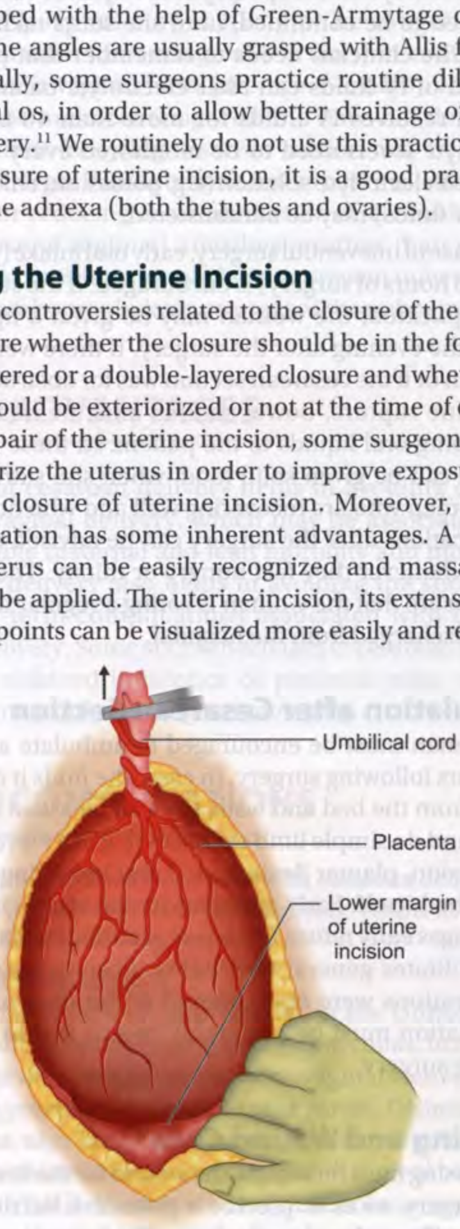


Fig. 10.4: Placental removal through controlled cord traction

Adnexal exposure is superior and it may be easier to carry out tubal sterilization. Also, uterine exteriorization has been found to be associated with higher rate of intraoperative nausea and vomiting.

According to the results of a large randomized trial (CORONIS), there were no statistically significant differences in maternal outcome based on the method of entry into the uterine cavity (blunt versus sharp entry) method of repair of the uterine incision (exterior versus intra-abdominal repair), method of closure (single-layer versus double-layer closure) and choice of suture material (chromic catgut versus polyglactin-910). Therefore, until there is emergence of better quality evidence proving otherwise, any of these surgical techniques is acceptable. Therefore, the choice of using a particular method depends on personal preference and the specific clinical settings.[12-14]

Incomplete healing of the scar of cesarean section may be associated with complications later in pregnancy such as scar pregnancy, morbidly adherent placenta, scar dehiscence or rupture.

Single-Layered or Double-Layered Closure of Uterine Incision

Both single-layered and double-layered closure of uterine incision are being currently practiced. Though single-layered closure is associated with reduced operative time and reduced blood loss in the short term, the risk of the uterine rupture during subsequent pregnancies is increased.[15,16] The current recommendation by NCCWCH, 2011 is to close the uterus in two layers, as the safety and efficacy of closing uterus in a single layer is presently uncertain.[8] In our setup, single-layered closure of the uterus, using continuous locked sutures is being done. If the approximation does not appear satisfactory or there are bleeding points, another layer of sutures may be used to obtain perfect approximation. Individual bleeding sites can be approximated with the help of figure-of-eight sutures. If tubal sterilization has to be performed, it is done following the closure of uterine incision. Following the uterine closure, swab and instrument count is done. Once the count is found to be correct, the abdominal incision is closed in layers.

Peritoneal Closure

The current recommendation by the Royal College of Obstetricians and Gynaecologists (RCOG) is that neither the visceral nor the parietal peritoneum should be sutured at the time of cesarean section as this reduces the operative time and the requirement for the postoperative analgesia.[17] In our setup, the edges of visceral peritoneum overlying the uterus and bladder are approximated using 2-0 chromic catgut. We routinely do not perform the closure of the parietal peritoneum. If any bleeding points are encountered during closure of any of the abdominal layers, these points can be either clamped and suture ligated or coagulated with an electrosurgical blade.

Closure of the Rectus Sheath

Rectus sheath closure is performed after identifying the angles and holding them with Allis forceps. The angles must be secured using 1-0 Vicryl sutures. The rectus layer is closed with the help of continuous locked sutures placed no more than 1 cm apart. Hemostasis must be checked at all levels.

Closure of Subcutaneous Space

There is no need for the routine closure of the subcutaneous tissue space, unless there is more than 2 cm of subcutaneous fat, because this practice has not been shown to reduce the incidence of wound infection.

Skin Closure

Obstetricians should be aware that presently the differences between the use of different suture materials and methods of skin closure at the time of cesarean section are not certain. Skin closure can be either performed, using subcutaneous, continuous repair absorbable or nonabsorbable stitches or using interrupted stitches with nonabsorbable sutures or staples.[18] In our setup, skin is closed with vertical mattress sutures of 3-0 or 4-0 silk. Following the skin closure, the vagina is swabbed dried and dressing applied to the wound.

POSTOPERATIVE CARE

IMMEDIATE POSTOPERATIVE CARE

- After surgery is completed, the woman needs to be monitored in a recovery area.
- Monitoring of routine vital signs (blood pressure, temperature, breathing), urine output, vaginal bleeding, bleeding from the incision site and uterine tonicity (to check, if the uterus remains adequately contracted), needs to be done at hourly intervals for the first 4 hours. Thereafter, the monitoring needs to be done at every four hourly intervals for the first postoperative day at least. Adequate analgesia needs to be provided, initially through the IV line and later with oral medications.
- When the effects of anesthesia have worn off, about 4–8 hours after surgery, the woman may be transferred to the postpartum room.

Pain Management after Cesarean Section

Adequate postoperative pain control is important. A woman, who is in severe pain may not recover well. However, excessive use of sedative drugs must be avoided, as this may limit the patient's mobility, which is important to prevent thromboembolism. Patient-controlled analgesia, using opioid analgesics should be offered after cesarean section because it is associated with higher rate of patient satisfaction. Women could be offered diamorphine (0.3–0.4 mg intrathecally) for intra- and postoperative analgesia. Nonsteroidal antiinflammatory drugs may be used postoperatively, as an adjunct to other analgesics because they help in reducing the requirement for opioids. Adding acetaminophen also increases the effects of the other medications with very little additional adverse risk. Analgesic rectal suppositories can also be used for providing relief from pain in women following cesarean section.

Fluids and Oral Food after Cesarean Section

As a general rule, about 3L of fluids must be replaced by intravenous infusion during the first postoperative day, provided that the woman's urine output remains greater than 30 mL/hour. If the urine output falls below 30 mL/hour, the woman needs to be reassessed to evaluate the cause of oliguria. In uncomplicated cases, the urinary catheter can be removed by 12 hours postoperatively. Intravenous fluids may need to be continued, until she starts taking liquids orally. The clinician needs to remember that prolonged infusion of IV fluids can alter electrolyte balance. If the woman receives IV fluids for more than 48 hours, her electrolyte levels need to be monitored every 48 hours. Balanced electrolyte solution (e.g. potassium chloride 1.5 g in 1 L IV fluids) may be administered.

In case of uneventful surgery, early oral intake (preferably within 6 hours of surgery) is encouraged. If the surgery was uncomplicated, the woman may be given a light liquid diet in the evening after the surgery. If there were signs of infection or if the cesarean section was for obstructed labor or uterine rupture, bowel sounds must be heard before prescribing oral liquids to the patient. In these cases, the woman can be given solid food, when she starts passing gas. Women who are recovering well and who do not have complications after the surgery can be advised to eat and drink, whenever they feel hungry or thirsty. The clinician must ensure that the woman is eating a regular diet before she is discharged from the hospital.

Ambulation after Cesarean Section

The woman must be encouraged to ambulate as soon as 6–8 hours following surgery. In case, she finds it difficult to get up from the bed and walk, she can be asked to remain in bed and do simple limb exercises (e.g. leg elevation, foot dorsiflexion, plantar flexion, etc.) and breathing exercises on the bed itself. Early ambulation enhances circulation, encourages early return of normal gastrointestinal function and facilitates general well-being. Even in cases, where complications were encountered at the time of surgery, mobilization must be preferably begun within 24 hours after the surgery.

Dressing and Wound Care

The dressing must be kept on the wound for the first 2–3 days after surgery, so as to provide a protective barrier against infection. Thereafter, dressing is usually not required. If blood or fluid is observed to be leaking through the initial dressing, the dressing must not be changed. The amount of blood/fluid lost must be monitored. If bleeding increases or the blood stain covers half the dressing or more, the dressing must be removed and replaced with another sterile dressing. The dressing must be changed while using a sterile technique. The surgical wound also needs to be carefully inspected.

Staples or nonabsorbable sutures (whichever were applied) can be removed by 3–4 days in case of transverse incision and minimal traction on the skin edges. In case of presence of risk factors for wound complications (e.g. diabetes, obese patients, etc.) or in case of vertical incision, the staples/sutures can be left in place for at least 5–7 days or longer depending upon the clinical situation.

Length of Hospital Stay

Length of hospital stay is likely to be longer after a cesarean section (an average of 3–4 days) in comparison to that after a vaginal birth (average 1–2 days). However, women who are recovering well and have not developed complications following cesarean section may be offered early discharge. Postoperative interventions, which can be used for reducing cesarean section related morbidity, include use of regional anesthesia rather than general anesthesia, antibiotic prophylaxis to prevent infection and use of thromboprophylaxis, to prevent thromboembolism.

ADVANTAGES

The use of cesarean delivery helps in avoiding difficult cases of vaginal delivery, which may be associated with considerable maternal and fetal mortality and morbidity. Cesarean delivery also helps in avoiding the short-term and long-term complications associated with difficult vaginal delivery. Some such advantages of cesarean delivery include: reduced incidence of perineal pain, urinary incontinence and uterovaginal prolapse.

COMPLICATIONS

Various complications associated with cesarean delivery are tabulated in Table 10.3 and are described below in details.

Uterine Rupture

Approximately 15% of all deliveries in the United States occur in women with previous cesarean sections. In a patient with a previous cesarean section, vaginal delivery may cause the previous uterine scar to separate. Disintegration of the scar, also known as scar rupture is one of the most disastrous complications associated with vaginal birth after cesarean (VBAC). The reported incidence of scar rupture for all pregnancies is 0.05%. Risk of scar rupture after vaginal delivery following one previous lower transverse segment cesarean section, on an average, is estimated to be about 0.8–1%. However, the exact risk of scar rupture depends upon the type of uterine incision, given at the time of previous cesarean (Table 10.4). The weakest type of scar that may give way at the time of VBAC is the previous classical incision in the upper segment of the uterus, which is associated with almost 10% risk of development of scar rupture. Uterine rupture can result in complete extrusion of the fetus into the maternal abdominal cavity. In other cases, rupture is associated with fetal distress or severe hemorrhage from the rupture site. Though uterine rupture is often associated with fetal bradycardia, there is no one specific fetal heart rate (FHR) pattern, which indicates the onset of uterine rupture. Variable and/or late decelerations often occur before the onset of fetal bradycardia. Symptoms of impending scar rupture during the labor include the following:

- Dull suprapubic pain or severe abdominal pain, especially if persisting in between the uterine contractions
- Slight vaginal bleeding or hematuria
- Bladder tenesmus or frequent desire to pass urine
- Unexplained maternal tachycardia
- Maternal hypotension
- Abnormal fetal heart rate pattern
- Scar tenderness
- Chest pain or shoulder tip pain or sudden onset of shortness of breath
- Onset of unexpected antepartum or postpartum hemorrhage
- On vaginal examination, there may be a failure of normal descent of the presenting part and the presenting part may remain high up. There also may be a sudden loss of station of the presenting part. All this may result in poor progress of labor.

Table 10.3: Complications associated with cesarean delivery

- Abdominal pain
- Injury to bladder, ureters, etc.
- Increased risk of rupture uterus and maternal death
- Neonatal respiratory morbidity
- Hysterectomy
- Thromboembolic disease
- Increased duration of hospital stay
- Antepartum or intrapartum intrauterine deaths in future pregnancies
- Patients with a previous history of cesarean delivery are more prone to develop complications, like placenta previa and adherent placenta during future pregnancies

Table 10.4: Risk of scar rupture based on the type of uterine scar, given at the time of previous cesarean delivery

Type of Previous Cesarean Scar	Estimated Risk of Rupture
Classical cesarean	4–9%
T-shaped incision	4–9%
Low vertical	1–7%
Low-transverse incision	0.8–1%

Types of Uterine Rupture

Uterine rupture is defined as a disruption of the uterine muscle extending to and involving the uterine serosa. At times, there may be disruption of the uterine muscle with extension to the bladder or broad ligament. The uterine rupture can be of two types: (1) complete rupture and (2) incomplete rupture.

1. *Complete rupture*: Complete rupture describes a full-thickness defect of the uterine wall and serosa, resulting in direct communication between the uterine cavity and the peritoneal cavity (Figs 10.5A and B).
2. *Incomplete rupture*: Incomplete rupture describes a defect of the uterine wall that is contained by the visceral peritoneum or broad ligament. Incomplete rupture is also known as uterine dehiscence and describes partial separation of the scar in association with minimal bleeding with the peritoneum and fetal membranes remaining intact.

The identification or suspicion of uterine rupture is a medical emergency and must be followed by an immediate and urgent response from the obstetrician. An emergency laparotomy is usually required to save the patient's life. Complete uterine rupture is very unlikely today. A complete rupture occurs in much less than 1% of women attempting VBAC. Incomplete rupture occurs in about 1–2% of the cases. There is no clear cut predictive indicator for rupture uterus. However several factors, which are indicative of a weak scar, are mentioned in Table 10.5.

Management of Rupture Uterus

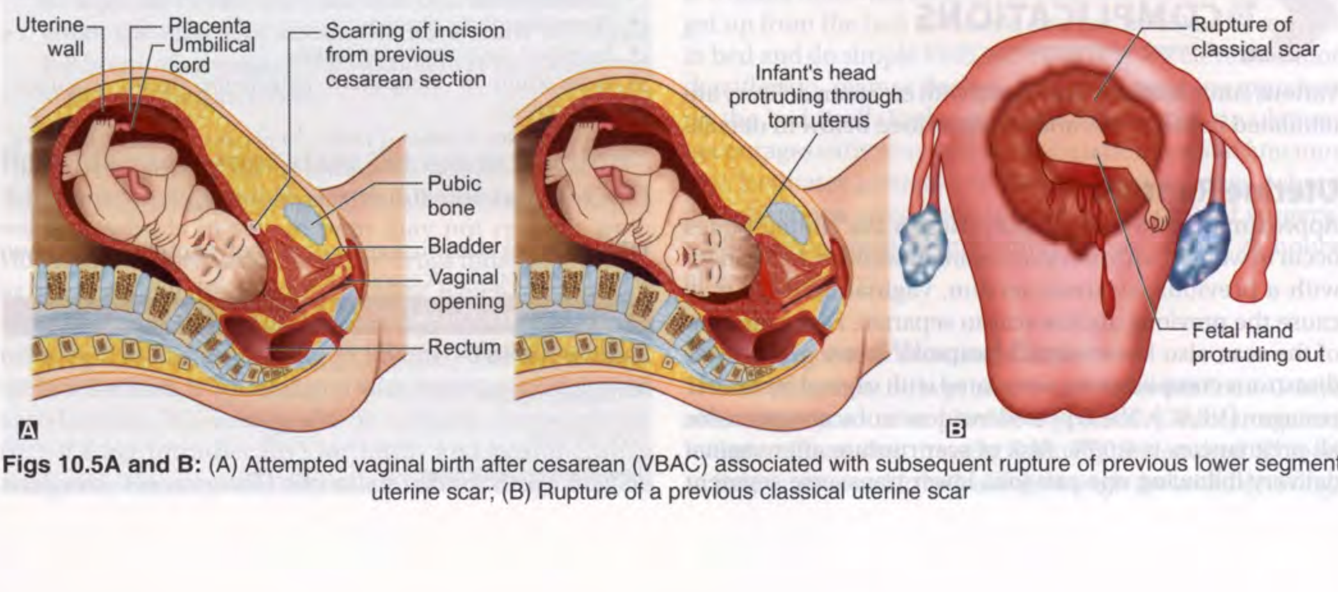
When uterine rupture is diagnosed or strongly suspected, surgery is necessary. While in the previous days, most cases of uterine rupture were managed with hysterectomy, nowadays most cases are managed by controlling the bleeding surgically and repairing the defect. A decision must be made regarding, whether to perform hysterectomy or to repair the rupture site. If future fertility is desirable and the rent in the uterus appears to be repairable (straight cut scar, rupture in the body of uterus, pelvic blood vessels are intact), repair of the rupture site must be performed. If future fertility is not desirable or the uterine rent appears to be unrepairable (multiple rents with ragged margins, injury to the iliac vessels, etc.), hysterectomy should be performed. Typically, longitudinal tears, especially those in a lateral position, should be treated by hysterectomy, whereas low transverse tears may be repaired. A lower segment rupture can cause transection of the uterine vessels. Therefore, the obstetrician must make special efforts to localize the site of bleeding, before placing clamps at the time of hysterectomy, in order to avoid injury to the ureter and iliac vessels. Bladder rupture must also be ruled out at the time of laparotomy by clearly mobilizing and inspecting the bladder to ensure that it is intact.

Though steps must be taken to resuscitate the patient, surgery should not be delayed owing to hypovolemic shock because it may not be easily reversible, until the hemorrhage from uterine rupture has been controlled. Uterine rupture may be associated with massive postpartum hemorrhage. Therefore upon laparotomy, various steps such as application of aortic compression, administration of oxytocics (oxytocin, ergot alkaloids, carboprost, misoprostol, etc.) and surgical options, like ligation of the hypogastric artery, uterine artery or ovarian arteries can be taken to reduce the amount of bleeding.

Due to the risk of rupture recurrence in a subsequent pregnancy, women with previously repaired uterine ruptures are advised not to attempt labor in the future. In case of future pregnancy, a repeat cesarean section should be performed prior to the onset of uterine contractions.

Table 10.5: Causes of a weak scar

♦ Improper hemostasis at the time of surgery
♦ Imperfect coaptation of uterine margins at the time of surgery
♦ Extension of the angles of uterine incision
♦ Infection during healing
♦ Placental implantation at the site of incision



Figs 10.5A and B: (A) Attempted vaginal birth after cesarean (VBAC) associated with subsequent rupture of previous lower segment uterine scar; (B) Rupture of a previous classical uterine scar

Assessment of Scar Integrity

In order to identify the previous cesarean scars, which are likely to give way during VBAC, the following investigations can be done:

- *Hysterogram*: Radiographic imaging of the uterus, which shows uterine defect in the lateral view.
- *Ultrasound imaging*: Ultrasound examination for visualization of scar defects and measurement of scar thickness.
- *Manual exploration*: Manual exploration of placenta to check scar integrity is especially useful, in case of continuing postpartum hemorrhage and in case of other third stage problems.

Ultrasound Imaging for Visualization of Scar Defects and Measurement of Scar Thickness

Ultrasound measurement of scar thickness at 37 weeks of gestation is based on the fact that the risk of a defective scar is directly related to the degree of thinning of the lower uterine segment at around 37 weeks of pregnancy. According to the largest study by Rozenberg et al. (1997),[19] cutoff value of 3.5 mm on ultrasound measurement of scar thickness at 36 weeks was observed to show negative predictive value of 99.3% for scar rupture. The high negative predictive value of this method may encourage the obstetricians to offer a trial of labor to patients with a thickness value of 3.5 mm or greater. Different studies show different cutoff values for estimating the strength of the scar. Therefore, presently there is no clear cut value of scar thickness to indicate the strength of the scar. Transvaginal ultrasound (TVS) seems to be more accurate than transabdominal ultrasound (TAS), yet it is not commonly used.[20]

Infection

Infection is a complication, which can commonly develop after cesarean section. Endometritis or infection of the endometrial cavity must be suspected, if there is excessive vaginal bleeding/discharge following the surgery. Infection of the urinary tract can result in symptoms like dysuria, increased urinary frequency, pyuria, etc.

Trauma to the Urinary Tract

This complication can occur during the cesarean surgery and, if not appropriately handled, can result in development of urinary tract fistulas.

Thromboembolism

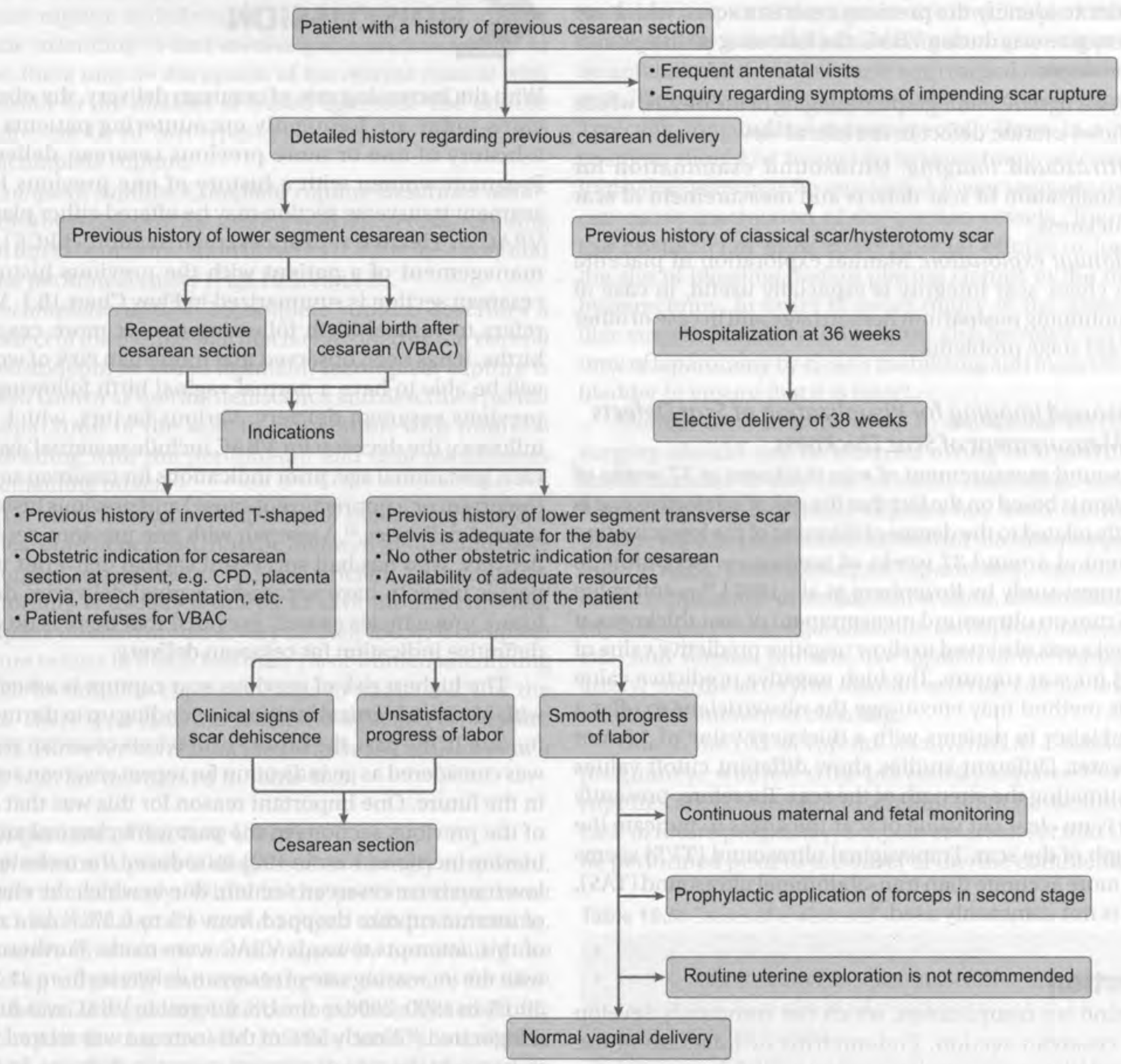
Thromboembolism must be suspected, if the patient develops cough, swollen calf muscles or positive Homan's sign. A positive Homan's sign is associated with deep vein thrombosis and is said to be present when passive dorsiflexion of the ankle by the examiner elicits sharp pain in the patient's calf.

DISCUSSION

With the increasing rate of cesarean delivery, the obstetricians today are frequently encountering patients with a history of one or more previous cesarean deliveries. Pregnant women with a history of one previous lower segment transverse section may be offered either planned VBAC or elective repeat cesarean section (ERCS). The management of a patient with the previous history of cesarean section is summarized in Flow Chart 10.1. VBAC refers to vaginal birth following one or more cesarean births. It has been observed that more than 80% of women will be able to have a normal vaginal birth following one previous cesarean delivery. Various factors, which may influence the decision for VBAC include maternal age and race, gestational age, prior indications for cesarean section (recurrent or a nonrecurrent cause) and previous history of vaginal deliveries.[21] A woman with one previous cesarean delivery, who has had successful vaginal deliveries in the past is likely to have successful vaginal deliveries during future pregnancies as well, provided that there is no other definitive indication for cesarean delivery.

The highest risk of previous scar rupture is associated with history of vertical incisions extending up to the uterine fundus. In the past, the history of previous cesarean section was considered as an indication for repeat cesarean section in the future. One important reason for this was that most of the previous sections in the past were classical vertical uterine incisions. Kerr in 1921 introduced the technique of low transverse cesarean section, due to which the chances of uterine rupture dropped from 4% to 0.5%.[22] As a result of this, attempts towards VBAC were made. Furthermore, with the increasing rate of cesarean deliveries from 21.2% to 30.1% in 1990–2008 in the US, interest in VBAC was further invigorated.[23] Nearly 50% of this increase was related to an increase in the rate of primary cesarean delivery. In 1988, the American Congress of Obstetricians and Gynecologists (ACOG) recommended that most women with one previous low transverse cesarean delivery should be attempted for a trial of vaginal delivery in the subsequent pregnancies. Numerous reports[24,25] have suggested that VBAC may be associated with high rate of uterine rupture and perinatal mortality. In a study by Landon et al. (2004) comparing VBAC with ERCS, it was observed that though VBAC is associated with the risk of uterine rupture; that risk is very low (about 1 per 1,000 patients).[26] On the other hand, ERCS is not associated with any risk of uterine rupture. The studies by Chauhan (2003), and Mozurkewich and Hutton (2000) have shown that VBAC may also be associated with the risk of stillbirths and hypoxic ischemic encephalopathy in the newborns.[27,28] However, Smith et al. have shown that the absolute risk of perinatal death is small (about 1 in 1,000) in the VBAC group.[29] Moreover, in comparison with the vaginal

Flow Chart 10.1: Management of a patient with the previous history of cesarean delivery



delivery, cesarean delivery is associated with an increased risk of complications such as hemorrhage, damage to the bladder and other pelvic organs, pelvic infections, and adhesion formation. Furthermore, these risks increase with an increase in the number of previous cesarean deliveries. The clinician needs to discuss and explore the specific reasons for the choice (VBAC or ERCS) with the patient and her partner. The risks and benefits of both cesarean section and vaginal delivery need to be explained to the patient. If the woman is just being apprehensive and fearful of the normal vaginal delivery due to the pain involved, she needs to be adequately counseled. Some of the conditions, where routine use of cesarean section is not required are mentioned in Table 10.6. VBAC should be undertaken only in the presence of the following circumstances:

- Previous history of one uncomplicated lower segment transverse cesarean section.
- Pelvis is adequate.
- Patient is willing for VBAC.
- Facilities for continuous fetal monitoring during labor are available.
- No other obstetrical contraindication for cesarean section is present. If the present pregnancy is associated with some other obstetrical indication for cesarean section (e.g. grade III, IV placenta previa, breech presentation, etc.), the patient must be considered for ERCS.
- Indication for the previous cesarean section was a nonrecurrent cause (e.g. fetal distress or nonprogress of labor), which may or may not recur in future pregnancies. However if the indication for previous cesarean section is a recurrent cause, like cephalopelvic disproportion, the option of ERCS would be more suitable.

Table 10.6: Conditions where and where not a repeat cesarean delivery would be required

Indications for Cesarean Delivery	Indications Not Requiring a Repeat Cesarean Delivery
Fetal distress	A twin pregnancy with first twin having a cephalic presentation
A term singleton breech (especially if external cephalic version is contraindicated or has failed)	Preterm birth
A twin pregnancy with first twin in noncephalic presentation	An intrauterine growth restriction (IUGR) baby
HIV-positive women (to reduce the risk of mother-child HIV transmission)	Infection with hepatitis B virus
Grade 3 and 4 placenta previa	Infection with hepatitis C virus
Dystocia (secondary arrest of cervical dilatation, arrest of descent, cephalopelvic disproportion, etc.)	Recurrent genital herpes in the third trimester

- *Ultrasound estimated fetal weight:* If the ultrasound estimated fetal weight is greater than or equal to 4.0 kg, the option of ERCS should be considered due to the increased risk of shoulder dystocia and fetal injuries with vaginal delivery.
- *Number of the previous sections:* According to recommendations by RCOG (2007),[30] women with the history of previous two uncomplicated low transverse cesarean sections can be considered for the planned VBAC. Though this practice is commonly employed in developed countries, in developing countries (including India) with limited health care settings, this is rarely practiced.
- VBAC should be undertaken in settings, where facilities for emergency cesarean section are present.

Some of the indications, where and where not a repeat cesarean delivery may be required are described in Table 10.6.

ALTERNATIVE TECHNIQUES FOR CESAREAN DELIVERY

In order to further reduce the operation time and reduce the complications associated with Joel-Cohen technique of cesarean delivery, several modifications of cesarean delivery have been introduced, some of which have been discussed next.

Misgav-Ladach Technique

This technique is a modified Joel-Cohen technique and is also known as Joel-Cohen-Stark technique. In this technique, the Joel-Cohen abdominal incision is used and the uterus is also opened in a manner similar to the Joel-Cohen method.[31] Following the manual removal of the placenta, the uterus is exteriorized. The myometrial incision is closed with one layer of locked continuous sutures. A second layer of sutures is placed only if required. The peritoneal layers (both the visceral and peritoneal) are not sutured. The fascia is reapproximated with a continuous running stitch. The skin is closed with two or three mattress sutures. The skin edges between these sutures are approximated with the help of Allis forceps. Similar to the Joel-Cohen technique, the Misgav-Ladach technique also favors minimization of sharp dissection.

It has been shown that the use of Misgav-Ladach technique is associated with fewer intraperitoneal adhesions at the time of repeat cesarean delivery.[32]

Pelosi Technique

Pelosi's technique can be described as a simple, least traumatic approach towards cesarean delivery. It is associated with short operating time, minimal instrumentation, reduced surgical dissection and reduced rate of postoperative complications such as pain, blood loss, infection and wound complications.[33,34] In this technique, a Pfannenstiel abdominal incision is given. Electrocautery is used for transversely cutting the subcutaneous tissues and the fascia. The rectus muscles are separated with the help of blunt dissection, using both the index fingers. The peritoneum is opened with blunt finger dissection, following which all the layers of the abdominal wall are stretched manually to the extent of the skin incision. The bladder is not reflected inferiorly. A small transverse incision is made over the lower uterine segment. It is extended laterally, curving upwards with blunt finger dissection or scissors. The baby is delivered with external fundal pressure. Following the delivery of the baby, oxytocin is administered and the placenta removed after spontaneous separation. The uterus is massaged. The myometrial incision is closed with single-layer chromic catgut continuous locking sutures. Neither visceral nor parietal peritoneal layer is sutured. The fascia is closed with a continuous synthetic absorbable suture. If the subcutaneous layer is thick, interrupted 3-0 absorbable sutures are used for obliterating the dead space. The skin is closed with staples. Presently, there are no randomized trials comparing Pelosi's technique to other techniques.

The Hemostatic Cesarean Section

This is a new surgical technique used for managing pregnant women infected with HIV-1. The surgeon must adorn double gloves while performing cesarean section in women who are HIV-positive. Hemostatic cesarean section is a type of elective cesarean section with technical modifications, which is used in all patients receiving antiretroviral treatment and in whom breastfeeding has been prohibited.

The patient is scheduled for surgery at 38 weeks of gestation, while the patient is not in labor and membranes are intact. The technique involves management of lower uterine segment while maintaining the integrity of membranes. This helps in avoiding massive contact between maternal blood and the fetus. Thus, this technique helps in reducing the rate of vertical transmission to less than 2%.

Classical Cesarean Section

Classical cesarean section involves giving a vertical uterine incision. The classical uterine scar is worse than a transverse uterine scar for the reasons which have already been discussed previously in this chapter.

Indications

Though nowadays classical incisions are rarely performed, they might be rarely done in cases where the lower segment is not easily accessible, e.g. bladder densely adherent to the lower segment; invasive carcinoma cervix; presence of a uterine myoma in the lower uterine segment; transverse lie of the fetus, with the shoulder impacted in the birth canal; massive maternal obesity; cases of placenta previa in which the placenta penetrates through the lower uterine segment (placenta percreta); cases where lower uterine segment has not formed especially in association with a very small fetus having breech presentation or with multifetal gestation, etc.

Procedure

In case of a classical cesarean section, the uterine incision is given vertically. The lower limit of the uterine incision is initiated as low as possible, usually above the level of bladder. The uterine incision is extended in the cephalad direction using a bandage scissors, until the incision becomes large enough to facilitate delivery. Following the delivery of the baby and the placenta, the uterine incision is closed in layers. The deeper layers are approximated using a layer of continuous 0 or no. 1 chromic catgut sutures. The outer layer is closed using figure-of-eight continuous sutures. The edges of the uterine serosa are approximated using continuous 2-0 chromic catgut sutures.

Avoiding a Classical Uterine Incision

A classical cesarean delivery is associated with a weaker scar in comparison to a transverse incision. Therefore, rather than performing a classical cesarean section, the clinicians prefer to use some kind of variations in the lower segment uterine incision. Mostly, the surgeon is able to decide the exact incision only at the time of surgery. Variations of the lower segment incision are commonly used, in cases where there is requirement for an extended surgical field, in order to avoid scar extension, e.g. transverse lie with hand prolapse and large baby, etc. Some of the variations include the following:

- *An inverted T-shaped incision:* This incision involves cutting upwards from the middle of the transverse incision.
- *J-shaped or hockey-stick incision:* This incision involves extension of one end of the transverse incision upwards.
- *U-shaped or trap-door incision:* This incision involves extension of both ends of the transverse scar upwards.

Of all these various choices, the T-shaped scar is the worst choice due to its difficult repair, poor healing and chances of scar rupture during subsequent pregnancies.

CONCLUSION

Cesarean delivery has become a commonly performed surgery in the clinical obstetric practice. Though the procedure is associated with its own inherent complications, its use does help in avoiding difficult vaginal deliveries, which could have led to considerable maternal morbidity and mortality. On the other hand, cesarean delivery on its own, being a major surgery is associated with some inherent complications of laparotomy, such as hemorrhage, infections, damage to the bladder and other pelvic organs, etc.

With the advancement in medical technology, an increasing rate of cesarean delivery has led to an important question, "should the women with previous cesarean delivery (for a nonrecurrent cause), be posted for an elective repeat cesarean section or be considered for trial of vaginal delivery?" The answers to this problem largely remain controversial. Though a large number of patients with previous cesarean delivery are being considered for VBAC, the risk of scar rupture, although small, still remains.

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11

CHAPTER

Medical Termination of Pregnancy

INTRODUCTION

Medical termination of pregnancy or induced abortion is often abbreviated as MTP. It is the medical method, which enables a couple to get free from the unwanted pregnancy. Termination of pregnancy has been practiced, since the time immemorial. Abortion has been widely practiced since ancient times and instruments for scraping the uterine cavity existed in Greek and Roman civilizations.[1] It has been estimated that every year, nearly 26 million pregnancies are terminated legally throughout the world. Despite the availability of medical services for legal abortion, nearly 20 million pregnancies are terminated illegally. This is responsible for nearly 78,000 deaths.[2] In India alone, 10–12 million abortions take place annually, resulting in 15,000–20,000 maternal deaths, mainly due to illegal abortions.[3] Nonavailability of trained medical help and the unwarranted secrecy surrounding the unwanted pregnancy, often force women to opt for illegal abortion, which may be fatal at times.

Most widely used legal methods for terminating pregnancy in first trimester are surgical, primarily suction evacuation. However, nowadays, a number of drugs considered safe for termination of pregnancy are being tried. The use of medicines for termination of pregnancy has been legalized, in cases where the pregnancy is less than 7 weeks in size. The number of first trimester medical abortions induced with help of medicines, such as mifepristone/misoprostol or misoprostol alone or in combination with methotrexate is slowly on the rise.

OVERVIEW OF SURGERY

Surgical techniques in the first trimester practically comprise entirely of vacuum or suction techniques. The terms, "vacuum curettage", "uterine aspiration" or "vacuum aspiration" are often used interchangeably. They all refer to evacuation of the uterus by suction, regardless of the source of the suction.

Prior to the surgical evacuation, the cervix is often dilated.[4] Mechanical dilation using physical dilators is currently the most frequently used method of dilating the cervix. Other methods for dilatation include osmotic dilatation, using laminaria tents[5,6] or use of pharmacological dilatation using medications, such as misoprostol. Hegar dilators are the standard instruments for cervical dilation, which are commonly used in our setup. These are blunt-ended instruments, having different sizes, of which different sizes vary by 1 mm. Misoprostol is a prostaglandin E2 analog, which has been approved by the US Food and Drug Administration (FDA) for prevention and treatment of gastric ulcers. This drug was contraindicated in pregnant women due to the risk of miscarriage. The side effect of this drug has been utilized and now it is extensively used for MTP, either alone or in combination with mifepristone or methotrexate. It can be administered by vaginal, oral or sublingual routes.

AIMS OF SURGERY

The main aim of surgery is to terminate the pregnancy safely and effectively and at the same time causing minimal maternal complications and side effects.

SURGICAL EQUIPMENT USED

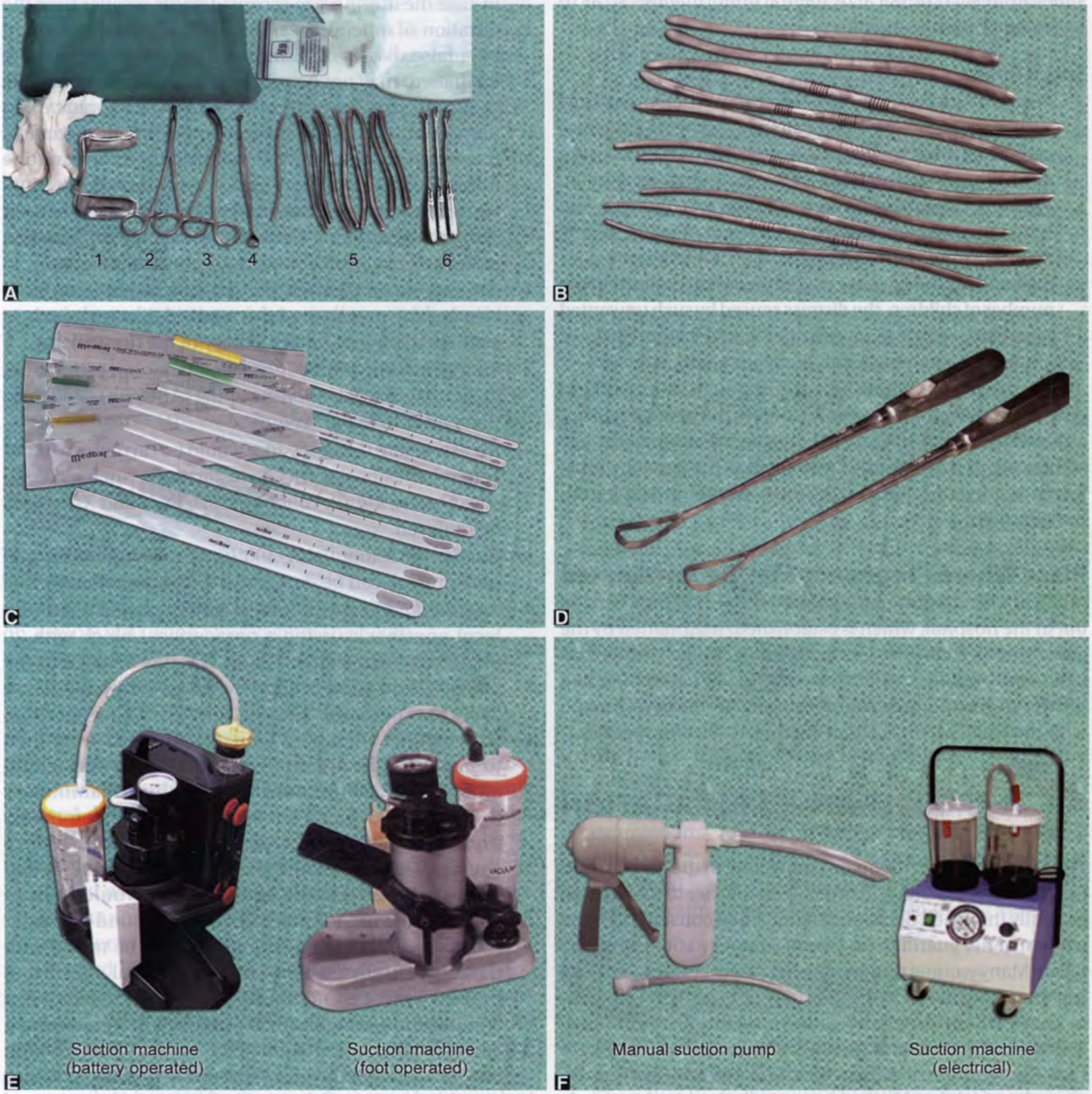
The various surgical instruments used for the procedure of vacuum aspiration are shown in Figures 11.1A to E.

INDICATIONS

MTP act passed in 1971 in India has legalized abortion up to the duration of 20 weeks of gestation.[7] This law holds true for all the Indian states except for the state of Jammu and Kashmir.

Termination of pregnancy by registered medical practitioners can be done as follows:

- When the length of the pregnancy is less than 12 weeks, it can be terminated by a registered medical practitioner.
- If the length of the pregnancy is between 12 and 20 weeks, termination can be done if at least two registered medical practitioners have given their approval for it in good faith.



Figs 11.1A to E: Instruments used for vacuum aspiration: (A) Tray containing various equipments used for suction evacuation: (1) Sims' speculum; (2) Sponge holder; (3) Vulsellum; (4) Anterior vaginal wall retractor; (5) Hegar's dilators of increasing sizes; (6) Uterine curettes of varying sizes; (B) Hegar's dilators of different sizes; (C) Karman's cannula of different sizes; (D) Uterine curettes of varying sizes; (E) Varying types of suction units

- The termination of the pregnancy can be done on the basis of below-mentioned grounds.

Medical Grounds

Continuation of the pregnancy is likely to put at risk, the life of the pregnant woman or cause grave injury to her physical or mental health.

Eugenic Cause

There is a substantial risk that if the child were born, it would suffer from such physical or mental abnormalities so as to be seriously handicapped.

Social Cause

- *Pregnancy occurs as a result of a rape:* When pregnancy is suspected to have been caused by rape, the distress caused by such pregnancy is presumed to be causing grave injury to the mental health of the pregnant woman.
- *Pregnancy occurs as a result of failure of contraception:* When the pregnancy occurs as a result of failure of any device or method used by the married woman or her husband for the purpose of contraception or limiting the number of children, the distress caused by such unwanted pregnancy may also be considered to constitute a grave injury to the mental health of the pregnant woman.

No pregnancy shall be terminated without taking consent of the pregnant woman, unless the woman has not attained the age of 18 years or who, having attained the age of 18 years, is a lunatic. In these cases the pregnancy must be terminated only after taking the consent in writing from her guardian.

Place Where Pregnancy May Be Terminated

Medical termination of pregnancy should be only carried out in the hospital, which is established/maintained by the government. It can also be carried out at a place, which has been approved for this purpose by the government or at a district level by a committee constituted by the government, with the Chief Medical Officer acting as the chairperson.

PREOPERATIVE PREPARATION

Patient counseling: Adequate counseling of the woman and her partner is essential, in order to enable her to make a free and fully informed decision. An informed consent from the woman or her guardian (in case of a minor patient) must be taken. Many women undergoing MTP may be apprehensive, frightened or guilty. Counseling may be especially required, in cases where pregnancies have resulted from abuse, coercion or assault. It is the duty of the surgeon, to ensure that the woman remains calm and relaxed during the procedure and should adopt a sympathetic attitude towards her. The woman should never be pressurized to proceed with the procedure, if she is not ready.

- *Estimation of the gestational age*: The clinician can estimate the gestational age by calculating the period of amenorrhea. The uterine size must be assessed by performing a bimanual examination. When the clinical estimate of gestational age disagrees with the period of amenorrhea, the clinician must find out the reason for this discrepancy before proceeding. Uterine size may be larger than the period of gestation in cases, such as multiple gestation, hydramnios, uterine anomaly, uterine fibroids, a molar pregnancy or an ovarian tumor. In case the uterine size is considerably smaller than the duration of amenorrhea, the likely explanations could be a false diagnosis of intrauterine pregnancy, where the patient may not be pregnant, may have a nonviable pregnancy or may have an ectopic pregnancy. An ultrasound examination can be performed to confirm the period of gestation. Many clinicians perform routine ultrasound examination before carrying out abortion. However, universal ultrasound examination has not been shown to be superior to selected ultrasound examination in the first trimester, in terms of complication rate.
- A complete medical history must be taken, in order to rule out the presence of the medical diseases, such as asthma, diabetes and the history of the drug allergy.
- Simple investigations, such as hemoglobin estimation, urine analysis and blood grouping (ABO, Rh) need to be done prior to the procedure.
- In case, where the procedure would be carried out under general anesthesia (GA), investigations, such as blood sugar levels, kidney function tests, ECG and X-ray may be required.
- Cervical priming using 400 µg of the vaginal or anal misoprostol, can be done prior to the procedure.[8-10]
- *Anesthesia*: The procedure is usually carried out under local anesthesia, using a paracervical block with 20 mL of 0.5% lignocaine.[11] Short GA may be used in the patients, who are very apprehensive. Many patients are likely to experience some discomfort during abortion, although the amount of pain usually varies from mild to moderate. In order to reduce the pain during and after the procedure nonsteroidal anti-inflammatory drugs, such as naproxen 550 mg, may be commonly prescribed before the procedure.[12,13] Vasoconstrictive agents, such as vasopressin (2 units) may be added to the local anesthetic agent, which would help in reducing the amount of bleeding in second-trimester procedures. Atropine (0.5 mg) can also be mixed with the local anesthetic agent to reduce vagal effects and prevent syncope and nausea. Vasovagal reaction is a complication, which can be produced in some women as a result of manipulation of the cervix.[14] This reaction may be associated with bradycardia, hypotension and possibly syncope. If the patient begins to show signs of vasovagal reaction, the surgeon should immediately stop the painful stimulus, give atropine 0.4–1.0 mg

intravenously or subcutaneously, turn the patient to a more comfortable position and then monitor the vital signs, while the patient recovers. When the patient has fully recovered, the abortion procedure may be safely resumed. Solutions containing epinephrine must not be used because they have a risk of causing anxiety and cardiac arrhythmia.

- *Prophylactic antibiotics*: In cases, where the possibility of intrauterine infection is suspected (e.g. history of prolonged bleeding per vaginum, patient at risk of bacterial endocarditis), antibiotics can be administered prior to the procedure.[15] Antibiotics are routinely prescribed following the procedure in our setup. It has also been observed that the routine use of prophylactic antibiotics can help in preventing nearly 50% cases of postabortion endometritis.[16]
- *Bladder catheterization*: Bladder must be emptied prior to the procedure.
- *Cleaning and draping*: Shaving the perineum is not required, but the perineal hair must be trimmed. After taking all aspectic precautions, the area of perineum, mons and lower part of the abdomen must be cleaned and draped, using povidone-iodine or chlorhexidine solution. The surgeon must use the "no-touch" technique, in which he/she must use sterile instruments and sterile gloves and take care never to touch that part of the instrument that would enter the uterus.

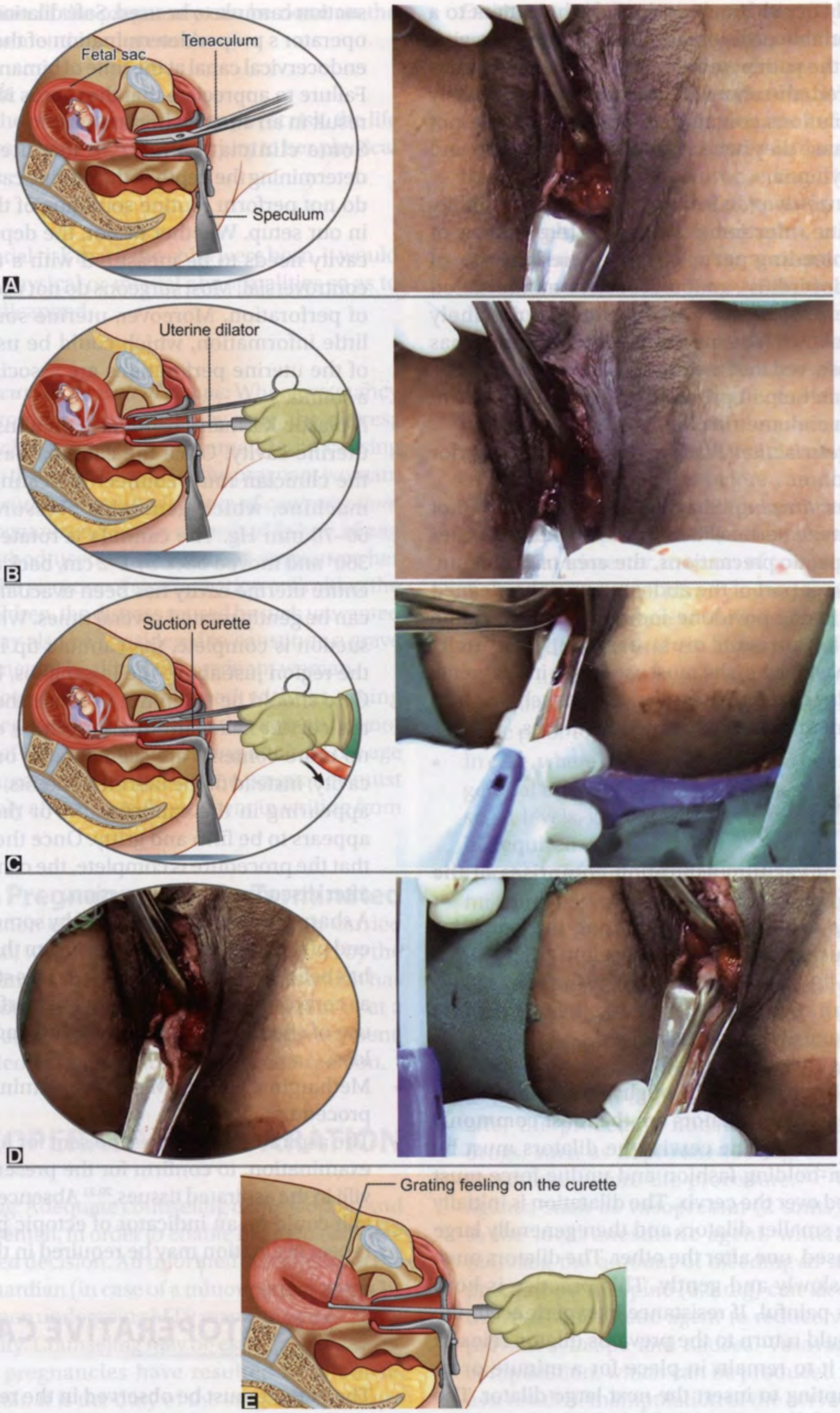
SURGICAL STEPS

The procedure of vacuum aspiration comprises of the following steps (Figures 11.2A to E):[17-19]

- The cervix is exposed after retracting the posterior vaginal wall using Sims vaginal speculum.
- The anterior lip of the cervix is held, using a Vulsellum or tenaculum. Once the cervix has been properly visualized, paracervical block is given.
- The cervix is then serially dilated, using a series of metallic or plastic dilators. Though a variety of dilators are available, Hegar's dilators are the most commonly used. While dilating the cervix, the dilators must be held in a pen-holding fashion and undue force must not be applied over the cervix. The dilatation is initially started using smaller dilators and then generally large dilators are used, one after the other. The dilators must be inserted slowly and gently. This practice is both safe and less painful. If resistance is experienced, the operator should return to the previous dilator, reinsert it and allow it to remain in place for a minute or so before attempting to insert the next large dilator. The rule normally followed is that "the size of the suction cannula to be used for the procedure must be equivalent to the size of the uterus." The dilation of the cervix must be approximately 0.5–1 mm more than the size of suction cannula to be used. Safe dilation depends on the operator's proper determination of the direction of the endocervical canal at the time of bimanual examination. Failure to appreciate that the uterus is retroverted may result in an anterior perforation.
- Some clinicians prefer to use uterine sound for determining the depth of the uterine cavity. We normally do not perform routine sounding of the uterine cavity in our setup. Whether or not, the depth of the uterine cavity needs to be measured with a uterine sound is controversial. Most surgeons do not use a sound for fear of perforation. Moreover, uterine sounding provides little information, which could be useful. Up to 25% of the uterine perforations are associated with use of a sound.
- A plastic Karman's cannula is then inserted inside the uterine cavity. Once the cannula has been inserted, the clinician must connect the cannula to a suction machine, which generates pressure equivalent to 60–70 mm Hg. The cannula is rotated at an angle of 360° and moved back by 1–2 cm, back and forth, till the entire uterine cavity has been evacuated. The cannula can be gently rotated several times. When one round of suction is complete, the cannula tip is pulled back to the region just above the internal os, but not out of it. Care should be taken not to rotate the cannula inside the cervix. Evacuation is said to be complete, when no more contents are seen coming out of the uterine cavity; instead of the uterine contents, air bubbles start appearing in the cannula and/or the uterine cavity appears to be firm and gritty. Once the surgeon is sure that the procedure is complete, the cannula is removed after disconnecting the suction.
- A sharp curettage is performed by some surgeons at the end of the procedure, just to confirm that the procedure has been completely performed. This step is considered as controversial and not everyone performs it, because use of sharp curettage may slightly increase the blood loss.
- Methargin 0.25 mg IM may be administered after the procedure.
- The aspirated tissue must be sent for histopathological examination, to confirm for the presence of chorionic villi in the aspirated tissues.[20,21] Absence of the chorionic villi could be an indicator of ectopic pregnancy and a repeat evaluation may be required in these cases.

POSTOPERATIVE CARE

- The patient must be observed in the recovery room for 2–3 hours before discharge.
- The patient's vital signs and blood loss must be regularly monitored.
- In case of pain, analgesic drugs may be prescribed.



Figs 11.2A to E: Steps of the procedure of vacuum aspiration: (A) Retracting the posterior wall of the uterus with Sims' speculum and grasping the anterior lip with vulsellum; (B) Dilating the external cervical os with Hegar's dilator; (C) Insertion of Karman's cannula for producing suction; (D) Removal of protruding products of conception using an ovum's forceps; (E) The evacuation of the uterine contents is almost complete resulting in a grating feeling

- If the procedure is performed under GA, the patient can be discharged after a few hours, once she has stabilized.
- Women who are Rhesus-negative can be given Rh immune globulins immediately following the procedure.
- A woman who has undergone MTP must be counseled regarding the use of contraception in future, in order to prevent the reoccurrence of unwanted pregnancies. Immediate contraception in form of intrauterine contraceptive device (IUCD) insertion or placement of a subdermal rod, intramuscular depot medroxyprogesterone acetate injections, etc. may be provided after the procedure depending on the patient's wishes.
- The patients are scheduled for a follow-up visit, 1–2 weeks after abortion, to check for the presence of any potential MTP-related complications.

COMPLICATIONS

Though small amount of cramping, pain and bleeding can commonly occur for 2–3 days after the procedure, severe degrees of persistent pain or amount of bleeding more than that associated with normal menstruation, especially in association with fever or fainting could be indicative of the underlying complications.[22] Some of these are:

Uterine Perforation

The most dreaded complication of the procedure is uterine perforation because the procedure of suction evacuation is essentially a blind one.[23] The risk of uterine perforation becomes greater with the increasing gestational age of the fetus. Most uterine perforations are thought to occur during the process of uterine sounding or cervical dilation because the most common site of perforation is the junction of the cervix and the lower uterine segment. While the midline perforations in this region are usually benign, lateral perforations at this location may be particularly hazardous for the patient because they may extend to the branches of the uterine artery resulting in profuse hemorrhage.

A uterine perforation must be suspected, when no tissue is obtained; when the instruments appear to be inserted deeper than the depth expected, on the basis of the gestational age; when hemorrhage occurs;[24] or when obvious maternal tissues, such as omentum are obtained. Sometimes, if the procedure is being performed under ultrasound guidance, uterine instrument (such as a uterine sound) may be visualized outside the uterine cavity. Sometimes when MTP is being performed during the procedure of laparoscopic sterilization, the perforation may be visualized laparoscopically.[25]

Treatment of perforation depends on the expected location, the woman's vital signs and condition and whether the abortion is complete or not. In case of a suspected perforation, the patient must be observed for a few hours for the signs of hypovolemia and shock. Intramuscular oxytocics (methargin) and antibiotics must be administered. If the patient's vitals are stable; the uterine perforation is midline; repeated pelvic examinations are negative; repeat hematocrit results are stable; the uterus is already empty and/or the amount of bleeding is minimal or none, then there is no need for patient hospitalization. The patient may be discharged home in the company of a responsible adult and instructed to visit the hospital immediately, in case she experiences excessive pain or bleeding or some other complication at any time. She must be scheduled for a repeat general physical and pelvic examination, the next day. In case the patient continues to experience bleeding, pain or her vitals continue to remain unstable, she should be admitted to a hospital for observation and a possible laparoscopic examination. If the abortion is not complete at the time perforation is suspected, it should be completed with the aid of ultrasound or laparoscopy. Laparotomy may be required, in cases where intraperitoneal bleeding or bowel injury is suspected.

Infection

This can be easily avoided by the administration of broad-spectrum antibiotics. In case the infection is as a result of incomplete evacuation, the surgeon first needs to completely evacuate the uterine cavity. Following this, the antibiotics must be given. In the cases of serious infection, intravenous antibiotics can be given. Laparotomy may be required in cases of peritonitis. If upon examination, the uterus appears to be tender and slightly enlarged, infection is a possibility. Infection in association with the retained products of conception is likely to result in the development of postabortion endometritis, among women undergoing first-trimester surgical abortion. Typically the woman returns 3 or 4 days, after the procedure with increased cramping and bleeding, sometimes accompanied by fever or nausea. The microorganism commonly involved in such cases is β-hemolytic streptococci. Endometritis should be treated immediately to avoid progression of infection. In most early cases, hospitalization is not required and the outpatient treatment proves to be sufficient. Ampicillin usually works against microorganisms such as hemolytic streptococci. In case of infection with organisms, such as *Chlamydia* or bacterial vaginosis or other anaerobic organisms, combination of oral metronidazole and ofloxacin is commonly prescribed.[26]

Incomplete Evacuation

The most common presentation in cases of incomplete evacuation is prolonged bleeding. In these cases the uterine contents have to be re-evacuated under the antibiotic coverage. Typical history suggestive of an incomplete evacuation is a woman returning several days after the procedure with the history of increased bleeding and cramping. On examination, she may have an enlarged uterus or tissue visible in the cervical os. Ultrasound examination is usually performed, but may not be always helpful because blood and debris are commonly present inside the uterus and the amount of retained tissue may be small.

Treatment of incomplete abortion may be pharmacologic. Uterotonic drugs, such as methylergonovine (methergine) may help to contract the uterus and expel the residual tissue. This method is appropriate when the amount of retained tissue is small and there are no signs of infection. If this method is chosen, the woman should be called for a follow-up visit within a few days, to make sure that her symptoms have resolved. If the amount of retained tissue inside the uterine cavity is large or if the woman cannot return for follow-up, then repeat suction should be done. Repeat suction is usually easy because the cervix is dilated and a cannula smaller than that used for the original procedure is adequate. Antibiotics must also be administered.

Bleeding During and Following the Abortion

Most women have minimal bleeding during first trimester abortion. However at times, there may be severe bleeding during and after the procedure. Uterine atony is the most likely the cause of heavy and prolonged bleeding in these cases.[27] Intravenous ergometrine (0.2 mg) or oxytocin (10–20 units) may be used to contract the uterus. Alternatively misoprostol, in the dosage of 400 μg may be prescribed either through oral or rectal route. Doses of misoprostol as high as 1,000 μg have been used per rectally in cases of atonic uterus. Prostaglandin F2α (carboprost) can be prescribed intramuscularly or into the uterus. In the absence of an obvious cervical or uterine injury, the surgeon should complete the abortion, evacuating the uterus rapidly, but gently. If the bleeding still continues to occur, the uterus is massaged between the two hands, e.g. bimanual compression. The aspirated tissue is examined to assess gestational age and to confirm that all fetal parts have been removed. If the bleeding still does not stop, the cervix should be explored for the presence of a likely laceration or for bleeding from the tenaculum site. Next, the uterus is gently explored with a sharp curette, preferably under ultrasound guidance, checking for uterine shape and size, retained tissue and uterine wall irregularities or defects. Repeat suction may remove clots and retained tissue and allow the uterus to contract. If bleeding persists even after the uterus has been emptied, the next maneuver is uterine tamponade. For details regarding control of bleeding from an atonic uterus, kindly refer to Chapter 13 (Surgical Interventions for Control of Postpartum Hemorrhage).

Failure of the Procedure

The procedure, if not performed properly, may result in the continuation of the pregnancy.[28] This may result in cases of very small sized uterus, where the suction cannula fails to suck out the product of conception. This may also occur in cases associated with a uterine anomaly (e.g. uterus didelphys or birconuate uterus) or cases of ectopic pregnancy.[29-31]

Hypotension

This could be related to excessive blood loss or due to a vasovagal response to pain. Management in these cases comprises of administration of IV fluids, oxygen, whole blood transfusion and corticosteroids.

Minor Complications

Minor complications like postoperative nausea and vomiting can be managed with antiemetics such as metoclopramide or ondansetron.

Asherman's Syndrome

This is delayed complication, which can occur as a result of vigorous curettage. This complication is usually managed by hysteroscopic resection of intrauterine adhesions, followed by insertion of an IUCD or a Foley's catheter, in order to keep the uterine wall apart.[30-33]

Cervical Lacerations/Cervical Incompetence

Rarely, vigorous dilatation may result in the development of cervical lacerations and/or cervical incompetence in the subsequent pregnancies.[34] This complication can be avoided by taking a good history and correct estimation of gestational age during the bimanual examination. Overzealous cervical dilation must be avoided. Dilatation is carried out using the smallest sized dilator. The Hegar's dilators are commonly used. These dilators must be held in a pen-holding fashion and must be gently inserted into the cervical canal. Undue force must not be used, while inserting the cannula. The dilatation must be started using the smallest size dilator. Gradually, larger sized dilators must be used. The cervix must be dilated about 0.5–1.0 mm more than the size of the suction cannula to be used. Cervical priming using prostaglandins, prior to the procedure, facilitates the process of dilatation without the use of undue force.

DISCUSSION

CHOICE BETWEEN MEDICAL AND SURGICAL ABORTION

As discussed previously, suction evacuation is the most commonly used method for termination of first trimester pregnancies. However, being an invasive surgical technique, it may be associated with risks of infection, perforation of uterus, incomplete abortion and postprocedure uterine synechiae formation (Asherman's syndrome), etc.

For MTP using medicines, the following regimen is used: the dose of mifepristone used is 200 mg on day 1 and misoprostol in the dose of 400–800 μg orally or vaginally on day 3. Sublingual administration of misoprostol has also shown to be effective and the success rate have been found to be more or less similar to the vaginal administration.

While medical abortion should be only used in cases the pregnancy is less than or equal to 7 weeks, vacuum aspiration can be performed, all through the 12 weeks in the first trimester. The chances of failed surgical abortion increase with pregnancy of less than 6 weeks.

Medical abortion usually requires many visits to the healthcare provider. A follow-up visit is essential and is usually fixed at 2 weeks from the time of first appointment. The procedure of surgical abortion usually requires a single visit to the clinic and takes about 15–20 minutes. Follow-up visit is fixed at 3–4 weeks' time. Rh-negative women should be administered 50 μg of anti-D immunoglobulins intramuscularly on the day of prostaglandin administration to prevent Rh isoimmunization.

Medical abortion may be associated with heavy bleeding and passage of clots for 3–4 days. The bleeding may last for 2 weeks or longer. Vacuum aspiration, on the other hand, is associated with light to moderate bleeding, which may continue for a few days.

Medical abortion is defined as being successful if there is complete termination of pregnancy without the requirement of a surgical procedure. Medical abortion is defined as being unsuccessful in case there is requirement for a surgical process which may be the result of continuation of pregnancy, incomplete expulsion or heavy bleeding. Medical abortion is successful in 97% cases. It may not be successful, in cases where period of gestation is greater than 7 weeks. If medical abortion fails, vacuum aspiration becomes essential. On the other hand, vacuum aspiration is more successful, the success rate being almost 99%.

Medical abortion has been found to be a safe and a noninvasive process. Serious complications rarely occur with this method. Vacuum aspiration has been used as a method of termination of pregnancy, since a past few decades. Though the complication rate is higher than that of medical abortion, serious complications usually do not occur in experienced hands.

Medical abortion takes longer time for complete termination. The process is more natural and may appear like a miscarriage. Vacuum aspiration, on the other hand, occurs quickly over a period of few minutes and is highly successful. With medical abortion, there is no requirement of anesthesia, vacuum aspiration machine and other instruments.

While medical abortion can be used only in early pregnancy, vacuum aspiration can be used until late first trimester.

In summary, medical abortion may take several days, is not completely predictable, may be associated with heavy bleeding and severe cramping, which may last for a longer period and has a higher failure rate in comparison with the surgical method. Occasionally, the medical method may be associated with side effects such as nausea and vomiting, diarrhea and abdominal cramps and rarely even fever. There are concerns related to excessive and prolonged bleeding, undiagnosed ectopic pregnancy and teratogenic side effects. Moreover these drugs can cross placenta, resulting in skull and limb deformities.

CONCLUSION

Since "prevention is better than cure," the women must be counseled to prevent the occurrence of unwanted pregnancy in the first place. If pregnancy does occur despite the use of appropriate contraceptive methods, the only option for the women to get freedom from the unwanted pregnancy is to undergo MTP.

The women must opt for legalized termination of pregnancy and not go for unsafe (illegal) methods for abortion. While surgical abortion, using vacuum aspiration is the most commonly used procedure for the termination of pregnancy, abortion using medicines, such as mifepristone and misoprostol is also commonly being used nowadays. While each method is associated with its own advantages and disadvantages, the surgeon must present both the options to the patient along with the pros and cons of using each method. The final decision regarding the type of method to be used should be made after discussing various options with the patient.

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12

CHAPTER

Cervical Incompetence

INTRODUCTION

Miscarriage is a painful experience both for the parents and their families as well as the obstetricians. Cervical incompetence is a common cause of recurrent second trimester miscarriages and was defined by Palmer and La Comme as a condition in which the pregnant woman's cervix starts dilating and effacing before her pregnancy has reached term, usually between 16 and 28 weeks of gestation and is, therefore, unable to retain the products of conception during pregnancy.[1] The cervical length is usually less than 25 mm. A history of second or third trimester fetal loss associated with painless cervical dilatation is suggestive of cervical incompetence. This could be associated with prolapse of the fetal membranes or expulsion of a live fetus despite minimal uterine activity. As a result, cervical incompetence may cause the second or third trimester miscarriages and preterm births. Cervical incompetence has been estimated to complicate as many as 0.05–0.2% of all pregnancies and is usually more common in cases with the previous history of second or third trimester loss.[2]

OVERVIEW

The woman gives history of recurrent second trimester pregnancy losses, occurring earlier in gestation in successive pregnancies and usually presents with a significant cervical dilatation of 2 cm or more in the early pregnancy. However, usually there is absence of any other symptoms. In the second trimester, cervix may dilate up to 4 cm in association with active uterine contractions. This may be associated with rupture of the membranes resulting in the spontaneous expulsion of the fetus. Cervical incompetence could be due to congenital or acquired causes. The most common acquired cause of cervical incompetence is a history of cervical trauma or the previous history of cervical lacerations. Therefore, history of any cervical procedure including cervical conization, loop electrosurgical excision procedure (LEEP), instrumental vaginal delivery or forceful cervical dilatation during previous miscarriage needs to be elicited. History of any cervical cerclage performed at the time of previous pregnancy also needs to be elicited.

Risk Factors

Some of the risk factors for development of cervical incompetence are listed in Table 12.1.

Diagnosis

Clinical Examination

The patient may give a history of complaints such as pelvic pressure and/or vaginal discharge. On clinical examination, the cervical canal may be dilated and effaced. Fetal membranes may be visible through the cervical os. Sonographic serial evaluation (every 2 weeks) of the cervix for funneling and shortening in response to transfundal pressure has been found to be useful in the evaluation of incompetent cervix.

Table 12.1: Risk factors for development of cervical incompetence

♦ Diagnosis of cervical incompetence in a previous pregnancy
♦ Previous history of preterm premature rupture of membranes
♦ History of diethylstilbestrol exposure, which can cause anatomical defects in uterus and cervix
♦ History of having received trauma to the cervix previously

Ultrasound Examination

Recently, ultrasound examination has become a gold standard in the diagnosis of cervical incompetence (Fig. 12.1A). Findings observed on ultrasound examination include the following:[3]

- Cervical length less than 25 mm. However, finding of the short cervical length on transvaginal sonography (TVS) is not a confirmed diagnostic test for incompetent cervix. It could also be due to early preterm labor.
- Protrusion of the fetal membranes.
- Presence of the fetal parts in the cervix or vagina.
- Cervical dilation and effacement with the changes in the form of T, Y, V, U (can be remembered using the mnemonic "Trust Your Vaginal Ultrasound")[4] (Figs 12.1B and C).

  T-shaped cervix on ultrasound examination points towards a normal cervix. As the internal cervical os opens and the membrane starts herniating into the upper part of endocervical canal, the cervical shape on ultrasound changes into a Y. With the further progression of above-mentioned cervical changes, Y shape changes into V and ultimately into U.
- Another important finding on TVS examination suggestive of cervical incompetence is funneling. Funneling implies herniation of fetal membranes into the upper part of endocervical canal. However, this too is not diagnostic of incompetent os.

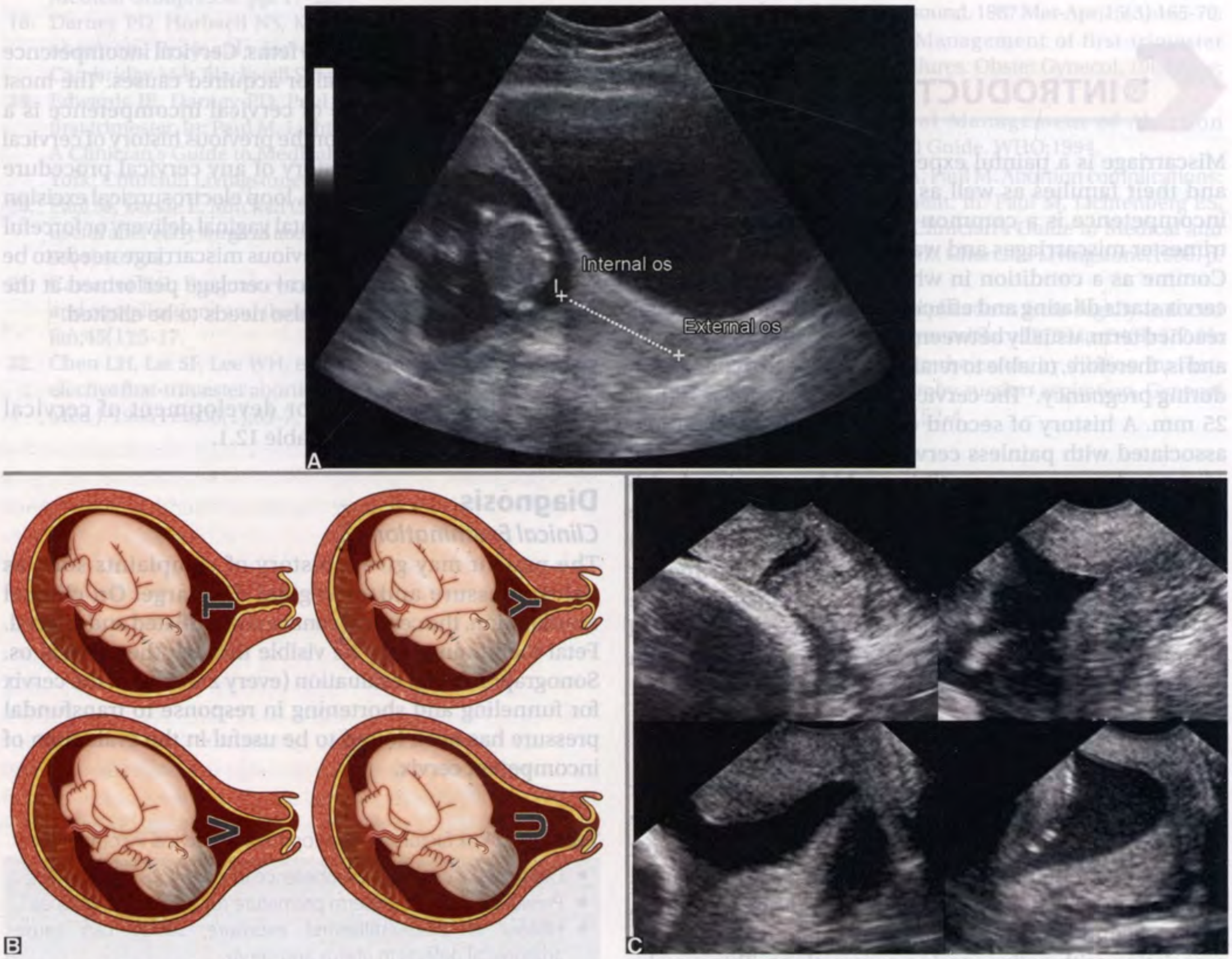
Other Tests

Some of the tests for diagnosing cervical incompetence, which were previously used and are still used at some places, include the following:

- Passage of a No. 8 (8 mm) Hegar's dilator.
- Traction using an intrauterine Foley catheter (No. 16).

AIMS OF SURGERY

The treatment of cervical incompetence involves surgery in which a surgical suture is placed to reinforce the



Figs 12.1A to C: (A) Measurement of normal cervical length on transvaginal ultrasound; (B) Anatomical changes in the endocervical canal associated with cervical incompetenc; (C) Ultrasound changes in endocervical canal with cervical incompetence

cervical muscles. No treatment for cervical incompetence is generally required, except when it appears to threaten a pregnancy. Cervical incompetence can be treated using surgery involving placement of a cervical cerclage suture, which reinforces the cervical muscle. Other alternatives which are sometimes considered include the following:

- Bed rest for which no trial has been conducted and there is little evidence regarding its effectiveness.
- The use of vaginal pessaries to elevate and close the cervix.

At present, the surgical approaches form the treatment of choice. Surgery involves placement of a cervical cerclage suture, either transabdominally or transvaginally. Different types of surgical procedures that can be performed include the following:

- McDonald's procedure
- Shirodkar's operation
- Wurm's procedure (Hefner cerclage)
- Transabdominal cerclage
- Lash procedure.

Out of the above-mentioned surgical procedures, McDonald's procedure and Shirodkar's procedure are most commonly performed. Cerclage could be performed either as an emergency or prophylactic procedure.

Prophylactic Cerclage

Prophylactic cerclage is placed at 12–16 weeks of gestation, but antibiotics are given perioperatively. Sexual intercourse, prolonged standing (> 90 minutes) and heavy lifting are to be avoided following cerclage. These patients should be followed-up with periodic vaginal sonography to assess stitch location and funneling. No additional restrictions are recommended as long as the stitches remain within the middle or upper third of the cervix without the development of a funnel and the length of the cervix is greater than 25 mm.

If vaginal surgery does not prove to be successful despite aggressive care, transabdominal cerclage can be tried.

Emergency/Rescue Cerclage

Emergency or rescue cerclage is used in cases of patients with acute presentation of incompetent cervix. Placement of emergency cerclage is both difficult as well as controversial. This surgery must be undertaken when there is still 10–15 mm or more of cervical canal left.

Patient must be admitted for at least 24 hours prior to the surgery. Perioperative treatment with indomethacin and antibiotics must be administered before placing the cerclage. Patient must be observed for 2–4 days postoperatively. The cerclage is rarely performed after 24–25 weeks of pregnancy. The cerclage is normally removed at 37 weeks or at the onset of the labor.

INDICATIONS

Indications for cerclage are as follows:

- History compatible with incompetent cervix
- Sonogram demonstrating funneling
- Clinical evidence of extensive obstetric trauma to the cervix or the history of cervical cone biopsy, which involved removal of large portions of cervix that may weaken it considerably. This is especially the case if internal cervical os had been removed at the time of biopsy. The trauma associated with first trimester miscarriage by D and E carries a high risk for subsequent pregnancy losses.

CONTRAINDICATIONS

Contraindications for cerclage are as follows:

- Uterine contractions/active labor
- Unexplained vaginal bleeding
- Chorioamnionitis
- Premature rupture of membranes (PROM)
- Cervical dilatation of more than 4 cm
- Polyhydramnios
- Fetal anomaly incompatible with life
- Intrauterine fetal death
- Gestational age more than 28 weeks
- Placenta previa with mucopurulent discharge and fetal membranes protruding out through the cervical os.

PREOPERATIVE PREPARATION

Two types of vaginal surgeries are most commonly performed during pregnancy. These include McDonald's surgery and Shirodkar's surgery. The McDonald's surgery is the simpler one, while the Shirodkar's surgery is relatively more complicated. In both these surgeries, after the confirmation of the diagnosis of cervical incompetence, a surgical reinforcement procedure, which involves placement of a purse-string suture as close to internal cervical os as possible, is performed. With these surgeries, success rate as high as 85–90% have been reported.[5,6] Most obstetricians prefer to use McDonald's surgery in cases of cervical incompetence and perform the more complicated Shirodkar's procedure only in cases where there has been previous failure of McDonald's procedure. The choice of the McDonald's cerclage versus Shirodkar's procedure is usually based on operator's experience. Presently there are no studies suggesting that one procedure is better than the other. Retrospective studies have confirmed that both the procedures can produce similar outcomes. Based on the timing of procedure, the following four types can be defined as:

1. Prophylactic cerclage prior to conception
2. Prophylactic cerclage during pregnancy

3. Emergency cerclage after exposure of membranes
4. Urgent cerclage after shortening of the cervix.

The following preoperative steps must be observed prior to undertaking any of the previously-mentioned cerclage procedures.

- Any contraindications for performance of cerclage procedure (as described before) must be ruled out before performing the procedure.
- Sonography must be performed to confirm a living fetus and to exclude any major congenital anomalies.
- Presence of cervical infection must be ruled out. For this, cervical specimen must be tested for presence of infections such as gonorrhea and chlamydia.
- Sexual intercourse must be prohibited for at least 1 week prior to and after the surgery.
- The procedure is usually performed under regional anesthesia, although at times the surgeon might prefer to perform the surgery under paracervical block.
- Under all aseptic precautions the vagina and cervix are swabbed with an antiseptic solution (usually savalon or betadine) and a sterile vaginal Sims' speculum is placed inside the vagina over the posterior vaginal wall. An anterior vaginal wall retractor is used for cervical visualization. The anterior lip of cervix is grasped at 12 O'clock and 9 O'clock positions with the help of sponge-holding forceps.

SURGICAL STEPS

Various types of surgeries which can be performed are described below.

McDONALD'S PROCEDURE

In McDonald's procedure, a 5-mm band of permanent purse string using 4–5 bites is placed high on the cervix (Fig. 12.2). The first bite is taken at 12 O'clock position in the cervico-vaginal junction. The needle exits a little above 9 O'clock position, re-enters at 9 O'clock position, exits again a little above 6 O'clock position, re-enters at 6 O'clock position, exits again a little below 3 O'clock position and re-enters at 3 O'clock position. Finally, it comes out at the 12 O'clock position, the site of original insertion. Following this, the needle is removed and the suture drawn closed in the form of a purse-string suture. A surgeon's knot is placed tightly and the ends are trimmed to 2–3 cm to allow easy identification and manipulation of the stitch at the time of removal. The stitch is usually removed at 37 weeks, unless there is a reason (e.g. infection, preterm labor, preterm rupture of membrane, etc.) for an earlier removal. In McDonald's procedure, no bladder dissection is required. It is associated with the success rate of approximately 80%. Steps of McDonald's procedure are shown in Figures 12.3A to G. The advantages of McDonald's procedure over Shirodkar's procedure include the following:

- Simplicity of the procedure (does not involve bladder dissection or complete burial of the sutures)

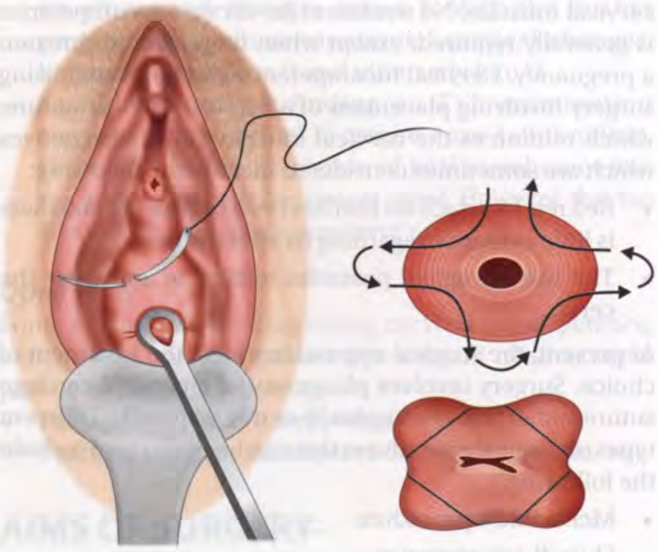


Fig. 12.2: McDonald's procedure

- Reduced blood loss at the time of surgery
- Ease of removal at the time of delivery
- The stitch can also be applied when the cervix is effaced or the fetal membranes are bulging.

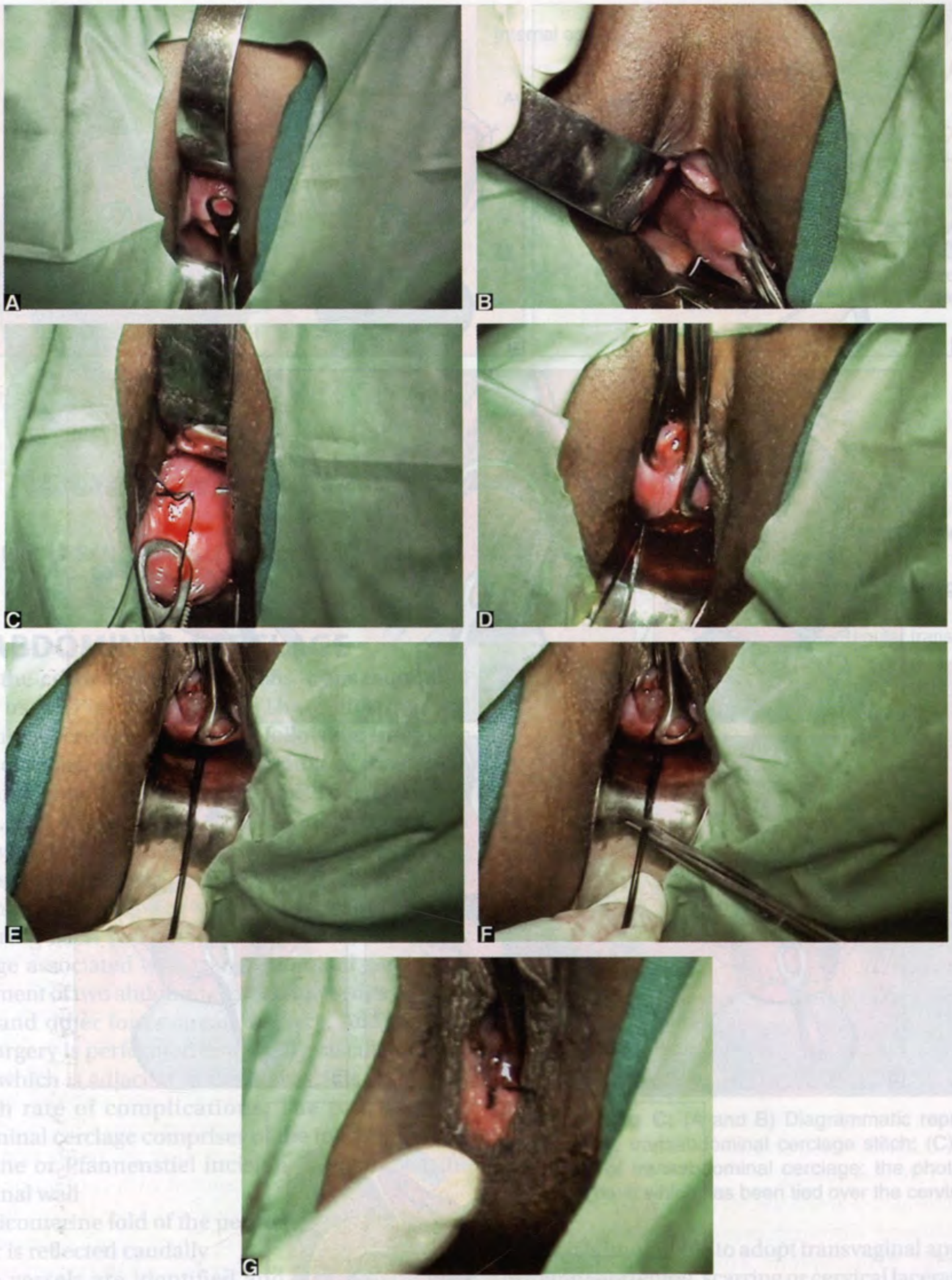
The main disadvantage of the procedure is the occurrence of excessive vaginal discharge with the exposed suture material.

SHIRODKAR'S TECHNIQUE

The Shirodkar's procedure (Figs 12.4A to G) was first described in 1955. In this procedure, a permanent purse string suture which would remain intact for life is applied. As a result, the patient needs to be delivered by a cesarean section for all future deliveries. The suture is placed submucosally as close to the internal os as possible by giving incisions both over the mucosa on the anterior and posterior aspects of the cervix. This is followed by dissection and separation of the bladder and the rectum from both anterior and posterior surface of the cervix respectively. Although the original Shirodkar's procedure involved the dissection of both bladder and rectal mucosa, the Shirodkar's procedure performed nowadays mainly involves opening of the anterior fornix and dissection of the adjacent bladder. The knot is tied anteriorly and buried by suturing the mucosal opening in the anterior fornix. Some obstetricians prefer tying a posterior knot in order to prevent erosion into the bladder.

This procedure is usually performed under spinal or epidural anesthesia. The advantages of the procedure include that the stitch can be placed high on the cervix near the internal os. Since the sutures are buried under the mucosa, this considerably helps in reducing the chances of infection.

Initially, both Shirodkar and the McDonald started suturing with the catgut but eventually Shirodkar turned to fascia lata and McDonald turned to silk. Presently, mersilene tape is used as an appropriate suture material. Both the procedures have been found to be equally effective.



Figs 12.3A to G: (A) Exposing the cervix; (B) Taking the first stitch; (C) Taking the second stitch; (D) Taking the last stitch; (E) Tying the knot posteriorly; (F) Cutting the excessive length of thread from the knot; (G) Appearance of cervix following surgery

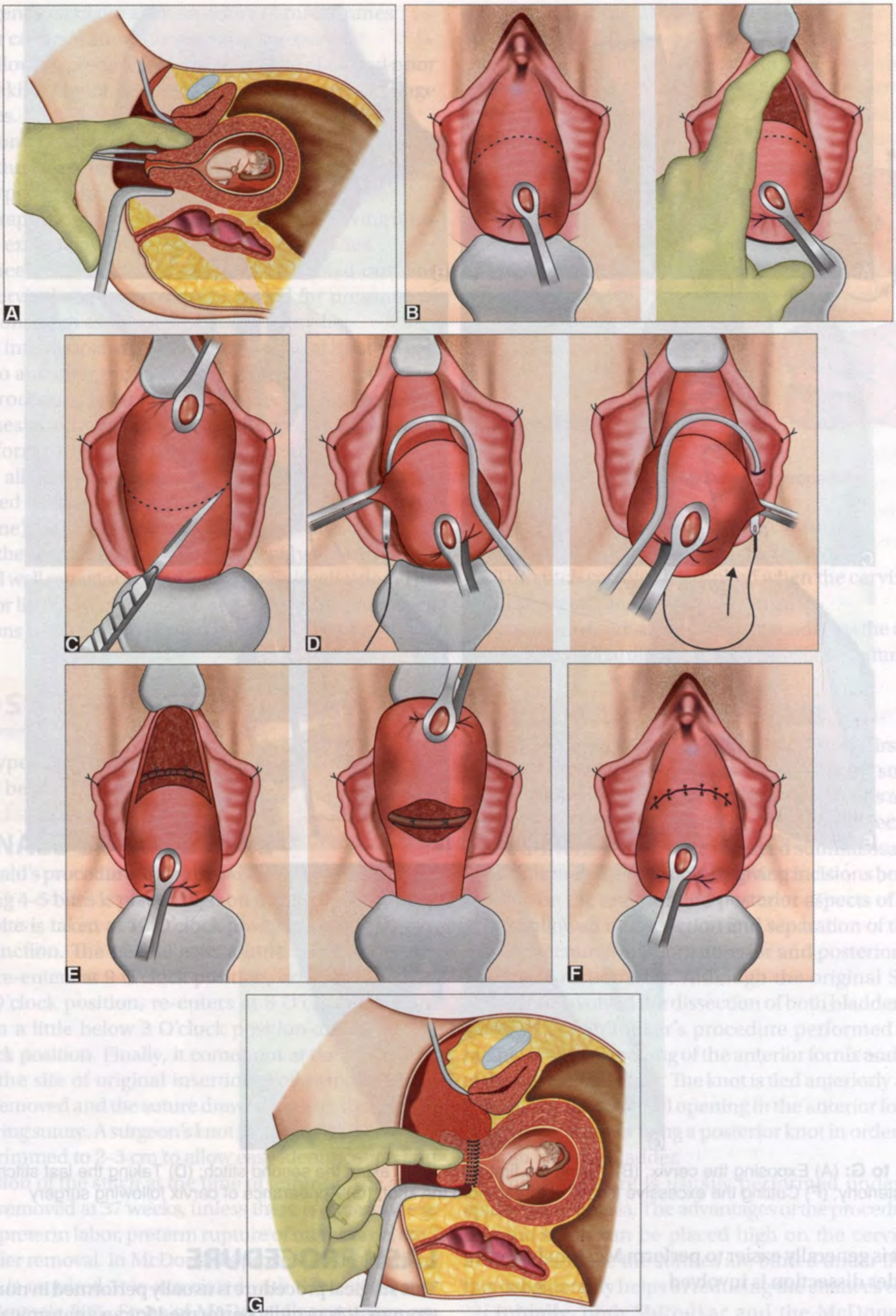
However, it is generally easier to perform McDonald suture as no bladder dissection is involved.

WURM'S PROCEDURE

Also known as Hefner's cerclage, it is done by application of U or mattress sutures (Fig. 12.5) and is of benefit when minimal amount of length of cervical canal left.

LASH PROCEDURE

This surgical procedure is usually performed in nonpregnant woman. It is usually performed for an anatomical defect in cervix resulting from cervical trauma. In this surgery, the cervical mucosa is opened anteriorly, bladder reflected and the cervical defect repaired with interrupted transverse sutures before closing the vaginal mucosa.



Figs 12.4A to G: Shirodkar's technique: (A) Pulling the anterior lip of cervix; (B) Incision and dissection of anterior vaginal mucosa; (C) Incision of posterior vaginal wall mucosa; (D) Application of the suture as close to the internal cervical os as possible; (E) Sutures have been tied both anteriorly and posteriorly; (F) Closure of the vaginal mucosa; (G) Appearance of cervix after application of Shirodkar's stitch

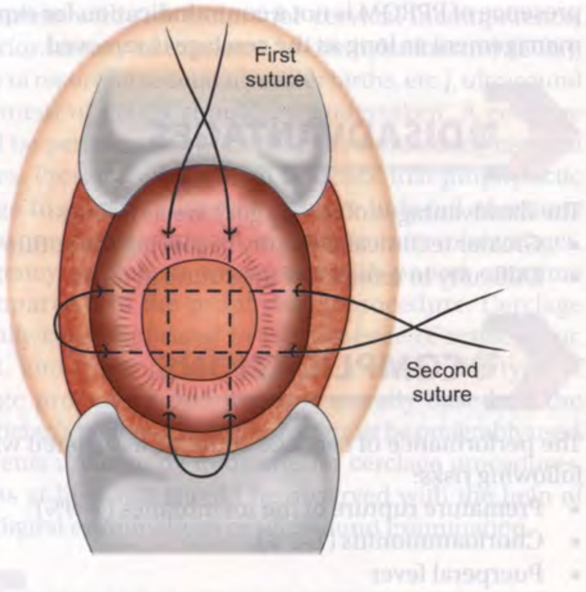


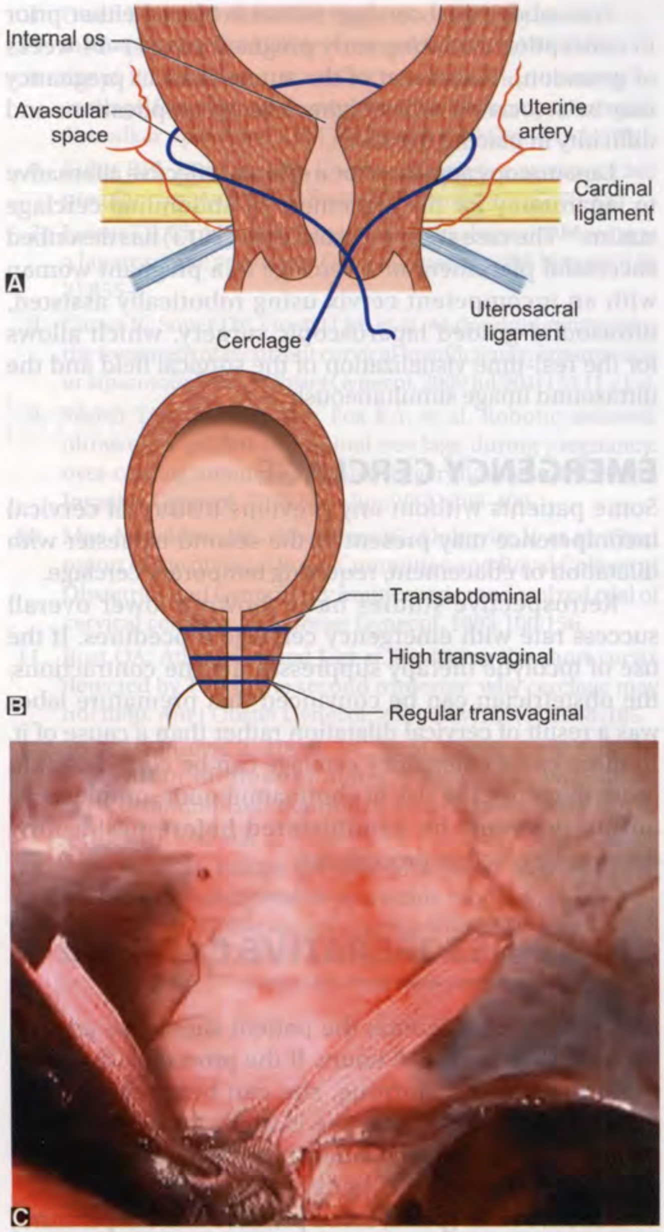
Fig. 12.5: Application of Wurm's stitch

TRANSABDOMINAL CERCLAGE

If either of the cervical procedures fails, transabdominal cerclage is used (Figs 12.6A to C). The indications for transabdominal cerclage include the following: traumatic cervical lacerations, congenital shortening of the cervix, previous failed vaginal cerclage and advanced cervical effacement. The original intention with transabdominal approach was that the suture was inserted between pregnancies or in the early pregnancy and left in situ for the rest of the life. The delivery was undertaken by cesarean section during each pregnancy. As a result, the major disadvantage associated with transabdominal cerclage is the requirement of two abdominal procedures: one to place the suture and other for cesarean delivery. Additionally, since the surgery is performed in a highly vascular area of the cervix, which is adjacent to the uterus, it is associated with a high rate of complications. The procedure of transabdominal cerclage comprises of the following steps:

- A midline or Pfannenstiel incision is given over the abdominal wall
- The vesicouterine fold of the peritoneum is divided
- Bladder is reflected caudally
- Uterine vessels are identified and a mersilene tape suture is passed through the broad ligament below the uterine vessels in the potential free space between the uterine vessels and the ureter.
- The suture is tied either anteriorly or posteriorly and the bladder is replaced.

Since the transabdominal procedure is associated with higher morbidity in comparison to the transvaginal procedure, transabdominal approach is only recommended in cases with cervical insufficiency in which two or more attempts at transvaginal cerclage have failed or in cases



Figs 12.6A to C: (A and B) Diagrammatic representation for placement of transabdominal cerclage stitch; (C) Laparoscopic placement of transabdominal cerclage: the photograph shows mersilene band which has been tied over the cervix

where it is impossible to adopt transvaginal approach due to extreme shortening, scarring or cervical lacerations. Despite of these drawbacks the transabdominal method is associated with certain benefits. Probable advantages of transabdominal over transvaginal cerclage include the following:

- More proximal placement of the stitch (at the level of the internal os)
- Reduced risk of suture migration
- Absence of a foreign body in the vagina which could be associated with infection
- It is possible to leave the suture in place for future pregnancies.

Transabdominal cerclage suture is placed either prior to conception or during early pregnancy (at 11–14 weeks of gestation). Placement of the suture later in pregnancy may be associated with a higher rate of complications and difficulty in placing the stitch.

Laparoscopy appears to be a safe and effective alternative to laparotomy for the placement of abdominal cerclage suture.[7,8] The case study by Walsh et al. (2013) has described successful placement of a cerclage in a pregnant woman with an incompetent cervix using robotically assisted, ultrasound-guided laparoscopic surgery, which allows for the real-time visualization of the surgical field and the ultrasound image simultaneously.[9]

EMERGENCY CERCLAGE

Some patients without any previous history of cervical incompetence may present in the second trimester with dilatation or effacement, requiring temporary cerclage.

Retrospective studies have shown a lower overall success rate with emergency cerclage procedures. If the use of tocolytic therapy suppresses uterine contractions, the obstetrician can be convinced that premature labor was a result of cervical dilatation rather than a cause of it. In these cases emergency cerclage can be considered. In order to reduce the risk of chorioamnionitis, prophylactic antibiotics must be administered before performing emergency cerclage procedures.

POSTOPERATIVE CARE

Following the procedure, the patient should be advised bed rest for at least 6–8 hours. If the procedure has been performed in the morning, she can be discharged by the evening provided that she is stable and there are no other complications. The following parameters need to be observed for the first 4–6 hours after surgery:

- Patient's vitals (pulse, blood pressure and temperature)
- Any bleeding through cervical os
- Presence of uterine contractions
- Fetal heart rate monitoring.

In case of uterine contractions, tocolysis with terbutaline can be administered. Although prescription of antibiotics is not essential, prophylactic antibiotics are usually prescribed.

In our setup, broad spectrum antibiotics are usually started just before the procedure and continued 1–3 days orally postoperatively.

REMOVAL OF CERCLAGE

The cerclage is usually removed at 37 weeks of gestation when the fetus has attained sufficient maturity. In case of significant uterine activity, the sutures can be removed at 35 weeks of gestation. Presence of a pre-existing cerclage in presence of PPROM is not a contraindication for expectant management as long as the cerclage is removed.

DISADVANTAGES

The disadvantages of the surgery are as follows:

- Greater technical difficulty in placing the suture
- Difficulty in removal of the suture at term.

COMPLICATIONS

The performance of cerclage could be associated with the following risks:

- Premature rupture of the membranes (1–9%)
- Chorioamnionitis (1–7%)
- Puerperal fever
- Preterm labor
- Cervical laceration or amputation resulting in the formation of scar tissue over the cervix
- Bladder injury
- Maternal hemorrhage
- Cervical dystocia
- Uterine rupture, vesicovaginal fistula.

DISCUSSION

The use of cerclage procedure in cases of cervical incompetence is controversial. Recently, more interest has been focused on the use of TVS for the diagnosis of cases with cervical incompetence. The length of cervix measured at the time of mid-pregnancy is used as a parameter for prediction of cervical incompetence. Another parameter, which helps in predicting cervical incompetence on TVS, is the funneling of fetal membranes.[4] Funneling refers to the ballooning of the fetal membranes into a dilated internal os, but with a closed external os. However, various studies regarding the role of ultrasound examination for prediction of cervical incompetence have presented with conflicting results.[10-13]

The surgery for cervical cerclage is usually performed between 12 and 16 weeks. There is still a debate regarding when the elective cerclage procedure be performed. There is a greater risk of preterm labor or PROM if the surgery is performed when the pregnancy is advanced. The cerclage is usually not performed after 23 weeks of pregnancy.

CONCLUSION

When the patient gives a classical clinical history of cervical incompetence, cerclage operation appears to be the most appropriate intervention an obstetrician can undertake.

In a patient with risk factors for cervical incompetence, [e.g. prior history of exposure to diethylstilbestrol (DES); history of recurrent second trimester births, etc.], ultrasound assessment of cervix should be undertaken. A cerclage should be performed only in cases demonstrating cervical changes. Presently, there is no evidence that prophylactic cerclage in women with two or more induced abortions helps in preventing recurrent second trimester miscarriages. Emergency cerclage is associated with poorer outcome in comparison to the prophylactic procedure. Cerclage is usually contraindicated in the presence of active labor, PROM, and unexplained vaginal bleeding. The type of cerclage procedure performed is usually based on the obstetrician's preference. Antibiotics must be preferably used in patients undergoing midtrimester cerclage procedures. Patients at high risk should be observed with the help of serial digital examinations or ultrasound examination.

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13

CHAPTER

Surgical Interventions for Control of Postpartum Hemorrhage

INTRODUCTION

According to the World Health Organization (WHO), postpartum hemorrhage (PPH) can be defined as excessive blood loss per vaginum (> 500 mL in case of normal vaginal delivery or > 1,000 mL following a cesarean section) from the time period within 24 hours of delivery of the baby lasting until the end of the puerperium.[1] Excessive blood loss can result in the development of symptoms such as light headedness, vertigo, syncope, palpitations, tachycardia, etc. The PPH can be considered as a major obstetric emergency and a leading cause of maternal mortality and morbidity. Some amount of blood loss can occur normally during the process of childbirth. Approximate blood loss at the time of normal vaginal delivery is considered to be 500 mL; 1,000 mL at the time of cesarean section and 1,500 mL during postpartum hysterectomy. The American Congress of Obstetricians and Gynecologists (ACOG) has defined PPH as a decrease in hematocrit by 10% or requirement of blood transfusion 24 hours after the delivery.[2] The WHO has classified PPH into two types: (1) primary PPH and (2) secondary PPH.

Primary PPH

Primary PPH can be defined as blood loss, estimated to be greater than 500 mL, occurring from the genital tract, within 24 hours of delivery. Primary PPH can be considered as the most common cause for obstetric hemorrhage.

Secondary PPH

Secondary PPH can be defined as abnormal bleeding from the genital tract, occurring 24 hours after delivery until 6 weeks postpartum.

CAUSES OF PPH

The mnemonic "4 Ts" (tone, trauma, tissue and thrombin) helps in describing the four important causes of PPH, which are enumerated in Table 13.1.[3,4]

Atonic Uterus

Uterine atony is one of the most important causes for PPH, which is responsible for nearly 90% cases. Uterine atony refers to the failure of the uterine muscle to contract normally following delivery of the baby and placenta.[3] Separation of the placenta from the wall of the uterus results in shearing off of the maternal blood vessels, which supply blood to the placenta. Under normal circumstances, the contraction of the uterine musculature causes compression of these blood vessels. However, the bleeding would continue to occur if the uterine musculature does not effectively contract (Fig. 13.1). Some of the causes of atonic uterus include overdistension of uterus, induction of labor, prolonged/precipitate labor, anesthesia (use of halogenated drugs like halothane), analgesia, grand multiparity, etc.

Traumatic Causes for PPH

The various traumatic causes for PPH are presence of large episiotomy and extensions, tears and lacerations of perineum, vagina or cervix, pelvic hematomas, uterine inversion, ruptured uterus, etc.

Table 13.1: Causes of postpartum hemorrhage (PPH)

- Tone: Atonic uterus
- Trauma: Cervical, vaginal and perineal lacerations, pelvic hematomas, uterine inversion, ruptured uterus
- Tissue: Retained tissue (placental fragments), invasive placenta
- Thrombin: Coagulopathies

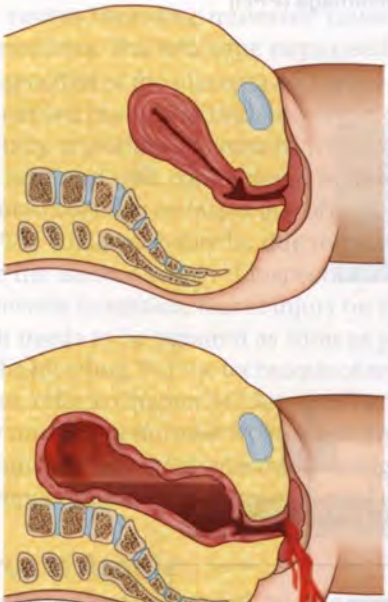


Fig. 13.1: Mechanism of bleeding in an atonic uterus

Tissue: Retained Tissue (Placental Fragments)

The PPH can commonly occur if retained bits of placental tissue or blood clot remain inside the uterine cavity and are not expelled out.

Thrombin: Coagulopathies

Abnormalities of the coagulation pathway (both intrinsic and extrinsic) can also commonly result in PPH. Drugs (e.g. aspirin, heparin, warfarin, alcohol, chemotherapy), liver diseases, severe vitamin K deficiency, Von Willebrand's disease, hemophilia, idiopathic thrombocytopenic purpura, heparin-induced thrombocytopenia, disseminated intravascular coagulation (DIC), etc.

OVERVIEW OF SURGERY

In earlier times, most cases of intractable PPH occurred due to uterine atony following normal vaginal delivery. However, nowadays, with increasing rate of cesarean deliveries, there has been an increase in the cases of PPH during cesarean section.[5] Uterine rupture has also become an important cause of PPH, which may require hysterectomy.

Surgical management in cases of PPH is usually required in severe cases experiencing life-threatening bleeding, which cannot be controlled by conservative or medical management. Surgical management becomes necessary if the uterus remains atonic and flabby despite of conservative management. The management of PPH at the time of cesarean delivery or uterine rupture is not greatly different from that following normal vaginal delivery. If the uterus is atonic, direct bimanual compression may be performed. In case of retained tissue, it can be removed under direct visualization. Direct intramyometrial injection of an uterotonic agent may also be administered in case of an atonic uterus.

Initially, the conservative surgical approaches for normal vaginal delivery are followed. In case these are not successful, there is uncontrollable hemorrhage and future childbearing is not required, emergency hysterectomy may be considered.

AIMS OF SURGERY

Aim of surgery in cases of PPH is mainly to control the continuing hemorrhage which might even prove to be life-threatening, if not controlled on time. The most commonly used surgical approach is the conservative type in which attempts are made to preserve the uterus and thereby future fertility. If the bleeding still remains uncontrollable, the surgeon may have to resort to more aggressive surgical approaches. If nothing seems to work, performing a hysterectomy may be the only option left to save life even in those women who require future fertility.

INDICATIONS

Some of the indications for surgery in case of PPH are as follows:

- Atonic uterus not responding to uterotonic drugs
- Severe uncontrollable bleeding following normal vaginal birth or cesarean delivery.

PREOPERATIVE PREPARATION

Management of a patient with PPH is shown in Flow Chart 13.1. According to the guidelines by the Scottish Executive Committee of the RCOG (2000), the immediate management in case with PPH comprises of the steps which are enumerated in Table 13.2.[6] All of these steps are required to be undertaken simultaneously.

While resuscitating the women, it is important to simultaneously assess the uterine tone. Once the maternal condition has stabilized, the cause of PPH must be identified and treated. Further management must be decided based on the fact whether the placenta has delivered or not. If the placenta has delivered, PPH could be due to uterine atonicity, uterine trauma, retained placental tissue, coagulation disorders, etc. Surgical options for controlling PPH vary depending on whether the placenta has delivered or not. Surgical options available for controlling PPH, if the placenta has delivered would be discussed in this chapter. Surgical options which must be used when the placenta has not yet delivered no matter whether the placenta is adherent or nonadherent would be discussed in Chapter 15 (Manual Removal of Placenta).

Flow Chart 13.1: Management of a case of postpartum hemorrhage (PPH)

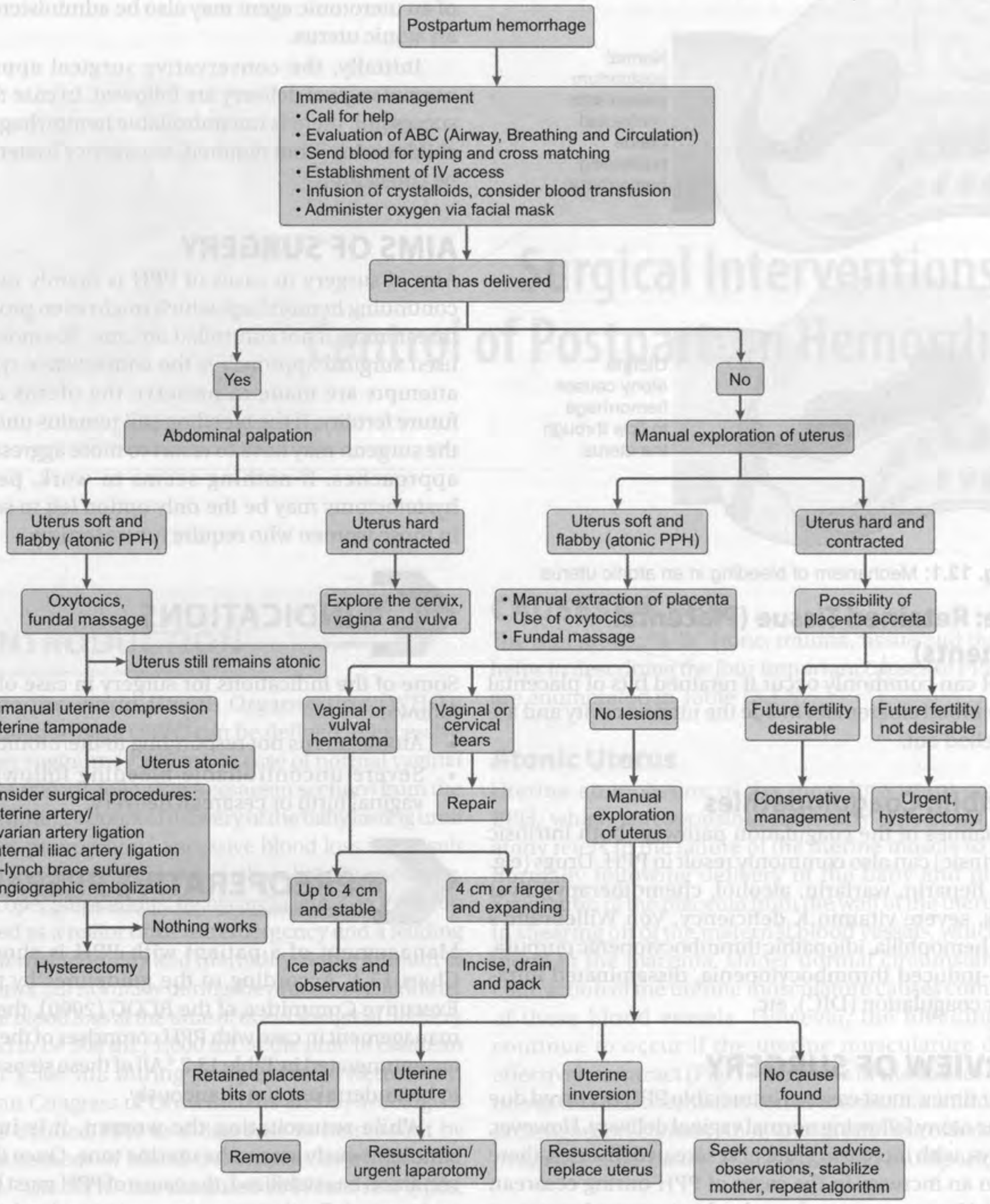


Table 13.2: Steps involved in the immediate management of patients with PPH[6]

♦ Communicate (call for additional staff to manage the obstetric emergency)
♦ Resuscitation of the patient (ABC: Airway, Breathing and Circulation)
♦ Monitoring the patient and carrying out certain investigations
♦ Assessment of the uterine tone
♦ Treating the underlying cause of bleeding

Abbreviation: PPH, postpartum hemorrhage

SURGICAL OPTIONS IF THE PLACENTA HAS DELIVERED

If the placenta has delivered, the main thing the clinician needs to see is whether the uterus has contracted or not. Uterine atony is evident by the presence of a boggy, soft uterus.

Uterus Well Contracted

If the uterus contracts but the bleeding continues despite a well-contracted uterus, the clinician must look for other causes including traumatic causes and coagulation abnormalities. The following steps need to be taken.

Inspection of the placenta and lower genital tract needs to be carried out to ascertain the origin of bleeding. This is especially important in cases in which the uterus appears to be firm and well contracted. There could be a missing placental cotyledon on inspection of placenta, which suggests that PPH could probably be due to retained placental bits inside the uterine cavity. If inspection of the lower genital tract reveals laceration, tear or injury on the cervix or vagina, then it needs to be repaired as soon as possible in order to stop the bleeding. For the technique of repair of genital tract injuries, refer to Chapter 14 (Repair of Perineal Injuries). The repair must be performed while the woman is positioned in lithotomy with adequate anesthesia/analgesia so as to ensure the proper examination of lower genital tract.

Uterus is Atonic

If the placenta has delivered, but the uterus is not hard and contracted; instead appears to be atonic and flabby, the PPH is of atonic type. In this case, the following steps need to be carried out:

- The urinary bladder must be emptied
- Exploration of the uterine cavity for any retained placental bits needs to be carried out
- The vagina and cervix must still be inspected for presence of lacerations and tears (traumatic PPH is commonly present in association with atonic PPH)
- Administration of oxytocic drugs (Table 13.3)[7,8]
- Bimanual uterine massage
- Uterine tamponade.

Bimanual Uterine Massage

If the clinician finds the uterus to be soft upon bimanual examination, a bimanual uterine massage must be performed to contract the myometrial muscles. Bimanual uterine massage must only be undertaken when either the drugs for controlling PPH are not available or when the drug therapy fails. The maneuver involves the massage of the posterior aspect of the uterus with the abdominal hand and that of the anterior aspect of the uterus with the vaginal hand and comprises of the following steps:

- One of the clinician's hands is formed into a fist and placed inside the vagina, with the back of the hand directed posteriorly and knuckles in the anterior fornix so as to push against the body of the uterus (Fig. 13.2).
- The other hand compresses the fundus from above through the abdominal wall. The fundus of the uterus must immediately be massaged, until uterus becomes well contracted.
- If this maneuver is able to control the bleeding, the uterus must be massaged every 15 minutes during the first 2 hours.

Uterine Tamponade

In patients who do not respond to uterotonics, an intrauterine balloon tamponade may be used for controlling PPH due to uterine atony before resorting to various surgical options. This method aims at increasing intrauterine pressure in order to control uterine bleeding. However, it carries the potential risk of infection and trauma. It may also conceal the bleeding and give a false sense of security. Uterine tamponade can be achieved in two ways:

1. *Intrauterine packing*: Intrauterine packing using ribbon gauze soaked in povidone-iodine solution helps in stopping bleeding. This is usually removed 24 hours later. This method is obsolete and is rarely used nowadays.
2. *Balloon tamponade*: This can be achieved using a large bulb Foley's catheter, Sengstaken-Blakemore tube, an SOS Bakri tamponade balloon, Rusch balloon or even

Table 13.3: Various oxytocics used for controlling PPH

Drug	Dosage	Side-effects	Contraindications
Oxytocin/Syntocinon	20 IU of oxytocin in 1 L of crystalloid solution may be infused intravenously at the rate of 125 mL/hour	Water intoxication and nausea at high dosage, requires refrigeration	Nil
Methylergometrine (methergine)	0.25 mg is administered either intramuscularly or intravenously	Nausea, vomiting, hypertension and retained placenta (if given before placental separation occurs)	Hypertension, heart disease
Carboprost (15-methyl PGF 2α)	250 μg is given in the form of intramuscular injection every 15 minutes for a maximum of 8 doses. 600–1,000 μg can also be given rectally or orally.	Diarrhea, pyrexia (> 40°C)	Significant pulmonary, cardiac, hepatic or renal disease
Misoprostol	Three 200 μg tablets (a total of 600 μg) is administered orally or rectally as a single dosage, to be given immediately after delivery.	Diarrhea, pyrexia (> 40°C)	It has been approved for use in only some countries. Significant pulmonary, cardiac, hepatic or renal disease

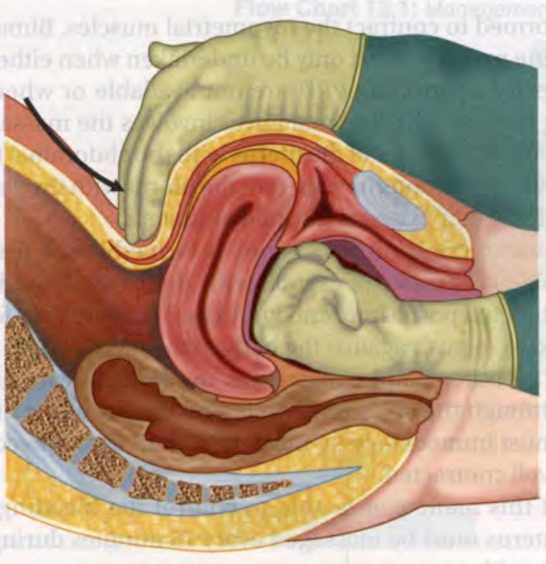


Fig. 13.2: Bimanual uterine massage

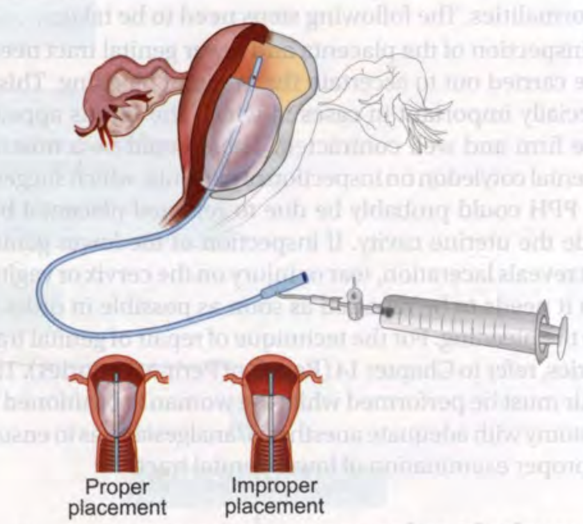


Fig. 13.3: Tamponade using SOB Bakri balloon catheter

an inflated condom.[9,10] A Foley's catheter with a balloon of 30 mL (which may be inflated up to 100 mL) is quite effective in controlling postpartum bleeding. The recently available SOS Bakri tamponade balloon (Fig. 13.3) has specifically been designed to deal with PPH. The Bakri tamponade balloon catheter helps in temporary control of PPH, potentially avoiding a hysterectomy. The balloon portion of the catheter is inserted past the cervical canal and internal ostium into the uterine cavity under ultrasound guidance. The balloon is inflated up to 500 mL and removed after 24 hours.

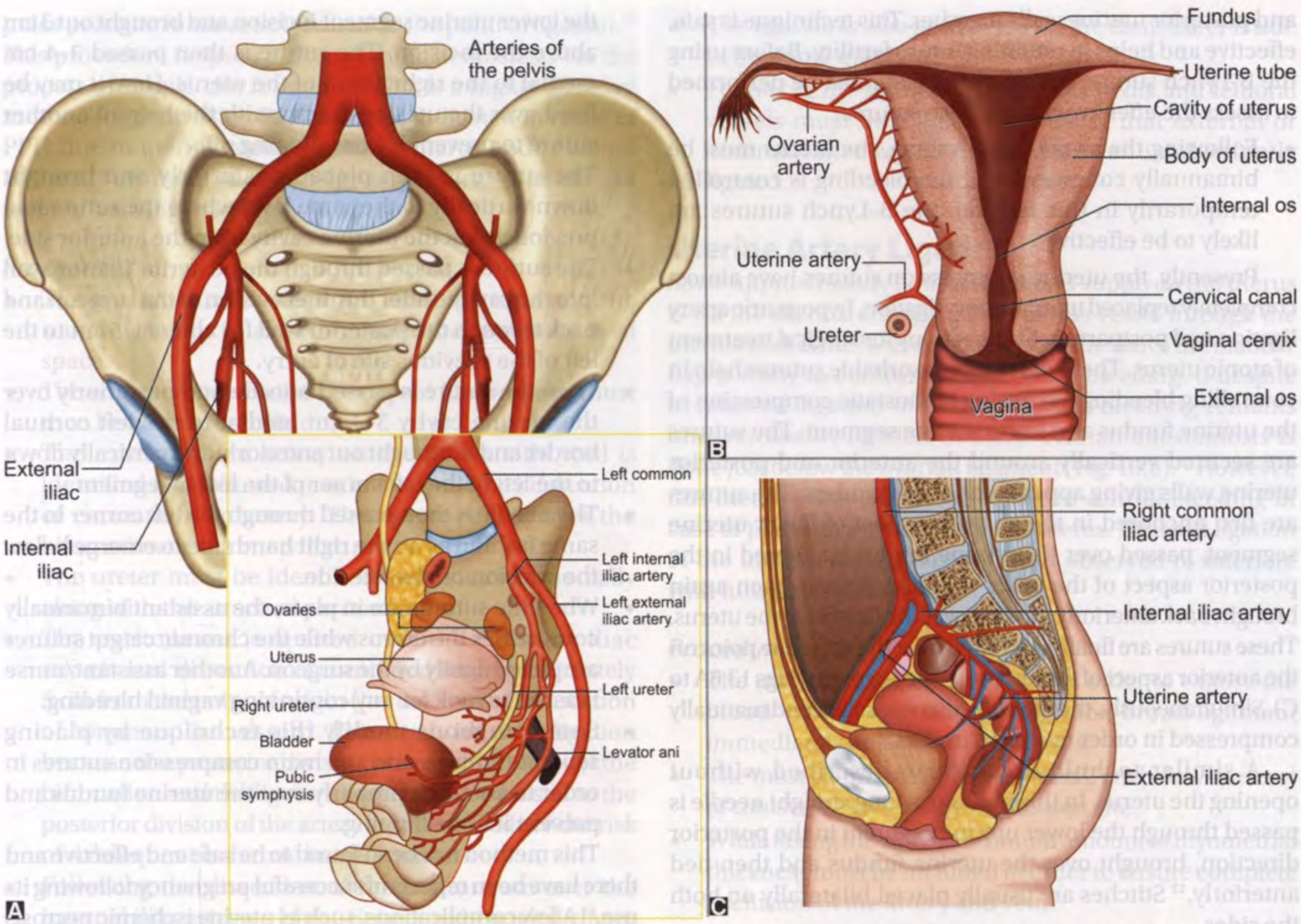
Laparotomy

If all the above described conservative measures fail to control PPH, laparotomy may be required to save the mother's life. Surgical hemostasis must be initiated as soon as possible in order to save the patient's life. Although there are different surgical options available, the surgical option of choice to be used in a particular patient depends upon the following factors:

- Extent and cause of hemorrhage
- General condition of patient
- Desirability for future reproduction
- Experience and skill of the obstetrician incharge.

Application of aortal compression at the time of surgery must be considered. Most of the surgical methods for controlling PPH aim at controlling the blood supply to the uterus by ligation of some of the vessels, which supply blood to the uterus. The blood supply to the pelvic structures is mainly by the common iliac vessels, which give rise to internal as well as external iliac arteries (Fig. 13.4A). The internal iliac artery (formerly known as the hypogastric artery) has an anterior division and a posterior division. Anterior division gives rise to five visceral branches and three parietal branches.[11] The visceral branches are: uterine; superior vesical; middle hemorrhoidal; inferior hemorrhoidal and vaginal arteries, whereas the parietal branches are: obturator artery; inferior gluteal and internal pudendal arteries. The posterior division on the other hand gives rise to the following branches: collateral branches to the pelvis, iliolumbar, lateral sacral and superior gluteal arteries.

The blood supply to the uterus is mainly via the uterine and ovarian vessels (Fig. 13.4B). The ovarian arteries are direct branches of the aorta, which arise beneath the renal arteries. The uterine artery is the branch of internal iliac vessel. The uterine artery passes inferiorly from its origin into the pelvic fascia. It runs medially in the base of broad ligament to reach the uterus. It then reaches the junction of the body and cervix of the uterus (internal os) by passing superiorly. While taking such a course, the uterine artery passes above the ureter at right angles. It then ascends along the lateral margin of the uterus within the broad ligament. It continues to move along the lower border of the fallopian tubes where it ends by anastomosing with the ovarian artery which is a direct branch from the abdominal aorta. The uterine artery also gives off a small descending branch that supplies the cervix and the vagina. The uterine vein follows the uterine artery all along its course and ultimately drains into the internal iliac vein. Blood supply to anterior and posterior uterine walls is provided by the arcuate arteries, which run circumferentially around the uterus (Fig. 13.4C). The arcuate arteries give rise to the radial arteries which enter the endometrium. The ultimate branches of uterine artery which connect maternal circulation to the endometrium are the spiral and the basal arteries.



Figs 13.4A to C: (A) Blood supply to the pelvis (front view); (B) Blood supply to the uterus; (C) Blood supply to the uterus (side view)

SURGICAL STEPS

TYPES OF SURGICAL OPTIONS

Various surgical options that can be used in a patient to control PPH are as follows and would be described in details next:

- Brace sutures of uterus: B-Lynch sutures
- Uterine artery or utero-ovarian artery ligation
- Bilateral ligation of internal iliac (hypogastric arteries)
- Angiographic embolization
- Hysterectomy (as a last option if nothing seems to work).

Brace Sutures of the Uterus

Application of uterine brace sutures can be considered as the best form of surgical approach for controlling atonic PPH as it helps in preserving the anatomical integrity of the uterus. Though the B-Lynch compression suture is the most commonly used hemostatic suture worldwide, newer modifications are gaining favor. Some such modifications include Cho multiple square sutures (Fig. 13.5), Hayman's technique (application of two vertical sutures which are tied over the uterine fundus), the Pereira technique (insertion of series of longitudinal and transverse sutures around the uterus), etc.

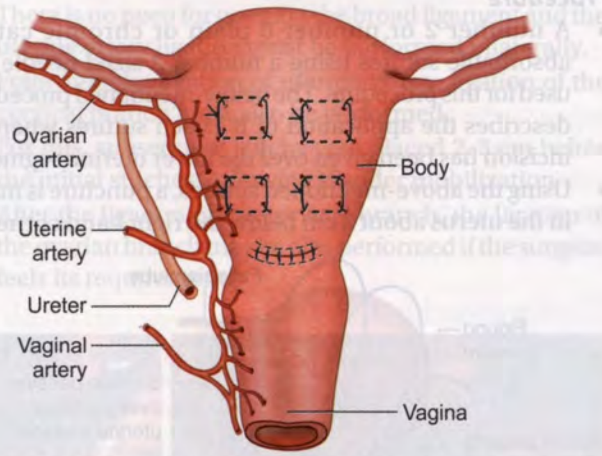


Fig. 13.5: Cho multiple square sutures compressing anterior to posterior uterine walls

B-Lynch Compression Sutures

The B-Lynch suture is the uterine bracing suture, which when tightened and tied helps in compressing the anterior and posterior uterine walls together. This technique is safe, effective and helps in retaining future fertility. Before using the B-Lynch suture, the following test must be performed to assess the effectiveness of these sutures:

- Following the swabbing of vagina, the uterus must be bimanually compressed. If the bleeding is controlled temporarily in this fashion, the B-Lynch sutures are likely to be effective.

Presently, the uterine compression sutures have almost completely replaced uterine artery ligation, hypogastric artery ligation and postpartum hysterectomy for surgical treatment of atonic uterus. These brace like absorbable sutures help in controlling bleeding by causing hemostatic compression of the uterine fundus and lower uterine segment. The sutures are secured vertically around the anterior and posterior uterine walls giving appearance of suspenders. The sutures are first anchored in the anterior aspect of lower uterine segment, passed over the uterine fundus, anchored in the posterior aspect of the lower uterine segment, then again brought back anteriorly passing over the fundus of the uterus. These sutures are finally anchored near the entrance point on the anterior aspect of the lower uterine segment (Figs 13.6A to C). Simultaneously, the uterus is also massaged and manually compressed in order to reduce its size.

A similar technique has been described without opening the uterus. In this method, a long straight needle is passed through the lower uterine segment in the posterior direction, brought over the uterine fundus and then tied anteriorly.[12] Stitches are usually placed bilaterally on both the sides.

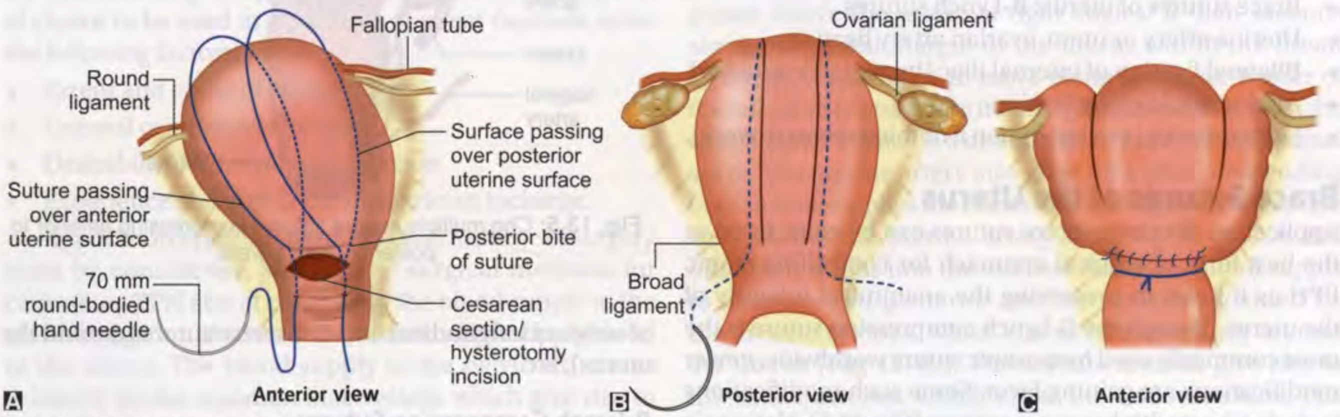
Procedure

- A number 2 or number 0 plain or chromic catgut absorbable sutures using a number 2 sized needle are used for this procedure. The below-mentioned procedure describes the application of B-Lynch sutures when an incision has been given over the lower uterine segment.
- Using the above-mentioned sutures, a puncture is made in the uterus about 3 cm below the right hand corner of the lower uterine segment incision and brought out 3 cm above the incision. The suture is then passed 3–4 cm medial to the right cornu of the uterus. Here it may be fixed over the uterine fundus with the help of another suture to prevent it from slipping off.
- The suture is then placed posteriorly and brought down vertically to the same level where the suture had previously left the uterine cavity from the anterior side.
- The suture is passed through the posterior uterine wall into the cavity under the direct vision of the surgeon and back through the posterior wall for about 4–5 cm to the left of the previous site of entry.
- Then the suture is passed outside and posteriorly over the uterine cavity 3–4 cm medial to the left cornual border and is brought out anteriorly and vertically down to the left of the left corner of the lower segment.
- The needle is then passed through the left corner in the same fashion as on the right hand side to emerge below the incision on the left side.
- When the sutures are in place, the assistant bimanually compresses the uterus while the chromic catgut sutures are pulled tightly by the surgeon. Another assistant/nurse is asked to look for any continuing vaginal bleeding.
- Some surgeons modify this technique by placing separate sutures over the main compression sutures in order to anchor it properly over the uterine fundus and prevent it from slipping.

This method has been found to be safe and effective and there have been reports of successful pregnancy following its use.[13] A few complications, such as uterine ischemic necrosis with peritonitis, have been described with its use.[14,15]

Hypogastric Artery Ligation

Bilateral ligation of internal iliac vessels was first performed by Kelly in 1894.[16] Appreciable reduction in the amount of bleeding can be achieved by the ligation of internal iliac vessels.[15,17] The procedure, however, is technically difficult and may be successful only in 50% of cases in whom it is performed. This method causes nearly 85% reduction in



Figs 13.6A to C: B-Lynch suture: (A) Anterior view; (B) Posterior view; (C) Anterior view
Source: B-Lynch C, Coker A, Lawal AH, et al. The B-Lynch surgical technique for the control of massive postpartum hemorrhage: an alternative to hysterectomy? Five cases reported. Br J Obstet Gynaecol. 1997 Mar;104(3):372-5.

pulse pressure in the arteries distal to the point of ligation.[17] This procedure helps in accomplishing hemostasis via the process of simple clot formation. This is a highly effective method for controlling PPH which is indicated in cases of PPH due to uterine atony, ruptured uterus and placenta accreta. This method also helps in preserving fertility of women desiring pregnancy in future.[18]

Procedure

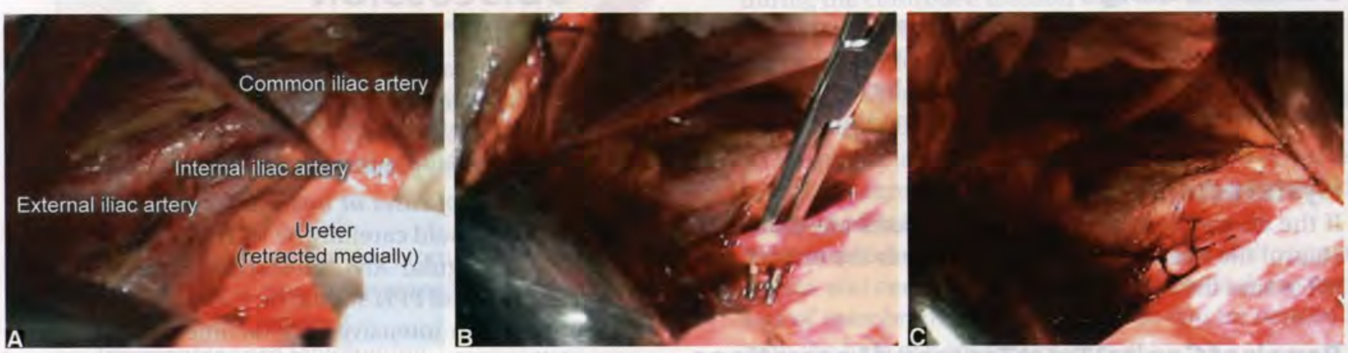
- The peritoneum between the fallopian tube and the round ligament is incised to enter the retroperitoneal space.
- The common, internal and external iliac arteries must then be clearly identified.
- The external iliac artery on the pelvic side wall is identified and followed proximally until the bifurcation of common iliac artery. The ureter passes over the bifurcation of common iliac artery.
- The ureter must be identified and reflected medially along with the attached peritoneum.
- The peritoneum is opened over the common iliac vessels and dissection is continued for approximately 5 cm from the point of origin (i.e. the level of bifurcation of common iliac vessels). This site is ideal for ligation because the posterior division arises within 3 cm of the bifurcation and the ligature must be placed distal to the posterior division of the artery in order to reduce the risk of subsequent ischemic buttock pain.
- Following the dissection of the peritoneum over the internal iliac artery, a blunt-tipped, right angled clamp is gently placed around the hypogastric artery, 5.0 cm distal to the bifurcation of the common iliac artery (Figs 13.7A to C). The surgeon must pass the tip of the clamp from lateral to medial side under the artery in order to prevent injuries to the underlying hypogastric vein.
- The hypogastric artery is double-ligated with non-absorbable sutures (1-0 silk or No. 2 chromic catgut) at two sites 1 cm apart. For this, a nonabsorbable suture is inserted into the open clamp, the jaws are locked and the suture is carried around the vessel. The vessel is then securely ligated. The vessel, however, must not be divided.
- The ligation is also performed on the contralateral side in the same manner.
- Following the ligation, the dorsalis pedis and femoral vessels must be palpated to ensure that external or common iliac arteries have not been inadvertently ligated.

Uterine Artery Ligation

Since approximately 90% of the blood supply to the uterus is via the uterine artery, ligation of this vessel through the uterine wall at the level of uterine isthmus above the bladder flap is likely to control the amount of bleeding. If despite of bilateral ligation of uterine vessels bleeding remains uncontrollable, ligation of utero-ovarian anastamosis is done just below the ovarian ligament (Fig. 13.8).[19] However, this method may not prove useful to control bleeding in case of placenta previa or rupture uterus. Bilateral ligation of the uterine vessels has not been observed to interfere with future reproduction.

Procedure

- The uterus is grasped and tilted in order to expose the blood vessels coursing through the broad ligament immediately adjacent to the uterus.
- The most common site of ligation is 2 cm below the level of transverse lower uterine incision site.
- While taking the stitch, maximum amount of myometrial thickness must be included in order to ensure complete occlusion of the artery and vein.
- The needle is then placed through an avascular portion of the broad ligament and tied anteriorly.
- There is no need for opening the broad ligament and the uterine artery ligation must be performed bilaterally.
- Following the ligation of uterine artery, ligation of the cervical branch must also be performed.
- For this, subsequent stitches are placed 2–3 cm below the initial stitches, following bladder mobilization.
- After the ligation of the cervical branch, the ligation of the ovarian branch may be also performed if the surgeon feels its requirement.



Figs 13.7A to C: Internal iliac artery ligation: (A) Dissection of the retroperioneal tissues to identify the internal iliac artery; (B) Placement of Mixter's forceps around the internal iliac artery; (C) Ligation of the internal iliac artery

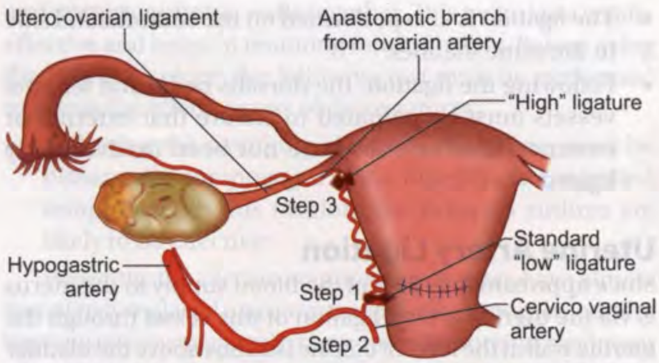


Fig. 13.8: Stepwise uterine devascularization: Step 1: Unilateral or bilateral ligature of uterine artery; step 2: unilateral or bilateral ligature of descending branch of uterine artery (cervicovaginal artery); step 3: unilateral or bilateral ligature of the anastomosis from ovarian artery

Selective Arterial Embolization

Nowadays, a commonly used alternative to uterine artery or internal iliac artery ligation is selective angiographic arterial embolization of a single bleeding vessel or embolization of the anterior divisions of internal iliac artery, if source is bilateral, with gelatin sponge or metallic platinum tufted coils.[20] The process involves selective occlusion of both the hypogastric vessels with small pledgets of gelfoam. Gelfoam acts as a selective occluding agent which dissolves within 2–3 weeks. In this method, ligation material, such as gelatin foam or polyvinyl alcohol, can also be injected through the internal iliac vessels (Figs 13.9A and B). This method has been found to be particularly useful in cases of retroperitoneal hematomas where surgery may be difficult. Success rate of up to 95% has been reported with this method. Though this method has been found to be generally safe, secondary amenorrhea has been reported following this method due to necrosis of the uterine wall and obliteration of the uterine cavity.[21] Complications associated with the procedure include local hematoma formation at the insertion site, infection, ischemic reaction and dye-related side effects.

Uterine Packing

Packing of the uterine cavity can be considered in women with refractory PPH due to uterine atony who want to preserve their fertility. However, it can be associated with complications such as concealed bleeding and infection.[22,23]

Hysterectomy

If the above-mentioned surgical options are unable to control the hemorrhage, hysterectomy is the only choice left to save the woman's life.[24]

Repair of Genital Tract Tears and Lacerations

Presence of tears and lacerations in the genital tract is an important cause for continued bleeding following the birth of the baby. The method of repair for such tears and lacerations is described in Chapter 14 (Repair of Perineal Injuries).

POSTOPERATIVE CARE

Following the surgery, the patient's vital signs must be observed initially at 15–30 minutes intervals and later at hourly intervals until she has stabilized. She must also be observed for any continuing bleeding. A hematocrit, including hemoglobin levels must be ordered to evaluate the requirement of blood transfusion. The patient may require blood transfusion in case her hemoglobin level is less than 8 gm%.

ADVANTAGES

The conservative surgical procedures for PPH help in alleviating major surgery, such as hysterectomy, thereby retaining childbearing function.

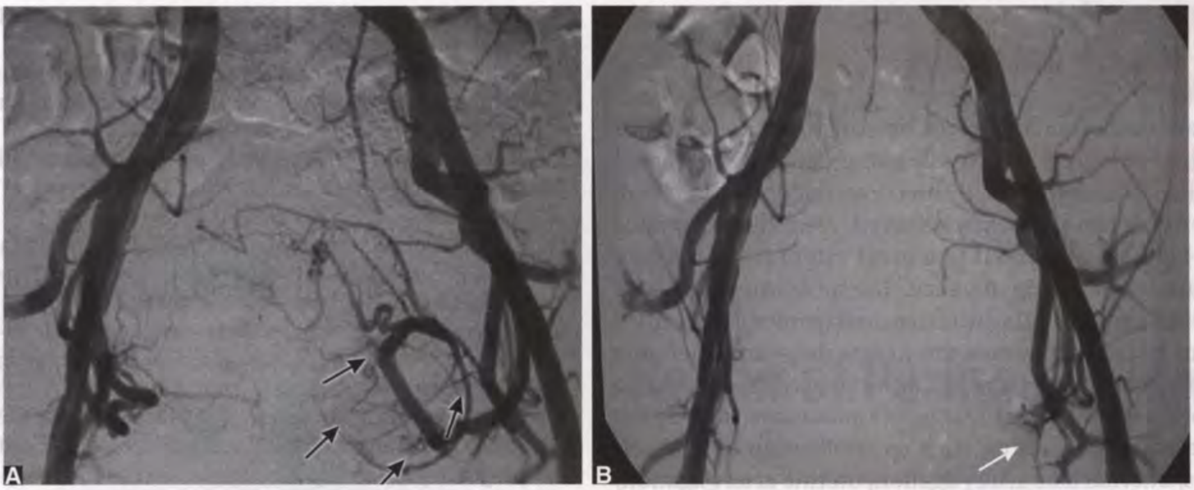
COMPLICATIONS

Postpartum hemorrhage is one of the important causes of maternal morbidity and mortality. Some of the complications related to PPH include the following: blood loss resulting in shock, DIC; septicemia and death; renal failure; puerperal sepsis; failure of lactation; blood transfusion reaction; thromboembolism; Sheehan's syndrome; hypovolemic shock; puerperal shock and multiple organ failure associated with circulatory collapse and decreased organ perfusion. If PPH becomes uncontrollable and life-threatening, there may be a need for emergency surgical intervention including hysterectomy and loss of childbearing potential.

DISCUSSION

As is commonly said that prevention is better than cure, steps must be taken by the obstetricians to prevent the occurrence of PPH, starting right from the antenatal period. Some of the steps for preventing PPH are described below:

- *Identification of cases at high risk of developing PPH*: Such cases should carefully be identified and assessed during the regular ANC checkups. All women with significant risk of PPH should be managed at a hospital equipped with intensive care facilities and access to specialist services. Facilities for rapid transportation of the patient to the nearest hospital at the earliest must be available.



Figs 13.9A and B: Uterine artery embolization (UAE): (A) Pelvic angiogram before uterine artery embolization; (B) Pelvic angiogram after UAE showing absence of large vessels (indicated by a white arrow)

- *Identification of anemia in the antenatal period*: Since anemia is an important risk factor contributing to the mortality and morbidity related to PPH, it should be diagnosed and treated as soon as possible in the antenatal period itself.
- *Active management of third stage of labor*: Perhaps the most important step which must routinely be used in the third stage for prevention of PPH is the active management of third stage of labor.[25] Active management of labor comprises of the following steps:
  - Administration of an uterotonic drug, usually 0.25 mg of methergine or ergometrine 0.2 mg soon after the delivery of the anterior shoulder and/or oxytocin 10 IU within 1 minute of the birth of the baby.
  - Clamping the cord as soon as it stops pulsating
  - Uterine massage
  - Controlled cord traction or Brandt-Andrews maneuver to deliver the placenta.

Controlled Cord Traction

The procedure of controlled cord traction is shown in Figure 13.10 and comprises of the following steps:

- The cord must be clamped as close to the perineum as possible.
- The clinician must look for the signs of placental separation.
- Some of the signs of placental separation are as follows:
  - Appearance of a suprapubic bulge due to hardening and contracting of uterus. This is usually the first sign to appear.
  - Sudden gush of blood
  - A rise in the height of the uterus (as observed over the abdomen) due to the passage of placenta to the lower uterine segment
  - Irreversible cord lengthening.
- Once these above-mentioned signs of placental separation occur, the clinician must hold the cord with the right hand and place the left hand over the mother's abdomen just above the pubic bone.

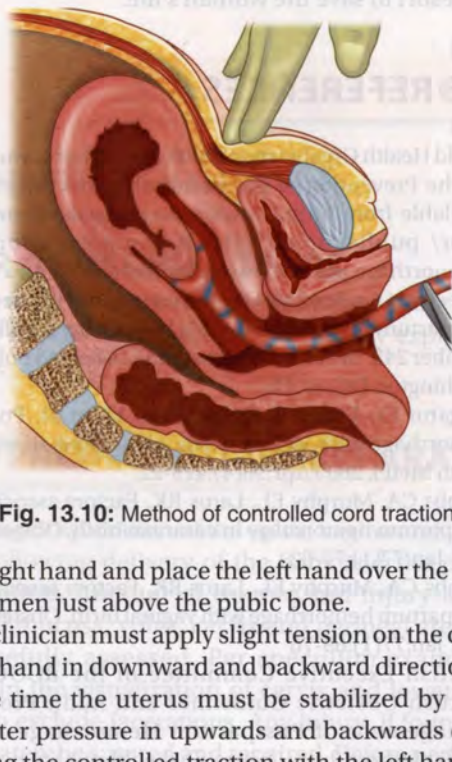


Fig. 13.10: Method of controlled cord traction

- The clinician must apply slight tension on the cord with right hand in downward and backward direction. At the same time the uterus must be stabilized by applying counter pressure in upwards and backwards direction during the controlled traction with the left hand.
- The mother should be encouraged to push with the uterine contractions.
- The cord should never be pulled without applying counter traction above the pubic bone.
- As the placenta delivers, it should be held in two hands and gently turned, until the membranes are twisted and stripped off intact from the uterine wall.
- If the membranes tear, gentle examination of the upper vagina and cervix must be carried out to look for torn bits of membrane. These, if present, can be removed with the help of a sponge forceps.
- The entire placenta and membranes must be examined carefully to look for any missing lobe/membrane bit.

CONCLUSION

Postpartum hemorrhage can be considered as a major obstetric emergency and a leading cause of maternal mortality and morbidity. If the correct actions are taken, mother's life can frequently be saved. Also the occurrence of PPH can be prevented to a great extent if appropriate steps are taken well in advance. The most important step for prevention of PPH is the active management of the third stage of labor. Sometimes the hemorrhage may become so profuse and severe that laparotomy may be required to control the bleeding. At the time of laparotomy, initially the conservative procedures, such as application of B-Lynch sutures, internal iliac artery ligation, uterine artery ligation, uterine artery embolization, etc., may be required. If nothing seems to work, hysterectomy may be required as the last resort to save the woman's life.

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14

CHAPTER

Repair of Perineal Injuries

INTRODUCTION

PERINEAL INJURY

Perineal injury can be defined as the injury, which occurs to the perineum, during the process of childbirth. Perineal and vaginal tears can commonly occur at the time of vaginal deliveries. The perineal injury can be classified into the following degrees (Figs 14.1A to D):[1]

- *First degree:* Injury to the vaginal mucosa not involving the perineal muscles
- *Second degree:* Injury to the perineum involving the perineal muscles, but not the anal sphincters
- *Third degree:* Injury to the perineum involving the anal sphincter complex (external and internal anal sphincter):
  - *3a:* Less than 50% of external anal sphincter is torn
  - *3b:* More than 50% of external anal sphincter is torn
  - *3c:* Internal anal sphincter also gets involved.
- *Fourth degree:* Injury to the perineum involving the anal sphincter complex (external and internal anal sphincters) and rectal mucosa.

OVERVIEW OF SURGERY

Adequate repair of perineal and vaginal tears is important not only to avoid immediate morbidity due to blood loss and hemorrhage but also long-term morbidity. Anal incontinence is likely to occur in nearly 40% of women following vaginal delivery.

AIMS OF SURGERY

The aims of surgery are as follows:

- Restoration of the pelvic and perineal anatomy as far as possible
- Prevention of immediate as well as long-term morbidity.

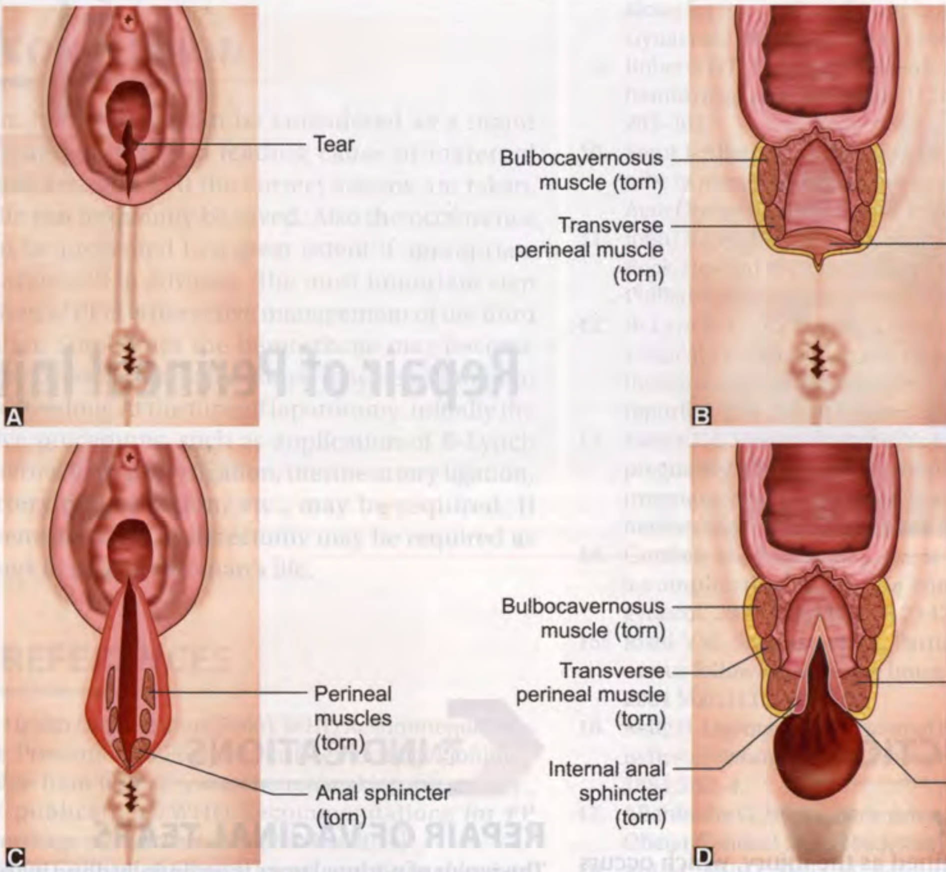
INDICATIONS

REPAIR OF VAGINAL TEARS

The repair of perineal tears is essentially done in the manner similar to that of an episiotomy previously explained in Chapter 9.

PREOPERATIVE PREPARATION

- Thorough exploration of the vulva, vagina and perineal area following delivery of the baby and the placenta is required. Amount of trauma and injury over the vaginal mucosa, vulva, cervix and perineal areas must be carefully assessed. Per speculum examination helps in the visualization of cervix and lower genital tract to exclude lacerations. Any injury, if found, must adequately be sutured and repaired. Before performing the repair, the perineum along with the site of incision must be well swabbed with an antiseptic solution.
- Endoanal ultrasound using high frequency (10 MHz) can be considered as the best imaging modality for the diagnosis of perineal trauma.[2]
- In case of deep tears, involvement of anal sphincters must also be assessed by placing a gloved finger in the anus and gently lifting it. The tightness or tone of the sphincter must also be assessed. If there is no tear in the sphincters, one must proceed with the suturing of vaginal tears. Small first-degree tears that are not actively bleeding may be left without being sutured.
- Under all aseptic precautions after cleaning and draping the perineum, the proposed site of repair is infiltrated



Figs 14.1A to D: (A) First-degree perineal tear involving only the vaginal mucosa and not the perineal muscles; (B) Second-degree perineal tear involving the perineal muscles as well; (C) Third-degree perineal tear involving the anal sphincter complex; (D) Fourth-degree perineal tear involving the rectal mucosa as well

with 10 mL of 1% lignocaine solution. Anesthesia in the form of nerve blocks or local injections of anesthetic drug is given if the patient has not received regional anesthesia (e.g. epidural anesthesia) for the delivery. If proper visualization of lower genital tract does not appear to be possible, it may be necessary to take the woman to theater for examination under anesthesia.

- While performing the repair of the vaginal or cervical tears, the patient must be placed in lithotomy position, with a good source of light from behind.
- The obstetrician must ensure that adequate assistance and instruments are also available in order to provide adequate exposure of the genital tract.

SURGICAL STEPS

REPAIR OF VAGINAL TEARS

The steps for repair of vaginal tears are as follows:

- Any tear in the vaginal mucosa is sutured with 2-0 Vicryl Rapide or chromic catgut sutures with the help of continuous stitches. The first stitch must be taken 1 cm above the apex of tear in the vaginal mucosal tissue. This stitch is particularly important because if apex is not securely closed it can be associated with continuing bleeding or a vulvar hematoma.
- Perineal muscles are approximated with 2-0 chromic catgut sutures with the help of interrupted stitches.
- Skin is closed with the help of interrupted mattress sutures using silk or subcuticular stitches.
- At the end of vaginal tear repair, a per rectal examination may be performed to ensure that no stitches have been taken through the rectal mucosa.

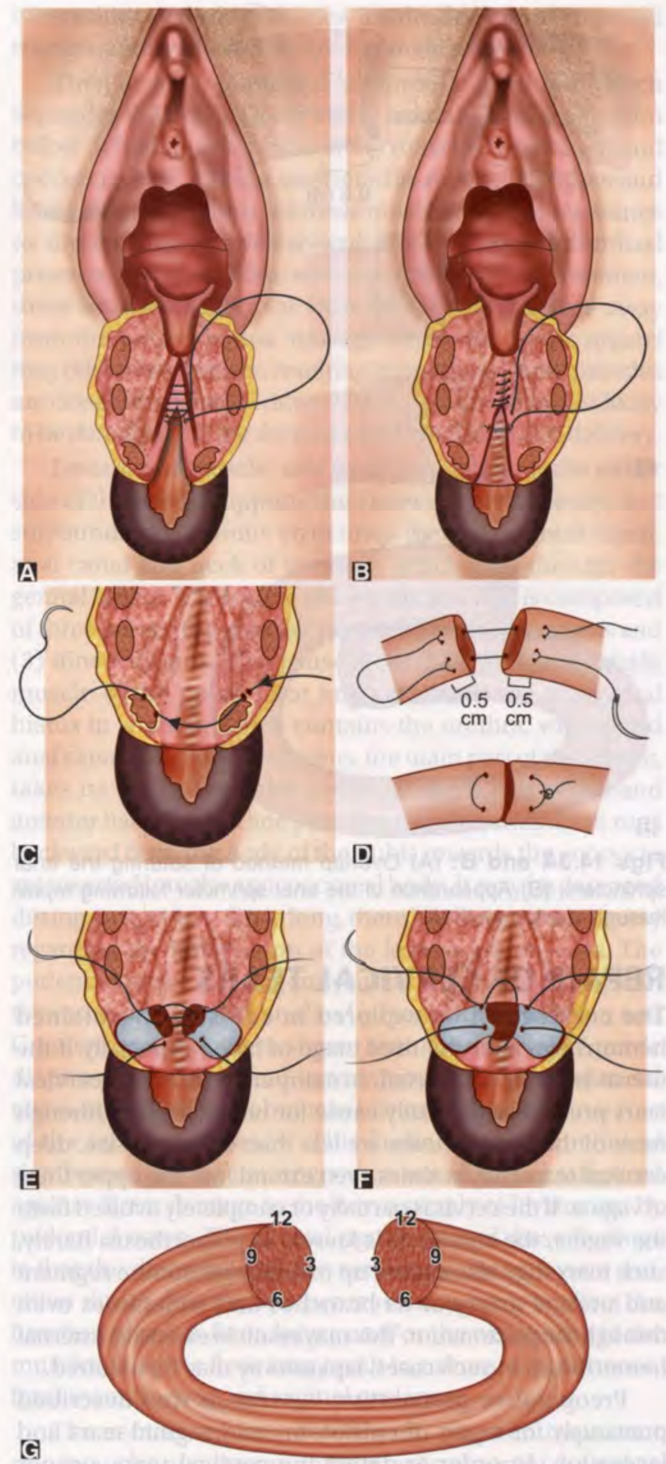
REPAIR OF A FOURTH-DEGREE LACERATION

In case of lacerations, the steps for repair are essentially the same as that of an episiotomy except in the cases of third-degree and fourth-degree lacerations where there might be an extension up to the anal sphincters and rectal mucosa respectively.[3,4] The preoperative preparation is the same as that described for episiotomy before.

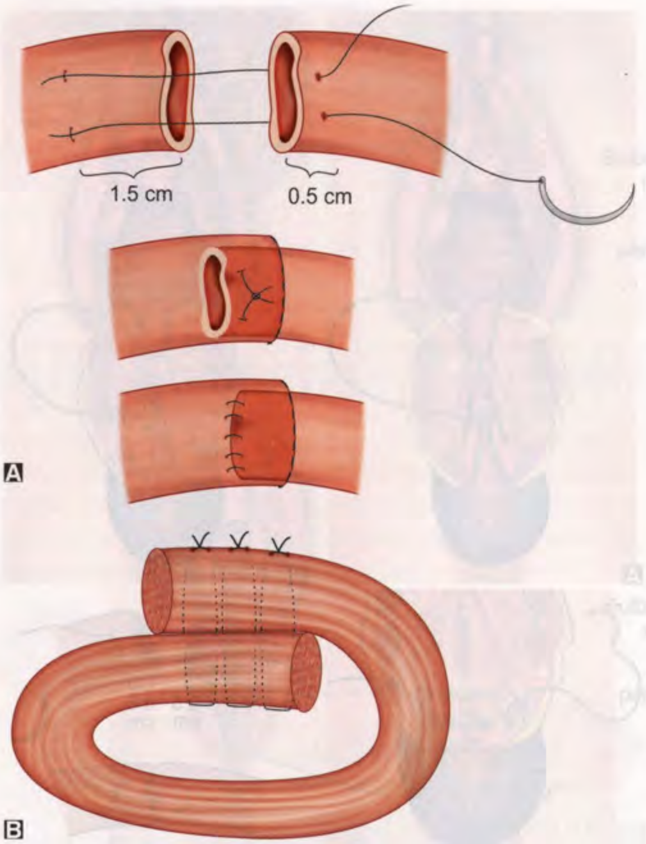
- In case of injury to the anal sphincters and rectal mucosa, the area is well irrigated with saline and antiseptic solution. The most experienced obstetrician available must be called.

- Prophylactic antibiotics are administered prior to the repair.
- In case of fourth-degree laceration, it is important to approximate the torn edges of the anorectal mucosa with fine absorbable sutures.
- Approximation of the anorectal mucosa and submucosa is done using 3-0 or 4-0 chromic catgut or Vicryl sutures in a running or an interrupted manner (Fig. 14.2A). Sutures are preferably placed in the muscularis avoiding the mucosa.
- The superior extent of the anterior anal laceration is identified and sutures are placed through the submucosa of the anorectum starting above the apex of the tear and extending down until the anal verge.
- A second layer of sutures is placed through rectal muscularis using 3-0 Vicryl or catgut sutures in a running or interrupted fashion (Fig. 14.2B). This layer of sutures acts as a reinforcing layer and incorporates the anal sphincter at the distal end.
- Finally, the torn edges of the anal sphincter are isolated, approximated and sutured together with 3 or 4 interrupted stitches using 3-0 Vicryl sutures. The anal sphincters need to be repaired in case of fourth-degree tears as well as some third-degree tears. The internal anal sphincter is identified as the thickening of the circular smooth muscle layer at the distal 2–3 cm of the anal canal. It appears as the glistening white fibrous structure lying between the anal canal submucosa and the fibers of external anal sphincter. In case the internal anal sphincters have retracted laterally, they need to be sought and brought together after holding them with Allis forceps.
- Following the repair of internal anal sphincters, the torn edges of external anal sphincters are identified and grasped with Allis clamp. The repair of these sphincters can be performed either using end-to-end repair (Figs 14.2C to G) or the overlap method (Figs 14.3 A and B).[5,6] For end-to-end approximation of the external anal sphincters, 4–6 simple interrupted sutures using 2-0 or 3-0 Vicryl are placed through the edges of external anal sphincter and its connective tissue capsule at 3, 6, 9 and 12 O'clock positions. The sutures are first placed through the inferior and posterior portions of the sphincter; these stitches are tied last in order to facilitate the repair. The overlap method involves taking two sets of sutures: the first row of sutures is taken 1.5 cm from the edge on one side and 0.5 cm on the other side in such a way that when the sutures are tied, the free ends overlap one another. The free end is then sutured to the rest of the sphincter. The overlap method was considered to be superior to the end-to-end method as it was thought to be associated with fewer postoperative complications such as fecal urgency and anal incontinence.[7]

The remainder of repair is same as that described for an episiotomy (refer to Chapter 9).



Figs 14.2A to G: (A) Approximation of anorectal mucosa and submucosa using continuous sutures; (B) Second layer of sutures placed through the rectal muscularis; (C) End-to-end approximation of the external anal sphincter. Sutures being placed through the posterior wall of external anal sphincters (these would be tied in the end); (D) Close-up view of the external anal sphincters showing end-to-end approximation; (E) End-to-end sutures taken through the interior of external anal sphincter (shown in whitish blue); (F) Approximation of the anterior wall of external anal sphincter; (G) Appearance of the anal sphincter following repair through end-to-end method



Figs 14.3A and B: (A) Overlap method of suturing the anal sphincters; (B) Appearance of the anal sphincter following repair through overlap method

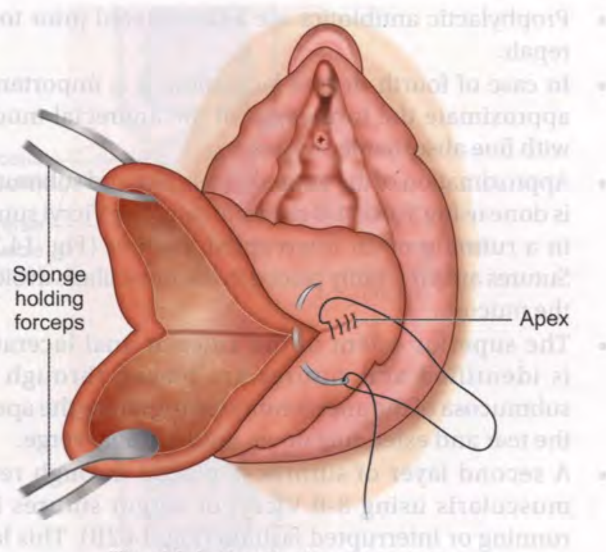


Fig. 14.4: Repair of a cervical tear

REPAIR OF CERVICAL TEARS

The cervix must be explored in cases of unexplained hemorrhage after the third stage of labor, especially if the uterus is firmly contracted. In many cases, the deep cervical tears present as the likely cause for hemorrhage. Although most of the cervical tears are less than 0.5 cm in size, deep cervical tears may at times even extend into the upper third of vagina. If the cervix is partially or completely avulsed from the vagina, the condition is known as colporrhexis. Rarely, such tears may also extend up to the lower uterine segment and uterine artery or its branches and sometimes even through the peritoneum. This may result in extensive external hemorrhage. In such cases, laparotomy may be required.

Preoperative preparation is same as that described previously for repair of episiotomy and vaginal tears and laceration. In order to detect the cervical tears, proper visualization and visual inspection of the cervix is essential. An assistant must be asked to apply firm pressure in the downwards direction over the uterus, while the surgeon must exert downwards traction on the lip of cervix with the help of sponge holding forceps. The procedure of repair comprises of the following steps (Fig. 14.4):

- Direct visualization and inspection of the cervix is done using three sponge holding forceps. The anterior lip of cervix is grasped with one forceps at 12 O'clock position, the second forceps is placed at 2 O'clock position and the third one is placed at 4 O'clock position. The position of these three forceps is progressively changed, i.e. the first forceps is placed at 2 O'clock position, second one is placed at 4 O'clock position and third one at 6 O'clock position.
- The changes in the position of forceps are done until the entire cervical circumference has been inspected. Small, nonbleeding lacerations of the cervix can be left unsutured. Lesions larger than 2 cm in size or those with a bleeding vessel need to be sutured.
- The lacerations can be stitched with the help of continuous interlocking chromic catgut sutures.
- The stitch must begin 1 cm above the apex of the tear. If the apex cannot be visualized, gentle traction must be applied to bring the apex into the view. The stitch must be placed as high as possible.
- After stitching the laceration, the obstetrician must look for any continuing bleeding. Pressure or packing over the area of repair may help in achieving hemostasis.

POSTOPERATIVE CARE

CARE OF A FOURTH-DEGREE LACERATION

The postoperative steps are essentially the same as those described for an episiotomy. Due to the involvement of anal sphincters and rectal mucosa, additional steps may be required, which are described as follows:

- In case of fourth-degree tears where the injury has extended until the rectal mucosa, the patient should be prescribed stool softeners for about a week or two. In these cases, the use of enemas must be avoided.
- Immediately following the surgery, the patient must be advised to take liquid diet for a day and then gradually convert to low-residue diet over a few days.

- Vaginal/rectal examination and sexual intercourse must be avoided for at least 2 weeks following the repair.
- Prophylactic oral antibiotics such as ampicillin (500 mg) and metronidazole (400 mg) must be administered before starting the procedure.[8]
- Daily follow-up is required to look for any evidence of wound infection. Rectal or vaginal examination must not be performed for approximately 2 weeks after the surgery until the healing is complete.

COMPLICATIONS

Perineal injury can be associated with extensions or tears into the muscle of the rectum or even the rectum itself. Some of the complications, which are likely to occur as a result of perineal injuries are as follows:

- *Bleeding*: There may be continuing bleeding which may or may not be accompanied by a hematoma formation. In case a hematoma is observed, the repair has to be opened and hematoma drained.
- Wound breakdown
- Infection
- *Perineal pain*: While a slight amount of pain which gets relieved on taking pain killers is a common occurrence with an episiotomy, persistent severe pain at the episiotomy site could be an indicator of presence of a large vulvar, paravaginal or ischiorectal hematoma, thereby necessitating a thorough exploration in these cases. There may be an accompanying superficial dyspareunia.
- Extension of the episiotomy into third- and fourth-degree vaginal lacerations
- Longer healing times
- Increased discomfort when intercourse is resumed
- Swelling
- *Persistence of incontinence*: Continuing fecal incontinence for 6 or more months calls for a repeat surgery. In order to restore sphincteric function and muscle bulk, augmented biofeedback physiotherapy can be done.
- *Abnormal signs of tissue healing*: Abnormal signs of tissue healing in the form of perineal granulation tissue, skin bridges, atrophy, localized scarring, etc. may be visible. In these cases, localized injection of corticosteroids or hyaluronidase may prove to be helpful.

DISCUSSION

ANATOMICAL CONSIDERATIONS

Perineum is a diamond-shaped aperture corresponding to the pelvic outlet. It is bounded on the anterior side by pubic symphysis, coccyx on the posterior side and ischial tuberosities on the lateral sides. It is divided into a urogenital triangle anteriorly and an anal triangle posteriorly.

The pelvic diaphragm is a muscular partition, which separates the pelvic cavity above from the perineal region below. It mainly comprises of the muscles, levator ani and coccygei, along with the associated fascia on their upper and lower aspects.[9,10] Together these muscles provide resistance to the continuous downward force of intraabdominal pressure. Acting together with the muscles of the abdomen, these muscles deflect the direction of this pressure away from the genital hiatus, through which the pelvic organs may otherwise descent, resulting in prolapse. These muscles are closely associated with pelvic viscera and are most likely to be damaged during the process of childbirth and delivery.

Levator ani muscle, one each is situated on the either side of the pelvis, supports the viscera in pelvic cavity, and surrounds the various structures (cervix, vaginal canal, anal canal and neck of urethra), which pass through the genital hiatus. The levator ani is a muscle that is composed of three parts: (1) pubococcygeus, (2) ischiococcygeus and (3) iliococcygeus. This muscle complex forms the main muscle of the pelvic floor and surrounds the urogenital hiatus in women, which contains the urethra, vagina and anal canal. The pubococcygeus, the main part of the levator, takes its origin from the posterior surface of pubis and anterior half of fascial line over obturator internus and it runs backward from the body of the pubis towards the coccyx to get inserted into the anococcygeal body. It may be damaged during parturition. Since long, there has been a controversy regarding the innervation of the levator ani muscles. The pudendal nerve arises from ventral division of S2 to S4 in the sacral pleuxes. The studies by Frenckner, and Euler; and Guaderrama et al. have shown that the muscles of pelvic diaphragm receive dual innervation from the pudendal nerve as well as direct branches from S3 and S4 nerve root of the sacral plexuses.[11,12] This finding is of great clinical significance as this dual innervation would act as a safeguard against direct damage to the nerve supply of levator ani by pudendal nerve. The clinical significance of these findings is that the damage to all the nerves supplying levator ani, either due to delivery or other reasons, is likely to affect the function of pelvic floor. Injury and/or the weakening of the muscles of pelvic floor may result in urinary incontinence, fecal incontinence and vaginal prolapse.

The central tendon of perineum plays an important role in anchoring the musculofascial support of the pelvic floor. Central tendon of the perineum is formed by the convergence of tendinous attachments of the following: bulbocavernosus, external anal sphincter and the superficial transverse perineal muscles. Tearing or stretching of the central tendon during delivery is likely to cause damage to the support of posterior vaginal wall, resulting in anal incontinence or anal prolapse.

Both internal and external anal sphincters help in maintaining anal continence. External anal sphincter has three parts, which have no distinct separation from each other. These parts are:

1. Subcutaneous part having no bony attachment
2. *Superficial oval part*: Fibers arise from the coccyx and anococcygeal ligament and pass anteriorly around the anus to get inserted into the perineal body.
3. *Deep part*: The muscle fibers arise from the perineal body and after encircling the lower half of anal canal, they get fused with the puborectalis.

Internal anal sphincter, which is involuntary, is formed by the smooth muscles of the rectum. It is innervated by the sympathetic fibers from the presacral ganglia (L5) and parasympathetic fibers from sacral segments (S2 to S4).

At the time of vaginal delivery, the vaginal introitus either stretches beyond its elastic capacity or expands too quickly. The tissues thus tend to tear resulting in perineal trauma. Anal incontinence, on the other hand, can occur due to the disruption of sphincter muscles, traction neuropathy of the pudendal nerve or a combination of both.

RISK FACTORS

Various obstetric risk factors responsible for the occurrence of vaginal tears are as follows:[13-18]

- *Vaginal delivery*: Vaginal deliveries, specifically instrumental vaginal deliveries (irrespective of the fact whether an episiotomy was given or not) may be associated with the occurrence of vaginal tears.
- *Epidural analgesia*: Due to prolongation of the second stage of labor, there is an increased requirement for episiotomy and instrumental delivery in women who have received epidural analgesia. This may result in an increased risk of perineal trauma.
- *Parity*: Primiparas are more at risk of perineal trauma in comparison to multigravidas.
- *Episiotomy*: Initially, episiotomies were introduced to prevent damage to the pelvic floor. However, evidence till date shows that a midline episiotomy is likely to place the sphincter at an increased risk for injury. Presently, there is no scientific justification for the use of episiotomy. An appropriately placed mediolateral episiotomy may, however, cause fewer tears.
- *Other intrapartum risk factors*: Other intrapartum risk factors include macrosomia (weight > 4 kg), shoulder dystocia, occipitoposterior positions, history of third-degree tears in previous deliveries and prolonged second stage of labor.

EFFECT OF THE CHILDBIRTH ON THE PELVIC FLOOR MUSCLES

Tearing and separation of the muscles of pelvic floor at the time of vaginal delivery weaken the pelvic floor and widen the genital hiatus. The medial fibers of pubococcygeal muscle are most commonly injured. These muscles can be strengthened through voluntary contractions in the form of perineal or Kegel exercises. Vaginal delivery can also cause injury to the pudendal nerve as described below:

- *Neurological compromise*: Stretching and compression of pudendal nerve occurs during labor as the baby's head travels through the birth canal. This compromise to the pudendal nerve is most intense during the second stage of labor, during vaginal delivery.[13]
- *Muscular impairment*: Extreme stretching of the pelvic floor tissue is inherent during the process of labor and vaginal delivery.

CONCLUSION

There is occurrence of the injuries to the perineum at the time of vaginal delivery especially in cases of instrumental delivery and/or the use of midline episiotomy. Repair of the perineal injuries especially those related to the injuries to the anal sphincter can help in considerably reducing morbidity related to the development of fecal incontinence or hemorrhage. Typically in case of lacerations involving the anal sphincter complex, special attention must be given towards maintaining the anatomical integrity. Employing proper technique for surgical repair is also important.

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15 CHAPTER

Manual Removal of Placenta

INTRODUCTION

In normal cases, the mean time from delivery until placental expulsion is approximately 8–9 minutes. Longer intervals for placental delivery are associated with an increased risk of postpartum hemorrhage (PPH), with rate doubling after 10 minutes.[1] In a majority of patients, the placenta may have completely separated within a few minutes after the delivery of the baby. It may, however, not be able to deliver outside the uterine cavity. The most common cause for this is uterine atony, contraction of cervix or misconduct of the third stage of labor. In these cases, manual removal of the placenta may be required. If the procedure is delayed, it may result in intractable bleeding and hemorrhage. For detailed management regarding primary PPH, refer to Chapter 13 (Surgical Interventions for Control of Postpartum Hemorrhage). Even in the absence of any continuing bleeding, the surgeon must not wait for more than half an hour before attempting the manual removal of placenta. However, in the presence of continuing bleeding or in cases where bleeding from the uterus exceeds 400 mL, the obstetrician must immediately proceed with the surgery.

OVERVIEW OF SURGERY

This chapter would focus on the surgical maneuvers to be performed when the placenta has not yet delivered. The surgical maneuvers for controlling PPH, when the placenta has delivered, have already been discussed in Chapter 13.

AIMS OF SURGERY

The aim of surgery in these cases is to facilitate the delivery of the placenta. Possible causes of placental adhesion, when it remains undelivered outside the uterine cavity are enumerated in Flow Chart 15.1.

In case of simple adherent placenta, manual removal of the placenta is the most suitable option to facilitate the placental delivery. However, in cases of pathologically adherent placenta (placenta accreta, placenta increta or placenta percreta), it may not be possible to find the correct cleavage plane between the placenta and the uterine musculature and therefore it may become impossible to manually remove the placenta. In these cases, other surgical procedures are performed in order to control any potential PPH.

INDICATIONS

Manual removal of placenta may be required in the following conditions.[2]

SIMPLE PLACENTAL RETENTION

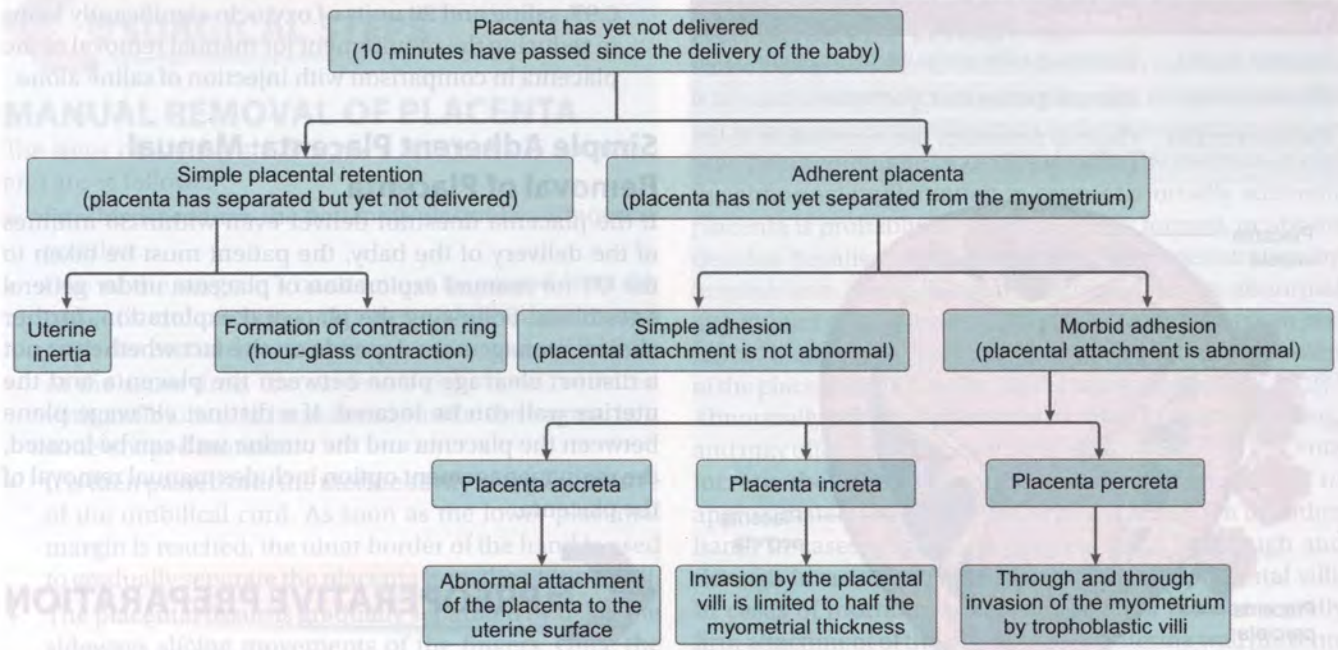
In these cases, placenta has separated out, but has not yet expelled out. This could be due to the following conditions:

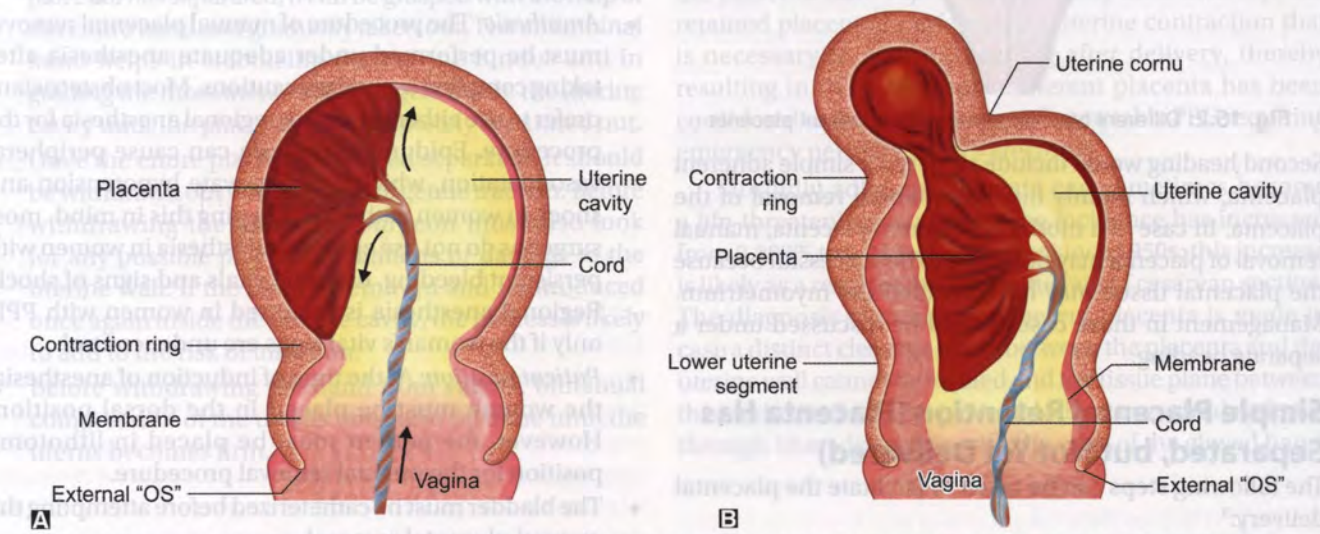
- *Uterine inertia*
- *Uterine atony*: In these cases, the uterine contractions are too feeble to facilitate placental delivery. Some of the reasons for this could be: mismanaged third stage of labor, formation of constriction ring (hour-ring contraction), bicornuate uterus, etc. (Figs 15.1A and B).

PLACENTAL SEPARATION HAS NOT OCCURRED

If the placenta has yet not separated, the condition is known as an adherent placenta. Adherent placenta could be due to

Flow Chart 15.1: Possible causes of placental adhesion when it remains undelivered





Figs 15.1A and B: Simple placental retention due to the formation of contraction ring: (A) Contraction ring below the placenta; (B) Contraction ring in upper segment

two causes: (1) simple adhesion and (2) morbid adhesion. In case of simple adhesion, although the placenta remains attached to the uterine wall, the placental attachments are not abnormal. In case of morbid adhesion, the placental attachment is definitely abnormal with chorionic villi being attached directly to the uterine muscle. This condition commonly occurs due to the deficiency of deciduas basalis because of which the uterine musculature is exposed to the invasion by trophoblasts and chorionic villi. This condition is especially rare in cases of normal placental position. However, it is more common in cases of placenta previa. Morbidly adherent placenta can be of three types: (1) placenta accreta, (2) placenta increta and (3) placenta percreta. These different types are briefly described in the Table 15.1 and Figure 15.2.

If within half an hour in the third stage of labor, the signs of placental separation and descent of placenta does not occur, the condition must be termed as retained placenta. In that case, urgent measures must be taken to facilitate its delivery. Surgical procedures for adherent placenta would be discussed under two headings: first heading would describe management in cases of simple retention, where the placenta has separated, but not yet delivered. In this case, signs of placental separation would be clinically apparent.

Table 15.1: Types of adherent placenta

Classification	Description
Placenta accreta	Placenta is adherent to the myometrium
Placenta increta	Placenta invades the myometrium
Placenta percreta	Placenta penetrates the myometrium to or beyond the serosa

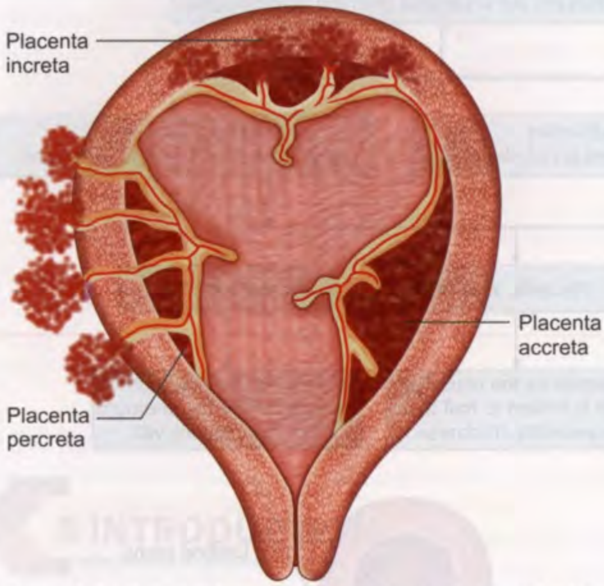


Fig. 15.2: Different types of abnormally adherent placenta

Second heading would include surgery for simple adherent placenta, which mainly involves manual removal of the placenta. In case of a morbidly adherent placenta, manual removal of placenta may not prove to be successful because the placental tissue may have invaded the myometrium. Management in those cases would be discussed under a separate heading.

Simple Placental Retention (Placenta Has Separated, but Not Yet Delivered)

The following steps can be taken to facilitate the placental delivery:[3]

- A maternal uterine massage must be performed to expel any clots.
- The dose of oxytocics can be repeated, e.g. syntocinon 10 IU intravenous or 10 IU intramuscular. Ergometrine/ Syntometrine must be avoided for retained placenta because they may cause tonic uterine contractions, which may delay expulsion.
- The urinary bladder must be emptied by catheterizing, if it has previously not been done.
- Controlled cord traction must be repeated to deliver the placenta.
- If possible, ultrasound scan must be done to see if the placenta is still in the upper segment or whether it has separated and is in the lower segment of the uterus.
- If the placenta appears to be in trapped in the lower uterine segment, a vaginal examination must be performed to remove the placenta and other clots.
- Injection of the umbilical vein with 20 mL solution of 0.9% saline and 20 units of oxytocin significantly helps in reducing the requirement for manual removal of the placenta in comparison with injection of saline alone.

Simple Adherent Placenta: Manual Removal of Placenta

If the placenta does not deliver even within 30 minutes of the delivery of the baby, the patient must be taken to the OT for manual exploration of placenta under general anesthesia. Following the placental exploration, further clinical management depends on the fact whether or not a distinct cleavage plane between the placenta and the uterine wall can be located. If a distinct cleavage plane between the placenta and the uterine wall can be located, the main management option includes manual removal of the placenta.

PREOPERATIVE PREPARATION

The preoperative care comprises of the following steps:

- *Anesthesia*: The procedure of manual placental removal must be performed under adequate anesthesia after taking complete aseptic precautions. Most obstetricians prefer to use either general or regional anesthesia for the procedure. Epidural anesthesia can cause peripheral vasodilatation, which can aggravate hypotension and shock in women with PPH. Keeping this in mind, most surgeons do not use epidural anesthesia in women with persistent bleeding, unstable vitals and signs of shock. Regional anesthesia is preferred in women with PPH only if the woman's vital signs are under control.
- *Patient position*: At the time of induction of anesthesia, the woman must be placed in the dorsal position. However, the patient must be placed in lithotomy position for the manual removal procedure.
- The bladder must be catheterized before attempting the manual placental removal.
- Maternal vital signs must be assessed and, if unstable, immediate steps must be taken to bring them under control.
- Four units of blood must be arranged especially if woman is having PPH.
- Two wide-bore IV cannulae must be inserted and immediate resuscitation with crystalloids started.
- A broad spectrum antibiotic must be administered to the patient.
- An informed consent must be taken from the patient before starting the procedure.
- Under all aseptic precautions, vulva and vagina are swabbed with antiseptic solution and the patient is cleaned and draped with sterile towels. The operator should wear fresh sterile long cuffed gloves and a sterile gown, while observing all aseptic precautions.

SURGICAL STEPS

MANUAL REMOVAL OF PLACENTA

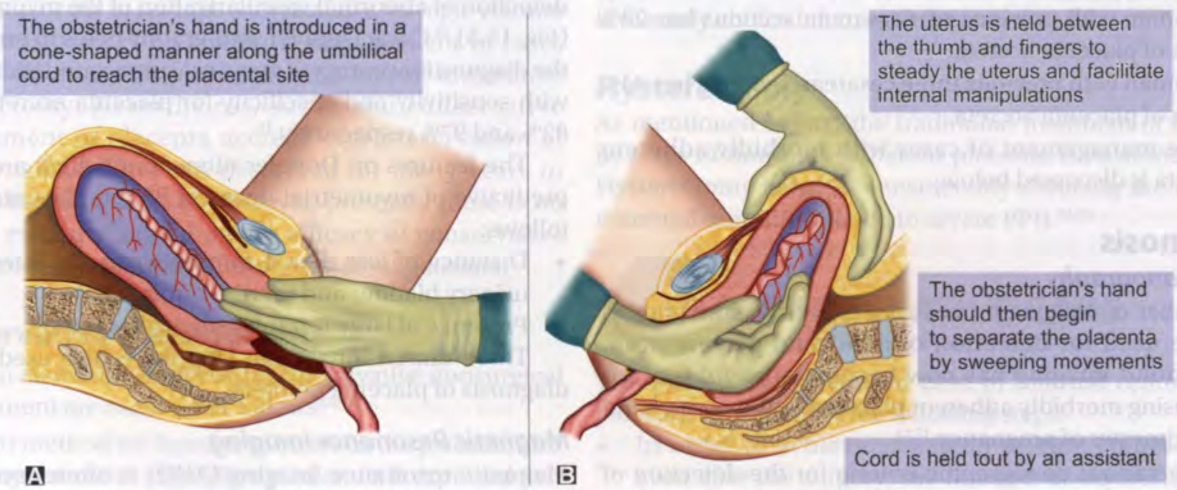
The steps of surgery are described in Figures 15.3A and B and are as follows:[2,3]

- For the procedure, the patient is placed in a lithotomy position.
- One of the surgeon's hands must be placed over the patient's abdomen in order to steady the fundus and push the uterus downwards.
- At the same time, the surgeon's right hand, smeared with antibiotics, is introduced inside the vagina in a cone-shaped manner.
- It is then passed into the uterine cavity along the course of the umbilical cord. As soon as the lower placental margin is reached, the ulnar border of the hand is used to gradually separate the placenta from the uterine wall.
- The placental tissue is gradually separated by using the sideways slicing movements of the fingers. Once the placenta has separated, it can be grasped with the help of the entire hand and gradually taken out. The abdominal hand helps in stabilizing the uterine fundus and in guiding the movements of the fingers inside the uterine cavity until the placenta has completely separated out.
- Once the entire placenta has been separated, it should be withdrawn out with the help of gentle traction. Before withdrawing the hand, the surgeon must also look for any possible placental remnants or damage to the uterine wall. If the hand is removed and reintroduced once again inside the uterine cavity, the process is likely to add to the risk of infection.
- Before withdrawing the hand from vagina, bimanual compression of the uterus must also be done until the uterus becomes firm.

MANAGEMENT OF MORBIDLY ADHERENT PLACENTA

Pathological adherence of the placenta to the myometrium is termed as morbidly adherent placenta. In these cases, the anchoring placental villi attach to the myometrium, rather than being contained by decidual cells. The mechanism for the abnormal implantation in cases of morbidly adherent placenta is probably due to thin, poorly formed, or absent decidua basalis that does not resist deep penetration by trophoblasts. While the term "accreta" refers to abnormal attachment of the placenta to the uterine myometrium, the terms "increta" and "percreta" refer to much deeper invasion of the placental villi into the uterine musculature (Fig. 15.2).[4] Abnormally adherent placenta can result in severe bleeding, and may often require cesarean hysterectomy.[5,6] In placenta increta, the invasion by the placental villi is limited to approximately half the myometrial thickness. On the other hand, in cases of placenta percreta there is through and through invasion of the uterine wall by the placental villi. In cases of morbidly adherent placenta, the abnormally firm attachment of the placenta to the uterine wall prevents the placenta from separating normally after delivery. The retained placenta interferes with uterine contraction that is necessary to control bleeding after delivery, thereby resulting in PPH. Morbidly adherent placenta has been considered as the leading cause of intractable PPH requiring emergency peripartum hysterectomy.

Morbidly adherent placenta can sometimes become a life-threatening condition. The incidence has increased from 0.003% to 0.04% of deliveries since 1950s; this increase is likely as a result of the rise in the rate of cesarean section. The diagnosis of morbidly adherent placenta is made in case a distinct cleavage plane between the placenta and the uterine wall cannot be located and the tissue plane between the uterine wall and the placental edge cannot be developed through blunt dissection with the edge of the gloved hand.



Figs 15.3A and B: Procedure of manual removal of the placenta

Fig. 15.4: Abdominal sonography at 27 weeks' gestation. The normal hypoechogenic retroplacental zone (clear space) is reduced in thickness (upper part X). The hyperechoic uterine serosa bladder interface is interrupted (<). Note also the prominent lacunar vascular spaces. The final diagnosis established following hysterectomy was that of placenta percreta (B: Bladder; P: Placenta)

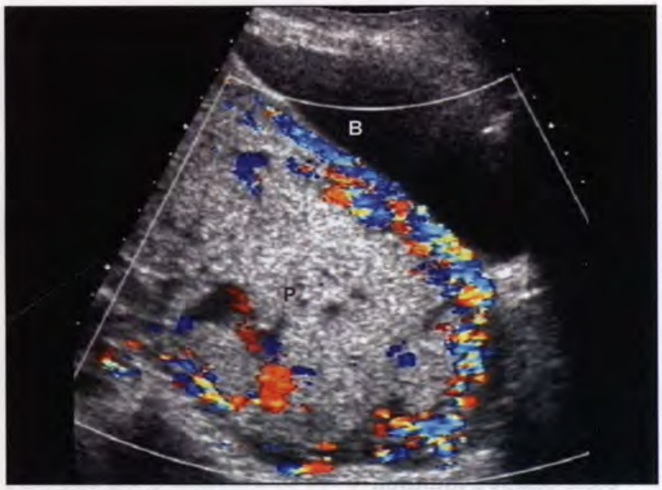


Fig. 15.5: Color Doppler scanning at 27 weeks' gestation in a case of placenta percreta demonstrating prominent placental vessels extending across the myometrium into the bladder wall (B: Bladder; P: Placenta)

Several risk factors for placenta accreta have been identified.[7-11] Among these, the most important one appears to be placenta previa. In patients with placenta previa the incidence of placenta accreta appears to correlate with the number of previous cesarean sections. Maternal age over 35 years also increases the risk of accreta. Other reported risk factors include multiple previous pregnancies, previous uterine surgery and previous dilation and curettage procedure. Although, the exact mechanism behind the association of placenta previa with previous scar is poorly understood, it may be due to reduced differential growth of the lower segment resulting in reduced upward shift in placental position with increasing gestation. In a patient with a previous cesarean section and a placenta previa, the risk of placenta accreta is dependent upon the number of previous cesarean sections as follows:[10]

- Woman with previous one cesarean section has 14% risk of placenta accreta.
- Woman with previous two cesarean sections has 24% risk of placenta accreta.
- Woman with previous three cesarean sections has 44% risk of placenta accreta.

The management of cases with morbidly adherent placenta is discussed below.

Diagnosis

Ultrasonography

A number of imaging procedures, especially sonography, can be used for detection of abnormal placentation. Ultrasound imaging has now become a useful tool for diagnosing morbidly adherent placenta in the second and third trimester of pregnancy.[12,13]

The various sonographic criteria for the detection of morbidly adherent placenta are as follows (Fig. 15.4):[14]

- Absence of a normal, hypodense retroplacental myometric zone.
- A reduced surface area between uterine serosa and urinary bladder.
- The presence of focal exophytic masses with the same echogenicity as placenta beyond the uterine serosa.
- Presence of unusual, prominent, lacunar vascular spaces within the placental parenchyma.

Prenatal ultrasound has been reported to have a sensitivity of 94% and specificity of 79% for diagnosis of cases of placenta accreta.[14]

Color Doppler

Doppler sonography has been found to be quite sensitive for the detection of placenta accreta. Ultrasonography, especially with color flow Doppler, serves as a useful investigation in making a prenatal diagnosis of placenta accreta because Doppler sonography can help in detection of abnormal vascularization of the myometrium (Fig. 15.5).[15] Color Doppler sonography helps in improving the diagnostic accuracy of gray-scale ultrasound techniques, with sensitivity and specificity for placenta accreta being 82% and 97% respectively.[15]

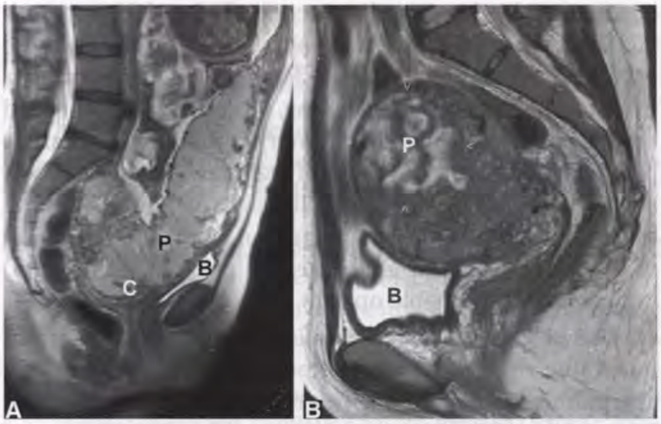
The features on Doppler ultrasound which are highly predictive of myometrial invasion by the placenta are as follows:

- Distance of less than 1 mm between the interface of urinary bladder and uterine serosa.
- Presence of large intraplacental lakes.

Three-dimensional color Doppler is also used for the diagnosis of placenta percreta.

Magnetic Resonance Imaging

Magnetic resonance imaging (MRI) is often used as an adjunct to sonography in cases with strong clinical suspicion



Figs 15.6A and B: (A) MRI of the patient with placenta percreta at 27 weeks' gestation (P: Placenta; C: Cervix; B: Bladder); (B) MRI of placenta increta at 10 days postpartum. Axial T2-weighted MRI demonstrates a retained placental mass as well as focal thinning of the fundus (P: Placenta; B: Bladder)

of placenta accreta. The MRI findings which help in the diagnosis of placenta accreta include the following:[16-20]

- Uterine bulging
- Heterogeneous signal intensity within the placenta
- Presence of dark intraplacental bands on T2 imaging.

Being a costly investigation, MRI is usually used as a supplementary diagnostic procedure in cases where the placenta cannot adequately be assessed by sonography and where there is an increased risk of abnormal placentation[21-23] (Figs 15.6A and B).

Management

When placenta accreta is anticipated, consultant anesthetic and consultant obstetrician need to discuss the plan of delivery.[24] Hysterectomy may sometimes be required in cases undergoing conservative management as a result of delayed hemorrhage.[25] Therefore, the consent for cesarean hysterectomy must be taken well in advance. Delivery should involve specialized multidisciplinary personnel and should occur in settings with facilities for high-volume blood transfusion.[26-29] Traditional management in cases of morbidly adherent placenta comprises of immediate hysterectomy. Nevertheless, successful conservative management of placenta accreta with preservation of the uterus has also been described for many years in certain clinical scenarios. However, presently there is no definite evidence regarding the efficacy of conservative management in cases of morbidly adherent placenta.

Conservative Management

The main elements of successful conservative nonsurgical management are outlined as follows:[30-32]

- In this method the fused area between the placenta and the myometrium is not disrupted and it is expected that bleeding will be minimal.
- In case of densely adherent placenta, the clinician must not try to remove any nonadherent portions of the placenta.
- The cord can be trimmed.
- The patient's vital signs and amount of bleeding should closely be observed.
- Since leaving the placenta in situ may result in infections, antibiotics should be administered.
- Since leaving the placental tissue in situ may also result in the development of uterine hypotonia, administration of oxytocin infusion can help in maintaining uterine contractions.
- In the woman who is stable, hysterectomy may be avoided by the use of methotrexate.

With conservative management, varied other therapeutic options are used including prophylactic or therapeutic uterine artery embolization and internal iliac artery ligation at the same time as initial surgery. Intramuscular methotrexate injections following the delivery of the baby is supposed to cause degeneration of the remnant placental tissues.[33-35] However, this method must be critically considered because many researchers[36-39] have reported high failure rate and extensive morbidity in association with the methotrexate therapy.

Surgical Management

If the bleeding remains uncontrolled despite of using conservative management, the following surgical options can be used:[40-54]

- Balloon catheter occlusion of the iliac vessels
- Uterine artery embolization
- Low and high bilateral uterine vessel ligation
- Ligation of internal iliac arteries.

These various methods have been discussed in details in Chapter 13 (Surgical Interventions for Control of Postpartum Hemorrhage). If the above-mentioned surgical options are unable to control the hemorrhage, hysterectomy is the only choice left to save the woman's life.

Hysterectomy

As mentioned before, the traditional treatment of choice in cases of morbidly adherent placenta is hysterectomy. Hysterectomy helps in considerably reducing the risk of maternal mortality related to severe PPH.[55,56]

POSTOPERATIVE CARE

The postoperative care in case of manual removal of placenta comprises of the following steps:

- In order to achieve sustained uterine contractions even after the surgery, the infusion of oxytocics must be continued.

- Intramuscular methergine/ergometrine 0.5 mg must be administered following the completion of the procedure.
- Blood transfusion may be required depending upon the patient's requirement.
- Broad spectrum antibiotics must be administered to the patient.
- An informed consent must be taken from the patient before starting the procedure.
- Postoperatively, charting of the following parameters must be done: vital signs, input-output charting, evidence of fresh bleeding, etc.

COMPLICATIONS

The following complications are likely to occur as a result of the procedure of manual removal:

- Perforation/uterine rupture
- Incomplete placental removal
- Hemorrhage
- *Infection*: In spite of strict aseptic precautions during the procedure, some uterine infection is inevitable; therefore a wide spectrum antibiotic cover must be provided for at least 5 days postoperatively
- Secondary PPH
- *Increased risk of Rh isoimmunization*: Manual removal of placenta should be preferably avoided in situations where potential isoimmunization can occur.

DISCUSSION

In normal cases, the placental separation is supposed to occur in two ways: (1) Schultze's method (central separation) or (2) Matthew-Duncan method (peripheral separation). Once the placental separation has occurred, the placenta is naturally forced down by recurring uterine contractions and retractions. The various signs of placental separation have been described previously in Chapter 13 (Surgical Interventions for Control of Postpartum Hemorrhage).

ANESTHESIA TECHNIQUE

Regional versus General Anesthesia

The procedure of manual removal of placenta can be either performed under general or regional anesthesia. However, in case of emergency, the procedure can be at times carried out under a pudendal block or even without using any anesthesia at all.

Since both epidural and subarachnoid anesthesia can cause peripheral vasodilation, they are likely to worsen hypotension and shock in women with PPH. Therefore, such regional anesthesia must be carefully used or best avoided in women with massive hemorrhage. The use of regional anesthesia in women with PPH presently remains controversial. When bleeding is controlled and the woman's vital signs are stable, it is acceptable to carefully institute epidural or spinal anesthesia. However, if the woman is experiencing persistent bleeding, which is not controlled by pharmacologic agents and uterine massage or there is presence of signs of shock, use of regional anesthesia is best avoided. In women with stable vital signs, where an epidural block was administered at the time of labor, augmentation of the block to provide uterine analgesia (T8-T10 level) appears to be a sensible option.

Use of general anesthesia is associated with certain inevitable risks, such as unexpected difficult intubation and pulmonary aspiration. This risk is further compounded by the delayed gastric emptying, resulting from the use of narcotic analgesia during labor. However, one advantage of using general anesthesia is the tocolytic effect of volatile anesthetic agents, which might facilitate adequate uterine exploration in cases of retained placenta. Therefore, the obstetrician must choose the appropriate anesthesia technique by weighing the immediate and remote risks against the benefits.

CONCLUSION

In earlier days, manual removal of placenta was considered very rarely in cases of failed placental delivery. However, nowadays with the advent of more effective antibiotics and advancements in the field of anesthesia, the procedure is more freely used. Immediate manual removal after delivery must not be performed as a routine procedure. In absence of significant bleeding and patient's stable vital signs, the surgeon must wait for at least half an hour before proceeding with the manual removal. However, an exception can be made to this rule in cases where intrauterine exploration is indicated (e.g. vaginal delivery after a previous cesarean section, version and extraction).

Morbidly adherent placenta is a pregnancy-related complication, which can be life-threatening for both mother and fetus. Three forms of morbidly adherent placenta have been identified: (1) placenta accreta, (2) placenta increta and (3) placenta percreta. In these cases, as a result of inadequate development of the decidua, there is an abnormal connection between the trophoblast and the myometrium. As a result, the condition can result in severe life-threatening hemorrhage. A timely diagnosis of morbidly adherent placenta is therefore of great importance for both mother and infant. The clinician should always remain aware regarding the correlation between placenta previa and abnormal placentation. In cases of suspicion, an exact diagnostic work-up especially sonography must be undertaken. It is then possible to plan therapy that in most cases comprises of hysterectomy. Hysterectomy helps in avoiding life threatening complications such as PPH.

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CHAPTER 16

Shoulder Dystocia

INTRODUCTION

Shoulder dystocia can be defined as the inability to deliver the fetal shoulders after the delivery of the fetal head without the aid of specific maneuvers (other than the gentle downward traction on the head).[1] The chances for the occurrence of shoulder dystocia are high when the diameter of the fetal shoulders (bisacromial diameter) is relatively larger than the biparietal diameter of fetal head. Shoulder dystocia occurs as a result of disproportion between the bisacromial diameter of the fetus and the anteroposterior diameter of the pelvic inlet, which causes impaction of the anterior shoulder behind the symphysis pubis.

Shoulder dystocia can occur both during a normal vaginal delivery or an assisted instrumental (ventouse or forceps) delivery. Shoulder dystocia occurs in about 0.5% births and can be of two types: (1) high shoulder dystocia and (2) the low shoulder dystocia.[2] Low shoulder dystocia results due to the failure of engagement of the anterior shoulder and impaction of anterior shoulder over the maternal symphysis pubis. This type of the shoulder dystocia is also known as unilateral shoulder dystocia. This is the more common type and is easily dealt with using standard techniques. There can be a high perinatal mortality and morbidity associated with this complication and therefore it needs to be managed appropriately. Since it is difficult to predict shoulder dystocia or prevent its occurrence, all the obstetricians must be well-versed with its management. Although not exactly involving obstetric surgery, the condition and its management are explained in details in this chapter because it is an important obstetric emergency, which must be managed within minutes in order to avoid any significant maternal and fetal complications.

OVERVIEW

Risk Factors

Shoulder dystocia is a largely unpredictable and unpreventable event as a large majority of cases occur in the children or women with no risk factors. Moreover, ultrasound prediction of fetal weight may be grossly inaccurate. However, the clinicians must be aware of existing risk factors and remain alert regarding the possibility of shoulder dystocia with any delivery.

Some important risk factors associated with occurrence of shoulder dystocia are listed in Table 16.1.[3-5] Maternal history of diabetes mellitus is considered as an important risk factor for the development of shoulder dystocia.[6] The American Congress of Obstetricians and Gynecologists (ACOG) has recommended that an estimated fetal weight of over 4.5 kg should be considered as an indication for delivery by cesarean section in order to reduce the potential morbidity and mortality in pregnancies complicated with

Table 16.1: Risk factors for shoulder dystocia

Prelabor factors	Intrapartum factors
• Previous history of shoulder dystocia • Macrosomia • Diabetes mellitus • Maternal body mass index > 30 kg/m² • Multiparity	• Prolonged first stage of labor • Secondary arrest • Oxytocin augmentation • Prolonged second stage of labor • Failure of descent of the head • Increased rate of assisted vaginal delivery

maternal diabetes mellitus.[7] Shoulder dystocia has been observed to recur in about 1–16% cases.

Diagnosis

There are two main signs that indicate the presence of shoulder dystocia:[8,9]

1. The baby's body does not emerge out even after the application of routine traction, and maternal pushing following the delivery of baby's head. Routine traction is defined as "the traction required for delivery of the shoulders in a normal vaginal delivery where there is no difficulty with the shoulders". There is also difficulty with the delivery of fetal face and chin.
2. *The "Turtle sign":* The fetal head suddenly retracts back against the mother's perineum after it emerges from the vaginal introitus. The baby's anterior shoulder is caught on the back of the maternal pubic bone, causing retraction of the fetal head and preventing delivery of the remainder of the baby. The baby's cheeks bulge out, resembling a turtle pulling its head back into its shell. There is failure of restitution of the fetal head and the descent of shoulders.

SURGICAL STEPS

Although not exactly involving surgery, various obstetric maneuvers to deal with shoulder dystocia would be described in this chapter.

Management of Shoulder Dystocia

Shoulder dystocia drill should form an important part of training for the junior doctor and the nurses. Drill is a practice run-through of the labor and delivery team for a simulated case of shoulder dystocia. The initial management in the cases of shoulder dystocia has also been summarized by the mnemonic HELPERR, which is described in Table 16.2.[9] The immediate steps which need to be taken in case of an anticipated or a recognized case of shoulder dystocia are described next:

Table 16.2: Mnemonic for describing initial management in the cases of shoulder dystocia

H	Call for **h**elp
E	Evaluate for **e**pisiotomy
L	**L**egs (the McRoberts maneuver)
P	Suprapubic **p**ressure
E	**E**nter the pelvis maneuvers (internal rotation): such as Rubin II maneuver, Wood's screw maneuver and reverse Wood's screw maneuver
R	**R**emove the posterior arm
R	**R**oll the patient

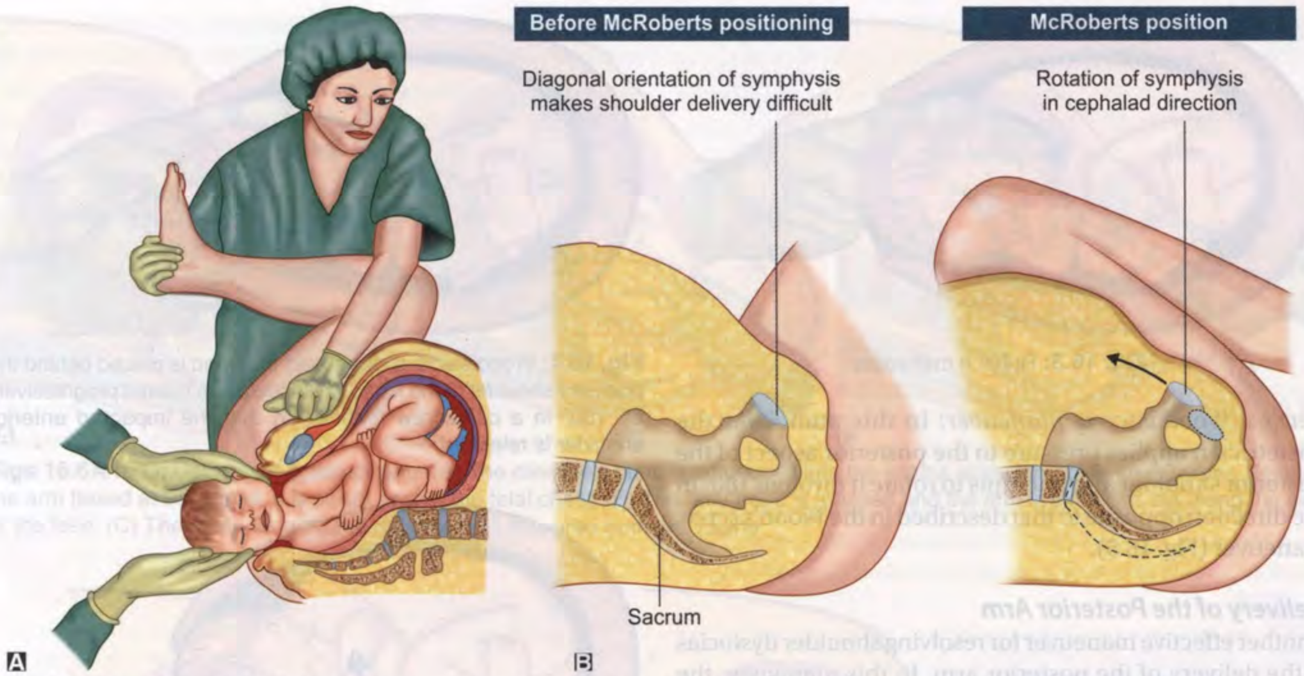
- After recognition of shoulder dystocia, extra help should be summoned immediately. This should include further midwifery assistance, an experienced obstetrician, a pediatric resuscitation team and an anesthetist. One person should be assigned the task of recording the time since the time of onset of dystocia and saying it loud after every 30 seconds.
- As soon as the shoulder dystocia has been identified, maternal pushing and fetal pulling and pivoting should be discouraged, as this may lead to further impaction of the shoulders.
- The woman should be maneuvered to bring her buttocks to the edge of the bed.
- Fundal pressure should not be employed. It is associated with a high rate of neonatal complications and may sometimes even result in uterine rupture.
- Enlarging the episiotomy may facilitate the delivery of shoulders in some cases. However, the routine use of episiotomy is not necessary in all cases. The clinicians should apply their own discretion regarding whether an episiotomy needs to be given or not; or if already given, does it need to be enlarged or not.
- Management of shoulder dystocia needs to be done within 5–7 minutes of the delivery of the fetal head in order to prevent irreversible fetal injury.[10-12]
- After delivery of baby, the clinicians should be alert regarding the possibility of maternal complications such as postpartum hemorrhage and third- and fourth-degree perineal tears. If the above-mentioned steps do not prove to be useful, the following maneuvers can be undertaken.

McRoberts Maneuver

McRoberts maneuver is the single most effective intervention, which is associated with success rate as high as 90% and should be the first maneuver to be performed.[13] Prophylactic McRoberts position may also be recommended in cases where shoulder dystocia is anticipated. The McRoberts maneuver (Figs 16.1A and B) involves sharp flexion and abduction of the maternal hips and positioning the maternal thighs on her abdomen. This maneuver helps in cephalad rotation of the symphysis pubis and the straightening of lumbosacral angle. This maneuver, by straightening the sacrum tends to free the impacted anterior shoulder.[14] In a large number of cases, this maneuver by itself helps to free the impacted anterior shoulder.

Suprapubic Pressure

Suprapubic pressure (also known as Rubin I maneuver) in conjunction with McRoberts maneuver is often all that is required to resolve 50–60% cases of shoulder dystocias. By application of suprapubic pressure, the obstetrician makes an attempt to manually dislodge the anterior shoulder from behind the pubic symphysis. In this maneuver the attendant



Figs 16.1A and B: (A) McRoberts maneuver (exaggerated hyperflexion of the thighs upon the maternal abdomen) and application of suprapubic pressure; (B) McRoberts maneuver causes the pubic symphysis to rotate in cephalad direction and straightening of lumbosacral angle

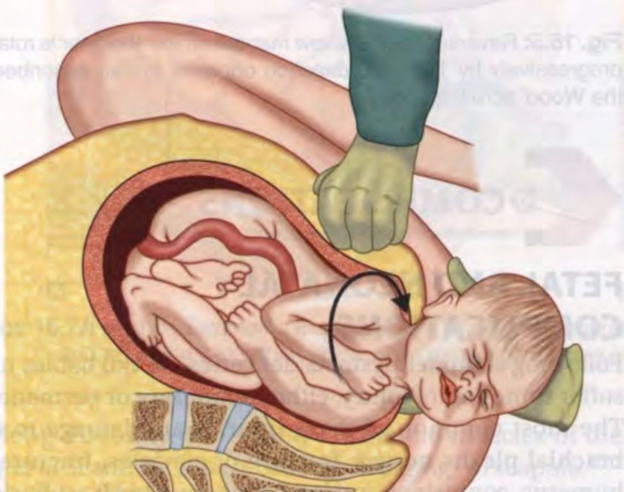


Fig. 16.2: Application of suprapubic pressure in the direction of fetal face

makes a fist and places it just above the maternal pubic bone and pushes in downwards and lateral direction to push the posterior aspect of the anterior shoulder towards the fetal chest for a period of at least 30 seconds (Fig. 16.2). Since shoulder dystocias are caused by an infant's shoulders entering the pelvis in a direct anterior-posterior orientation instead of the more physiologic oblique diameter, pushing the baby's anterior shoulder to one side or the other from above often helps in changing its position to the oblique, which would facilitate its delivery.

If these simple measures (the McRoberts maneuver and suprapubic pressure) fail then a choice needs to be made between the all-four-position and internal manipulation.

Some of the maneuvers for internal manipulation include Wood's screw maneuver, Rubin II maneuver, and reverse Wood's screw maneuver. These maneuvers are more commonly used in comparison to the all-four-position.

Enter the Pelvis Maneuvers[15]

Rubin II maneuver: In this maneuver, the obstetrician inserts the fingers of his/her right hand into the vagina and applies digital pressure on to the posterior aspect of the anterior shoulder (or the most accessible fetal shoulder) making an attempt to push it towards the fetal chest (Fig. 16.3). This rotates the shoulders forward into the more favorable oblique diameter. The delivery is likely to be successful, if attempted, after the application of this maneuver.

Wood's screw maneuver: In this maneuver, the obstetrician's hand is placed behind the posterior shoulder of the fetus (Fig. 16.4). The shoulder is rotated progressively by 180° in a corkscrew manner so that the impacted anterior shoulder is released.

A variation of this is the Rubin II maneuver, which involves pushing on the posterior surface of the posterior shoulder. In addition to the corkscrew effect, pressure on the posterior shoulder has the advantage of flexing the fetal shoulders across the chest. This decreases the distance between the shoulders, thereby reducing the dimension that must come out through the pelvis.

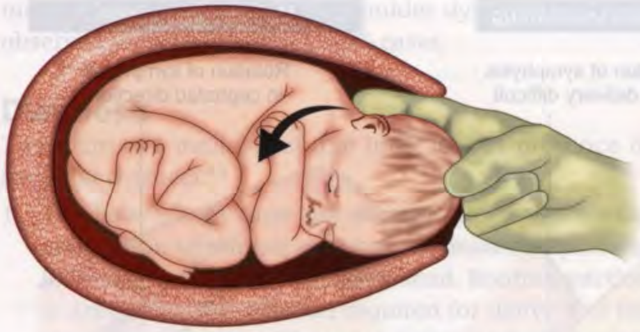


Fig. 16.3: Rubin II maneuver

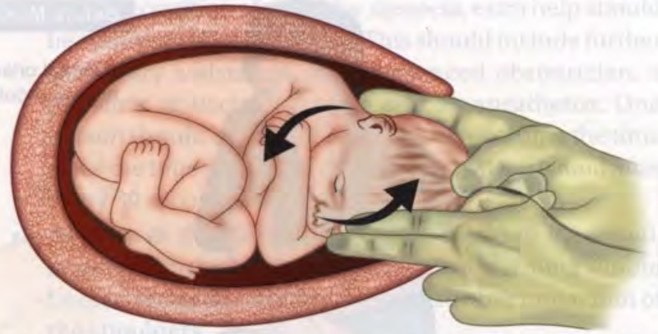


Fig. 16.4: Wood's screw maneuver: the hand is placed behind the posterior shoulder of the fetus. The shoulder is rotated progressively by 180° in a corkscrew manner so that the impacted anterior shoulder is released

Reverse Wood's screw maneuver: In this maneuver the obstetrician applies pressure to the posterior aspect of the posterior shoulder and attempts to rotate it through 180° in the direction opposite to that described in the Wood's screw maneuver (Fig. 16.5).

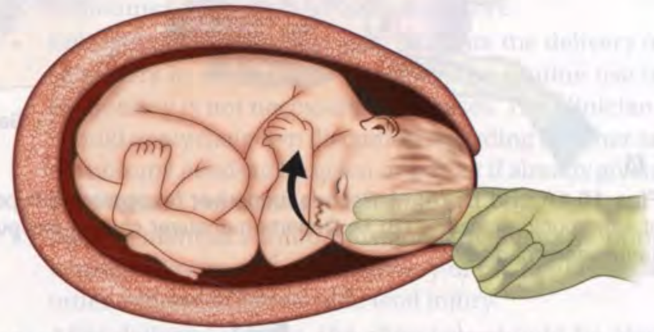


Fig. 16.5: Reverse Wood's screw maneuver: the shoulder is rotated progressively by 180° in a direction opposite to that described in the Wood' screw maneuver

Delivery of the Posterior Arm

Another effective maneuver for resolving shoulder dystocias is the delivery of the posterior arm. In this maneuver, the obstetrician places his/her hand behind the posterior shoulder of the fetus and locates the arm. This arm is then swept across the fetal chest and delivered (Figs 16.6A to C). With the posterior arm and shoulder now delivered, it is relatively easy to rotate the baby, dislodge the anterior shoulder and allow delivery of the remainder of the baby.

All-Four Maneuver[16]

In this maneuver, the patient is instructed to roll over from her existing position and to take a knee chest position on all her four limbs. This allows rotational movement of the sacroiliac joints, resulting in a 1–2 cm increase in the sagittal diameter of the pelvic outlet. This disimpacts the shoulders, allowing them to slide over the sacral promontory.

Third-Line Maneuvers

Several third-line methods have been described for cases, which are resistant to all simple measures. Some of these maneuvers include cleidotomy, symphysiotomy and the Zavanelli maneuver. These maneuvers are rarely employed in today's modern obstetric practice.

Cleidotomy: This involves bending the clavicle with a finger or its surgical division.

Symphysiotomy: This involves surgical division of the symphyseal ligament.[17]

Zavanelli maneuver: The Zavanelli maneuver involves cephalic replacement of the head followed by cesarean section. In this maneuver, firstly the fetal head is rotated back into its prerestitution position, i.e. occiput anterior (Fig. 16.7A). Following this, the head is flexed and pushed back up into the vagina (Fig. 16.7B). Once the fetal head gets back into the pelvis, an emergency cesarean section is performed to deliver a live baby.[18]

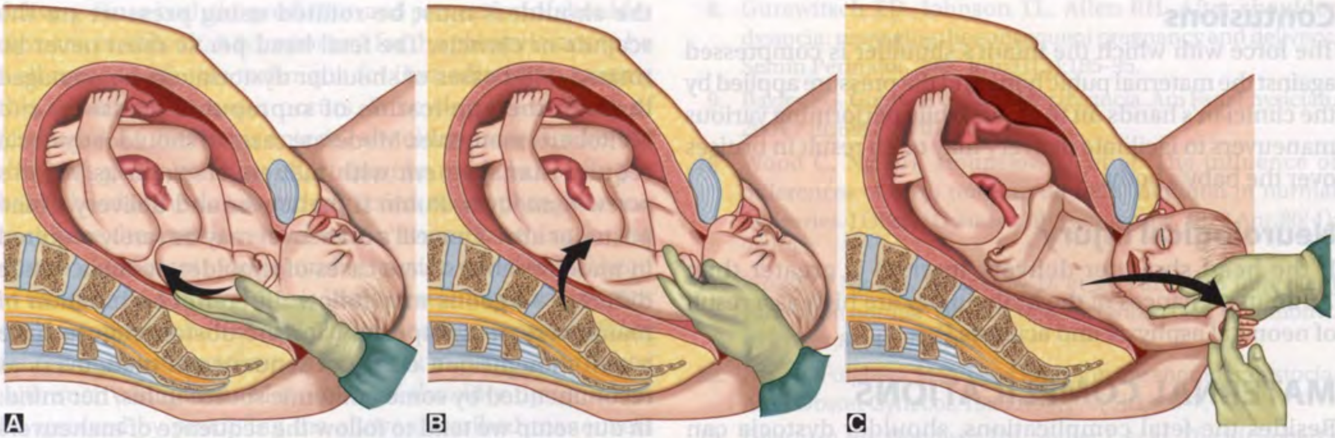
COMPLICATIONS

FETAL AND NEONATAL COMPLICATIONS

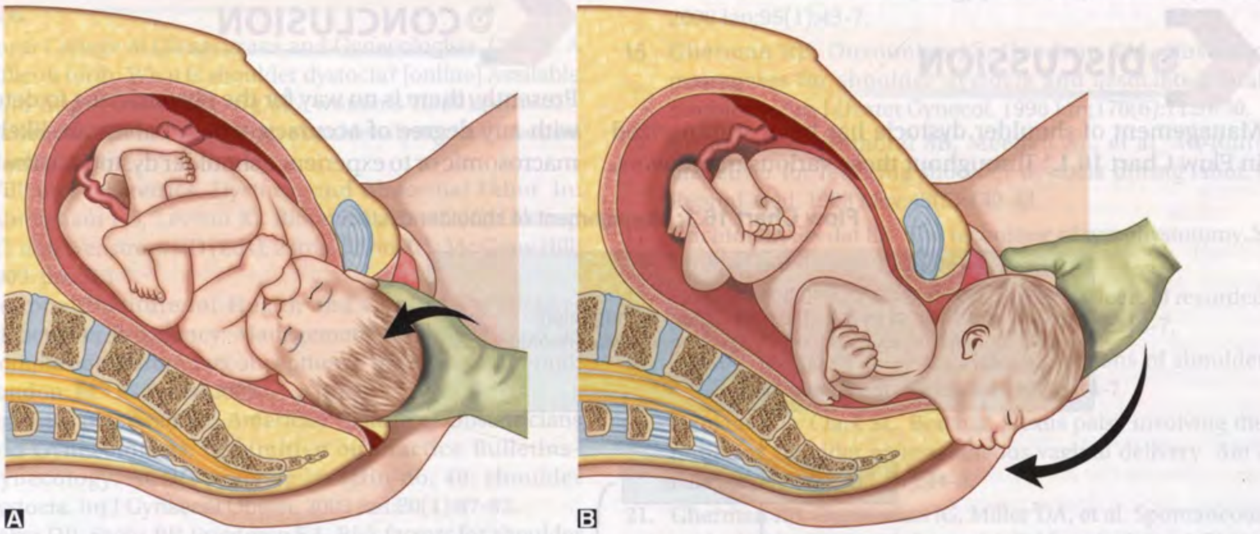
Following shoulder dystocia deliveries, 20% of babies may suffer some sort of injury, either temporary or permanent. The most common of these injuries are damage to the brachial plexus nerves, fracture of clavicles, fracture of humerus, contusions and lacerations and birth asphyxia.[19] Some of the fetal complications resulting due to shoulder dystocia are described next.

Brachial Plexus Injuries[20]

The brachial plexus consists of the nerve roots of spinal cord segments C5, C6, C7, C8 and T1. These nerve roots form three trunks, upper, middle and lower, which further divide into anterior and posterior divisions. The upper trunk is made up of nerves from C5 and C6, the middle trunk from undivided fibers of C7 and the lower most trunk is made up of nerves from C8 and T1. Injury to the upper part of the brachial plexus is called Erb's palsy (C5 to C7) while injury to the lower nerves of the plexus is called Klumpke's palsy (C8 to T1). Both the types of injuries can cause significant,



Figs 16.6A to C: Delivery of posterior arm: (A) The clinician's hand is introduced into the vagina along the posterior shoulder. Keeping the arm flexed at the elbow, it is swept across the fetal chest; (B) The fetal hand is grasped and the arm is extended out along the side of the face; (C) The posterior arm and shoulder are delivered from the vagina



Figs 16.7A and B: Zavanelli's maneuver: (A) The head is manually rotated to occipitoanterior position; (B) Flexion of the fetal head and returning it into the vagina while applying constant pressure. This is followed by an immediate cesarean section

lifelong disability. Erb's palsy affects the muscles of the upper arm and shoulders causing "winging" of scapula.[21,22] Due to impaction of shoulder as a result of shoulder dystocia application of upwards lateral traction on the fetal head results in the stretching of brachial plexus (Fig. 16.8). This type of injury also causes adduction and internal rotation of humerus with the forearm extended. This has also been described as the "waiters tip" position. Klumpke's palsy involves lower trunk lesions from nerve roots C7, C8 and T1. In this injury the elbow becomes flexed and the forearm supinated (opened up, palm upwards) with a characteristic claw-like deformity of the hand.

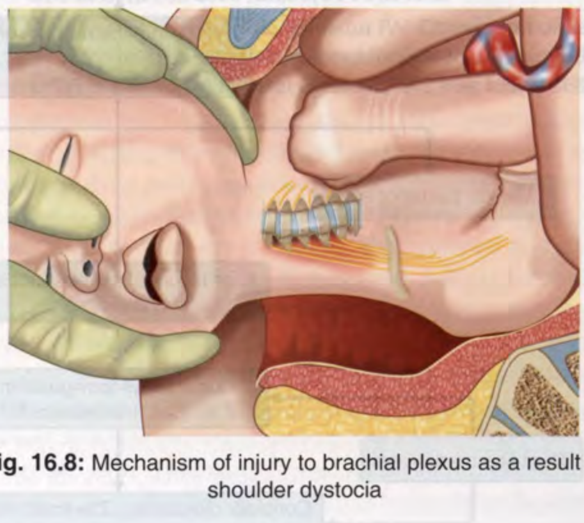


Fig. 16.8: Mechanism of injury to brachial plexus as a result of shoulder dystocia

Fractured Clavicle

The second most common type of injury suffered by infants following shoulder dystocia deliveries is fracture of clavicle, which has an incidence rate of nearly 10%.

Contusions

The force with which the infant's shoulder is compressed against the maternal pubic bone and the pressure applied by the clinician's hands on the fetus while performing various maneuvers to facilitate delivery may often result in bruises over the baby's body.

Neurological Injury

If the head-shoulder delivery interval is greater than 7 minutes, chances of the brain injury are high as a result of neonatal asphyxia and acidosis.[23]

MATERNAL COMPLICATIONS

Besides the fetal complications, shoulder dystocia can also produce some complications in the mother. The most common maternal complications include postpartum hemorrhage, second- and third-degree perineal tears, cervical lacerations and vaginal and vulvar lacerations.

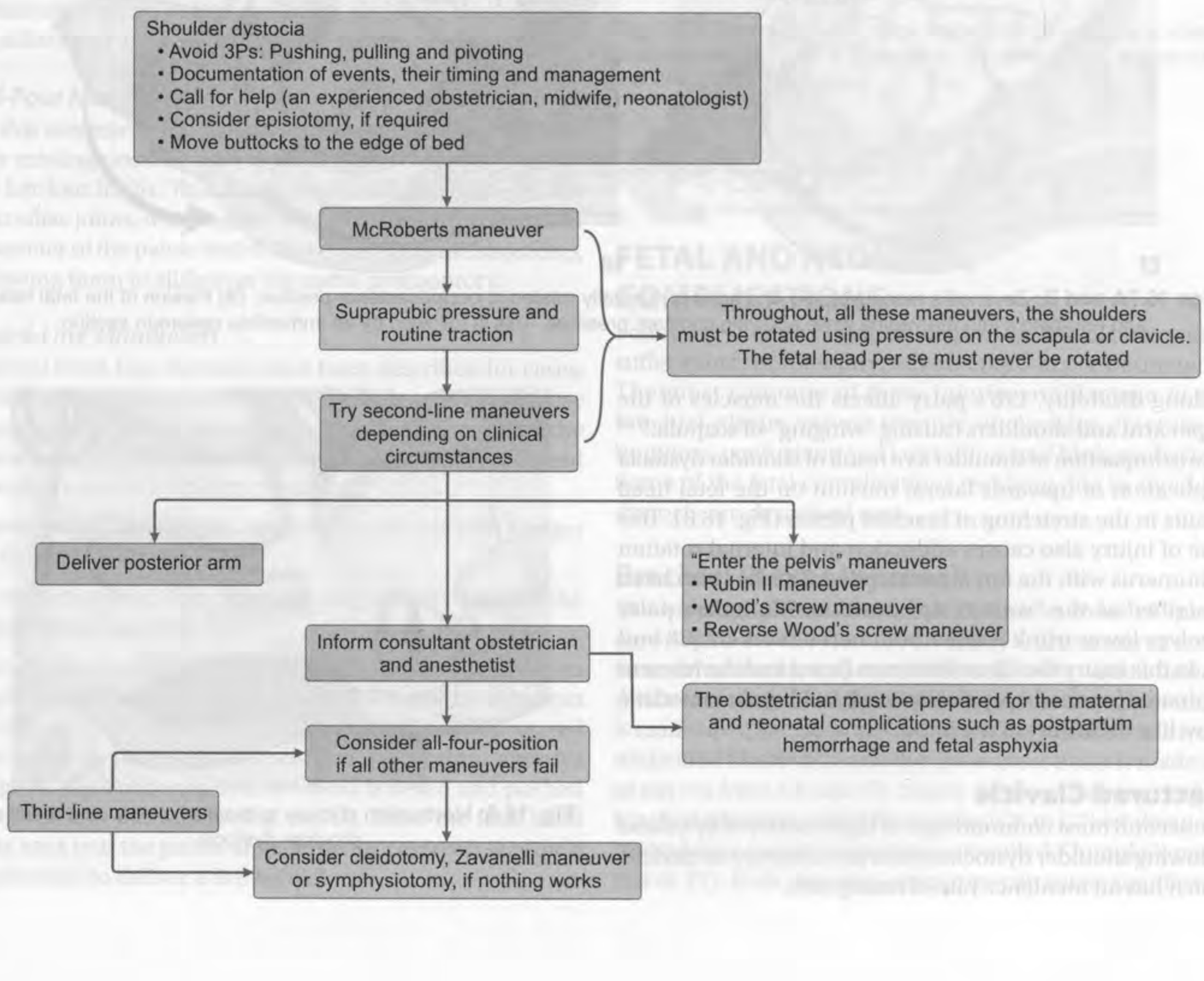
DISCUSSION

Management of shoulder dystocia has been summarized in Flow Chart 16.1.[4] Throughout these various maneuvers, the shoulders must be rotated using pressure on the scapula or clavicle. The fetal head per se must never be rotated. Mild cases of shoulder dystocia can be managed through the application of suprapubic pressure, and McRoberts maneuver. Moderate cases of shoulder dystocia require management with maneuvers such as Wood's screw maneuver, Rubin II maneuver and delivery of the posterior arm. Zanvelli's maneuver may be rarely required in undeliverable/severe cases of shoulder dystocia. While different surgeons may follow different combination of maneuvers, it is important for the obstetrician to have a well thought-out, clear cut sequence of maneuvers as recommended by some authentic source in his/her mind. In our setup we tend to follow the sequence of maneuvers as recommended by ACOG and is described in the Flow Chart 16.1.

CONCLUSION

Presently, there is no way for the obstetricians to determine with any degree of accuracy, which babies are likely to be macrosomic or to experience shoulder dystocia at the time of

Flow Chart 16.1: Management of shoulder dystocia



delivery. Since both the prediction and prevention of shoulder dystocia is difficult, it is important for the obstetricians to be well-versed with this technique for immediately managing this condition in case it occurs. Following the delivery of fetal head, as the baby's anterior shoulder passes under the mother's pubic bone, an effort must be made to deflect the baby's head in the downwards direction and applying traction to release the anterior shoulder. An important thing for the obstetricians is not to apply undue traction over the fetal head at the time of delivery as it is likely to result in fetal injuries such as injury to the brachial plexus. Another important thing for the obstetrician to remember is not to panic when faced with such a situation. Most cases of shoulder dystocia can be resolved by practicing the above described maneuvers with a cool mind.

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17

CHAPTER

Obstetric Hysterectomy

INTRODUCTION

Obstetric hysterectomy refers to the removal of the uterus at the time of a planned or unplanned cesarean section (CS). It involves either the removal of pregnant uterus with pregnancy in situ or a recently pregnant uterus due to some complications of delivery.[1] Sometimes hysterectomy may be required following delivery, either vaginal or cesarean in order to save mother's life. Obstetric hysterectomy can be performed in the antepartum, peripartum or the postpartum period. When hysterectomy is performed at the time of cesarean delivery, the procedure is termed as the cesarean hysterectomy. If performed within the short time after vaginal delivery, it is termed as postpartum hysterectomy.

According to Shellhaas et al. cesarean hysterectomy is performed in nearly 1 out of every 200 cesarean deliveries. The reported incidence of cesarean hysterectomy is 5–8 per 1,000 cesarean deliveries.[2] In most cases of hysterectomy following vaginal birth, the indication for the procedure is uterine atony with uncontrolled hemorrhage that has failed to respond to conservative measures. The most common indication for hysterectomy at the time of CS is rupture uterus. In contrast, placenta accreta with or without an associated placenta previa is the most common indication for postcesarean hysterectomy. History of a previous CS increases the likelihood of placenta previa, placenta accreta, scar dehiscence and overt uterine rupture. Each of these diagnosis increases the risk for emergency hysterectomy. In previous times, severe uterine infection was also treated with cesarean hysterectomy. However, now with the advent of modern microbiological therapy, sepsis due to chorioamnionitis is rarely encountered.

OVERVIEW OF SURGERY

Obstetric hysterectomy could be performed as an emergency or an elective procedure depending upon the indications and circumstances under which it is performed. It could be of the subtotal/supracervical type (involving the removal of the uterus above the cervix), total (involving the removal of both uterus and cervix) or the radical type.

AIMS OF SURGERY

The procedure is usually performed as an emergency in order to control intractable primary postpartum hemorrhage (PPH) following childbirth and delivery. Before resorting to hysterectomy, a sequence of the conservative measures to control hemorrhage must be initiated.

INDICATIONS

Some important causes for emergency obstetric hysterectomy are enumerated in Table 17.1.[3]

OBSTETRIC INDICATIONS FOR EMERGENCY HYSTERECTOMY

- Severe obstetric hemorrhage, as a result of uterine atony, uterine inversion, coagulopathy or laceration of a pelvic vessel: Before taking the decision for hysterectomy, various uterus saving procedures such as ligation of uterine artery, ovarian artery, internal iliac arteries, uterine brace sutures must be resorted to if possible.
- Hysterectomy needs to be performed as a last resort in order to save the woman's life:
  - Uterine infection

Table 17.1: Indications for obstetric hysterectomy

Obstetric Emergencies
Postpartum hemorrhage: ♦ Intractable uterine atony ♦ Inverted uterus ♦ Coagulopathy ♦ Laceration of a pelvic vessel Sepsis: ♦ Chorioamnionitis with sepsis ♦ Myometrial abscesses
Cesarean Delivery
Ruptured uterus: ♦ Traumatic ♦ Spontaneous ♦ Extending pelvic hematoma ♦ Lateral extension of the uterine incision with the involvement of uterine vessels
Nonemergency Situations
Coexisting gynecological disorders: ♦ Leiomyomas ♦ Stage I cervical carcinoma ♦ Cervical intraepithelial neoplasia ♦ Ovarian malignancy
Previous gynecological disorders: ♦ Endometritis ♦ Pelvic inflammatory disease ♦ Heavy and irregular menstrual bleeding ♦ Pelvic adhesions

- Stage I cervical cancer with pregnancy: in these cases, the treatment is by cesarean delivery followed by a radical hysterectomy.

INDICATIONS FOR HYSTERECTOMY AT THE TIME OF CESAREAN SECTION

- Placental implantation in the lower segment (placenta accreta, increta or percreta)
- Lateral extension of the uterine incision with the involvement of the uterine vessels
- Uterine rupture
- Presence of large or symptomatic leiomyomas, which may prevent effective uterine repair
- Presence of severe cervical dysplasia or carcinoma in situ
- Uncontrollable PPH
- Unrepairable rupture uterus
- Operable cancer cervix
- Couvelaire uterus
- Severe uterine infection particularly that caused by *Clostridium welchii.*

INDICATIONS FOR PERIPARTUM HYSTERECTOMY

There is much controversy regarding whether peripartum hysterectomy be performed for nonemergency indications. These usually include the cases where women requiring CS have a coexistent gynecological disorder, which is usually managed by hysterectomy. This is often termed as nonemergency, planned or anticipated cesarean hysterectomy and may be performed for the following reasons:

- Multiple uterine myomas in a woman not desiring future pregnancy. However, in these cases, it is preferable to perform hysterectomy 3 months later. Performance of elective hysterectomy at the time of delivery is associated with much controversy because at this time, the pelvic organs are highly vascular. Therefore, hysterectomy if performed at this stage is likely to be associated with considerable morbidity.
- Previous history of severe endometriosis or pelvic inflammatory disease (PID).

PREOPERATIVE PREPARATION

The technique of hysterectomy, which could be either supracervical or total, is essentially the same as that described in the Chapter 24 (Hysterectomy) and would be described later in brief.[4-6] The preoperative investigations to be performed are as follows:

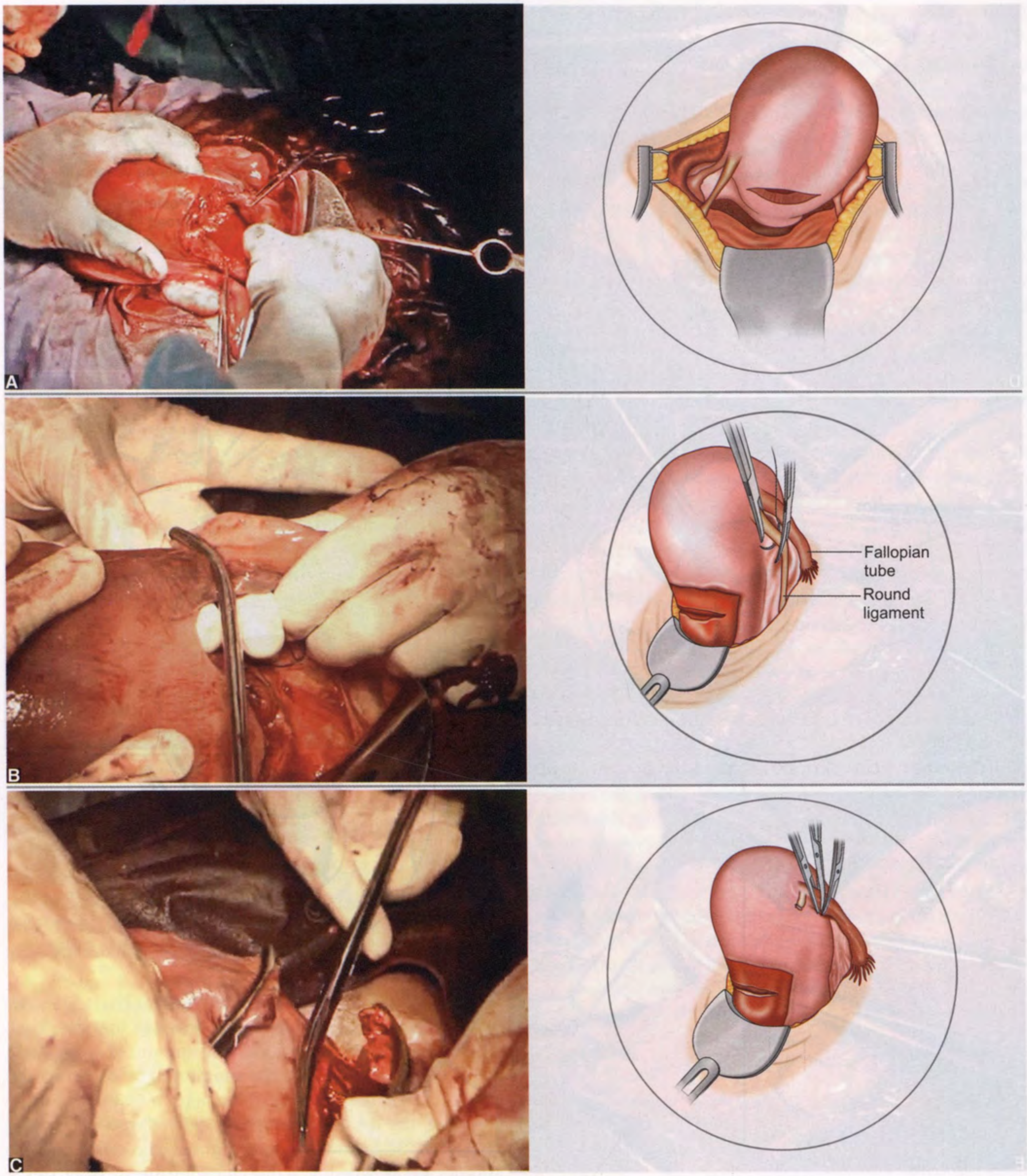
- *Hematocrit assessment*: Pregnant women should be offered a hemoglobin assessment before CS to identify those who have anemia. Although blood loss of more than 1,000 mL is infrequent after CS, it occurs in 4–8% cases of CS, and can be a potentially serious complication.
- *Blood transfusion*: Pregnant women having CS for antepartum hemorrhage, abruption, uterine rupture and placenta previa are at an increased risk of blood loss greater than 1,000 mL and should have the CS carried out at a maternity unit with on-site blood transfusion services.
- *Informed consent*: The indications for the procedure and its possible outcomes must be discussed with the patient and her partner and an informed consent should be obtained prior to labor and delivery.
- *Prophylactic antibiotics*: Antibiotics (single dose of first-generation cephalosporin or ampicillin) must be prescribed prior to the procedure.
- *Assessment of the risk for thromboembolic disease*: If the patient appears to be at a high risk of thromboembolic disorders, she can be offered graduated stockings, hydration, early mobilization and low molecular weight heparin.
- *Preanesthetic preparation*: In order to reduce the risk of aspiration pneumonitis, the patient must be kept nil per mouth at least 12 hours prior to the surgery. If performed as an emergency procedure, the patient must be given premedication with an antacid (sodium citrate 0.3%, 30 mL or magnesium trisilicate, 300 mg), H_2 antagonist

(cimetidine) IV and an antiemetic (Perinorm), at least 1 hour prior to the procedure.
- *Catheterization*: In order to prevent injury to the urinary bladder at the time of surgery, it is important that the bladder be catheterized prior to undertaking the surgery. Women having CS with regional anesthesia require an indwelling urinary catheter to prevent over-distension of the bladder, because the anesthetic block interferes with normal bladder function.
- *Maternal position during CS*: All obstetric patients undergoing CS should be positioned with left lateral tilt to avoid aortocaval compression. This can be achieved by tilting the operating table to the left or by placing a pillow under the patient's right lower back.
- *Anesthesia*: The procedure can be performed either under general anesthesia or regional anesthesia (epidural or spinal block). Regional anesthesia is regarded as considerably safer than general anesthesia and is most commonly used in our setup.
- *Preparation of the skin*: The area around the proposed incision site must be washed with soap and water. The woman's pubic hair must not be shaved as this increases the risk of wound infection. The hair may be trimmed, if necessary.
- *Cleaning and draping*: The skin at the operation site is routinely cleaned with antiseptic solutions before surgery because this practice is thought to reduce the risk of postoperative wound infections. An antiseptic solution (e.g. betadine) must be applied at least three times at the incision site using a high-level disinfected ring forceps and cotton or gauze swab.

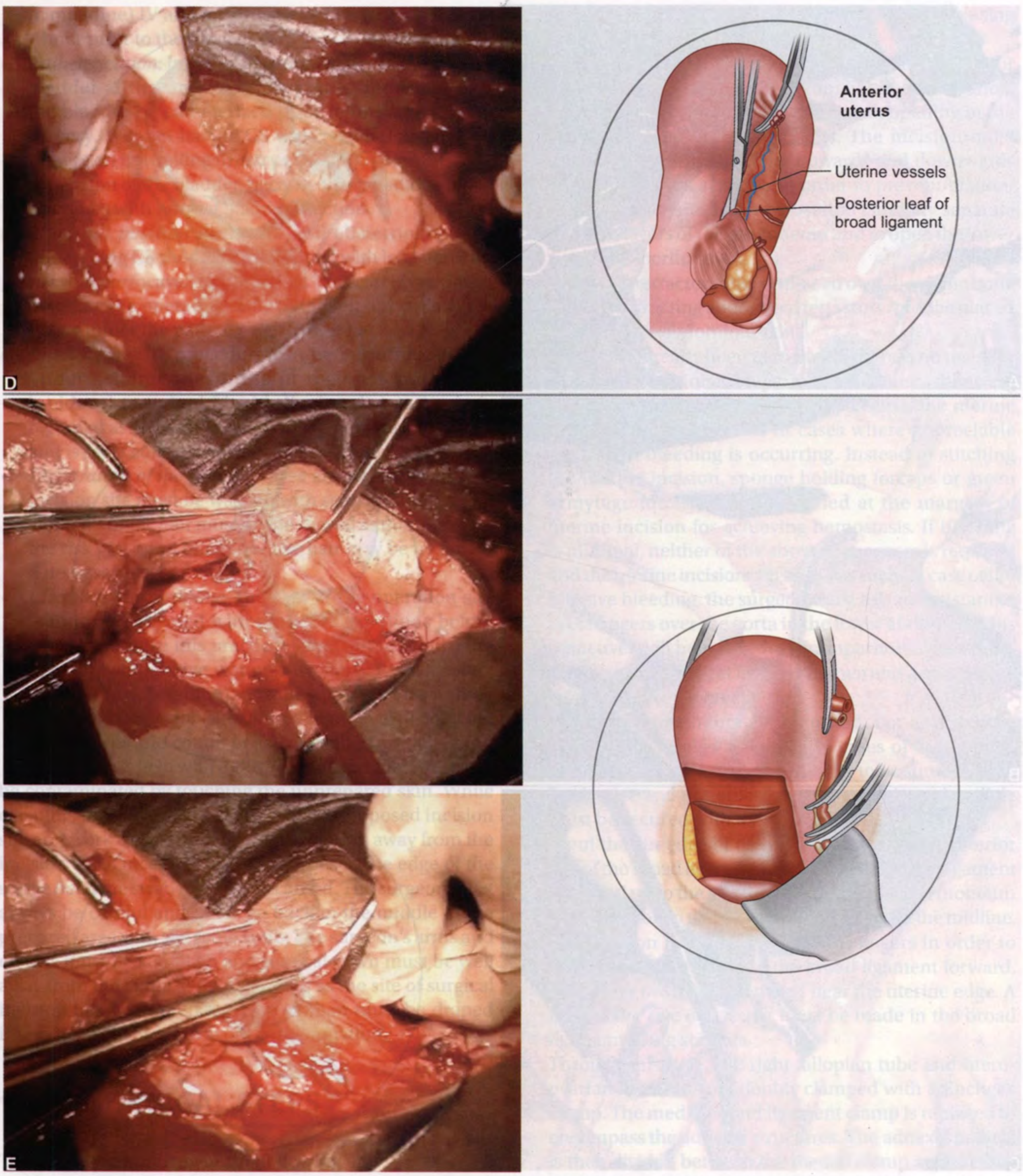
If the swab is held with a gloved hand, the glove must not be contaminated by touching the unprepared skin. While cleaning, the surgeon must begin at the proposed incision site and work outwards in a circular motion away from the incision site. Once the surgeon reaches at the edge of the sterile field, the swab must be discarded. The surgeon must always be careful and never go back to the middle of the prepared area with the same swab. The surgeon's arms and elbows must be kept high and surgical gown must be well away from the surgical field. As soon as the site of surgical incision has been prepared, the woman must be draped immediately in order to avoid contamination.

SURGICAL STEPS

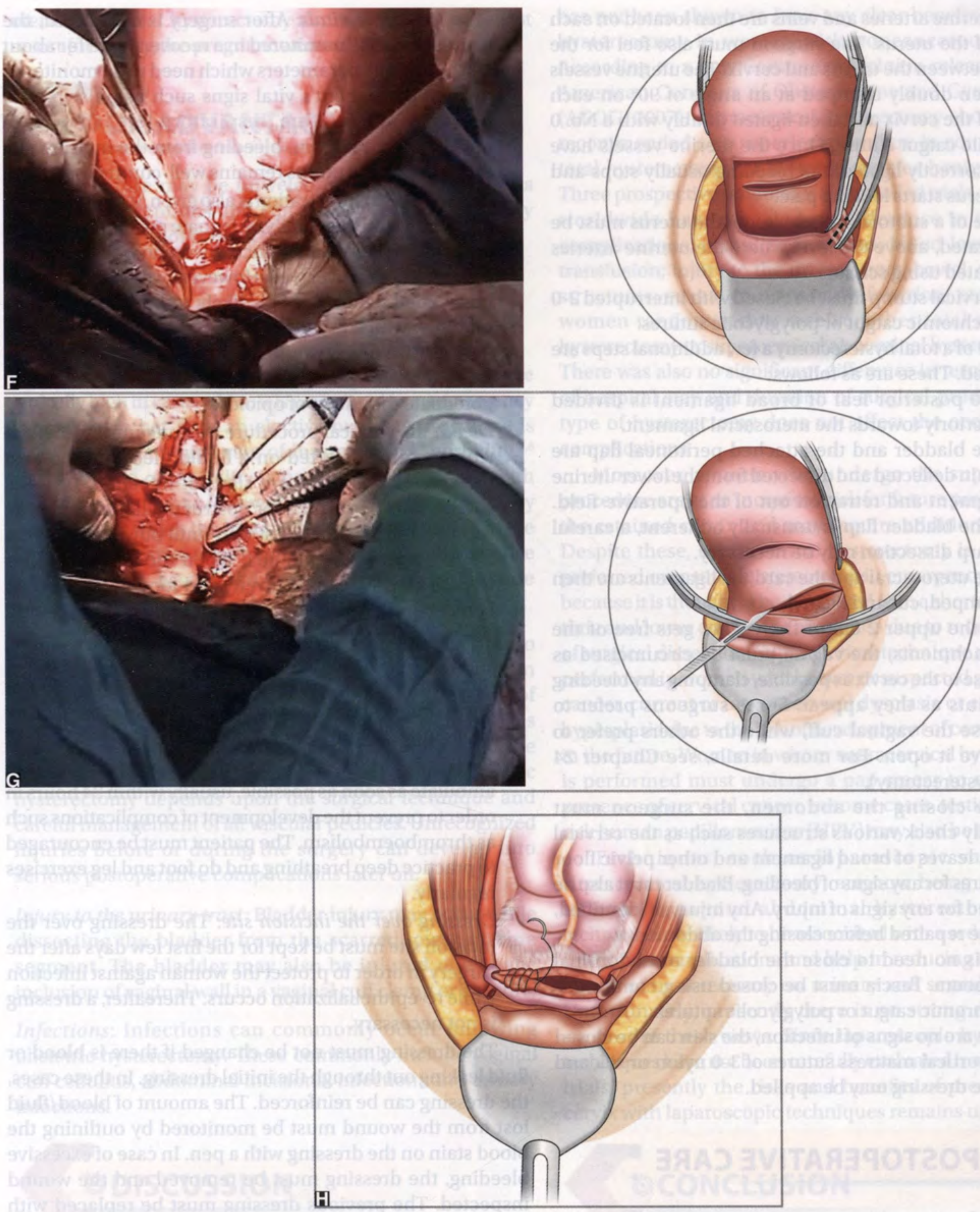
The surgery comprises of the following steps (Figs 17.1A to H):
- If a CS has not been performed prior to the hysterectomy, a vertical midline incision must be given below the umbilicus until the pubic hairline, through the skin and to the level of the fascia.
- After giving a vertical fascial incision (about 2–3 cm in length), the edges of the fascia must be held with the forceps and the incision lengthened up and down using scissors.
- The rectus muscles must be separated using fingers or the scissors. Once the peritoneum has been identified, the fingers must be used for making an opening in the peritoneum near the umbilicus. The incision must carefully be extended in the upwards and downwards direction using a scissors. In order to prevent bladder injury, the scissors must be used to carefully separate different layers of the peritoneum and to open the lower part of the peritoneum.
- A bladder retractor must be placed over the pubic bone and self-retracting abdominal retractors must be placed to retract the abdominal skin.
- If a CS has already been performed, there is no need for the above-mentioned steps. In these women, following the delivery of the baby and the placenta, the uterine incision may be stitched in cases where appreciable amount of bleeding is occurring. Instead of stitching the uterine incision, sponge holding forceps or green armytage forceps can be applied at the margins of uterine incision for achieving hemostasis. If bleeding is minimal, neither of the above maneuvers is required and the uterine incision can be left as such. In case of the massive bleeding, the surgeon must ask an assistant to press fingers over the aorta in the lower abdomen. This maneuver will help to reduce intraperitonial bleeding.
- The uterus is lifted out of the abdomen and gently pulled in order to keep it erect.
- The round ligaments are clamped, cut and double ligated with Kocher's clamps. In cases of emergency, the pedicle may be dropped initially to be sutured later. In elective and nonemergent cases, the lateral pedicle must be secured with an absorbable suture.
- From the cut edge of the round ligament, the anterior leaf of the broad ligament is opened. The broad ligament is incised up to the point where the bladder peritoneum is reflected on to the lower uterine surface in the midline.
- The surgeon must use his/her two fingers in order to push the posterior leaf of the broad ligament forward, just under the tube and ovary, near the uterine edge. A hole of the size of a finger must be made in the broad ligament using scissors.
- Through this hole, the right fallopian tube and utero-ovarian ligaments are doubly clamped with a Kocher's clamp. The medial round ligament clamp is replaced to encompass the adnexal structures. The adnexal pedicle is then divided between the medial clamp and the two lateral clamps. The pedicle is dropped to be sutured later.
- The edge of the bladder flap must be grasped with forceps or a small clamp. The surgeon must dissect the bladder downwards off the lower uterine segment using finger or scissors. The pressure must be directed downwards, but inwards towards the cervix and the lower uterine segment.



Figs 17.1A to C



Figs 17.1D and E



Figs 17.1F to H

Figs 17.1A to H: (A) Incision in the uterus as a result of cesarean section; uncontrolled bleeding is occurring; (B) Clamping, cutting and ligating the round ligaments; (C) The utero-ovarian ligaments and fallopian tubes are clamped and cut bilaterally; (D) Tracing the path of the uterine vessels; (E) Uterine vessels are clamped, cut and ligated bilaterally; (F) Cardinal and uterosacral ligaments are clamped, cut and ligated bilaterally; (G) Separating the uterus from the vaginal vault; (H) Closure of the vaginal vault

- The uterine arteries and veins are then located on each side of the uterus. The surgeon must also feel for the joint between the uterus and cervix. The uterine vessels are then doubly clamped at an angle of 90° on each side of the cervix and then ligated doubly with a No. 0 chromic catgut suture. Once the uterine vessels have been correctly ligated, the bleeding usually stops and the uterus starts looking pale.
- In case of a subtotal hysterectomy the uterus must be amputated, above the level where the uterine arteries are ligated using scissors.
- The cervical stump must be closed with interrupted 2-0 or 3-0 chromic catgut or polyglycolic sutures.
- In case of a total hysterectomy a few additional steps are required. These are as follows:
  - The posterior leaf of broad ligament is divided inferiorly towards the uterosacral ligament.
  - The bladder and the attached peritoneal flap are again deflected and dissected from the lower uterine segment and retracted out of the operative field. If the bladder flap is unusually adherent, a careful sharp dissection may be necessary.
  - The uterosacral and the cardinal ligaments are then clamped, cut and ligated.
  - As the upper 2 cm of the vagina gets free of the attachments, the vagina must be circumcised as close to the cervix as possible, clamping any bleeding points as they appear. Some surgeons prefer to close the vaginal cuff, while the others prefer to leave it open. For more details, see Chapter 24 (Hysterectomy).
- Before closing the abdomen, the surgeon must carefully check various structures such as the cervical stump, leaves of broad ligament and other pelvic floor structures for any signs of bleeding. Bladder must also be checked for any signs of injury. Any injury, if identified, must be repaired before closing the abdomen.
- There is no need to close the bladder or abdominal peritoneum. Fascia must be closed using continuous No 0 chromic catgut or polyglycolic sutures.
- If there are no signs of infection, the skin can be closed using vertical mattress sutures of 3-0 nylon or silk and a sterile dressing may be applied.

POSTOPERATIVE CARE

- *Prophylactic antibiotics*: Immediately after the cord is clamped, a single dose of prophylactic antibiotics must be given intravenously. This could include ampicillin 2 g IV or cefazolin 1 g IV. No additional benefit has been demonstrated with the use of multiple-dose regimens. If signs of infection are present or the woman currently has fever, antibiotics must be continued until the woman is fever-free for at least 48 hours.
- *Monitoring the vitals*: After surgery is completed, the woman must be monitored in a recovery area for about 4–8 hours. The parameters which need to be monitored include the patient's vital signs such as pulse, blood pressure, temperature, respiratory rate, amount of bleeding per vaginum, bleeding from the incision site and whether the uterus remains well-contracted or not.
- *Analgesics*: Pain medication is also given, initially through the IV line, and later orally. Adequate postoperative pain control is of prime importance. A woman who is in severe pain may not recover well. However, over-sedation must be avoided because this is likely to limit the patient's mobility, which is important during the postoperative period. Use of nonsteroidal anti-inflammatory drugs (NSAIDs) along with the opioids has been shown to potentiate the effects of opioids.
- *Diet*: If the surgical procedure was uncomplicated, the woman can be started on a liquid diet from the next day onwards. If there are signs of infection, or if the surgery was performed for obstructed labor or uterine rupture, the surgeon must wait until bowel sounds are heard before giving liquids. When the woman begins to pass gas, she can be given solid food. If the woman is receiving IV fluids, they should be continued until she starts accepting liquids well. Prior to discharge, the surgeon must ensure that the woman is eating a regular diet. Women who are recovering well and who do not have complications after hysterectomy can eat and drink when they feel hungry or thirsty.
- *Early ambulation*: The woman must be encouraged to ambulate as soon as possible, usually within 24 hours in order to prevent the development of complications such as thromboembolism. The patient must be encouraged to practice deep breathing and do foot and leg exercises regularly.
- *Dressing over the incision site*: The dressing over the incision site must be kept for the first few days after the surgery in order to protect the woman against infection while re-epithelialization occurs. Thereafter, a dressing is not necessary.

The dressing must not be changed if there is blood or fluid leaking out through the initial dressing. In these cases, the dressing can be reinforced. The amount of blood/fluid lost from the wound must be monitored by outlining the blood stain on the dressing with a pen. In case of excessive bleeding, the dressing must be removed and the wound inspected. The previous dressing must be replaced with another sterile dressing. While changing the dressing, sterile techniques must be adopted.

ADVANTAGES

The advantage of performing hysterectomy after CS is the ease of development of the tissue planes in a pregnant uterus. Cesarean hysterectomy at times serves as the last resort for saving the pregnant woman's life.

DISADVANTAGES

This procedure may be unwelcome in women desirous of future conceptions and can be associated with many complications as described next.

COMPLICATIONS

The complications associated with cesarean hysterectomy are typically high in cases where it is performed as an emergency procedure rather than an elective one. The procedure is associated with a high rate of mortality and morbidity.[7,8] The high rate of mortality is usually not associated with the procedure per se, but with the underlying emergency condition for which the hysterectomy was performed in the first instant. The two most frequently encountered operative complications associated with the procedure include hemorrhage and injury to the urinary tract.[7,8]

Hemorrhage: Obstetric hysterectomy in comparison to the normal elective hysterectomy is associated with an increased risk of the blood loss due to the presence of hypertrophied pelvic vessels in the pregnant women. This may be associated with an increased requirement for the blood transfusion. Control of blood loss during obstetric hysterectomy depends upon the surgical technique and careful management of all vascular pedicles. Unrecognized injuries before or during the surgery can develop into serious postoperative complications later on.

Injury to the urinary tract: Bladder injury may occur while dissecting the bladder from the scarred lower uterine segment. The bladder may also be injured due to the inclusion of vaginal wall in a vaginal cuff clamp or a suture.

Infections: Infections can commonly occur following obstetric hysterectomy. These commonly include vaginal cuff cellulitis, abdominal incisional infections and urinary infections.

DISCUSSION

Hysterectomy is the second most common major surgery amongst reproductive-aged women, after cesarean delivery. According to the National Center for Health Statistics, there were approximately 617,000 hysterectomies performed in the year 2004.

Supracervical hysterectomy, a surgical technique which removes the uterus while leaving the cervix intact, has not been shown to have any clear benefits over total hysterectomy in women with noncancerous disease. According to a new Committee Opinion released by The American Congress of Obstetricians and Gynecologists (ACOG, 2007), supracervical hysterectomy should not be recommended as a superior procedure in comparison to total hysterectomy for hysterectomy for benign disease.[1] Three prospective randomized controlled trials, performed worldwide have revealed no difference in the rate of complications, including infection; blood loss requiring transfusion; injury to the urinary tract, bowel, or vascular structures; sexual or urinary dysfunction, etc. amongst women randomized to receive either total abdominal hysterectomy or supracervical abdominal hysterectomy.[9-11] There was also no significant difference in terms of length of hospital stay and duration of surgical procedure. The type of hysterectomy does not affect the occurrence of complications.

Moreover, women who undergo the supracervical procedure are at an increased risk for future problems with the retained cervix and may require additional surgery. Despite these, supracervical hysterectomy is sometimes preferred over total hysterectomy in emergency situations because it is thought to be associated with a shorter operative time and lower amount of blood loss due to reduced extent of surgical dissection. Supracervical technique must not be performed in women with known or suspected gynecologic cancer, current or recent cervical dysplasia or endometrial hyperplasia due to the risk of development of cervical cancer in the future. Women in whom supracervical hysterectomy is performed must undergo a pap smear to exclude the presence of cervical cancer. In some cases, testing for high-risk human papillomavirus (HPV) may also be considered.

Techniques, such as laparascopic vaginal and supracervical hysterectomy, are now being used as an alternative to total abdominal hysterectomy. These techniques are likely to be associated with a reduced rate of operative complications and help in reducing the adverse effects of hysterectomy on urinary and sexual functions. Unfortunately, presently there is no strong evidence in support of these views. Since laparoscopic hysterectomy techniques have not been carefully evaluated in randomized trials, presently the risks and benefits of preserving the cervix with laparoscopic techniques remains unclear.

CONCLUSION

Emergency obstetric hysterectomy has become an indispensable life-saving procedure in the obstetric practice. Presently, the technique of peripartum hysterectomy has become an essential part of the obstetrician's armamentarium. This procedure is usually performed under emergency situations such as catastrophic uterine rupture or refractory uterine atony with life-threatening hemorrhage.

When performed under such emergency circumstances, the rate of complications such as bladder or urethral injury, and requirement for blood transfusion are increased. In cases of severe hemorrhage or disseminated intravascular coagulation, supracervical hysterectomy should preferably be used in place of a total hysterectomy as it is likely to reduce the operative time as well as minimize the extent of surgical dissection and blood loss. In all other cases, total hysterectomy is usually preferred. Hysterectomy is sometimes used for the pregnant woman with gynecological disorders, such as leiomyomas or the high grade cervical intraepithelial neoplasia, but this surgery usually can be safely delayed until the pelvic structures return to their pre-pregnant state. Elective hysterectomy at the time of delivery is a controversial procedure due to the increased morbidity related to the surgery being performed on highly vascular pelvic organs.

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18

CHAPTER

Ectopic Pregnancy

INTRODUCTION

In an ectopic (meaning "out of place") pregnancy, the fertilized ovum gets implanted outside the uterus as a result of which the pregnancy occurs outside the uterine cavity (Figs 18.1A to C). Ectopic pregnancy usually occurs as a result of delay or prevention in passage of the blastocyst to the uterine cavity resulting in its premature implantation in the extrauterine tissues. Most commonly, in nearly 95% of cases, the fertilized ovum gets implanted inside the fallopian tube.[1] The ovum buries into the tube and induces a decidual reaction in the cells of the endosalpinx. However, this reaction is feeble. Moreover, there occurs invasion of the trophoblastic cells into the wall of the fallopian tube. As a result, there is a high risk of choriodecidual hemorrhage and of erosion or rupture of the tube wall. Since the uterus itself is under the influence of the hormones of the corpus luteum and of the trophoblast, there occurs generalized enlargement, increased vascularity, tissue hypertrophy and decidual reaction in the endometrium.

Other extrauterine locations where an ectopic pregnancy can get implanted, include the ovary, abdomen or the cervix. Average incidence for occurrence of pregnancy at various locations is enumerated in Table 18.1 and is shown in Figure 18.2. The various risk factors for ectopic pregnancy are prior history of an ectopic pregnancy; history of pelvic infections such as pelvic inflammatory disease (or disorder) (PID), sexually transmitted disease (STD), salpingitis and tuberculosis; history of prior surgeries in the fallopian tubes, including tubal reconstructive surgery, tubectomy, etc.; presence of endometriosis or pelvic adhesions; previous history of using intrauterine devices and hormonal contraception; tuberculosis of the tubes or assisted reproductive technologies (ART) procedures.[2-4] The implanted tubal pregnancy can take the following course:

- *Tubal abortion:* The pregnancy gets aborted out through the tube. It may either get completely absorbed or there may be complete or incomplete abortion. If the internal bleeding continues to occur, the condition may become symptomatic.
- *Tubal mole:* The embryo dies due to faulty environment and gets converted into a carneous mole.
- *Tubal rupture:* The fallopian tube may rupture due to its thin lumen at the isthmus and ampulla. The lumen is incapable of distention due to burrowing in and erosion by the blastocyst. Tubal rupture is usually intraperitoneal and may result in severe bleeding and partial or complete extrusion of chorionic villi resulting in hemodynamic instability and shock-like features. Rarely, the rupture may be extraperitoneal. If the rupture occurs in the broad ligament, this may result in the development of a broad ligament hematoma.
- *Chronic ectopic adnexal mass:* The products of conception are partially extruded out through the fimbriae or partial rupture. After a slight or moderate bleeding, the hemorrhage may get arrested and result in the formation of an adnexal mass involving the tube and ovaries.
- *Fetal survival to term:* This usually does not occur as the fetus is commonly unable to develop beyond 6 weeks of gestation.

OVERVIEW OF SURGERY

The extrauterine locations do not have either sufficient space or nurturing tissues to support a growing pregnancy.

Figs 18.1A to C: (A) Diagrammatic representation of ectopic pregnancy; (B and C) Tubal ectopic pregnancy

Table 18.1: Average incidence for occurrence of ectopic pregnancy at various locations

Location of Extrauterine Pregnancy	Incidence
Fallopian tube	97%
Ampulla	80%
Isthmus	11%
Fimbria	4%
Cornua	2%
Interstitium	3%
Abdominal cavity, ovary and cervix	3%

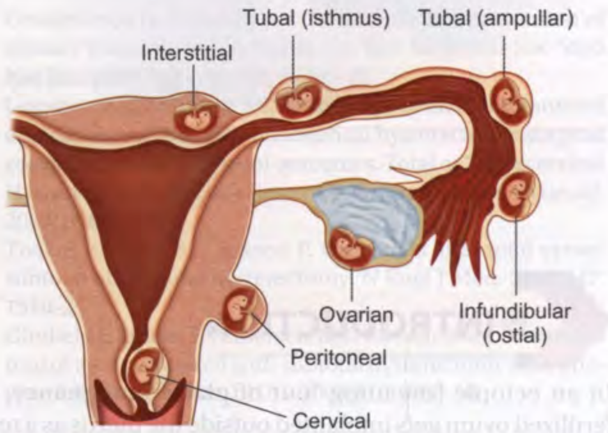


Fig. 18.2: Common sites for occurrence of ectopic pregnancy

Since none of these areas have been equipped by nature to support a growing pregnancy, with the continuing growth of the fetus, the gestational sac and the organ containing it break open. This can result in severe bleeding, sometimes even endangering the woman's life. A classical ectopic pregnancy normally does not develop into a live birth. Although spontaneous resolution of ectopic pregnancy can sometimes occur, patients are at risk of tubal rupture and catastrophic hemorrhage. Ectopic pregnancy is estimated to occur in 2% of all pregnancies.

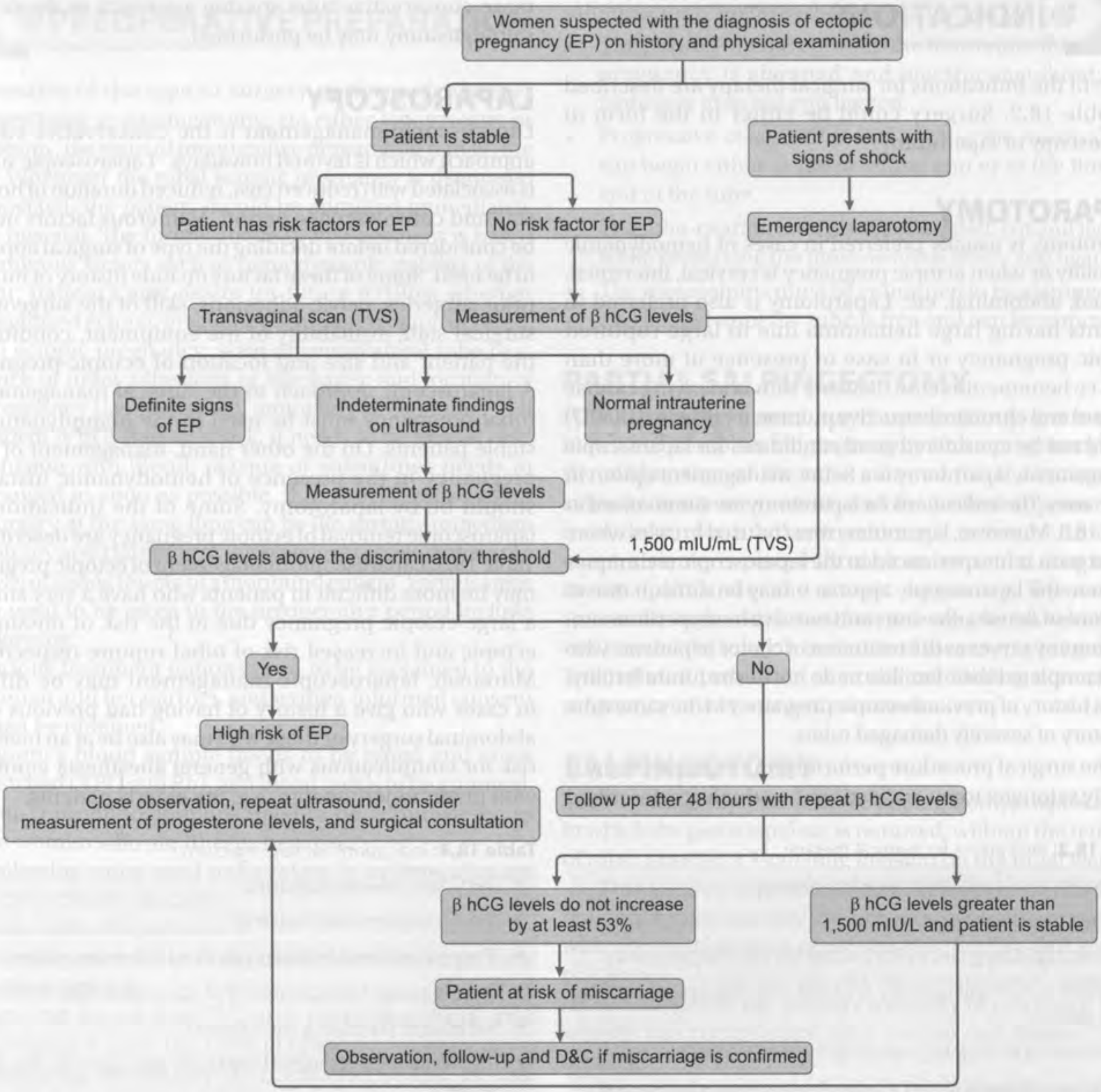
It remains a major cause of maternal morbidity and mortality when misdiagnosed or left untreated. By the early 20th century, the standard treatment for ectopic pregnancy included laparotomy and ligation of the bleeding vessels with removal of the affected tube (salpingectomy). Since the 1980s and 1990s, medical therapy of ectopic pregnancy had been implemented and had replaced surgical treatment in many cases. However, now in the 21st century, the treatment modality has shifted towards minimal invasive surgery (operative laparoscopy) and salpingostomy, which have largely replaced laparotomy and salpingectomy.[5] Management plan for a patient with suspected ectopic pregnancy has been summarized in Flow Chart 18.1.

AIMS OF SURGERY

Surgical treatment in the form of open surgery (laparotomy) or minimal invasive surgery (laparoscopy) is the most commonly used treatment option. The procedures which can be performed at the time of both laparotomy and laparoscopy include salpingectomy or salpingotomy. Numerous factors need to be considered before deciding the type of surgical approach to be used. Some of these factors include history of multiple prior surgeries, pelvic adhesions, skill of the surgeon and surgical staff, availability of the equipment, condition of the patient and size and location of ectopic pregnancy. A laparoscopic approach for the surgical management of tubal pregnancy must be used in the hemodynamically stable patients. On the other hand, management of tubal pregnancy in the presence of hemodynamic instability should be by laparotomy. Moreover, there is no role for medical management in the treatment of tubal pregnancy or suspected tubal pregnancy when a patient is showing signs of hypovolemic shock.

Medical management is nowadays being sometimes employed in stable patients with a medically treatable ectopic pregnancy or in the presence of other medical conditions which would make the risk of surgery unacceptable. An early ectopic pregnancy can sometimes be treated with an injection of methotrexate, which stops the growth of the embryo. Initial protocols for medical treatment of ectopic pregnancy required long-term hospitalization and multiple doses of methotrexate. This was associated with significant side effects. With the advancement in science and technology over the years, modification and

Flow Chart 18.1: Management of patients with suspected diagnosis of ectopic pregnancy



refinements of the protocols for medical therapy of ectopic pregnancy have now allowed for single-dose outpatient therapy. While methotrexate presently remains the most effective and commonly used drug in medical therapy for treatment of an ectopic pregnancy, other protocols employing drugs, such as potassium chloride, hyperosmolar glucose, RU486 and prostaglandins, have also been used. These drugs may be administered orally, systemically and locally into the ectopic pregnancy under direct vision. Medical therapy is commonly being employed nowadays in cases of ectopic pregnancy, especially if the patient is hemodynamically stable and does not have pelvic pain; patient desires future fertility; ectopic pregnancy is smaller than 4 cm in diameter and there is no fetal heart activity on transvaginal ultrasound scan (TVS) or smaller than 3.5 cm with presence of cardiac activity and absence of any free fluid in the pouch of Douglas; there is no evidence of tubal rupture and the patient appears to be reliable and compliant who will return for post-treatment follow-up care; serum human chorionic gonadotropin or human chorionic gonadotropin (hCG) is below 3,000 IU/L, with minimal symptoms; there is no coexisting intrauterine pregnancy; there is availability of facilities for follow-up care following the use of methotrexate; patient agrees to use reliable contraception for 3–4 months post treatment; patient has no underlying severe medical condition or disorder and there is no underlying abnormality of liver function tests (LFTs), kidney function test (KFT) or full blood count (FBC) suggestive of liver, renal or bone marrow impairment.[6] In case any of the above-mentioned conditions are fulfilled, the patient may not be suitable for medical therapy. In these cases, surgical treatment may be the only option left.

INDICATIONS

Some of the indications for surgical therapy are described in Table 18.2. Surgery could be either in the form of laparoscopy or laparotomy.

LAPAROTOMY

Laparotomy is usually preferred in cases of hemodynamic instability or when ectopic pregnancy is cervical, interstitial, cornual, abdominal, etc. Laparotomy is also preferred in patients having large hematoma due to large ruptured ectopic pregnancy or in case of presence of more than 1,500 cc hemoperitoneum. Patients with underlying cardiac diseases and chronic obstructive pulmonary disease (COPD) should not be considered good candidates for laparoscopic management; laparotomy is a better management option in these cases. The indications for laparotomy are summarized in Table 18.3. Moreover, laparotomy must be used in cases where the surgeon is inexperienced in the laparoscopic techniques or where the laparoscopic approach may be difficult due to presence of dense adhesions and massive hemoperitoneum. Laparotomy serves as the treatment of choice in patients who have completed their families or do not desire future fertility, have a history of previous ectopic pregnancy in the same tube or history of severely damaged tubes.

The surgical procedure performed during laparotomy is usually salpingectomy, indications for which are described in Table 18.4. Sometimes instead of removal of tubes, a more conservative tube sparing approach in the form of salpingostomy may be performed.

LAPAROSCOPY

Laparoscopic management is the conservative surgical approach which is favored nowadays.[7] Laparoscopic surgery is associated with reduced cost, reduced duration of hospital stay and convalescence period. Numerous factors need to be considered before deciding the type of surgical approach to be used. Some of these factors include history of multiple prior surgeries, pelvic adhesions, skill of the surgeon and surgical staff, availability of the equipment, condition of the patient and size and location of ectopic pregnancy. A laparoscopic approach to the surgical management of tubal pregnancy must be used in the hemodynamically stable patients. On the other hand, management of tubal pregnancy in the presence of hemodynamic instability should be by laparotomy. Some of the indications for laparoscopic removal of ectopic pregnancy are described in Table 18.5. Laparoscopic management of ectopic pregnancy may be more difficult in patients who have a very small or a large ectopic pregnancy due to the risk of missing the ectopic and increased risk of tubal rupture respectively.[8] Moreover, laparoscopic management may be difficult in cases who give a history of having had previous lower abdominal surgery or those who may also be at an increased risk for complications with general anesthesia combined with pneumoperitoneum, e.g. the elderly patients.

Table 18.2: Indications for surgical therapy

- Candidate not suitable for medical therapy
- Failed medical therapy
- Heterotopic pregnancy with a viable intrauterine pregnancy
- Patient is hemodynamically unstable and requires immediate treatment
- Impending or ongoing rupture of the ectopic mass
- Absence of timely access to a medical institution for managing tubal rupture
- Patient desires a permanent method of contraception

Table 18.3: Indications for laparotomy

- Patients are hemodynamically unstable
- Cervical, interstitial, cornual or abdominal ectopic pregnancy
- Patients having large hematoma due to large ruptured ectopic pregnancy
- Presence of more than 1,500 cc hemoperitoneum
- Patients with underlying cardiac diseases and chronic obstructive pulmonary disease
- History of abdominal surgery in the past
- Patients at increased risk of complications with general anesthesia

Table 18.4: Indications for salpingectomy

- The tube is severely damaged
- There is uncontrolled bleeding
- There is a recurrent ectopic pregnancy in the same tube
- There is a large tubal pregnancy of size greater than 5 cm
- The ectopic pregnancy has ruptured
- The woman has completed her family and future fertility is not desired
- Ectopic pregnancy has resulted due to sterilization failure
- Ectopic pregnancy has occurred in a previously reconstructed tube
- Patient requests sterilization
- Hemorrhage continues to occur even after salpingotomy
- Cases of chronic tubal pregnancy

Table 18.5: Indications for laparoscopic management of ectopic pregnancy

- Hemodynamically stable patients
- Unruptured ectopic pregnancy
- Absence of hemoperitoneum
- The ectopic pregnancy is not very small ($\leq$ 3 cm) or very large ($\geq$ 5 cm) in size

PREOPERATIVE PREPARATION

Irrespective of the type of surgery performed, whether salpingectomy or salpingotomy, via either laparoscopy or laparotomy, the steps of preoperative preparation remain the same. Whenever the tubal ectopic pregnancy is diagnosed or suspected, the patient should be admitted immediately to the hospital. The further mode of management is based on numerous factors such as hemodynamic stability of the patient; patient's age; desire for future fertility; whether the diagnosed ectopic pregnancy is ruptured or unruptured; size of ectopic pregnancy; state of contralateral tube (e.g. presence of tubal adhesions or blockage); and location of the pregnancy (i.e. interstitial, ampullary or isthmus).[9,10] If the patient is in a state of shock, it needs to be treated first. Transfusion with blood, plasma or substitutes needs to be arranged as soon as possible. If in shock, resuscitation and surgery at the same time can be life saving. Immediate laparotomy and clamping of the bleeding vessels may be the only way of saving the life of a moribund patient. Various steps which need to be taken in the preoperative period include the following:

- Various treatment options need to be explained to the woman and her partner, and written informed consent must be obtained.
- Patient's blood sample needs to be typed and cross matched (ABO and Rh), and blood needs to be arranged.
- Anti-D immunoglobulins need to be administered to the women who are Rhesus negative.

The following steps need to be taken in women who are hemodynamically unstable:

- Immediate resuscitation
- Securing immediate IV access by inserting large bore venous cannula
- Sending blood for FBC and cross matching and arranging at least four units of blood
- Informing the theater staff, anesthetist and on-call gynecology consultant
- Foley's catheter must be inserted prior to starting the procedure.

The urgency of the situation must be stressed to all concerned. The surgery must not be delayed and should be performed even before blood and fluid losses have been replaced.

SURGICAL STEPS

SALPINGECTOMY

Salpingectomy involves removal of the ectopic pregnancy along with the fallopian tube of affected side. Salpingectomy may be done in cases of uncontrollable bleeding, tubal destruction, recurrent ectopic pregnancy, severe adhesions or presence of hydrosalpinx.[11] The procedure of salpingectomy involves the following steps:

- The portion of tube between the uterus and the ectopic pregnancy is clamped and electrocoagulated. The pedicle is then cut and ligated.
- Progressive coagulation and cutting the mesosalpinx can begin either at the proximal end or at the fimbrial end of the tube.
- The tubo-ovarian artery is also clamped, cut and ligated, while preserving the utero-ovarian artery and ligament.
- The mesosalpinx must be continued to be clamped, cut and ligated until the tube is free and can be removed.

PARTIAL SALPINGECTOMY

Partial salpingectomy may be sometimes performed instead of complete salpingectomy if the pregnancy is in the midportion of the tube; none of the indications for salpingectomy are present, and the patient appears to be a candidate for tubal reanastomosis in future. In these cases, a clamp is placed through an avascular area in the mesosalpinx under the ectopic pregnancy. This creates spaces through which two free ties are placed, which are tied around the tube on each side of the ectopic pregnancy. The isolated portion of the tube containing the ectopic pregnancy is then cut and removed.

SALPINGOTOMY

Tube-sparing salpingostomy or salpingotomy is a procedure in which the gestational sac is removed, without the removal of tube, through a 1-cm long incision on the tubal wall.[12]

This surgery is preferred over salpingectomy because not only is salpingotomy less invasive, but is also associated with comparable rates of subsequent fertility and ectopic pregnancy.[13] Laparoscopic salpingotomy should especially be considered as the primary modality of treatment if the woman has contralateral tube disease and desires future fertility.

When salpingotomy is used for the management of tubal pregnancy, follow-up protocols (weekly serum hCG levels) are necessary for the identification and treatment of women with persistent trophoblastic disease. Persistent trophoblasts are detected by the failure of serum hCG levels to fall as expected after initial treatment. The steps of surgery are as follows:

- The mesosalpinx slightly inferior to the pregnancy and the antimesenteric surface of the tubal segment containing the pregnancy is infiltrated using a laparoscopic needle with 5–7 mL vasopressin (20 IU in 150 mL NS). Although vasopressin is not universally used, if used the surgeon must be careful not to inject it into the blood vessels as this could result in arterial hypotension, bradycardia and death.
- A 1–2 cm incision is made on the antimesenteric side of the tube using laser scissors or a microelectrode. As the

incision is given, the pregnancy begins to extrude out. This can be completed using hydrodissection or gentle traction with the forceps. A syringe filled with saline is inserted deep into the incision and the fluid is injected forcefully in such a way so as to dislodge the ectopic pregnancy and clots. The contents of ectopic pregnancy and clots are aspirated out.

- Following this, the bed of the ectopic pregnancy must be irrigated well. In case some trophoblastic tissue remains, the prior injection of vasopressin may lead to anoxia and death of the trophoblasts, preventing postoperative growth.
- Coagulation may occasionally be required for hemostasis. Oozing from the implantation site usually stops on its own.
- The incision on the fallopian tube is left to heal by secondary intention. If the opening on the tube appears to be too large, it can be brought together using 4-0 absorbable sutures. In case the pregnancy is in the distal ampullary portion of the tube, it can be grasped with the help of forceps and the pregnancy can then be pulled out of the tubal fimbriae. Linear salpingostomy may not prove to be very successful in the management of isthmic ectopic pregnancies because in most of the cases the pregnancy has eroded through the muscularis layer. In these cases, segmental resection using bipolar cautery, laser, sutures, clips or stapling devices must be done. Cornual pregnancy can be either managed using traditional laparotomy with salpingectomy and/or cornual resection.

LAPAROSCOPIC SURGERY

Laparoscopic Salpingectomy

Laparoscopic salpingectomy (Figs 18.3A to E) involves the use of bipolar cautery for desiccation of tube. The rest of the procedure is same as that performed during laparotomy. Products of conception can be removed from the abdomen using a 10-mm trocar port.[14,15]

Tube-Sparing Salpingotomy

- The procedure of laparoscopic salpingotomy (Figs 18.4A to H) is same as that described with laparotomy before.[16]

POSTOPERATIVE CARE

The postoperative care comprises of the following steps:

- *Weekly measurement of hCG levels:* Regular follow-up must be done following surgery in order to ensure that the patient's hCG levels have returned to zero. This may take several weeks. Although the hCG levels come back to normal in 2–3 weeks time, the period of observation must last for up to 6 weeks. Elevated hCG levels could mean that some ectopic trophoblastic tissue which was missed at the time of removal is still remaining inside. This may especially be the reason in cases where salpingostomy has been performed, because this procedure is associated with a 5–15% rate of persistent trophoblastic tissues. This tissue may have to be removed using methotrexate or additional surgery. Patients should be advised to use some form of effective contraception until their hCG levels have returned to nonpregnant levels.
- The patient must be instructed to visit the clinician after 1 week for removal of sutures.
- The patient must be counseled that she may experience mild bleeding or pain during the first postoperative week. In case of mild pain, she can use simple analgesic drugs available over the counter. In case of pain or bleeding of severe intensity, she must be instructed to report to the clinician immediately.

ADVANTAGES

BENEFITS OF LAPAROSCOPIC MANAGEMENT OF TUBAL PREGNANCY

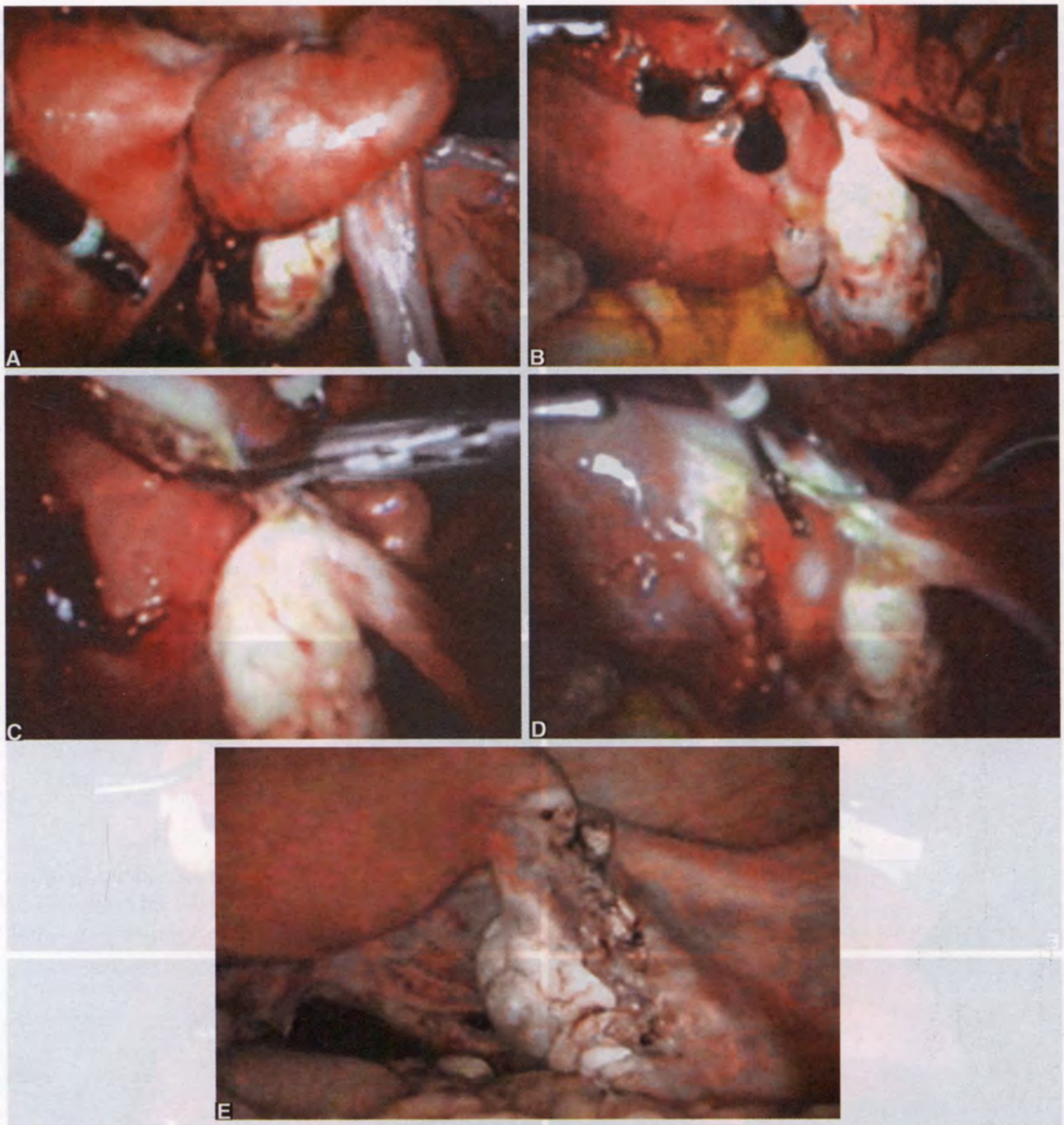
Laparoscopic management is associated with considerably reduced postoperative morbidity, duration of hospital stay, complication rate and time duration of return to normal activity level in comparison to the management by laparotomy.[17-20] Most of the cases of ruptured as well as unruptured tubal pregnancy can be treated laparoscopically. Laparoscopic management is a useful method for reducing hospital stay, complications and return to normal activity. The main advantages of laparoscopic surgery are enumerated in Table 18.6. Vermesh et al. found the laparoscopic approach to be more economical (reduction in health care costs).[21] Futhermore, laparoscopic treatment of ectopic pregnancy is associated with a reduced rate of postoperative adhesion formation and destruction of the pelvic anatomy. Laparoscopic surgery is also associated with reduced blood loss, reduced analgesic requirements and reduced duration of postoperative hospital stay.

LAPAROTOMY

There are times when laparotomy is favored over the laparoscopic approach and the surgeon needs to perform laparotomy instead of laparoscopy.

COMPLICATIONS

In the past few decades, ruptured ectopic pregnancy was amongst one of the leading causes of maternal mortality.[22] With the improvement in imaging and minimal invasive procedures in cases of ectopic pregnancy, the mortality rate

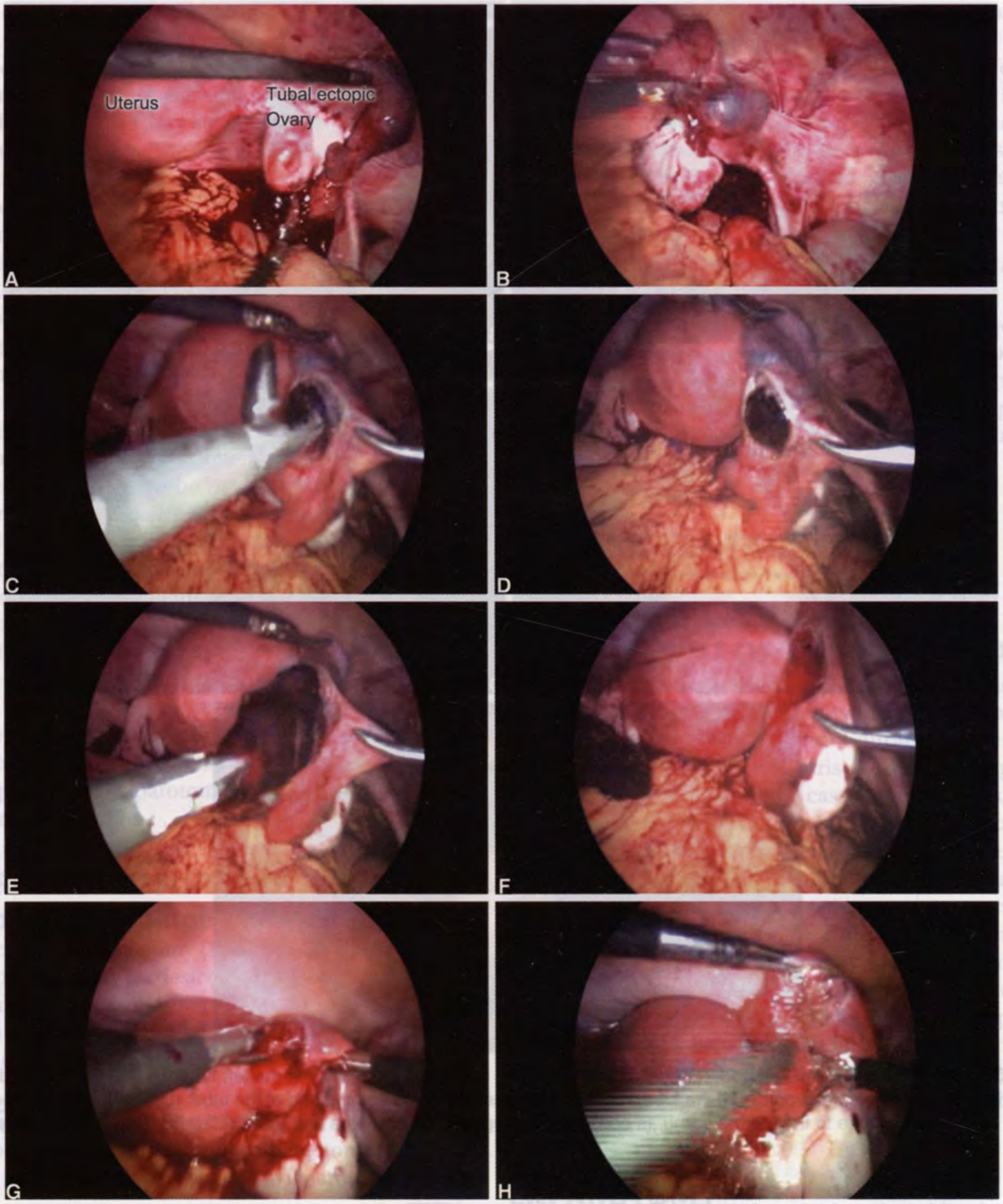


Figs 18.3A to E: (A) Laparoscopic appearance showing presence of ectopic pregnancy in the left tube; (B and C) Bipolar dissection and cutting along the mesenteric border of the tube after applying traction on the fimbrial end of the tube; (D) The bipolar dissection and cutting is continued as close to the uterine cornu as possible; (E) Appearance of uterus and tubes following left salpingectomy

has considerably reduced. Nowadays, the trend is towards the use of minimal invasive surgery in cases of ectopic pregnancy. Although operative laparoscopy is associated with its own inherent complications, in experienced hands there are usually minimal complications related to the laparoscopic procedure. However, if the surgeon is not trained enough in laparoscopy then the chance of complications as described in Table 18.7 is there. In experienced hands, the chances of these complications are extremely rare. Altogether laparoscopic procedure has a much lower complication rate in comparison to the conventional surgery.

DISCUSSION

Various treatment options for ectopic pregnancy include expectant, medical and surgical management (Flow Chart 18.2). Before deciding the treatment option in a woman with ectopic pregnancy, she and her partner must be fully involved in deciding the relevant management plan. They must be provided with the written information regarding the various treatment options and carefully explained about the advantages and disadvantages associated with each



Figs 18.4A to H: Laparoscopic salpingotomy: (A) Laparoscopic view showing the uterus, adnexa and the tubal ectopic pregnancy; (B) Grasping the tube containing ectopic pregnancy, before giving the incision; (C) A small 1 cm incision is given over the tubal ectopic; (D) The ectopic pregnancy protruding out of the tubal incision; (E) Tubal contents being removed out of the tube; (F) Appearance of the tube after the tubal contents have been completely removed; (G) The entire salpingotomy incision is left unstitched, only the bleeding vessels on the incision site are coagulated; (H) Irrigation of the area of incision with normal saline before closing the abdomen

approach.[23-26] The couple must be counseled about the likelihood of requirement for laparotomy or even hysterectomy with salpingectomy in case of uncontrollable bleeding or other unexpected surgical findings. Even if neither of the tubes can be saved, all attempts must be made to preserve the uterus and at least one ovary to keep up the hope of future pregnancy using the technique of in vitro fertilization.

Before deciding the appropriate surgical management, the opposite tube and ovary must definitely be examined. The procedure must then be performed after taking into consideration the patient's age, future reproductive capacity as well as the nature of lesion. Endoscopic surgery, therefore, has presently become the preferred option in the surgical management of ectopic pregnancy. Various

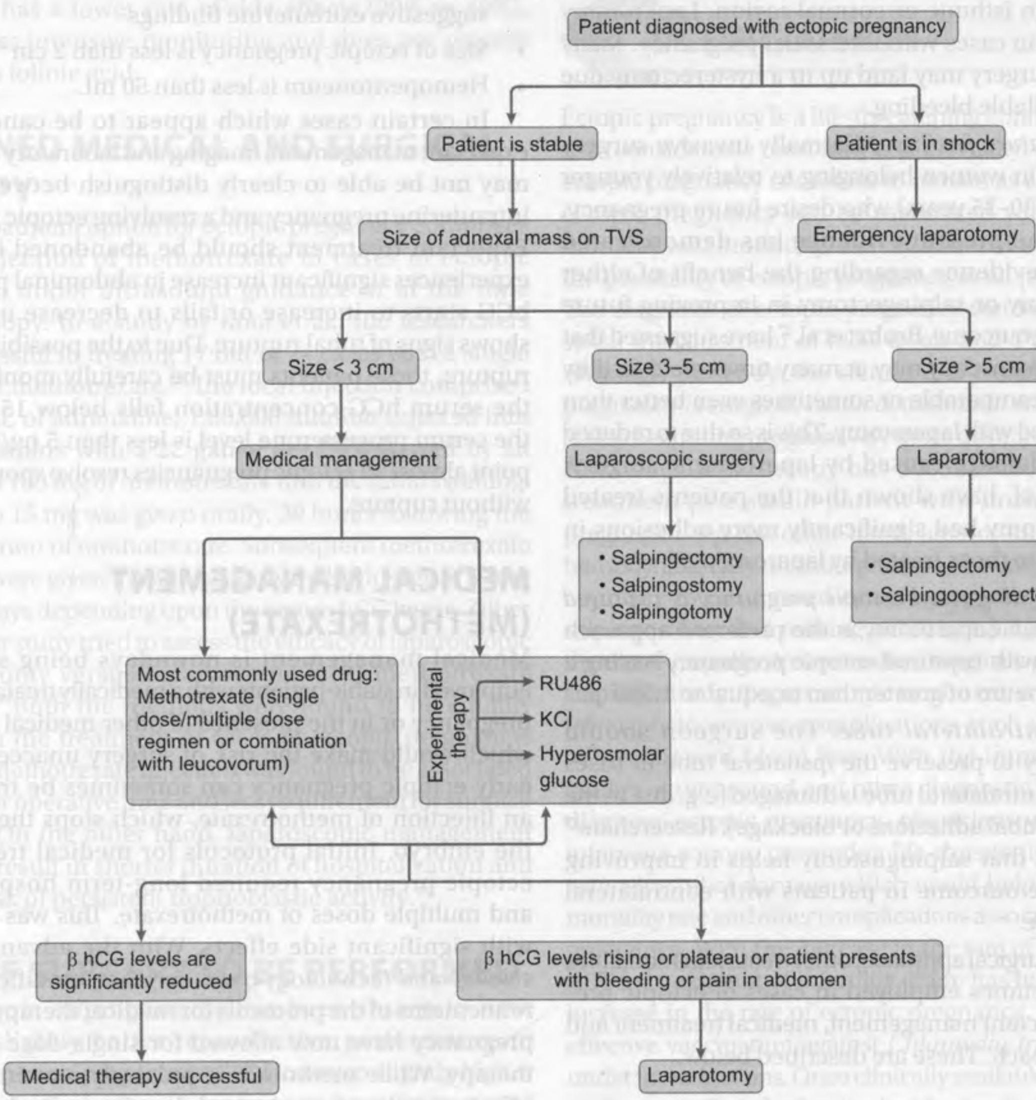
Table 18.6: Advantages of laparoscopic surgery

- Reduced amount of postoperative pain
- Faster recovery
- Shorter duration of hospital stay
- Lower rate of postoperative complications such as wound infection
- Cost-effectiveness
- Reduced postoperative analgesic requirement
- Reduced adhesion formation

Table 18.7: Complications due to laparoscopic surgery

- Missed diagnosis
- Bleeding
- Incomplete removal of ectopic pregnancy
- Visceral injury
- Leakage of purulent exudates
- Intra-abdominal abscess
- Hernia

Flow Chart 18.2: Treatment plan for patients with ectopic pregnancy



advantages of laparoscopic surgery in comparison to laparotomy have been discussed previously. Endoscopic surgery, therefore, has become the preferred option in the surgical management of cases of ectopic pregnancy. Decisions regarding management using endoscopic surgery should be based on the following inclusion criteria. Some of these are as follows:

- *Patient's hemodynamic stability*: Treatment of an ectopic pregnancy varies depending on how medically stable the woman is. Surgery using laparotomy is the only treatment option which must be used in hemodynamically unstable patients.
- *The size of ectopic pregnancy*: Medical management can be used in cases of ectopic pregnancy less than

3 cm in size. In case the size of ectopic pregnancy varies between 3 cm and 5 cm, minimal invasive surgery may be used. Cases of ectopic pregnancy with size of ectopic less than 3 cm may be missed on laparoscopy. A large sized ectopic pregnancy should preferably be managed by laparotomy due to high risk of rupture with a large sized ectopic.

- *Location of the pregnancy (i.e. interstitial, ampullary or isthmic)*: Laparoscopic salpingotomy can be used in hemodynamically stable patients having a small unruptured ectopic pregnancy in the ampullary region. Salpingectomy is preferred in cases with ectopic pregnancy in isthmic or cornual region. Laparotomy is preferred in cases with interstitial pregnancy. Many times, the surgery may land up in a hysterectomy due to uncontrollable bleeding.
- *Desire for future fertility*: Minimally invasive surgery is preferred in women belonging to relatively younger age groups (30–35 years) who desire future pregnancy. However, the present evidence has demonstrated conflicting evidence regarding the benefit of either salpingostomy or salpingectomy in improving future reproductive outcome. Bruhat et al.[27] have suggested that operative laparoscopy may at many times yield fertility rates either comparable or sometimes even better than those reported with laparotomy. This is so due to reduced peritoneal damage caused by laparoscopic surgery. Lundorff et al. have shown that the patients treated with laparotomy had significantly more adhesions in comparison to those treated by laparoscopy.[28]
- *Whether the diagnosed ectopic pregnancy is ruptured or unruptured*: Laparotomy is the preferred approach in a patient with ruptured ectopic pregnancy having a hemoperitoneum of greater than or equal to 1,500 cc.
- *State of contralateral tube*: The surgeon should preferably try to preserve the ipsilateral tube in cases where the contralateral tube is damaged (e.g. due to the presence of tubal adhesions or blockage). Researchers[29] have shown that salpingostomy helps in improving reproductive outcome in patients with contralateral tubal damage.

Besides the surgical approach, other treatment modalities which are sometimes employed in cases of ectopic pregnancy are expectant management, medical treatment and combined approach. These are described below.

EXPECTANT MANAGEMENT

Expectant management of ectopic pregnancy is based on the assumption that a certain proportion of all ectopic pregnancies will regress spontaneously and be slowly absorbed. Such pregnancies will not progress to tubal rupture. Expectant management must be used in asymptomatic cases, with no evidence of rupture or hemodynamic instability. Moreover, the patients should be fully compliant and willing for a follow-up in the form of weekly hCG levels. This type of management may also be considered in cases where the hCG levels appear to be falling and the woman appears clinically well. If the initial hCG level is less than 200 mIU/mL, 88% of patients may experience spontaneous resolution.[30] Expectant management should be offered only when TVS fails to show the location of the gestational sac and the serum levels of hCG and progesterone are low and declining, and the patient desires future fertility.[31] The criteria for expectant management of ectopic pregnancy are as follows:

- Serum hCG levels less than 200 mIU/mL
- Ectopic pregnancy is suspected, but TVS fails to reveal suggestive extrauterine findings.
- Size of ectopic pregnancy is less than 2 cm
- Hemoperitoneum is less than 50 mL.

In certain cases which appear to be candidates for expectant management, imaging and laboratory assessment may not be able to clearly distinguish between a failed intrauterine pregnancy and a resolving ectopic pregnancy. Expectant treatment should be abandoned if a patient experiences significant increase in abdominal pain, serum hCG starts to increase or fails to decrease or a patient shows signs of tubal rupture. Due to the possibility of tubal rupture, these patients must be carefully monitored until the serum hCG concentration falls below 15 IU/L, and the serum progesterone level is less than 5 ng/mL. At this point almost all ectopic pregnancies resolve spontaneously, without rupture.

MEDICAL MANAGEMENT (METHOTREXATE)

Medical management is nowadays being sometimes employed in stable patients with a medically treatable ectopic pregnancy or in the presence of other medical conditions which would make the risk of surgery unacceptable. An early ectopic pregnancy can sometimes be treated with an injection of methotrexate, which stops the growth of the embryo. Initial protocols for medical treatment of ectopic pregnancy required long-term hospitalization and multiple doses of methotrexate. This was associated with significant side effects. With the advancement in science and technology over the years, modifications and refinements of the protocols for medical therapy of ectopic pregnancy have now allowed for single-dose outpatient therapy. While methotrexate presently remains the most effective and commonly used drug in medical therapy for treatment of an ectopic pregnancy, other protocols using drugs, such as potassium chloride, hyperosmolar glucose, RU486 and prostaglandins, have also been employed. These drugs may be administered orally, systemically and locally into the ectopic pregnancy under direct vision. However, these therapies are largely experimental at present since there is limited experience in using them and the efficacy of such treatment modalities over standard methotrexate protocol has not been established. Presently, the focus is mainly on the use of methotrexate therapy for treatment of ectopic pregnancy. Methotrexate therapy can be offered to those women who show abnormal doubling rate of the hCG levels and an extrauterine gestational sac has been identified on sonographic examination. Methotrexate therapy is also sometimes used in the form of prophylaxis to cause resorption of residual trophoblastic tissue in women who have undergone salpingostomy.[32,33] The overall success rate with multiple-dose methotrexate therapy has been found to be greater than that associated with single-dose methotrexate therapy. However, single-dose therapy is less expensive, has a lower rate of side effects (29% vs 48%), requires less intensive monitoring and does not require rescue with folinic acid.

COMBINED MEDICAL AND SURGICAL THERAPY

Another treatment option for ectopic pregnancy comprises of local injection of methotrexate in cases of ectopic pregnancy, under ultrasound guidance or at the time of laparoscopy. In a study by Kooi et al., the researchers were successful in treating 17 out of 24 cases with a single injection of methotrexate.[34] The local injection comprised of 10–20 mL of adrenaline, 1:80,000 dilution injected into the mesosalpinx with a 22-gauge needle followed by an injection of 100 mg of methotrexate into the tubal swelling. Leucovorin 15 mg was given orally, 30 hours following the administration of methotrexate. Subsequent methotrexate injections were given intramuscularly in the dosage of 50 mg every 2–4 days depending upon the serum hCG levels. Zilber et al. in their study tried to assess the efficacy of laparoscopic salpingostomy versus laparoscopic local methotrexate injection.[35] Both the methods were found to be equally effective in the treatment of cases of ectopic pregnancy. Localized methotrexate injection was found to be associated with shorter operative time and less requirement for surgical expertise. On the other hand, laparoscopic management is likely to result in shorter duration of hospitalization and reduced risk of persistent trophoblastic activity.[36]

TYPE OF SURGERY TO BE PERFORMED

Laparoscopic salpingostomy has been shown to have equal or slightly better reproductive performance in comparison to salpingectomy.[37,38] However, slightly higher rates of recurrent ectopic pregnancy have been noted in the salpingostomy group.[29] Laparoscopic treatments appear to be preferable to laparotomy. However, when the contralateral fallopian tube is normal, the subsequent fertility rate is independent of the type of surgery. Future fertility rates are similar in patients who were treated surgically by laparoscopy or laparotomy.[24]

In cases of unruptured tubal pregnancy in women who want to preserve their fertility, linear salpingostomy can be considered as the procedure of choice.[39] Both salpingostomy and salpingectomy are associated with comparable fertility rates. Medical treatment with methotrexate should be considered as first line of management in women with nontubal ectopic pregnancy such as cervical, interstitial, or cesarean scar pregnancy, similar to the cases of tubal ectopic pregnancy. These types of ectopic pregnancies may be associated with massive bleeding during surgery. Precautionary procedures such as placement of an angiographic catheter for possible uterine artery embolization must be considered in these patients.[39]

CONCLUSION

Ectopic pregnancy is a life-threatening condition associated with considerable morbidity and mortality. The treatment of ectopic pregnancy continues to remain as a dilemma. Since ectopic pregnancy can be associated with considerable mortality and morbidity, the clinicians must remain alert to the possibility of ectopic pregnancy in all pregnant women. The diagnosis of ectopic pregnancy can be made through serial measurement of hCG levels and TVS examination. Although presently, the standard of treatment for ectopic pregnancy is surgical, medical treatment with methotrexate is also becoming progressively more desirable and common. Nowadays, laparoscopy has become the recommended treatment in a stable patient with unruptured ectopic pregnancy. On the other hand, laparotomy is reserved for hemodynamically unstable patients. The conservative surgical approach to unruptured ectopic pregnancy includes linear salpingostomy and milking of the ectopic pregnancy out of the distal ampulla. A more radical surgical approach involves salpingectomy. Laparoscopic treatment is associated with fewer postoperative complications such as postoperative adhesions and blood loss. With the improvement in the quality of ultrasound and other diagnostic investigations to diagnose ectopic pregnancy, physicians would be able to intervene sooner, preventing life-threatening sequelae and extensive tubal damage which could help in reducing the mortality rate and other complications associated with ectopic pregnancy. With the increase in the rate of STDs and use of ART for treatment of infertility, there has been a progressive increase in the rate of ectopic pregnancy. Development of effective vaccination against *Chlamydia trachomatis* is still under investigations. Once clinically available, this would help in dramatically reducing the incidence of ectopic pregnancy by reducing the incidence of PID.

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19 CHAPTER

Fetal Surgery

INTRODUCTION

Presence of a lethal fetal anomaly detected early in pregnancy, such as bilateral renal agenesis, anencephaly, etc. can be managed by termination of pregnancy (TOP). A nonfatal anomaly detected late in pregnancy, associated with mild organ damage such as mild ventriculomegaly, hydronephrosis, etc. may be left as it is. The newborn in these cases may be managed after birth by a multidisciplinary team of neonatologists or pediatric surgeon/nephrologist/cardiologist/neurologist, etc. depending on the case. However, if continuation of the pregnancy is required in a fetus with grave structural defect, likely to be associated with significant morbidity or mortality if left as it is, the option of "fetal surgery" seems to be the most feasible option. Fetal surgery involves administration of therapeutic/surgical interventions on the fetus in utero.

OVERVIEW OF SURGERY

Previously, open fetal surgery was performed by hysterotomy, where the fetal interventions were performed after opening the uterine cavity and partially extracting the fetus from the uterus. Once the fetal surgical procedure was performed, the fetus was returned inside the uterine cavity. The amniotic fluid was replaced and uterine incision was repaired. Premature uterine contractions often followed, which jeopardized the results of surgery.

With recent advances in the field of interventional ultrasound and laparoscopy, less invasive techniques are nowadays being sought. This has paved the path for minimally invasive fetal surgery or fetal endoscopic surgery (FETENDO).[1] In this technique, small incisions are given over the mother's abdomen and fetal surgery is directed with help of sonography and fetoscopy (Figs 19.1A and B). The first clinical fetoscopic surgeries were performed in 1990s and involved interventions on the umbilical cord and the placenta. This is often referred to as obstetrical endoscopy.

AIMS OF SURGERY

The main aim of surgery is to correct a progressive fetal structural malformation or disease process which may lead to severe damage to fetal vital organs by the time of birth. Fetal surgery, by rectifying a near fatal fetal defect, may serve as an alternative to abortion, intrauterine death, or a life with disability.

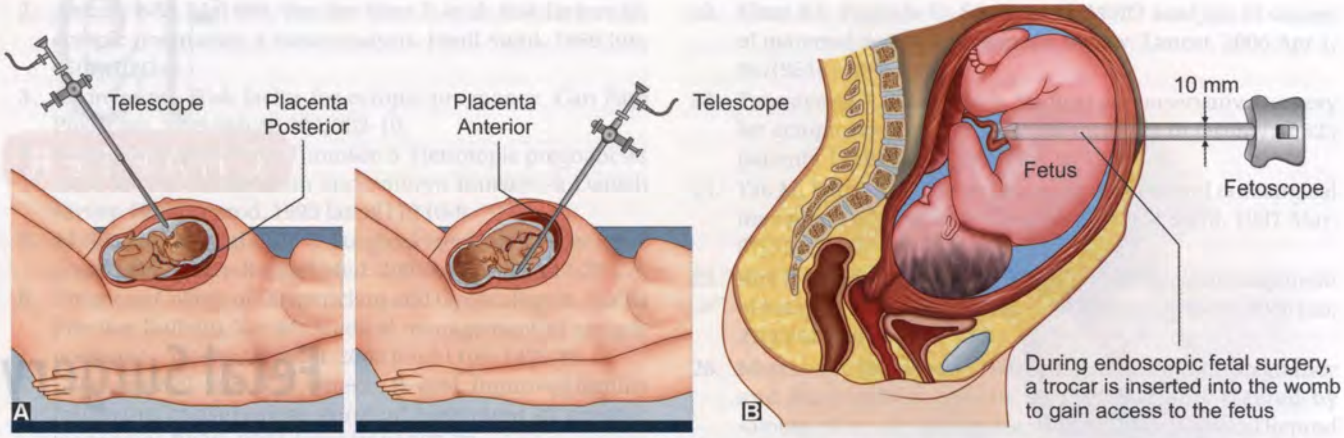
INDICATIONS

Various fetal conditions and malformations, which are likely to benefit from fetal surgery, are described next in Table 19.1.[2]

PREOPERATIVE PREPARATION

Certain steps, which need to be taken before undertaking fetal surgery, are as follows:

- *Assessment of the fetal status and formulation of the fetal management plan*: A thorough and accurate assessment of fetal status and management plan should be determined in consultation with a multidisciplinary



Figs 19.1A and B: Fetal endoscopic surgery: (A) Diagrammatic representation of fetal endoscopic surgery depending upon the location of the placenta; (B) Close-up view

Table 19.1: Indications for fetal surgery and their recommended treatment options

Fetal structural defect	Recommended treatment
♦ Urinary tract obstructive defects - Pelviureteric junction obstruction - Ureterovescical junction obstruction - Urethral obstruction - Ureterocele	♦ Vesicocentesis ♦ Vesicoamniotic shunt ♦ Fetoscopic vesicostomy ♦ Laser ablation
♦ Lung defects - Cystic adenomatoid malformations - Pleural effusion - Pulmonary sequestration	♦ Pleuroamniotic shunt ♦ Thoracoamniotic shunt ♦ Open pulmonary lobectomy
♦ Diaphragmatic hernia	♦ Open complete repair ♦ Temporary tracheal occlusion
♦ Multiple pregnancy - Twin-to-twin transfusion syndrome - Acardiac twins	♦ Laser ablation ♦ Cord occlusion
♦ Sacrococcygeal teratoma	♦ Resection of tumor ♦ Radiofrequency ablation ♦ Fetoscopic vascular occlusion
♦ Ovarian cysts	♦ Cyst aspiration
♦ Placenta or amnion - Chorioangioma of placenta - Amniotic band syndrome	♦ Vascular occlusion
♦ CNS defects - Aqueductal stenosis - Dandy Walker syndrome - Myelomeningocele	♦ Ventriculoamniotic shunt ♦ Open ventriculoperitoneal shunt ♦ Fetoscopic coverage ♦ Open repair
♦ Facial defects - Cleft lip and palate	♦ Fetoscopic coverage ♦ Open repair

team comprising of ultrasonologist, geneticist, neonatologist, pediatric surgeon, etc. This is especially important because fetal structural abnormalities can present with a wide spectrum of clinical presentations and prognosis. The results of various investigations must be checked to correctly determine the type and severity of fetal abnormality. Detailed targeted ultrasonography (USG) should be done for detection of any associated abnormalities or syndromes. In case where a chromosomal abnormality is suspected, a fetal karyotype analysis must be performed through amniotic fluid or cord blood sampling.

- *Patient counseling*: Parents should be counseled regarding the maternal and fetal risks and interventions, various complications of the procedure, the total cost involved, length of expected hospital stay and ultimate neonatal prognosis.
- *Sonographic evaluation*: Sonography forms an integral aspect of the specialty of fetal surgery and before undertaking any surgical fetal procedure an extensive sonographic evaluation of the fetus for the diagnosis of a particular structural/congenital malformation is a must.[3]
- *Amniocentesis*: Amniocentesis is usually performed in these cases to rule out any associated genetic defects and congenital infection.
- *Administration of the tocolytic agents*: The woman is often administered tocolytic agents prior to surgery to prevent the onset of preterm labor. However, these should not be administered in cases of suspected/confirmed intrauterine infection, unexplained vaginal bleeding and fetal distress.
- *Anesthesia*: The surgery is usually performed under general anesthesia.[4] An H_2 antagonist is usually administered the evening before and the morning of the surgery. An antacid is also administered prior to induction (in cases of general anesthesia) to reduce the risk of acid aspiration.

- *Ultrasound examination:* Prior to the procedure, the placental and fetal location and position are identified on ultrasound examination. This helps in avoiding passing through the placenta. Besides ultrasound, MRI examination plays an important role in the preoperative evaluation of the fetal lesion.
- *Ruling out the presence of other fetal anomalies*: Presence of other structural or chromosomal anomalies in the fetus must be ruled by performing various investigations such as ultrasound, amniocentesis, percutaneous umbilical blood sampling (PUBS), cardiac ECHO, etc.

SURGICAL STEPS

Various surgeries done for a particular anomaly shall be briefly described.

SURGERY FOR URINARY TRACT OBSTRUCTIVE DEFECTS

The posterior urethral valves and urethral agenesis are the most common causes of lower urinary tract obstruction.[5,6] Numerous surgical procedures, which have been devised to deal with these obstructive pathologies include serial vesicocentesis and placement of vesicoamniotic shunt.

Fetal Vesicocentesis

In this procedure, a 22- to 23-gauge needle is inserted inside the fetal bladder under continuous visualization with color Doppler ultrasound to prevent any inadvertent injury to the umbilical vessels. A 20-mL syringe is used for aspirating the urine from the bladder. The aspirated sample of urine is then sent for required analysis. Normal urinary values indicate the absence of renal dysplasia. In unilateral disease also, the values may be normal because of normal functioning of the contralateral kidney. If the values are high, repeat vesicocentesis should be repeated after 48 hours. If the urine values still remain high, a third sampling can be performed.[7]

Percutaneous Vesicoamniotic Shunt

This shunt procedure is performed if the kidney is functioning normally, the karyotype is normal and there are no major malformations in the fetus.

In case of oligohydramnios, amnioinfusion may be carried out using warmed Ringer lactate solution. The fetus is first given analgesia (0.2 mg/kg pancuronium, 10 mg/kg/fentanyl). Though it can be performed under local, regional or general anesthesia, local anesthesia is usually preferred. Fetal analgesia is administered in the form of 0.2 mg/kg pancuronium and 10 mg/kg fentanyl. A small 3–5 mm stab incision is made below the umbilicus, avoiding entry into vessels as observed by color Doppler.

The shunt trocar is then carefully introduced into the amniotic space near the lower part of the fetal abdomen into a fetal amniotic pocket. It is then quickly inserted into the fetal bladder using sharp, shift movements of the hand and placed in a central position. Urine sample is aspirated, sent for culture and analysis of renal function. A double pigtail "Rodeck" or "Harrison" shunt catheter is then gently straightened and threaded into the trocar sheath before removing the internal stylet wire. The proximal segment of the catheter is pushed into the fetal bladder and the distal end of the catheter is positioned in the amniotic space (Fig. 19.2).

Percutaneous Fetal Cystoscopy

In this procedure the fetal bladder is entered similar to the shunt procedure, following which ablation of urethral valve or ureterocele wall lysis is done using contact yttrium aluminum garnet (YAG) laser.[8]

SURGERY FOR LUNG DEFECTS

Cystic Adenomatoid Malformation

Congenital cystic adenomatoid malformation (CCAM) of the lung is a nonfunctioning benign lung tumor, which may be either hamartomatous or dysplastic in origin.[9] They may be of two types:

1. Macrocystic malformations: This usually occurs in form of a single, 2–10 cm cyst within lungs.
2. Microcystic malformations: This appears as a solid, echogenic mass.

Course of treatment is based on whether hydrops fetalis and polyhydramnios are present or not (Flow Chart 19.1).[10-12]

Bronchopulmonary Sequestration

In these cases there may be intralobar and extralobar lung masses of benign pulmonary tissue without tracheobronchial communication. In presence of fetal hydrops and/or fetal hydrothorax, treatment comprises of pleuroamniotic shunting.[13,14]

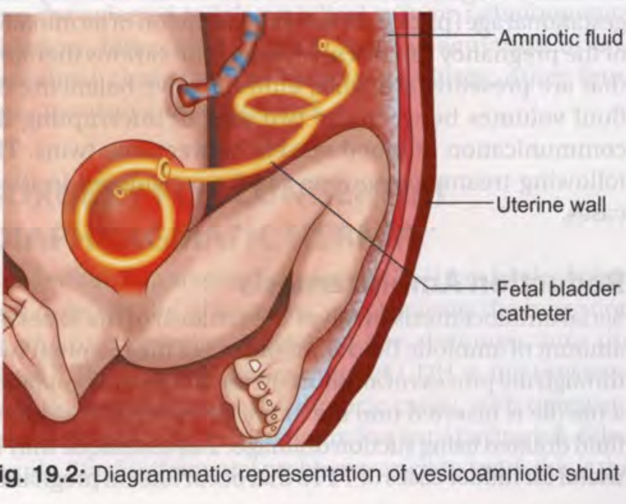
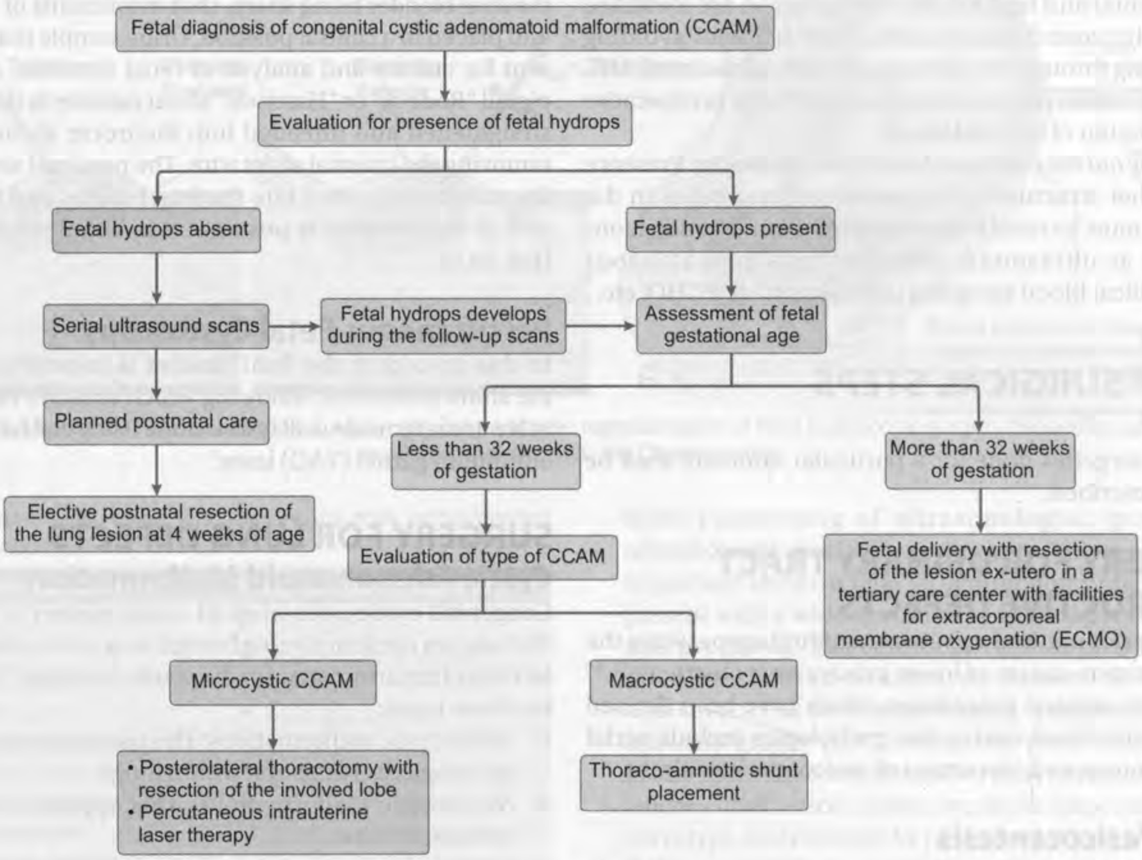


Fig. 19.2: Diagrammatic representation of vesicoamniotic shunt

Flow Chart 19.1: Management of fetal congenital cystic adenomatoid malformations (CCAM)



FETAL SURGERY FOR TWIN-TO-TWIN TRANSFUSION SYNDROME

This is a rare complication that can occur in cases of monozygotic monochorionic diamniotic twins, which causes the blood to pass from one twin to the other. This usually occurs due to the presence of placental vascular communication.

Since more advanced stages of twin-to-twin transfusion syndrome (TTTS) have a worse prognosis in comparison to the earlier stages, when severe TTTS occurs at a very early gestational age (prior to 16 weeks), the option of termination of the pregnancy can be considered. The various therapies that are presently available, either involve balancing the fluid volumes between the two sacs or interrupting the communication of blood vessels between the twins. The following treatment options can be considered in these cases.

Reduction Amniocentesis

Serial amniocentesis involves the removal of the excessive amount of amniotic fluid from the sac of the recipient twin through the process of amniocentesis. Under USG guidance, a needle is inserted into the amniotic cavity and amniotic fluid drained using suction drainage. This technique may be useful for milder cases of TTTS that occur later in pregnancy. The procedure is generally not thought to be effective for more advanced stages of TTTS. As a general rule, no more than 5 L of amniotic fluid is removed at any one time. The procedure is usually completed within 30 minutes or less. However, the procedure may only temporarily restore the balance in the amniotic fluid in both twins' sacs as the fluid levels may return back within a few days. Thus, the procedure might require to be repeated after every few days. The procedure of repeated amniocenteses for the treatment of TTTS can result in numerous complications such as premature labor, premature rupture of the membranes and rarely infection or an abruption.[15] Pregnancies managed with serial reduction amniocentesis on an average deliver by 29–30 weeks of gestation.

Septostomy (Microseptostomy)

Septostomy involves the creation of a hole in the membrane between the fetal sacs using a needle. This causes the movement of the fluid from the amniotic sac of the recipient into the sac with absent or low fluid (donor's sac). Though the risk for complications like infection, premature labor and premature rupture of the membranes are rare, septostomy does carry the additional potential risk for the hole between the two sacs to become too large. Sometimes it can cause the entire separating membrane to get disrupted, allowing the babies to share the same amniotic space. In the worst

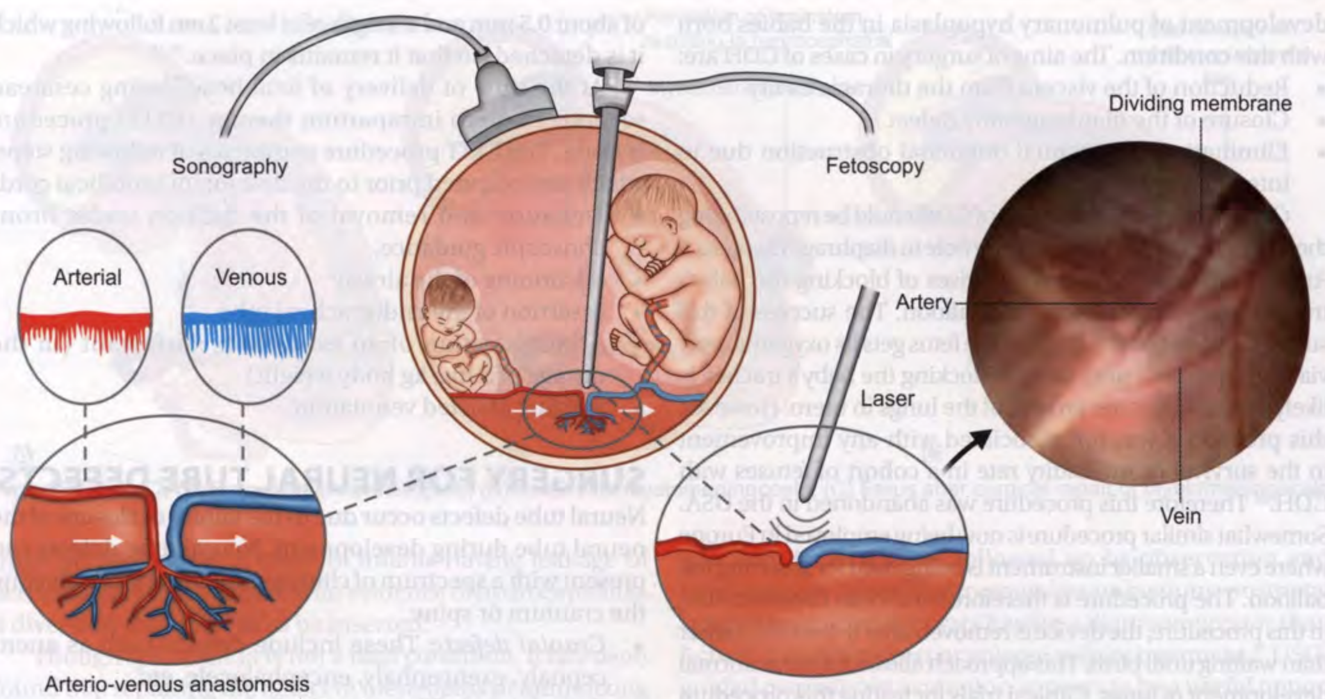


Fig. 19.3: Selective laser ablation of the placental anastomotic vessels

case, this could result in entanglement of the umbilical cords of the two twins, resulting in the death of one or both the fetuses. However, the advantage of septostomy over amnioreduction is that the patients undergoing septostomy typically require fewer procedures in comparison to those treated with amnioreduction.

Selective Laser Ablation of the Placental Anastomotic Vessels

In more advanced stages of TTTS, ablation of the communicating vessels on the placenta surface using laser beams under ultrasound guidance can act as a curative procedure. This procedure involves endoscopic coagulation of the vascular anastomoses responsible for fetofetal transfusion using a neodymium:yttrium-aluminum-garnet (Nd:YAG) laser.[16-18] A fetoscope (2 mm in diameter, housed in a 2.7 mm cannula) is introduced in the amniotic cavity after administration of adequate anesthesia to the patient in order to directly visualize the blood vessels on the surface of the placenta. Vessels that are found to communicate between the twins are then ablated using laser light energy (Fig. 19.3). Being a more invasive procedure in comparison to amnioreduction or septostomy, laser ablation is associated with a higher risk of complications such as premature contractions, premature rupture of the membranes (15–20% of cases), placental separation (2%) and infection.

Selective Cord Coagulation

In this procedure, under ultrasound guidance, one of the twins is purposefully sacrificed in order to save the life of other twin. This procedure is used when laser ablation of the connecting vessels is not possible or if one of the twins is so close to death that laser ablation is unlikely to be successful. In this procedure, the umbilical cord is grasped and electrical current is applied to coagulate the blood vessels in the cord in order to stop the blood flow through them. Complications of this procedure include premature delivery and premature rupture of the membranes.

Selective Fetal Reduction

This option is considered if severe disturbances in amniotic fluid volume and growth disturbances develop before 20 weeks of gestation. In such cases, due to shared circulation amongst twins, both fetuses typically will die without any intervention. Various techniques, which may be used for feticide include injection of an occlusive substance into the selected twin's umbilical vein or radiofrequency ablation, fetoscopic ligation, laser coagulation of one umbilical cord. Despite these procedures, other fetus remains at an appreciable risk.

SURGERY FOR CONGENITAL DIAPHRAGMATIC HERNIA

Congenital diaphragmatic hernia (CDH) can be described as a defect in the diaphragm, which causes the migration of organs, normally situated in the abdomen, into the chest.[19] The classical clinical sign of CDH is the presence of abdominal organs in the thoracic cavity, with rightward displacement of the mediastinum in a fetus having left-sided hernia. The fundamental problem associated with this is the

development of pulmonary hypoplasia in the babies born with this condition. The aims of surgery in cases of CDH are:
- Reduction of the viscera from the thoracic cavity
- Closure of the diaphragmatic defect
- Elimination of potential duodenal obstruction due to intestinal nonrotation.

One surgical option in cases of CDH could be repositioning the baby's organs and repairing the hole in diaphragm in utero.[20] Another treatment option comprises of blocking the baby's trachea with a small inflatable balloon. The success of this surgery is based on the fact that the fetus gets its oxygen supply via umbilical cord until birth.[21] Blocking the baby's trachea is likely to result in faster growth of the lungs in utero. However, this procedure was not associated with any improvement in the survival or morbidity rate in a cohort of fetuses with CDH.[22] Therefore this procedure was abandoned in the USA. Somewhat similar procedure is now being employed in Europe where even a smaller instrument is being used for inserting the balloon. The procedure is therefore much less invasive. Also, in this procedure, the device is removed after 6–8 weeks, rather than waiting until birth. This approach allows for more normal development of lungs. Clinical trials for testing this procedure are presently under way.

Clip or Balloon Fetal Endoscopic Tracheal Occlusion (FETO)

This procedure is performed at about 23–27 weeks of gestation. Preoperatively, the patient is given betamethasone for attaining fetal lung maturity. In this surgery, a 5-mm trocar is inserted inside the uterine cavity. Through this, a 4-mm perfusion hysteroscope is guided through the fetal vocal cords under the guidance of a fetoscope and ultrasound examination. A detachable silicone balloon is placed in the fetal trachea midway between the carina and vocal cords (Fig. 19.4). It is then inflated with iso-osmotic contrast material so as to fill the fetal trachea to a diameter

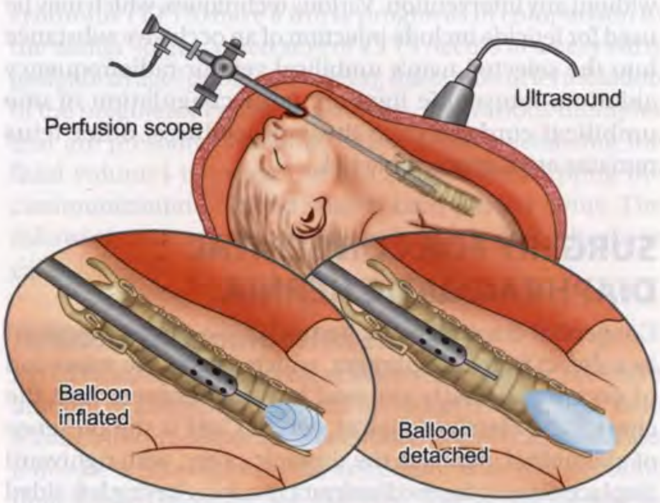


Fig. 19.4: Fetal endoscopic tracheal occlusion

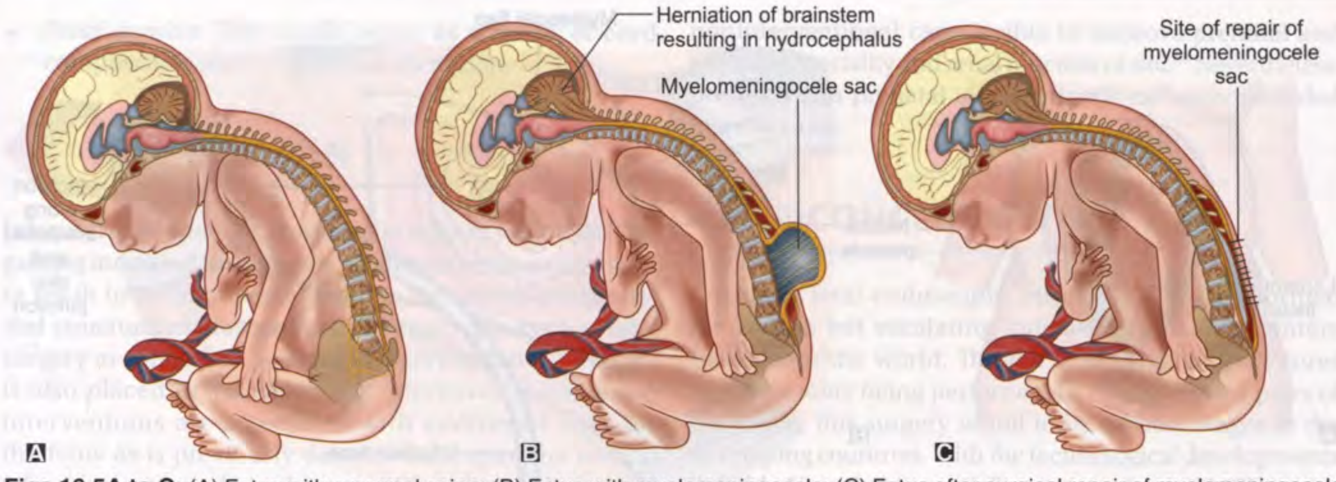
of about 0.5 mm and a length of at least 2 cm following which it is detached, so that it remains in place.[23,24]

At the time of delivery of fetal head during cesarean section, ex-utero intrapartum therapy (EXIT) procedure is done. The EXIT procedure comprises of following steps, which are executed prior to the division of umbilical cord:
- Deflation and removal of the balloon under bronchoscopic guidance,
- Suctioning of the airway
- Insertion of the endotracheal tube
- Administration of an exogenous surfactant (in the dosage of 3 mg/kg body weight)
- Starting assisted ventilation.

SURGERY FOR NEURAL TUBE DEFECTS

Neural tube defects occur due to the failure of closure of the neural tube during development. Neural tube defects can present with a spectrum of clinical manifestations, affecting the cranium or spine.
- *Cranial defects*: These include defects such as anencephaly, exencephaly, encephalocele, etc.
- *Spinal defects*: These can include defects such as open spinal dysraphism (spina bifida aperta) or closed spinal dysraphism (occult spinal dysraphism or spina bifida occulta).
  - Open spinal dysraphism: These defects are characterized by a cleft in the spinal column, through which there may occur herniation of the meninges (meningocele) or herniation of meninges along with the spinal cord (myelomeningocele). Myelomeningocele may be associated with severe nerve damage and other disabilities. Seventy to ninety percent of children with this condition also have hydrocephalus. On the other hand, some individuals with meningocele may have few or no symptoms while others may experience symptoms similar to closed spinal dysraphism.
  - Closed spinal dysraphism: This is characterized by failure of fusion of the vertebral bodies due to abnormal fusion of the posterior vertebral arches. There is no exposed neural tissue and the skin overlying the defect is intact. Spina occulta is the mildest and most common form of spina bifida in which one or more vertebrae are malformed. In most individuals it may not be associated with any symptoms and may be discovered at the time of radiological examination of the spine.

Current preventive strategies for prevention of neural tube defects are mainly based on folic acid supplementation in the antenatal period. They may be associated with the most common severely disabling birth defects. In the cases of open defects, the spinal cord must be covered surgically within a few days of birth (preferably within 48 hours of birth). It may be also closed in utero or at the time of fetal surgery (Figs 19.5A to C). Immediate closure of defect



Figs 19.5A to C: (A) Fetus with a normal spine; (B) Fetus with myelomeningocele; (C) Fetus after surgical repair of myelomeningocele

must be performed in cases of infants having leakage of cerebrospinal fluid. If there is an evidence of hydrocephalus, a diversion shunt needs to be inserted.

Though spina bifida is not a fatal condition, it has been found that repairing the defect in utero helps in minimizing the damage caused by spina bifida including paralysis, hydrocephalus, etc. Percutaneous fetoscopic patch coverage of spina bifida aperta also appears to be a feasible option in human fetuses and is likely to be associated with a significant reduction of maternal trauma in comparison to open fetal repair.[25] Further clinical experience is now required before proving the efficacy of the new approach to guard the bare neural tissue from mechanical and chemical damage and to improve hindbrain herniation.

According to the recently published results of the first part of "MOMS trial" (Management of Myelomeningocele Study), an ongoing randomized controlled trial since 2003, prenatal surgery for myelomeningocele at 26 weeks of gestation has been found to be associated with reduced requirement for postnatal shunting (at 12 months of age) and improved motor outcomes at 30 months.[26] However, the procedure has been found to be associated with significant maternal and fetal risks (prematurity, default hysterotomy scar, etc.). Therefore, potential benefits of prenatal surgery need to be balanced against the risks of prematurity and maternal morbidity.

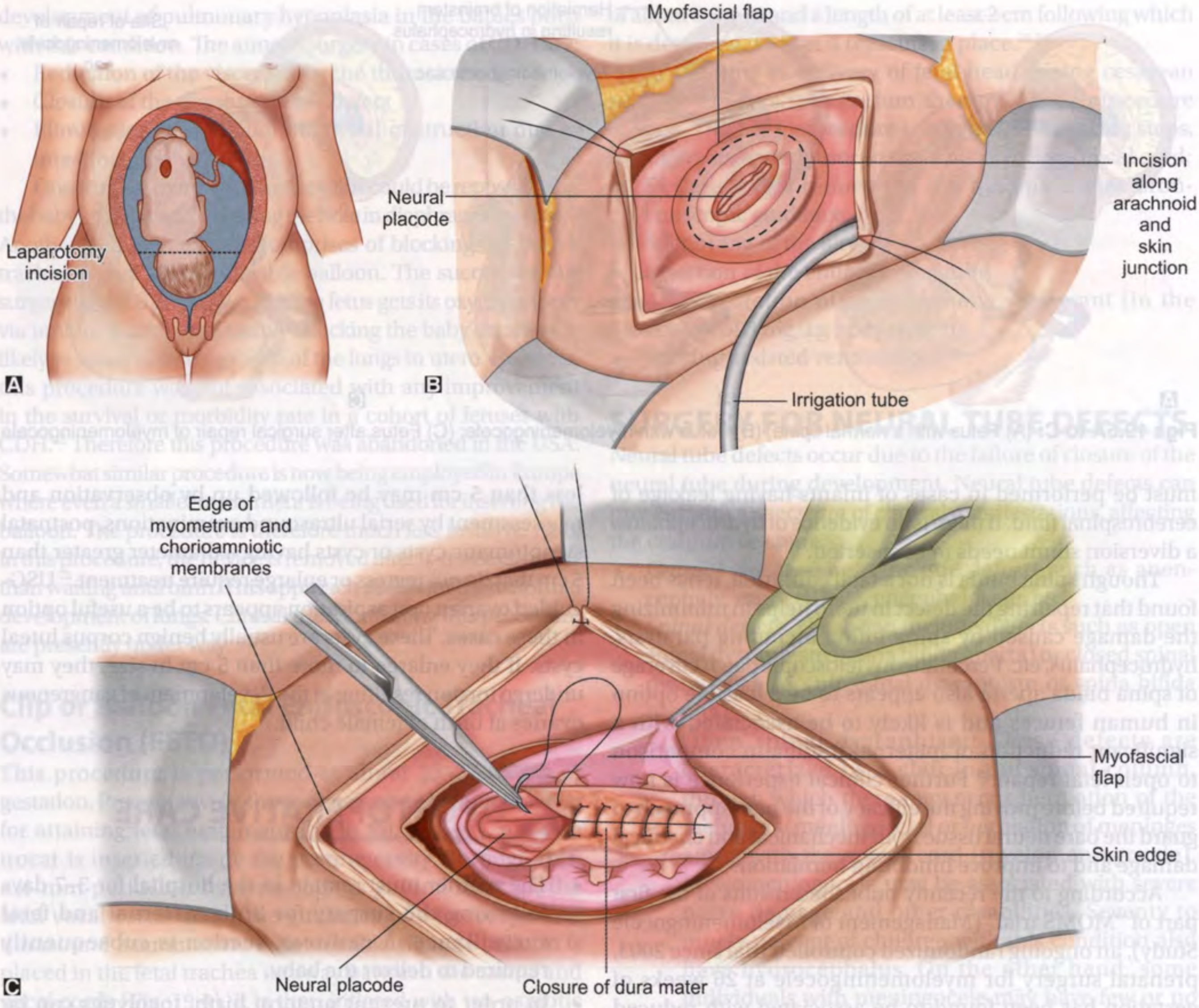
The prenatal surgery for myelomeningocele repair involves a laparotomy, hysterotomy and amniotomy to expose the fetal back in the defect. The closure of the defect is performed in a similar way as that performed in the postnatal stage (Figs 19.6A to C).

FETAL SURGERY FOR OVARIAN CYSTS

The most frequently diagnosed intra-abdominal cysts in the prenatal period are the ovarian cysts. Fetal or neonatal ovarian cyst may be associated with complications such as ovarian torsion, requiring surgical intervention. Though uncomplicated asymptomatic cysts having a diameter less than 5 cm may be followed up by observation and reassessment by serial ultrasound examinations, postnatal symptomatic cysts or cysts having a diameter greater than 5 cm that do not regress or enlarge require treatment.[27] USG-guided ovarian cyst aspiration appears to be a useful option in these cases. These cysts are usually benign corpus luteal cysts. If they enlarge to more than 5 cm in size, they may undergo torsion resulting in the development of gangrenous ovaries at birth of female child.

POSTOPERATIVE CARE

- The mother must remain in the hospital for 3–7 days following the surgery for both maternal and fetal surveillance. A cesarean section is subsequently required to deliver the baby.
- In order to prevent preterm birth, tocolytics can be administered both before and after the procedure.
- Antibiotics can also be administered both before and after the procedure to prevent infection.
- Constant maternal and fetal surveillance following the fetal surgery is required until the baby has been delivered. The patient is monitored using external cardiotocography for 2 hours after the procedure and the uterine irritability is treated with tocolysis and intravenous fluids. Fetus is monitored using ultrasound examination at 24–48 hours after the procedure and then weekly for 4–6 weeks to confirm fetal well-being, amniotic fluid volume, and functioning of the organ on which surgery had been performed.
- Delivery of the baby: Infants are delivered by planned cesarean delivery at approximately 36 weeks of gestation after the confirmation of fetal lung maturity by amniocentesis, unless premature labor results in an earlier delivery.
- Postnatal fetal assessment at regular intervals.



Figs 19.6A to C: Steps of fetal surgery involving repair of a meningomyelocele

ADVANTAGES

Fetal surgery is associated with the following advantages:

- Treatment of fetal diseases, which may result in intrauterine death if allowed to continue.
- Treatment of fetal diseases, which may result in irreparable damage postnatally if allowed to continue in utero.

COMPLICATIONS

Some of the complications related to fetal surgery are as follows:[28]

- *Maternal complications:* In fetal surgery mother is an innocent bystander, who is at risk of various complications related to anesthesia and surgery, e.g. blood loss, infection, injury to the surrounding organs, bowel obstruction, etc. Other complications related to surgery in pregnant women include placental abruption, chorioamnionitis, pulmonary edema due to tocolytic therapy, risk of uterine dehiscence and rupture.
- *Preterm labor*: Though the laparoscopic procedures are associated with much lower risk in comparison to the endoscopic procedures, all the procedures are associated with a substantial risk of preterm prelabor rupture of the membranes, preterm labor and birth of a premature baby.
- *Injury to the fetus during surgery*: The fetus may get injured at the time of fetoscopic surgery.
- *Requirement of cesarean delivery for future pregnancies*: In cases of open fetal surgery, cesarean delivery is required for all future pregnancies for the mother because of the hysterotomy.

- *Fetal demise*: This could occur as a result of cord compression and/or placental abruption.

DISCUSSION

Intrauterine repair of fetal malformations is nowadays gaining increased importance. Such interventions are likely to result in an improved prognosis for several congenital and structural malformations. The main drawback of fetal surgery in contrast to postnatal surgery is that the mother is also placed at increased risk. Moreover, intrauterine interventions are associated with additional risks for the fetus as is previously described. Despite the several advancements made in the area of imaging and minimal invasive surgery, there are many technical hurdles, which still need to be overcome. This includes requirements for miniaturized instrumentation, real-time high-resolution imaging, and harmless fetal access.[29] There is also ongoing research regarding the implementation of robotics in the field of fetal surgery.[30] This may help in reducing the morbidity rate while at the same time providing improved outcomes.

Application of stem cell or gene therapy also appears to be the future of fetal surgery. Through application of this therapy in utero, clinicians would have better chances of treatment of this disease before the appearance of debilitating symptoms. Moreover, in utero the immune system of the fetus is not properly developed. Therefore, the acceptance of the foreign cells at this stage appears to be more likely. If this could be made possible, it might become possible to treat diseases such as sickle cell anemia and other genetic blood disorders.[31] However, much more research and technical advancements are required before this therapy could turn into reality. Till then the clinicians need to rely on fetal surgery per se.

Several randomized trials have confirmed the benefit of fetoscopic laser coagulation of placental anastomoses in cases of TTTS[32,33] These trials have demonstrated the superiority of laser coagulation over serial amniotic drainage. Recently published results of the first part of "MOMS trial" have also demonstrated that prenatal closure of the myelomeningocele defect is associated with reduced requirement for postnatal shunting (ventriculoperitoneal shunt) and improved motor outcomes.[26] More randomized controlled trials are required in future in support of other fetoscopic procedures.

A systematic review of the literature has failed to show any benefit of prenatal interventions for preserving renal function.[34] In fact, in patients with normal renal function, it might be associated with the reduced chances of survival. Results of a randomized clinical trial (PLUTO trial), once published would help to determine whether intrauterine vesicoamniotic shunting for fetal bladder outflow obstruction, in comparison with conservative, noninterventional care, is able to improve prenatal and perinatal mortality and renal function or not.[35] Nevertheless, presently this prenatal intervention is not recommended in most cases.

CONCLUSION

Currently fetal endoscopic surgery is being performed for limited but escalating indications in select centers throughout the world. Though fetal surgical procedures are commonly being performed in the developed parts of the world, this surgery is still in its nascent stages in the developing countries. With the technological developments in field of imaging (especially sonography and MRI), many advances have being made in the field of fetal surgery. However, there still remains a wide potential for further development and many obstacles still need to be overcome.

Sonography is an essential part of this specialty and has been used extensively in the diagnosis of some congenital anomalies that may have debilitating or lethal consequences for the fetus. Nevertheless, the management of fetuses with treatable structural and congenital malformation continues to be one of the most significant challenges of obstetric surgery. Further experience and refinement is required for accurately providing prognosis for subsequent organ function following the completion of surgery. While performing these procedures, the surgeon has a moral and ethical responsibility of weighing maternal risks against fetal benefits. It may be reasonable to withhold a particular surgical procedure, especially that having questionable fetal outcome, so as not to endanger the mother's life. In future it may be possible to combine the in utero fetal surgical technique with stem cell therapy to repair the defects at an earlier stage, which might help in improving the overall outcome. Presently fetal therapy must be performed only in centers having extensive experience in the field of fetal medicine.

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SECTION 3

Operative Gynecology

20

CHAPTER

Surgery for Uterine Leiomyomas

INTRODUCTION

Myomas (fibromyomas, leiomyomas or fibroids) are well circumscribed benign tumors developing from uterine myometrium, most commonly encountered among women of reproductive age group (30–45 years), with their prevalence ranging between 20% and 40%.[1] The chances of having uterine fibroids increase until 50 years of age and then decline sharply. There are three types of fibroids: (1) submucosal; (2) intramural and (3) subserosal (Fig. 20.1A). Of the different types of fibroids, the most common are intramural (interstitial) fibroids, which are present in nearly 75% cases, followed by submucous (15%) and subserous fibroids (10%).[2] The submucosal fibroids, also known as subendometrial fibroids, grow beneath the uterine endometrial lining. This type of fibroid is thought to be primarily responsible for producing prolonged, heavy menstrual bleeding.[3] Intramural fibroids are the most common type and are located in the middle of myometrium. Subserosal fibroids, also known as the pedunculated fibroids grow beneath the uterine serosa, the outer uterine covering. These types of fibroids are the least common type.[4] Sometimes they may develop a pedicle and extrude out from the surface in form of pedunculated fibroids. Both submucous and subserosal fibroids can be pedunculated. Morphologically, a typical myoma appears as a pale, firm, rubbery, well-circumscribed mass distinct from neighboring tissues and has a whorled appearance due to presence of interlacing fibers of myometrial muscle, separated by varying amount of connective tissue fibers (Figs 20.1B and C). The fibroid is surrounded by a connective tissue capsule, which helps in fixing it to the myometrium.[5]

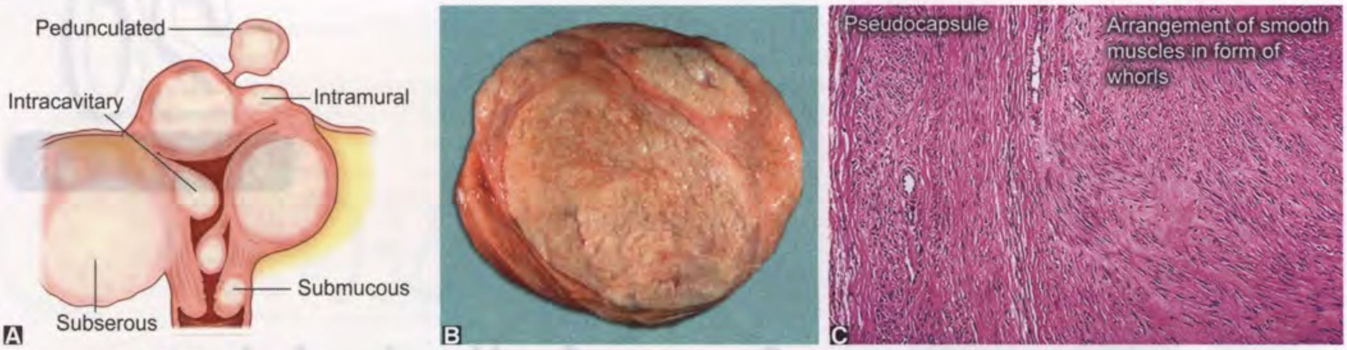
Fibroids can be single or multiple and may range in size from that of a small seedling to that of bulky masses, which can distort and enlarge the uterus. Small fibroids often remain undiagnosed as they rarely produce any symptoms. Although most leiomyomas are situated in the body of the uterus, they may be confined to the cervix, especially the supravaginal portion in nearly 1–2% cases.[6] The characteristic symptom of leiomyomas is menorrhagia; the duration of menstrual period may be normal or prolonged and the blood loss is usually heaviest on 2nd and 3rd day. The nearer the leiomyomas are to the endometrial cavity, the more likely are they to produce menorrhagia.[7,8]

OVERVIEW OF SURGERY

Surgery forms the definite treatment modality for uterine leiomyomas. The three main surgical options, which can be used in the women with leiomyoma uterus include: myomectomy, hysterectomy and more recently uterine artery embolization (UAE). Hysterectomy has been discussed in details in Chapter 24 (Hysterectomy). The remaining two procedures would be discussed in details in this chapter. Myomectomy refers to selective surgical removal of the uterine leiomyomas. UAE is a procedure which aims at causing the shrinkage of a fibroid by blocking its blood supply.

AIMS OF SURGERY

Each of the surgical option mentioned above either helps in removal of the myoma or causing reduction in its size by blocking their blood supply. The advantage of myomectomy or UAE over hysterectomy in the patients with uterine fibroids is that besides enabling the removal of a uterine



Figs 20.1A to C: (A) Different types of leiomyomas; (B) Macroscopic appearance of a leiomyoma appearing as a pale, firm, rubbery, well-circumscribed mass; (C) Histological appearance of a fibroid showing presence of interlacing smooth muscle fibers surrounded by varying amount of connective tissue

myoma, the procedure such as UAE or myomectomy enables the women to retain their fertility.

INDICATIONS

Medical therapy has no role in the definite treatment of myomas. Surgery forms the mainstay of treatment in cases of leiomyomas. Besides acting as the definitive cure for myomas, surgical management is also used in the circumstances which are enumerated below:[9,10]

- Control of excessive uterine bleeding.
- Control of pain and symptoms related to excessive pelvic pressure.
- Cases where the fibroids appear to be the likely cause of infertility by causing distortion of endometrial cavity or tubal occlusion.[11]
- Cases of menorrhagia not responding to conservative or other medical treatment modalities.
- Cases where there is a high clinical suspicion of malignancy.
- Growth of fibroid continues to occur even following the menopause.
- Menorrhagia results in severe iron deficiency anemia.
- Cases of recurrent pregnancy losses (all the other causes have been ruled out and uterine fibroids appear to be the most likely cause of recurrent miscarriages).

Some of the indications for surgery in cases of leiomyomas are summarized in Table 20.1. Myomectomy is indicated in infertility patients only if there is a significant distortion of the uterine wall or endometrial cavity or if there is obstruction or distortion of the fallopian tubes by the myomas. Secondly, myomectomy is indicated in patients who wish to retain their uterus and the myomas are significantly symptomatic.

The two surgical procedures which are commonly performed in the cases of leiomyomas are myomectomy, which involves selective removal of fibroids from the uterine cavity and hysterectomy, which involves the removal of the entire uterus. The route of surgery can vary from case to case. Myomectomy can be performed as a laparotomy procedure or at times even through the laparoscope or a hysteroscope. Hysterectomy can be performed in three ways: (1) abdominally; (2) vaginally and (3) in some cases laparoscopically. Different factors to be taken into consideration before deciding the route of surgery are enumerated in Table 20.2. For detailed description of various types of hysterectomies, refer to Chapter 24 (Hysterectomy).

Table 20.1: Indications for surgery in cases of leiomyomas

♦ Presence of large fibroids (> 3 cm in diameter)
♦ Severe bleeding, having a significant impact on a woman's quality of life, which is refractory to medical therapy
♦ Persistent or intolerable pain or pressure
♦ Urinary or intestinal symptoms due to presence of a large myoma
♦ History of infertility and future pregnancy is desired
♦ History of recurrent spontaneous abortions and future pregnancy is desired
♦ Rapid enlargement of a myoma (especially after menopause) raising the suspicion of leiomyosarcoma (a rare cause)

HYSTERECTOMY

Hysterectomy, a major surgical operation involving the removal of the woman's uterus helps in providing definitive cure for uterine leiomyomas. Some of the indications for hysterectomy are enumerated in Table 20.3.[12]

Usually vaginal hysterectomy is preferred over abdominal hysterectomy. Compared with abdominal hysterectomy, vaginal hysterectomy is associated with reduced rate of morbidity (shorter hospital stay and faster recovery) and other complications. Laparoscopic hysterectomy or laparoscopically assisted vaginal hysterectomy (LAVH) is also associated with reduced rate of morbidity and complications (postoperative pain, hospital stay and recovery period) in comparison with abdominal hysterectomy.[13] However, LAVH may not be widely available

Table 20.2: Factors to be taken into consideration before deciding the route of surgery

♦ Presence of other gynecological conditions or diseases
♦ Uterine size
♦ Location, number and size of uterine fibroids
♦ Mobility and descent of the uterus
♦ Size and shape of the vagina
♦ History of previous abdominal surgery

Table 20.3: Indications for hysterectomy

♦ The woman no longer wishes to retain her uterus and fertility
♦ Patient wishes for amenorrhea
♦ Other treatment options (medical, myomectomy, UAE, etc.) have failed or are contraindicated

Abbreviation: UAE, uterine artery embolization

as its performance requires specific laparoscopic training and skills.

MYOMECTOMY

Surgical removal of myomas from the uterine cavity is termed as myomectomy. Although myomectomy allows preservation of the uterus, present evidence indicates a higher risk of blood loss and greater operative time with myomectomy in comparison with hysterectomy.[14] Numerous techniques are used nowadays for performing myomectomy. These include the following: performing a myomectomy through an abdominal incision (Fig. 20.2) with the help of a hysteroscope (Fig. 20.3) or a laparoscope (Fig. 20.4). Removal of the myoma relieves symptoms in more than 75% of women. Some of the indications for myomectomy are listed in Table 20.4.

For detailed description regarding hysterectomy, kindly refer to Chapter 24 (Hysterectomy). This section would be primarily discussing various types of myomectomies. Summary of American Congress of Obstetricians and Gynecologists (ACOG) practice bulletin (2000) regarding the management of leiomyomas is enumerated in Table 20.5.[15] There are times, when myomectomy is associated with uncontrollable bleeding and thus needs to be converted into an abdominal hysterectomy during the time of planned surgery. Therefore, if myomectomy is selected as the therapeutic option, the women should be counseled about small risk of reoperation and the risk of conversion to hysterectomy.

Deciding the Type of Myomectomy to be Performed

Myomectomy can be performed via abdominal, laparoscopic, hysteroscopic or robotic routes. The next question, which requires to be answered is, what type of myomectomy would be associated with the best patient outcome—abdominal, laparoscopic, hysteroscopic or robotic? These various options are discussed further.

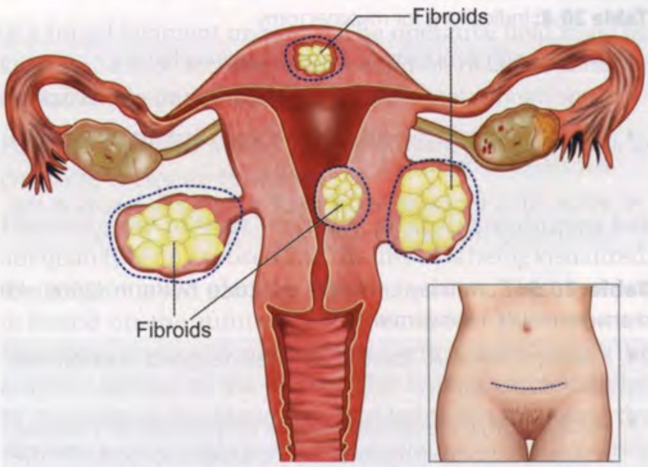


Fig. 20.2: Abdominal myomectomy

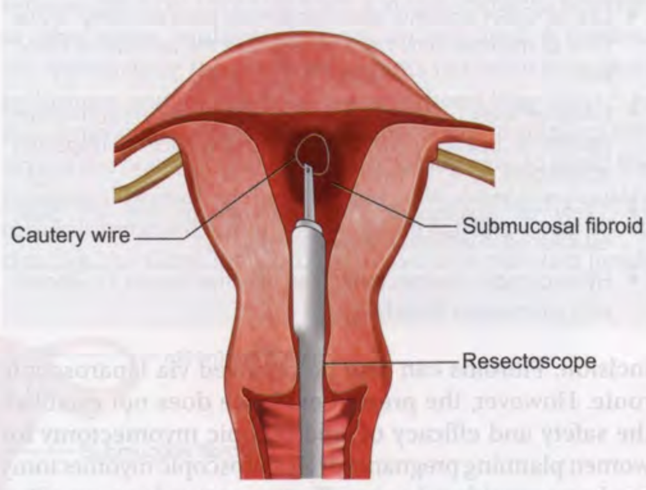


Fig. 20.3: Hysteroscopic myomectomy

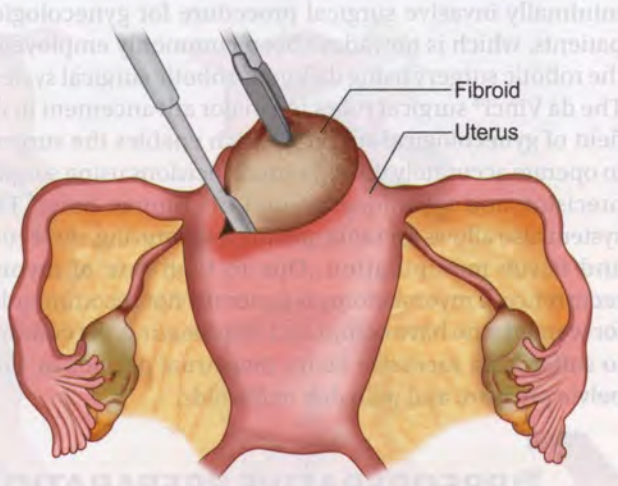


Fig. 20.4: Laparoscopic myomectomy

The advantage of abdominal myomectomy is that large fibroids can be quickly removed. The surgeon is able to feel the uterus which is helpful in locating myomas that may be deep in the uterine wall or are very small in size. The disadvantage of laparotomy is that it requires an abdominal

Table 20.4: Indications for myomectomy

• Women with symptomatic myomas, desiring fertility
• Large myomas (especially the submucosal or intramural type)
• Any symptomatic fibroid (which causes menometrorrhagia) also needs to be treated
• When IVF is indicated (especially if the myoma results in the distortion of the uterine cavity)

Table 20.5: Summary of ACOG practice bulletin (2000) for management of leiomyomas

• Evidence level A (based on well-designed, randomized controlled trials)
• Hysterectomy is the definitive cure for symptomatic leiomyomas; however, abdominal myomectomy is a safer and more effective option in women who wish to become pregnant
• Use of GnRH agonists and vasopressin preoperatively at the time of myomectomy helps in reducing the amount of blood loss
• Evidence level C (based on evidence from expert committee reports or opinions and/or clinical experience of respected authorities)
• Safety of laparoscopic myomectomy has not yet been established in women planning pregnancy
• Hysteroscopic myomectomy is an effective option for women with submucous fibroids

incision. Fibroids can also be removed via laparoscopic route. However, the present evidence does not establish the safety and efficacy of laparoscopic myomectomy for women planning pregnancy.[16] Hysteroscopic myomectomy has been considered as an effective option for controlling menorrhagia in women with submucous fibroids.[17,18] A new minimally invasive surgical procedure for gynecological patients, which is nowadays been commonly employed is the robotic surgery using da Vinci® robotic surgical system. The da Vinci® surgical robot is a major advancement in the field of gynecological surgery, which enables the surgeon to operate accurately through small incisions using surgical precision and technique beyond the human hand. This system also allows for rapid and precise suturing, dissection and tissue manipulation. Due to high rate of myoma recurrence, a myomectomy is generally not recommended for women who have completed childbearing, yet continue to suffer from excessive heavy menstrual periods or from pelvic pressure and pain due to fibroids.

PREOPERATIVE PREPARATION

MYOMECTOMY

The preoperative preparation prior to myomectomy (whether performed abdominally, laparoscopically, hysteroscopically or via robotic route) involves the following steps:

- *Patient counseling and informed consent*: The patient must be made to understand the exact nature of the procedure of myomectomy so that she knows what to expect. She should also be counseled regarding the possibility that intraoperative findings may contraindicate myomectomy and the surgeon may be forced to perform a hysterectomy instead of myomectomy.
- Patient's hematological status must be determined. Since the women with uterine fibroids may be commonly suffering from menorrhagia, the patient's iron stores must be preferably built up prior to the procedure.
- If the patient is suffering from severe menorrhagia, amenorrhea can be induced using the drugs such as progesterone acetate, danazol, GnRH agonists, etc.
- Hysteroscopy, hysterosalpingography or transvaginal sonography must be performed prior to myomectomy in order to assess the number, location and size of myomas. A preoperative hysterosalpingogram helps in assessing the distortion of the fallopian tubes or the uterine cavity. Assessment of the patency of the uterine tubes helps in predicting fertility. Tubal occlusion does not serve as a contraindication for myomectomy because the patient may still be able to conceive with the help of in vitro fertilization (IVF).
- Preoperative antimicrobial prophylaxis is required before the commencement of surgery.
- The surgery is usually performed under general anesthesia.
- After the administration of anesthesia, careful abdominal and pelvic examination including a rectovaginal and abdominal bimanual examination under general anesthesia must be performed. Abdomen must also be palpated for presence of any mass. Palpating a large myoma per abdominally prior to laparoscopic myomectomy may help in determining the position of laparoscopic probes. The laparoscopic ports must be placed above and lateral to the mass in order to maximize visualization at the time of surgery.
- Cervical dilatation to facilitate postoperative drainage from the uterine cavity must be performed, especially for the cases where the endometrial cavity had been entered during myomectomy.
- The patient's abdomen must be cleaned and draped.
- Bladder must be catheterized with the help of Foley's catheter.

UTERINE ARTERY EMBOLIZATION

The procedure of UAE itself lasts 1–2 hours. Although anesthesia is not required, the procedure is usually performed under sedation. The remaining preoperative steps are same as those previously described with myomectomy except for those which are specific for myomectomy.

SURGICAL STEPS

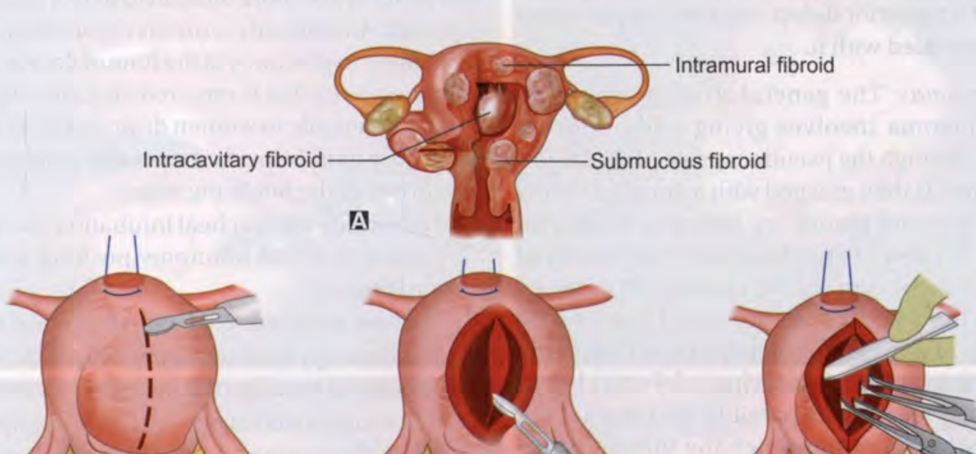
ABDOMINAL MYOMECTOMY

Technique of abdominal myomectomy has been explained in Figures 20.5A to G.

Abdominal incision: Type of abdominal incision must be decided only after taking into account the size, location and the number of the myomas. The surgeon needs to form a mental picture regarding how he/she would go about removing the myomas and reconstructing the uterus following their removal. Planning the adequate surgical exposure is of vital importance. It helps in shortening the bleeding time as well as identifying any bleeding occurring from the uterine surface. Adequate exposure can be usually achieved through a Pfannenstiel incision. However, if more space is required, a modification of the transverse incision, i.e. either a Cherney's incision (rectus muscles are separated from the pubis symphysis) or Maylard's incision (rectus muscles are transversely cut), can be performed. Sometimes a vertical midline incision can also be given if larger space at the time of surgery is required, e.g. in case of a broad ligament myoma.[19] The operative field must be kept moist and clot-free using a solution of lactated ringer containing heparin.

Patient's position: A mild Trendelenburg position helps in ensuring adequate exposure.

Planning the uterine incision: After the abdomen has adequately been exposed and the uterus is being visualized, the surgeon must plan the uterine incision. This decision is based on the number and location of the myomas. The most preferred incision is a vertical incision on the anterior surface of the uterus. This type of incision helps in minimizing the blood loss and helps in preventing the development of adhesions of the ovaries to the posterior uterine walls postoperatively. The surgeon often can remove multiple myomas from a single incision, whereas at other times, multiple incisions are required. A method for approaching the posterior myoma has been described by Bonney and is called the Bonney's hood (Fig. 20.6).[20] In this approach, an elliptical incision is made transversely across the posterior fundal region, taking care to avoid the interstitial portion of the fallopian tube. After the primary tumor is removed, other leiomyomata can also be removed through the same incision. Excessive myometrium needs



Figs 20.5A to G: Procedure of abdominal myomectomy: (A) Uterus showing presence of multiple myomas; (B) A vertical uterine incision given over the anterior surface of the uterus, avoiding a posterior incision wherever possible; (C) The incision extended through the pseudocapsule to expose the myoma; (D) The plane of cleavage being developed between the myoma and the myometrium with the help of blunt and sharp dissection; (E) The myoma is enucleated and delivered outside the uterus; as many myomas as possible are removed from this incision, thereby avoiding a second incision; (F) The uterine myometrium is being approximated using layered interrupted delayed-absorbable suture and (G) The uterine serosa is sutured in a running "baseball" fashion

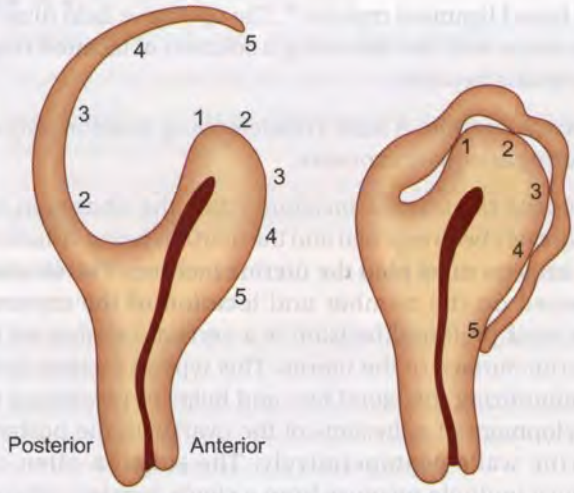


Fig. 20.6: Bonney's hood

to be trimmed away. Interrupted sutures in layers are then used to obliterate the dead space, approximate the myometrium and accomplish satisfactory hemostasis. The posterior flap of myometrium is draped over the fundus and fixed to the anterior surface of the uterus with the help of fine sutures. This is known as the Bonney's hood. Thus, this method creates a functional anterior incision, but at the same time avoids a posterior defect and the complications which may be associated with it.

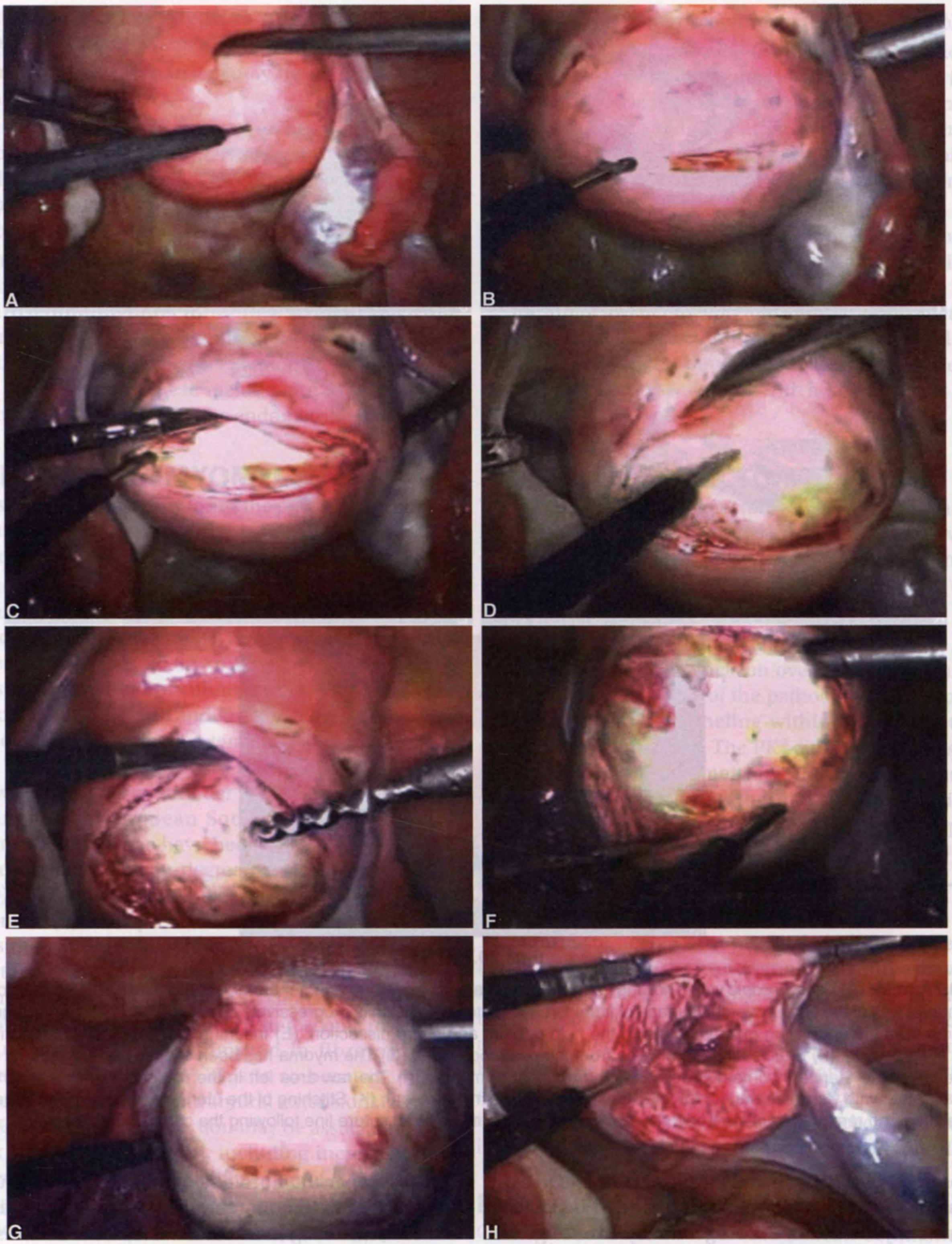
Removing the myomas: The general strategy employed for removing a myoma involves giving a linear or an elliptical incision through the pseudocapsule of the largest myoma. The myoma is then grasped with a double toothed tenaculum. As the tissue planes are exposed, blunt and sharp dissection is used to enucleate the myoma out of the capsule. If the dissection can be carried out between the myoma and the pseudocapsule, blood loss can be minimized. As the myoma is completely excised out of the uterine myometrium, an oozing cavitary defect is left in the uterus. As many myomas as possible are resected out through this incision, following which the uterine defect is closed.

Repair of the uterine defect: Method of closing the resultant uterine defect varies from individual to individual. The main aim is to restore normal anatomy and to ensure adequate hemostasis. At the same time, due attention must be paid towards minimizing the dead space. Despite meticulous attempts to achieve this, many a times, some areas may remain open and fill up with blood. These pockets of blood may serve as the medium for infection. To minimize the development of dead space, most surgeons prefer to close myoma bed using interrupted figure-of-eight sutures or mattress 2-0 delayed absorbable sutures rather than the continuous ones. Layered interrupted sutures are time consuming but provide the best prospects for tissue coaptation. After the myometrial layers have been adequately reapproximated, excess serosa may be trimmed and the serosal defect repaired with a fine polyglycolic suture in a running "baseball" fashion. Following the end of the repair process, an absorbable barrier, such as intercede (oxidized regenerated cellulose), can be placed over the uterine corpus to protect the tubes and ovaries from denuded peritoneal surfaces and uterine incision. This technique helps in minimizing the development of uterine adhesions.

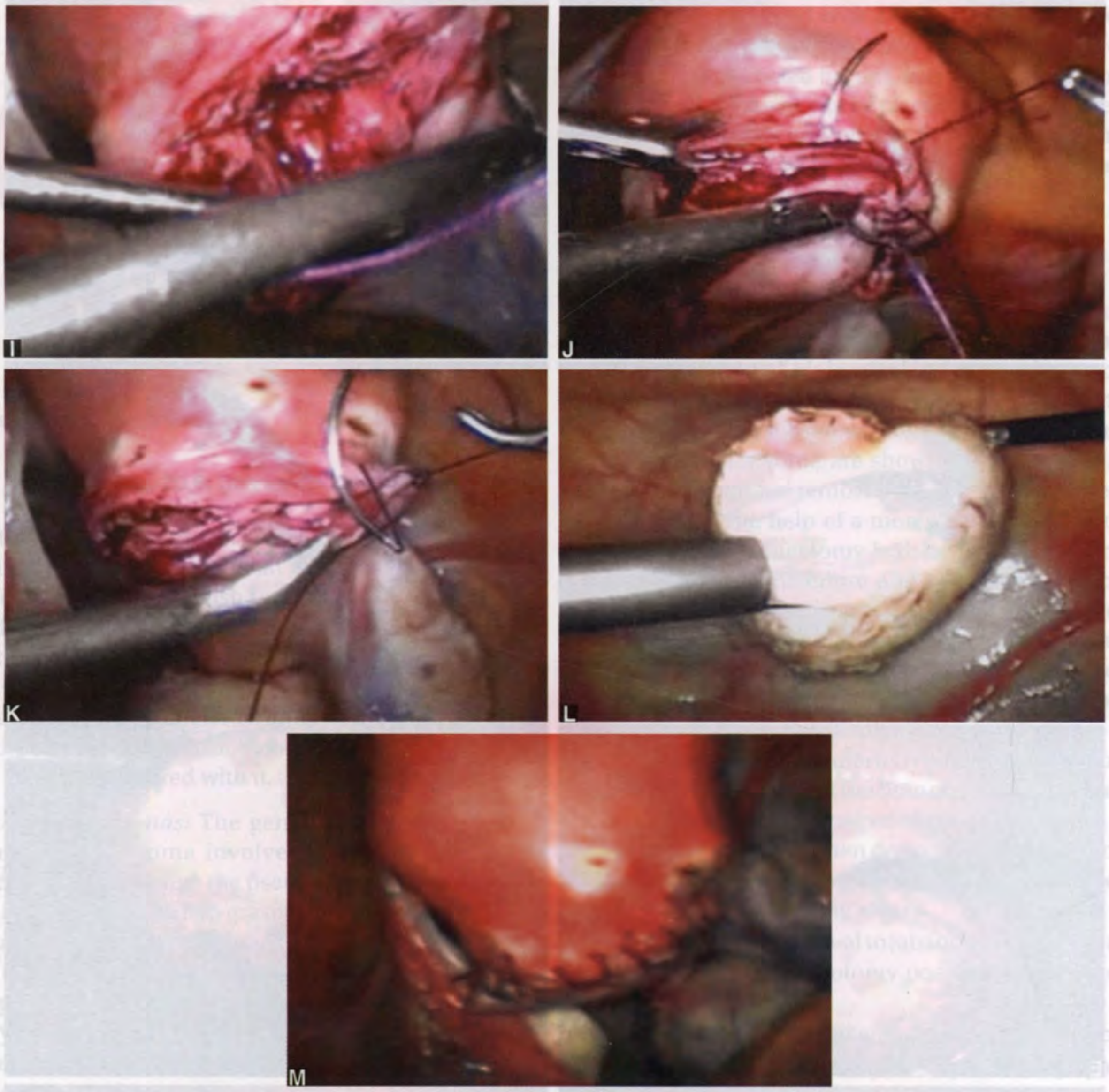
LAPAROSCOPIC MYOMECTOMY

Fibroids can also be removed by laparoscopy. The challenges of this surgery rest with the surgeon's ability to remove the mass through a small abdominal incision and to reconstruct the uterus.[21] Laparoscopic myomectomy is most commonly used for removing subserosal fibroids. The steps for removal of a subserosal myoma are shown in Figures 20.7A to M. Once the fibroids are removed, they are cut into pieces and removed with the help of a morcellator. The advantage of laparoscopic myomectomy is that this can be performed as an outpatient procedure and allows faster recovery in comparison with a conventional laparotomy. One of the disadvantages of the procedure is that extended time may be sometimes required for removing large fibroids from the abdomen. Since the surgeon cannot actually touch the uterus, it may be more difficult to detect and remove smaller myomas. Additionally, a uterus repaired laparoscopically is more likely to give away at the time of delivery in comparison with the uterus that is repaired abdominally.[22] This is likely to be problematic in women desiring future pregnancy. The procedure must be performed under general anesthesia and comprises of the following steps:

- Following endotracheal intubation, the patient must be placed in dorsal lithotomy position and then cleaned and draped.
- Bladder is catheterized with the help of Foley's catheter.
- Hysteroscopy is mandatory before performing laparoscopy in order to visualize the uterine endometrium.
- Following hysteroscopy, a uterine manipulator is placed inside the uterine cavity to facilitate its mobilization and visualization.
- Initially a diagnostic laparoscopy is performed. If there are adhesions, endometriosis or ovarian cysts at the time of pelvic examination, these conditions must be treated accordingly.
- In order to minimize blood loss at the time of myomectomy, myometrium around the myoma is injected with a dilute vasopressin solution.
- Two or three small, half-inch incisions are made above the pubic hairline and the laparoscopic instruments are passed through these small incisions to perform the surgery.
- After reaching the uterus, the subserosal fibroid is grasped and freed from its attachments to the normal uterine muscle. In case of a subserosal fibroid attached by a stalk to the uterine surface, the stalk of the



Figs 20.7A to H



Figs 20.7I to M

Figs 20.7A to M: (A) Laparoscopic view showing the presence of a fibroid over the anterior surface of the uterus; (B) An incision given in the anterior wall of the fibroid over the surface of fibroid; (C) The uterine incision is progressively enlarged; (D) The myoma is gradually shelled out from the underlying myometrium with the help of blunt and sharp dissection; (E) Inserting a myoma screw to facilitate the process of dissection; (F) Enucleating the myoma from the pseudocapsule; (G) The myoma has been shelled out completely; (H) The raw area left in the uterine myometrium following the removal of myoma; (I) The raw area left in the uterus after myoma removal is stitched together with vicryl sutures; (J) Layered closure of uterine myometrium; (K) Stitching of the uterine serosa; (L) The large fibroid is morcellated and removed from the body; (M) Appearance of the myometrial suture line following the completion of surgery

subserosal fibroid is cut and the fibroid is freed. In case of a subserosal fibroid, partly embedded inside the uterine myometrium, the surgeon may have to give a uterine incision over the myoma.

- While performing the hysterotomy incision, it is important to incise through the pseudocapsule of fibroid to facilitate its dissection.
- Once the myoma is seen pushing through the pseudocapsule, strong and firm grasping equipment must be used to dissect out and hold the myoma.
- The deeper the fibroid is embedded into the uterine muscle wall, the more difficulty may be encountered while removing it. In these cases, an incision is given over the surface of the fibroid, following which the fibroid is gradually shelled out from the uterine musculature or removed using a myoma screw.
- Once the entire myoma has been shelled out, meticulous multilayered closure of the uterine defect must be performed. The uterine wall is repaired using laparoscopically applied sutures. Laparoscopic suturing

with small instruments requires considerable amount of surgeon skill, experience and judgment.

- Interceed adhesion barriers may be placed over the repaired uterine defect.
- The shelled out fibroids must then be evacuated from the pelvis as a separate step. The fibroid can be cut into small pieces with a specially designed instrument called a morcellator and brought out of the abdomen through the port sites.
- If future fertility is desired, then the strength of the uterine wall repair is important. Thus before undertaking laparoscopic myomectomy in a woman desiring future fertility, factors which are likely to influence uterine wall strength following repair, need to be taken into consideration. These include size of fibroid and closeness of the myoma to the endometrial cavity.

HYSTEROSCOPIC MYOMECTOMY

Hysteroscopic myomectomy forms the procedure of choice for completely submucosal myomas or those myomas having less than 50% extension into the myometrium.

Hysteroscopic myomectomy can be performed as a simple outpatient procedure wherein a hysteroscope is placed inside the uterine cavity and the leiomyomas are resected out (Figs 20.8A to H).[23] The technique of hysteroscopic resection of submucous leiomyomas was first described by Neuwirth and Amin in 1976.[24] In order to avoid the possibility of inadvertent uterine perforation or to allow its immediate diagnosis, hysteroscopic resection must always be performed under laparoscopic guidance. According to the European Society of Hysteroscopy, submucous leiomyomas have been classified into three categories depending on the degree of myometrial invasion (Fig 20.9): (1) T-0 corresponds to pedunculated submucous leiomyomas; (2) T-I represents submucous leiomyomas with less than 50% invasion into the myometrial wall and (3) T-II those with greater than 50% invasion. Myomas belonging to the categories T-0 and T-I should be attempted for removal using a hysteroscope. Hysteroscopic resection should not normally be attempted in fibromyomas belonging to T-II category.[25] This is so because, when submucous myomas have intramural extensions greater than 50%, hysteroscopic resection may be associated with a higher rate of complication, including increased rate of conversion to laparotomy, higher rate of intravascular extravasation of distending media, prolonged operating times and increased requirement for repeat surgery.

Therefore, endoscopic removal of intramural or submucosal leiomyomas larger than 5 cm in diameter or with myometrial involvement greater than 50% should be attempted only by very experienced endoscopists.[26] Hysteroscopic resection of submucous fibroids also helps in alleviation of symptoms, such as menorrhagia or abnormal uterine bleeding (AUB).

The steps of hysteroscopic myomectomy are as follows:

- *Instillation of fluid inside the uterine cavity*: Since the use of hysteroscope requires instillation of fluid inside the uterine cavity, it is important to monitor ongoing fluid balance carefully during hysteroscopic removal of fibroids. Fluid balance must carefully be monitored by the surgeon and the anesthetist in order to prevent the fluid overload.
- *Resection of the myoma*: The submucosal myoma is resected out using a resectoscope. Sometimes, it may not be possible to perform a complete resection when the tumor invaders deeply into the uterine myometrium. All the tissue resected out must be submitted for a histopathological examination. Resection is carried out with a hysteroresectoscope with a 12° angle lens and a matching electrode.

ROBOTIC MYOMECTOMY

The steps of robotic myomectomy have been illustrated in Figures 20.10A to F. There are four following ways in which da Vinci® technology facilitates a precise myomectomy:

Hysterotomy

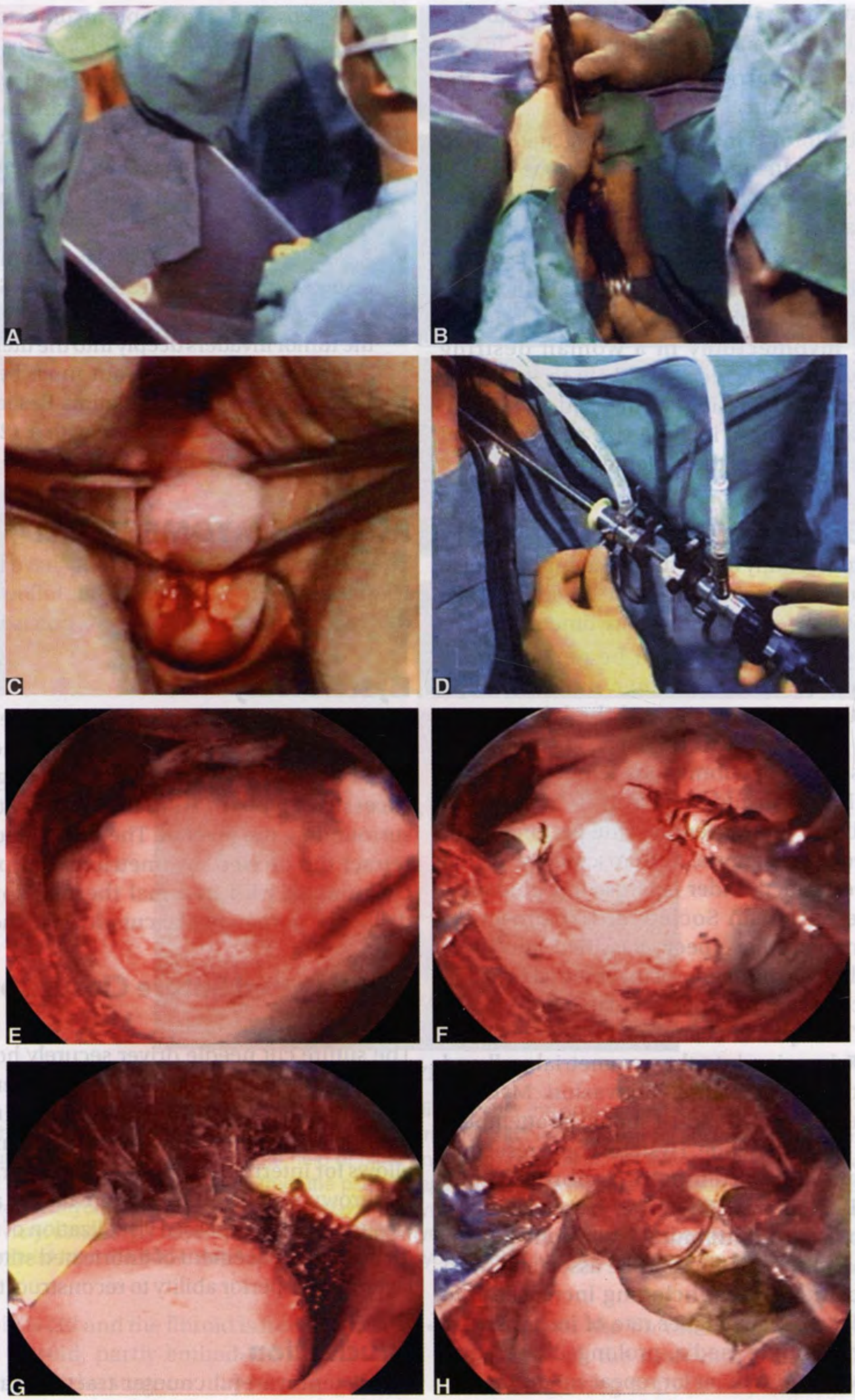
The permanent cautery hook allows the surgeon to make a horizontal or vertical incision over the uterine surface, based upon the location of the pathology, while avoiding excessive divots or tunneling within the myometrium surrounding the myoma. The PK® dissecting forceps help retract the incised myometrium and provide improved coagulation with minimal thermal spread to facilitate deliberate perpendicular cuts down to the myoma capsule.

Multilayered Suture Closure of Defect—Deep Layers

The suture cut needle driver securely holds CT-2 needles as they pass through the myometrial layers while providing integrated cutting following knot tying for improved operative efficiency. The EndoWrist® large needle driver allows for interrupted figure-of-eight or running sutures to be thrown and tied intracorporeally for a deep multilayer closure. The unsurpassed visualization of the camera allows for accurate placement of imbricated stitches in additional layers and superior ability to reconstruct the uterine defect.

Enucleation

Consistent, careful counter traction can be attained by utilizing the EndoWrist® tenaculum forceps while avoiding entrance into the endometrial cavity or premature avulsion of the myoma. The PK® dissecting forceps facilitate development of the correct dissection plane surrounding the myoma, while also providing more site-specific counter traction, facilitating a more precise dissection and enucleation of the fibroid. The hot shears is used to peel the



Figs 20.8A to H: Steps of hysteroscopic myomectomy: (A) Aseptic preparation of vagina before the introduction of hysteroscope; (B) Introduction of the Sims' speculum to retract the posterior vaginal wall; (C) Holding the anterior lip of cervix with tenaculum forceps; (D) Introduction of hysteroscope; (E) Hysteroscopic view of the uterus showing submucous leiomyoma; (F) The resectoscope loop placed over the fibroid before starting resection; (G) Progressive resection of successive layers of myomas; (H) Appearance of the uterine endometrium after the resection of uterine myoma is almost complete

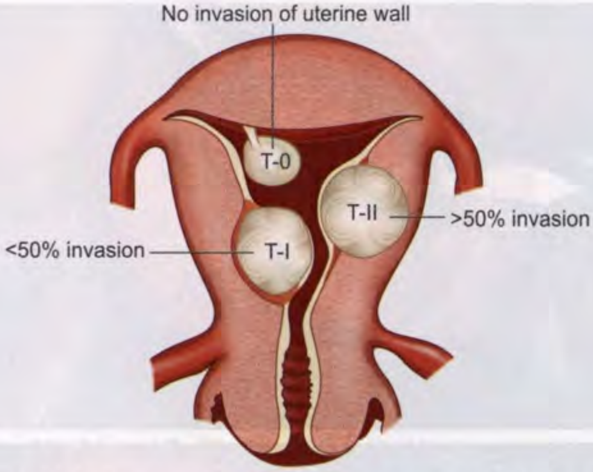


Fig. 20.9: European Society of Hysteroscopy classification of myomas

myoma free of all attachments. Coagulation with the PK® dissecting forceps should be carefully used to proactively deal with vascular attachments.

Multilayered Suture Closure of Defect—Superficial Layer

All EndoWrist® needle drivers are fully wristed, enabling quick and efficient knot typing. The long tip forceps is used to perform a running baseball stitch with an SH needle in order to close any dead space and avoid serosal pull-through. The suture cut needle driver is used to manipulate the tissue for needle bite placement and to cut the suture.

UTERINE ARTERY EMBOLIZATION

The UAE is a relatively new, novel technique for treatment of uterine fibroids, which was first performed by Ravina, a French Gynecologist in 1995.[27] The UAE is a nonhysterectomy surgical technique, which helps in reducing the size of the uterine fibroids by shrinking them, without actually removing them. Besides uterine fibroids, the technique of embolization has been used to treat various other medical pathologies such as inoperable cancers, brain aneurysms, arteriovenous shunts in the lung, etc.

The procedure of UAE comprises of the following steps:

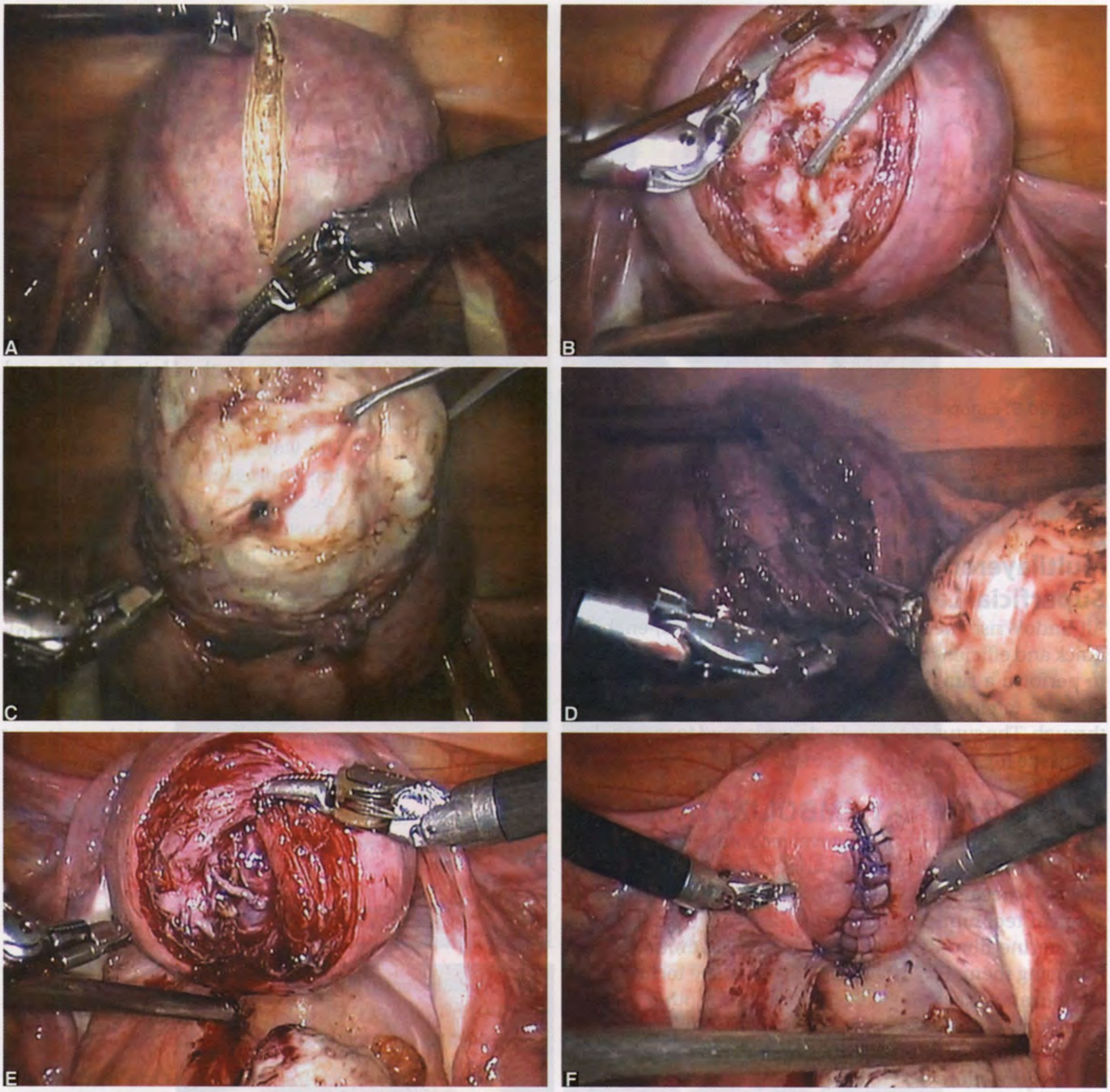
- The interventional radiologist introduces and manipulates a catheter through the femoral artery into the internal iliac and uterine arteries (Fig. 20.11).
- Once the fibroids are visualized on X-ray, an embolizing agent [gelatin microspheres (trisacryl gelatin) or polyvinyl alcohol] is injected, which helps in blocking both the uterine arteries, thereby cutting off the blood supply to the fibroids (Figs 20.12A and B). Compared to normal uterine cells, fibroid cells are much more sensitive to low oxygen saturation. Thus, the lack of sufficient blood supply causes the fibroids to become avascular and shrink, ultimately resulting in cell death, their degeneration and eventual absorption by the myometrium. The normal myometrium, on the other hand, receives new blood supply from vaginal and ovarian vasculature.
- As fibroids begin to undergo necrosis, any active bleeding commonly subsides.
- The dying cells of the fibroids may release toxins, which may cause irritation of the surrounding tissues, thereby causing pain and inflammation in the first few days following the procedure. Although the rate of recovery usually varies from one woman to the other, it usually takes a few months for the fibroids to fully shrink and the full effect of the procedure to be evident.

Till date, this procedure has been performed in approximately 30,000 women in the United States and another 20,000 women worldwide. As a result, presently there is limited evidence regarding the safety and efficacy of the procedure.[28] The worldwide success rate of the procedure in producing improvement of symptoms has been considered to be approximately 85%. The UAE may be the right treatment choice in women in whom the symptomatic relief may be obtained by shrinking the fibroids to a little more than half their present size. However, UAE may not be very helpful for women with extremely large fibroids because they may not shrink enough to make a significant difference in the symptoms. Around 3–6 months following UAE, the uterus and fibroids are likely to have reduced by about 40% in size. About 90% of women who were symptomatic due to the large size of their fibroids would experience a significant improvement in their symptoms. About 10–15% of women who have UAE may continue to suffer from menorrhagia and may require some other treatment modality.

POSTOPERATIVE CARE

Postoperative care following the procedure of myomectomy (whether abdominal, hysteroscopic or laparoscopic) comprises of the following steps:

Detection of postoperative bleeding: One of the most important complications associated with the procedure of myomectomy is the occurrence of intraperitoneal bleeding. Therefore, the surgeon must remain extremely vigilant during the postoperative period to detect such bleeding. The diagnosis of intraperitoneal bleeding during the postoperative period may be difficult. Even in the presence of intraperitoneal bleeding, the vital signs can remain stable for several hours before they actually start deteriorating. Peritoneal signs are often subtle and may be masked by the incisional pain and analgesic medications. Additionally, peritoneal cavity has an enormous capacity for accommodating the occult blood loss. A large amount of blood may accumulate in the peritoneal cavity without



Figs 20.10A to F: Robotic myomectomy: (A) Using the robotic harmonic shears, a hysterotomy is made over the myoma; (B and C) Shelling out of myoma; (D) Myoma has been completely removed from the myoma bed; (E) A multilayer closure is performed employing sutures and suturing techniques that are identical to those of an open myomectomy; (F) Suturing of the uterine surface is complete

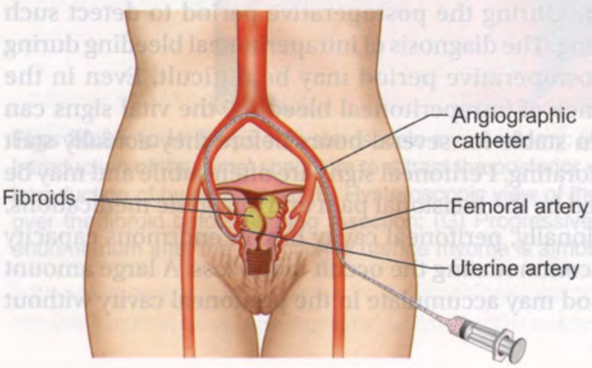
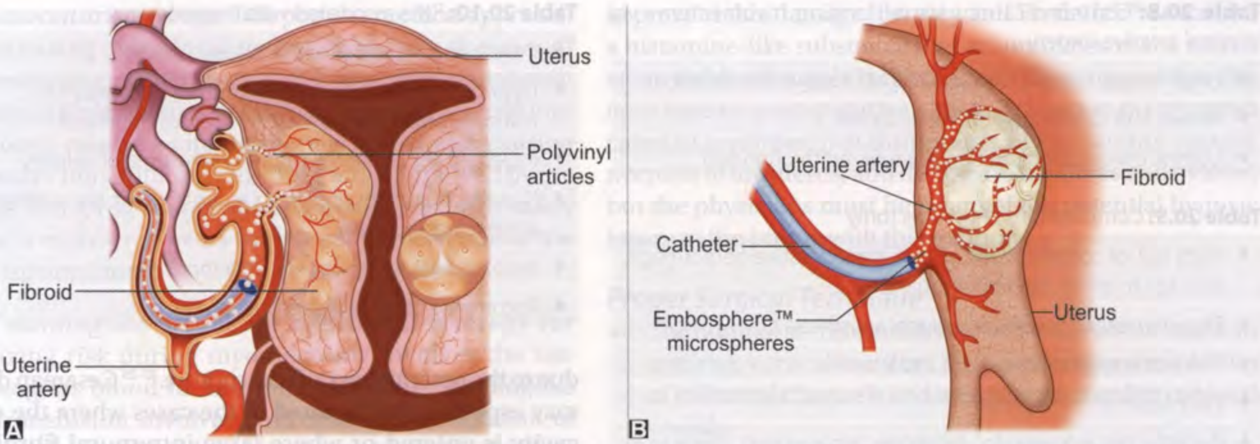


Fig. 20.11: Passing the catheter through femoral artery into the uterine artery



Figs 20.12A and B: Effect of UAE on the blood supply of the myometrial tissue: (A) Blocking the blood supply of fibroids through the polyvinyl particles; (B) Magnified view showing UAE blocking the feeding blood vessel

causing an accompanying change in the abdominal girth. Therefore the patient must be monitored carefully for the first 24 hours following myomectomy. In the first 2 hours following the surgery, the vital signs must be checked after every 15 minutes. Thereafter, these signs are checked after every 30 minutes till the patient is stable. Subsequently, these signs are monitored every 2–4 hours for the first 24 hours postoperatively. Hematocrit must be performed 6 hours after the surgery and then again on the morning of first postoperative day. In case of any suspicion regarding intraperitoneal bleeding, anemia or hypovolemia, the hematocrit can be performed earlier. Any signs of restlessness, tachypnea or tachycardia can be considered as indicators of blood loss, especially when associated with hypotension.

Contraception: For patients desiring fertility, local methods of contraception (diaphragm, condom, spermicidal jelly or foam) must be used for at least 3 months to avoid conception, until the myomectomy incisions have healed.

Antibiotic prophylaxis: Since infection is one of the most common complications of myomectomy, antibiotic prophylaxis must be preferably started preoperatively and continued till the first postoperative day.

ADVANTAGES

ADVANTAGES OF LAPAROSCOPIC MYOMECTOMY

Advantages of laparoscopic myomectomy are described in Table 20.6.

ADVANTAGES OF ROBOTIC MYOMECTOMY

Advantages of robotic myomectomy are listed in Table 20.7.[29]

Table 20.6: Advantages of laparoscopic myomectomy

- Less invasive procedure
- Fewer operative and postoperative complications (post-operative adhesions, blood loss, paralytic ileus, infection, etc.)
- Reduced surgical morbidity resulting in improved postsurgical outcomes
- Significantly reduced hospital stay and quick recovery[30]
- May be performed as an outpatient surgery under general or regional anesthesia

Table 20.7: Advantages of robotic myomectomy

- Shorter duration of hospital stay
- Reduced blood loss
- Quicker return to daily activities
- Reduced scarring
- Fewer postoperative complications
- Reduced blood loss
- Procurement of a three-dimensional image
- Absence of tremor and superior instrument articulation in comparison to conventional laparoscopy
- Downscaling of movements
- Increased comfort for the surgeon

DISADVANTAGES

It may not be possible to perform myomectomy through minimal invasive surgery (either hysteroscopic, laparoscopic or robotic) in presence of conditions listed in Table 20.8.

COMPLICATIONS

HYSTERECTOMY

Hysterectomy is a major surgery, which is associated with numerous complications including high rate of morbidity

Table 20.8: Contraindications for performing myomectomy via minimal invasive surgery

• Large fibroid: Uterine fundus is palpable above the umbilicus
• Presence of diffuse adenomysosis on MRI
• Uterine cavity cannot be clearly visualized through MRI

Table 20.9: Complications of hysterectomy

• High risk of complications (risk of intraoperative hemorrhage, damage to other abdominal organs, etc.)
• Requirement of general or regional anesthesia
• The recovery time varies from 2 to 8 weeks
• Early onset of menopause
• Possible requirement for hormone replacement therapy in future
• This procedure is more expensive
• High rate of mortality and morbidity

and mortality. The mortality rate for hysterectomy ranges between 0.1 and 1.1 cases per 1,000 procedures. The morbidity rate is usually 40%. Some other disadvantages of hysterectomy are enumerated in Table 20.9. The removal of the uterus can frequently result in significant physical strain and psychological stress.

For detailed discussion regarding the complications associated with hysterectomy, refer to Chapter 24 (Hysterectomy).

MYOMECTOMY

Like any other pelvic surgery, myomectomy may be associated with complications such as hemorrhage, infection (postoperative febrile morbidity), bowel obstruction, adhesion formation, damage to bowel, bladder, fallopian tube, ureter, wound infection and wound dehiscence.[21] Various risks associated with myomectomy are enumerated in Table 20.10. Furthermore, roughly 20–25% of patients undergoing myomectomy require another pelvic operation, usually hysterectomy, due to recurrence of symptoms. Recurrent myomas are common, especially in patients having multiple myomas. Patients with a solitary myoma have a 27% recurrence rate, and those with multiple myomas have a rate of 59%.[31] Patients undergoing myomectomy should be counseled preoperatively about these risks and must understand that a myomectomy may sometimes not be possible due to intraoperative findings (e.g. excessive bleeding). Uncontrolled intraoperative hemorrhage usually may end up in a hysterectomy. Since it may be difficult to predict preoperatively which patients may require hysterectomy, all patients should be warned about the risk. The patient must also be made aware about the higher probability for blood transfusion intraoperatively and during the period of recovery. Furthermore, the patients desiring future fertility should be counseled regarding the possible requirement of cesarean section in subsequent pregnancies

Table 20.10: Risks associated with myomectomy

• Increased postoperative blood loss
• Hysterectomy may be required during the surgery, if myomectomy appears to be dangerous or difficult
• Increased risk of uterine rupture at the time of delivery
• Need for mandatory cesarean section in case the patient achieves pregnancy
• Increased risk for postoperative adhesions
• Recurrence of myoma postoperatively

due to the potential risk of scar rupture.[32-35] Cesarean delivery may especially be required in the cases where the uterine cavity is entered or where large intramural fibroids are removed.[34] The most significant complications associated with the procedure, i.e. hemorrhage, infection, development of postoperative adhesions and the risk of scar rupture in the subsequent pregnancies and the methods for avoiding their occurrence would now be described in details.

Hemorrhage

Intraperitoneal bleeding after myomectomy is usually due to the failure of achieving adequate hemostasis in the myometrial vessels during the closure of the myoma beds and uterine incisions.

Techniques to Reduce Hemorrhage

Myomectomy is perhaps one of the bloodiest gynecologic operations performed, and the most significant morbidity associated with it includes blood loss.[36] A variety of methods have been described that are aimed at minimizing blood loss.[37] In earlier days the surgeon's assistants were instructed to grasp both the broad ligaments with each hand in order to impede the blood flow through the uterine vessels. Specially designed clamps were introduced by Bonney in 1920, which were placed around the uterine vessels and round ligament. In 1938, Rubin used elastic rubber tourniquets through the broad ligament, encircling the cervix and occluding the uterine vessels. Rubber-shod clamps applied to the broad ligament have also been used to occlude the uterine vessels and control bleeding. Tourniquets are commonly placed around the cervix and each infundibulopelvic ligament to control the blood flow. Once the tourniquets are tightened in place, myomectomy should proceed fast in order to prevent ischemic damage to the uterus, tubes and ovaries. The main approaches, which are utilized for reducing the blood supply to the myoma include the medical, mechanical and surgical approaches.

Medical Methods

Hypotensive anesthesia: Controlled hypotensive anesthesia has become a useful adjunct to reduce the amount of bleeding in selected patients as it helps in the reduction of venous tone.

Use of vasoconstrictor drugs: One popular medical approach for decreasing the blood loss is based on the use of vasoconstricting agents such as 8-L-arginine vasopressin (Pitressin). Dilute solutions of this are injected directly into the myoma, raising a circumferential wheal and causing vasoconstriction. Although the drug is not approved by the US Food and Drug Association, this drug has been safely used for a number of years to prevent hemorrhage at the time of myomectomy.

Use of autologous blood: An additional strategy for minimizing risk during myomectomy involves the use of autologous blood to minimize infection. Autologous blood transfusion involves collection and reinfusion of the patient's own blood or blood components. Patients can store up to 1 unit every 2 weeks, and with the ability to freeze autologous blood, a large quantity of blood can be obtained. These patients should be given supplemental iron during this time.

GnRH agonists: In the patient with large fibroids, gonadotropin-releasing hormone (GnRH) agonists can be used concomitantly to shrink the myomas. The GnRH agonists allow time for the patient to bank autologous blood, and they also decrease the size of the myomas, thereby making myomectomy technically easier.

Mechanical Method

Bonney's atraumatic clamp: The most direct method for minimizing the blood loss during myomectomy is to use mechanical methods that decrease uterine blood flow. These methods usually utilize a variety of clamps and tourniquets, which have been used over the past few decades in order to reduce the myomectomy-related hemorrhage. Bonney[20] first described the use of an atraumatic clamp that compresses the uterine vessels and decreases uterine blood flow. The Bonney's clamp is applied from the pubic end of the abdominal wound; it must contain the round ligament in its grip, or else it would slip below the uterine vessels. Blood flow from the infundibulopelvic ligament is compressed using a ring forceps. The location of the ureter must be known before applying any clamps. Other variations of this method include using bulldog clamps, rubber-shod clamps or tourniquets. The disadvantage of using a tourniquet is that a small incision is often made in an avascular area of the broad ligament. The tourniquet is then applied around the cardinal ligaments, obstructing the uterine vessel blood flow. A tourniquet can also be applied around the infundibulopelvic ligament in a similar fashion. The defect in the broad ligament has to be repaired with a fine suture and therefore becomes another site for possible adhesion formation. The unknown aspect of these mechanical methods is the duration for which the blood supply to the uterus can be occluded before irreversible ischemic damage occurs. Some investigators recommend that the clamps or tourniquets be released every 15 minutes to prevent this damage. Ranney and Frederick[38] described a histamine-like substance that accumulates in the uterus when its blood supply is obstructed. They suggest that this may lead to postoperative shock. There are no reported cases of postoperative thrombosis of the uterine vessels, necrosis of the uterus, and damage to the tubes and ovaries, but the physicians must be aware of the potential hypoxic injury to the uterus with this method.

Proper Surgical Technique

- The optimal uterine incision to minimize blood loss is an anterior, vertical incision. This cuts across a minimum of collateral channels and a minimum number of blood vessels.
- As many tumors as possible should be removed through the single incision. Method of removing myomata through a single anterior incision has been previously described by Bonney. The linear or elliptical incision must be over the largest myoma. In order to minimize the blood flow, the dissection must be carried out between the myoma and the pseudocapsule.

Postoperative Febrile Morbidity

This may be related to extensive tissue trauma or infection during the procedure. Administration of preoperative antibiotics helps in the prevention of infection. In case of any evidence of infection, the patient must be treated vigorously and promptly because infection is likely to result in the development of adhesions and have a devastating effect on future fertility. Therefore, it is important to observe a meticulous and sterile surgical technique during myomectomy in order to reduce the incidence of infection.

Adhesions

The most significant disadvantage of myomectomy is the risk of development of postoperative pelvic adhesions. The location of myomas also affects adhesion formation. Adhesions are most likely to develop when the incision is in the posterior uterine wall. During laparoscopy, a separate incision must be made over each individual myoma. With laparotomy, a single anterior uterine incision may be used for removing multiple myomas even when a few myomas are posteriorly present. The presence of adhesions restricts the adnexal mobility, thereby limiting the ability of the fimbria to pick up an oocyte. This may affect the woman's future ferility. In order to reduce the risk of development of adhesions, in incisions over the peritoneal aspect of the posterior uterine wall must be avoided during surgery.

Techniques to Prevent Adhesion Formation

The major reason by which myomectomy can endanger the woman's fertility is through the formation of adhesions. Gehlbach et al.[39] have demonstrated that formation of adhesions during myomectomy, significantly reduces the likelihood for future conception. Factors which are associated with an increased likelihood of adhesions include posterior wall incisions, uterine size larger than 13 weeks of gestation and presence of large intramural myomas. Various strategies, which can be adopted at the time of surgery for minimizing the development of adhesions are as follows:[40-42]

- The vertical, anterior uterine incision in comparison with a posterior one can help to reduce the blood loss and formation of adhesions that involve the tubes, ovaries or bowel.
- Use of adhesion barriers, such as interceed (Fig. 20.13), Gore-Tex and Seprafilm, also help in preventing adhesions between the peritoneal surface and the adnexa.
- Other strategies, which help to prevent the development of adhesions include using various substances, such as dextran 40, factor 13 with finexa, fibrinogen, etc. for the purpose of copious irrigation at the time of surgery.
- Meticulous hemostasis must be maintained at the time of surgery.

Weakening of the Uterine Musculature

The main complication of myomectomy is that it weakens the uterine musculature. As a result, a woman who becomes pregnant after a myomectomy may require a cesarean delivery to prevent rupture of the uterus at the myomectomy site. Since there are numerous risks associated with myomectomy, the expected benefits of myomectomy must be weighed against the risks associated with the procedure, before carrying out this surgery. Before performing myomectomy, it is important to counsel the patient regarding the possibility that intraoperative findings may contraindicate myomectomy and require that hysterectomy be performed instead. If pregnancy is desired, there is a risk of uterine rupture after myomectomy during delivery. This can occur irrespective of the route for myomectomy

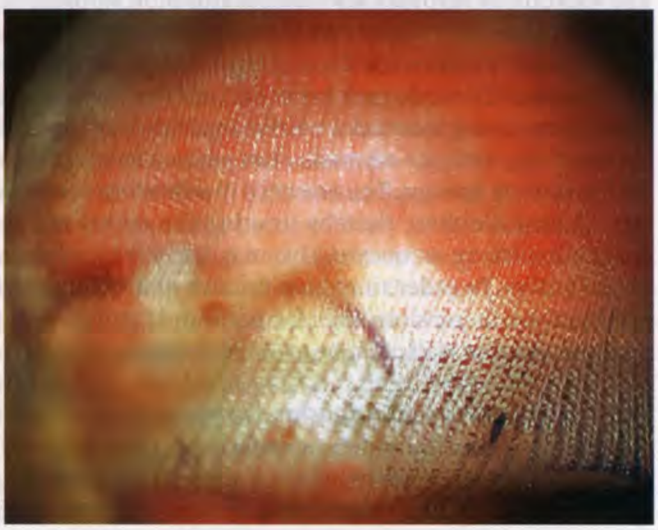


Fig. 20.13: Use of interceed adhesion barrier over the surface of uterine incision in order to prevent the development of adhesions

(abdominal, laparoscopic or hysteroscopic myomectomy) due to excessive dissection of myometrial muscles during the surgery.

Recurrence of myomas postoperatively is another complication associated with myomectomy (more with laparoscopic as compared to the abdominal procedure). A small myoma at the time of surgery may get overlooked and not get removed. This may result in future recurrence of myoma postoperatively.

COMPLICATIONS OF LAPAROSCOPIC MYOMECTOMY

Complications of laparoscopic myomectomy are listed in Table 20.11.[43-46] The most important complication following myomectomy is the development of adhesions postoperatively. Development of these postoperative adhesions is particularly important as these adhesions can trap the adnexa, resulting in tubal blockage, etc. Hence, this can impair the woman's fertility, resulting in further problems in women desiring future fertility. There has been a recent advancement in laparoscopic surgery, associated with the use of special substances, called adhesion barriers, which help prevent the formation of scar tissue after surgery. Small sheets of cloth-like material can be wrapped around the raw areas from surgery and this material prevents nearby tissue from adhering to the site of surgery. After a few weeks, the material dissolves, leaving the newly healed surgery sites fairly free of adhesions. While the use of these barriers may not be completely perfect in preventing adhesions, they have been shown to help reduce the formation of adhesions. One of the most important complications associated with any type of myomectomy is the risk of uterine rupture during pregnancy. Although both laparoscopic and abdominal myomectomies can result in uterine rupture, the timing of this drastic complication varies between the two procedures. While, uterine rupture following abdominal myomectomy commonly occurs during labor, that following laparoscopic myomectomy commonly occurs during the third trimester of pregnancy (after 36 weeks).[33] Some possible reasons for the uterus to rupture following laparoscopic myomectomy are listed in Table 20.12.

In order to avoid scar rupture during pregnancy, some of the precautions which can be taken are listed in Table 20.13. Another possible complication of myomectomy is the recurrence of myoma following surgery. Laparoscopic

Table 20.11: Complications of laparoscopic myomectomy

♦ Development of uterine rupture during pregnancy (most commonly in third trimester)
♦ Development of postoperative adhesions
♦ Recurrence of myoma after myomectomy
♦ Technically more difficult than the laparotomy
♦ The procedure requires more level of skill and training in comparison with the abdominal surgery

Table 20.12: Possible reasons for uterine rupture following laparoscopic myomectomy

♦ Natural tendency of the uterus to undergo hyperplasia and hypertrophy during pregnancy
♦ Less perfect reconstruction of uterine tissues
♦ Proper repair of the uterine wall may not be possible (especially with large, numerous or deeply embedded uterine myomas)
♦ Presence of a hematoma over scar tissue
♦ Wide use of electrosurgery for obtaining hemostasis during laparoscopic surgery

Table 20.13: Precautions to be taken to prevent scar rupture after laparoscopic myomectomy

♦ Proper approximation of the edges of the incision (inverting the edges of the myometrium)
♦ One must never use radiofrequencies to achieve hemostasis during surgery
♦ Long time interval must be planned between surgery and pregnancy (more than 1 year)
♦ Elective cesarean section in these patients before 36 weeks

myomectomy, due to limited exposure may result in less effective removal of the fibroid tissue. This is especially the case if multiple myomas are present in the uterus. Incomplete removal of myoma tissue may result in development of recurrence following laparoscopic myomectomy. Moreover, the procedure of laparoscopic myomectomy is technically more difficult than that of laparotomy. This could be due to the following reasons:

- Difficulty in locating the myomas, especially if they are deeply placed
- Difficulty in enucleation
- Multilayer uterine closure
- Difficulty in myoma extraction.

COMPLICATIONS ASSOCIATED WITH UAE

Contraindications for UAE include presence of intrauterine pregnancy, active pelvic infection, severe allergy to the contrast medium, AV malformations, desire for future pregnancy, strong suspicion for adenomyosis or pedunculated leiomyoma or presence of an undiagnosed pelvic mass.

Major Complications

Major complications such as pulmonary embolism, arterial thrombosis, groin hematomas, local infections, guide-wire perforation of arteries, allergic reaction to contrast medium, endometritis, ischemia of pelvic organs, sepsis and death are rare events with UAE. These may occur in approximately 0.5% cases of embolization performed for symptomatic fibroids. Till date, only four fatalities have been reported among more than 30,000 procedures, which have been performed worldwide.

Minor Complications

Early acute abdominal pelvic pain: Nearly all women may experience some degree of acute pain within the first few weeks, often requiring hospitalization with intensive pain management protocols and monitoring. The pain is thought to be due to nonspecific ischemia of the uterus and fibroids. It often responds to pain control with analgesics like opiates and nonsteroidal anti-inflammatory drugs.

Postembolization syndrome: Following UAE, some women may develop low-grade fever, leukocytosis, increasing pelvic pain and a vaginal discharge in the first 10–14 days after UAE. Many of these women may also experience malaise, nausea and exhaustion. The combination of these symptoms is known as postembolization syndrome and is probably related to transient fibroid degeneration and uterine ischemia. The condition is usually self-limiting and symptoms may last from few days to weeks. The syndrome rarely requires treatment other than the antipyretics; sometimes the patient may be hospitalized for antibiotic therapy.

The postembolization syndrome normally regresses over time. However, if the symptoms seem to worsen over the period of time, an examination and evaluation for infection is important. In presence of severe infection, hysterectomy may be required.

Misembolization: Since the particles that are used for embolization are very small, in a few instances, the particles may travel through blood vessels to areas besides the fibroid tissue, where they are actually intended to go. This is termed as misembolization.

Infection: The incidence of febrile morbidity and sepsis following embolization has been reported to be between 1.0% and 1.8%. Some of the infections, which can occur, include pyometra with endomyometritis, bilateral chronic salpingitis, tubo-ovarian abscess and infection of the myomas. The most frequent pathogen that has been isolated is *Escherichia coli*. Though some women may respond to antibiotic therapy, others may require prolonged hospitalization, intensive therapy and sometimes even hysterectomy. Prophylactic antibiotics have not been shown to be effective and should be used only in women at higher risk of infection.

Effect on fertility: The ovaries may stop functioning in about 5% of the women, following embolization and early menopause may result. This may be a particularly devastating complication for young patients who wish to conceive in future. The ovarian function may cease due to reduced blood supply. The blood supply to the ovaries may be blocked off due to misembolization or as a result of the blockage of uterine artery in women in whom the main blood vessels supplying the ovaries branches off from the uterine artery. As a result, if the uterine artery is blocked, the blood supply to the ovary is also blocked off and the ovaries cease functioning.

Pregnancy outcomes: Although this procedure helps in preserving the uterus, pregnancies following UAE have been reported to be at higher risk in comparison with the general population. Women becoming pregnant following UAE may be at significantly increased risk for postpartum hemorrhage, preterm delivery, cesarean delivery, malpresentation and uterine rupture.

Presently, however, there is limited evidence regarding the pregnancy outcomes following UAE. As a result, the women who wish to conceive in future are not recommended to use UAE as treatment option for their fibroids. Better evidence in form of future, well-designed, randomized studies is required before UAE can be confidently recommended to the women with fibroids desiring future fertility.

Risk of underlying malignancy: No samples are sent for biopsy in UAE; therefore, any underlying malignancy is likely to remain undetected. However this is unlikely to cause any problem because the chances of malignancy in cases of fibroids is extremely low.

Persistent or chronic pain: In 5–10% of women, the pain persists for more than 2 weeks. Presence of uterine infection should be ruled out in these cases. Persistent pain in the absence of infection or pain lasting longer than 2–3 months may require surgical intervention.

Transcervical fibroid tissue passage: Overall, transcervical fibroid tissue passage may occur in approximately 2.5% of the patients. This may be associated with severe pain, infection or bleeding and is one of the most common complications requiring hospitalization.

DISCUSSION

The definitive treatment for myomas is surgical, either via hysterectomy (removal of the entire uterus containing the myoma) or myomectomy (selective removal of myoma, leaving the uterus behind). Myomectomy is a very challenging procedure because it may require extensive manipulation and reconstruction of the uterine tissue. Moreover, the uterus is an organ which undergoes remarkable structural changes (hypertrophy and hyperplasia), both during pregnancy and puerperium. Massive enlargement of the uterus during pregnancy can result in weakening of the uterine scar, increasing the risk for uterine rupture.[47,48]

Besides this natural disadvantage, the microsurgical procedure (laparoscopic myomectomy) is associated with less perfect reconstruction of uterine tissue in comparison with abdominal myomectomy.[49] As a result, the risk of uterine rupture is more with laparoscopic procedure in comparison with abdominal procedure. Also, when the myomas are deeply embedded in the myometrium or are large in size or numerous, proper repair of the uterine wall may not be possible with laparoscopic procedure.[50] Wide use of electrosurgery for obtaining hemostasis during laparoscopic surgery may be another factor involved in reducing the scar strength. Use of electrosurgery may result in poor vascularization, tissue necrosis and adverse effects on scar strength. Excessive bleeding during the surgery can result in hematoma formation, which can weaken the uterine walls by resulting in the formation of fibrous tissue.

During myomectomy, extensive manipulation of uterine tissues is performed. The uterine muscles have an ability to regenerate slowly. If the edges of the wound are accurately sutured, the healing of the uterine wound takes place through regeneration of myometrial muscles. This results in strengthening of the uterine walls. On the other hand, if the edges of the wound are not approximated properly, healing occurs by secondary intention, thereby resulting in the formation of fibrous tissue, which considerably weakens the postoperative scar.

Robotic myomectomy is presently performed in patients with any single myoma smaller than 15 cm and fewer than 15 myomas in total.[51] Preoperative MRI is very useful for defining the myoma size, number and locations, and for ruling out adenomyosis.

The integrity of scar following robotic myomectomy has yet not been tested because there have been small reports of pregnancy occurring following robotic-assisted myomectomy.[52]

CONCLUSION

Myomectomy serves as an effective option for reducing heavy bleeding in patients presenting with menorrhagia. In patients with infertility, myomectomy whether performed by abdominal, laparoscopic, hysteroscopic or robotic approach must be performed only after complete evaluation of other potential causes of infertility. Myomectomy by any route (abdominal, laparoscopic, hysteroscopic or robotic), even though helps in preserving the uterus, is a major surgery which is associated with considerable mortality and morbidity even more than that associated with hysterectomy.[14,53] The two most important complications associated with the procedure include febrile morbidity and intraperitoneal bleeding. Moreover, there is a possibility for development of uterine rupture during pregnancy following myomectomy via laparoscopic, robotic or abdominal routes.

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CHAPTER 21

Surgery for Polycystic Ovarian Disease

INTRODUCTION

The condition, polycystic ovarian disease, also known as PCOD, is a relatively common endocrine disorder amongst women of reproductive age group. It is associated with anovulation, features of androgen excess, obesity, infertility and hypersecretion of luteinizing hormone (LH). It is characterized by the presence of many minute cysts in the ovaries and excessive production of androgens. The pathophysiology of PCOD is shown in Flow Chart 21.1. PCOD is frequently associated with weight gain, excessive hair growth on the face and body, oligomenorrhea or amenorrhea, infrequent or absent ovulation, miscarriage and infertility. Diagnosis of PCOD is made through ultrasound examination or diagnostic laparoscopy. Blood levels of hormones, such as LH, follicle-stimulating hormone (FSH), androgens and serum hormone-binding globulins (SHBG), must also be performed in these patients. FSH levels are low or normal and LH levels are often raised, resulting in a raised LH/FSH ratio. The levels of androgens and testosterone may also be raised. According to the American Society of Reproductive Medicine (ASRM) and the European Society of Human Reproduction and Embryology (ESHRE) joint consensus meeting in November 2003, the diagnosis of PCOD should be made, when two of the following three criteria are met:[1]

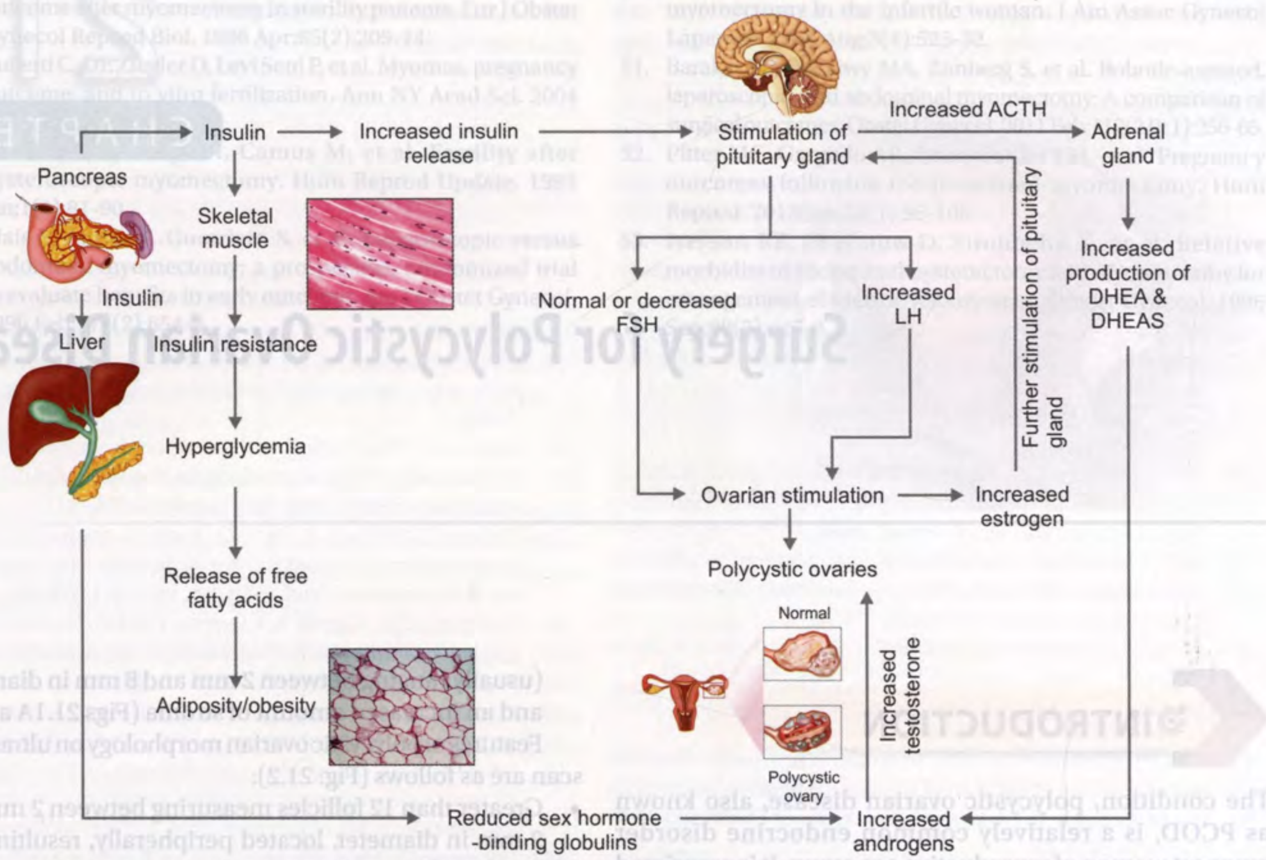
1. Infrequent or absent ovulation
2. Clinical or biochemical features of hyperandrogenism, such as excessive hair growth, acne, raised LH and raised androgen levels
3. Morphologically there is bilateral enlargement, thickened ovarian capsule, multiple follicular cysts (usually ranging between 2 mm and 8 mm in diameter) and an increased amount of stroma (Figs 21.1A and B).

Features of polycystic ovarian morphology on ultrasound scan are as follows (Fig. 21.2):

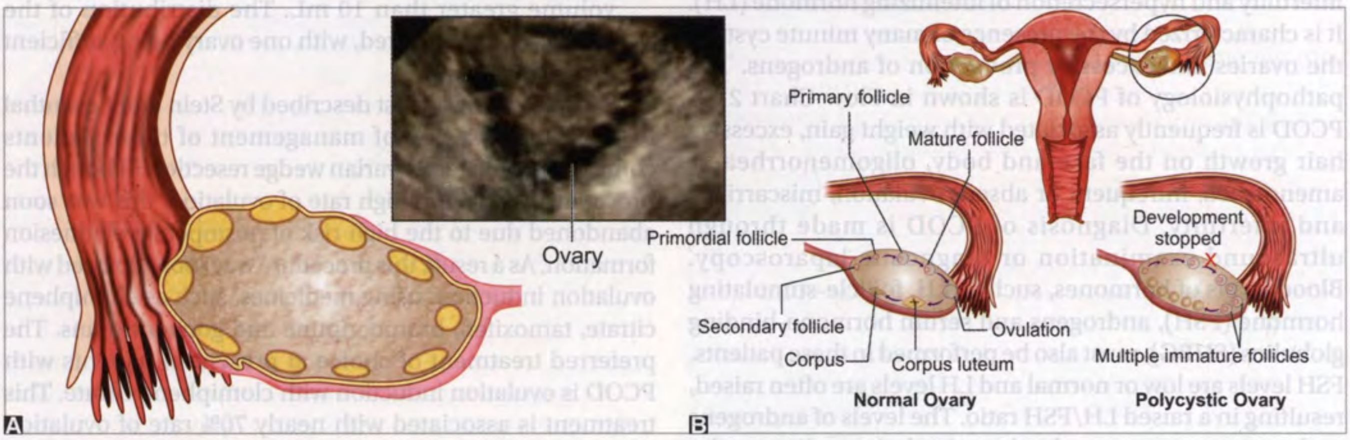
- Greater than 12 follicles measuring between 2 mm and 9 mm in diameter, located peripherally, resulting in a pearl necklace appearance.
- Increased echogenity of ovarian stroma and/or ovarian volume greater than 10 mL. The distribution of the follicles is not required, with one ovary being sufficient for the diagnosis.

When PCOD was first described by Stein and Levanthal in 1935, the first line of management of these patients comprised of bilateral ovarian wedge resection.[2] Though the procedure resulted in high rate of ovulation, this was soon abandoned due to the high risk of postoperative adhesion formation. As a result, this procedure was soon replaced with ovulation induction, using medicines, such as clomiphene citrate, tamoxifen, bromocriptine and gonadotropins. The preferred treatment of choice at present in patients with PCOD is ovulation induction with clomiphene citrate. This treatment is associated with nearly 70% rate of ovulation after the first treatment. However the use of gonadotropins may be associated with complications, such as polyfollicular response, the risk of ovarian hyperstimulation syndrome (OHSS) and multiple pregnancy.[3] Moreover, it is expensive, stressful and time-consuming form of treatment, which usually needs intensive monitoring. Recent studies have also suggested a possible linkage between the use of ovulation-inducing drugs and long-term risk of ovarian cancer. As a result, a new mode of surgical therapy known as laparoscopic ovarian drilling (LOD) has gained popularity because this procedure is associated with none or minimal requirement of gonadotropins for inducing ovulation.[4] Moreover, it can

Flow Chart 21.1: Pathophysiology of polycystic ovarian disease



Abbreviations: ACTH, adrenocorticotrophic hormone; FSH, follicle stimulating hormone; LH, luteinizing hormone; DHEA, dehydroepiandrosterone; DHEAS, dehydroepiandrosterone sulfate



Figs 21.1A and B: (A) Comparison of polycystic ovary (gross and ultrasound appearance); (B) Formation of multiple follicles in case of polycystic ovarian disease

be performed as an outpatient procedure and is associated with reduced amount of surgical trauma and postoperative adhesion formation.[5] It has now been recognized that LOD is an effective treatment option for clomiphene citrate resistance and anovulatory infertility associated with PCOD.[6]

OVERVIEW OF SURGERY

Laparoscopic ovarian drilling is a surgical treatment that can trigger ovulation in women with PCOD. In this method, different techniques, such as electrocauterization, laser, electrocoagulation, biopsy, etc. are used for destroying ovarian follicles.

AIMS OF SURGERY

Ovarian drilling is sometimes used for women with PCOD, who are still not ovulating after trying options, such as weight loss and fertility medicine. Destroying part of the ovaries has been reported to restore regular ovulation cycles.

Fig. 21.2: Ultrasound features of polycystic ovarian morphology

INDICATIONS

As discussed previously, the surgical option is commonly used in women, in whom ovulation does not occur even after weight loss and use of ovulation induction medicines. The main surgery which would be discussed in this section is LOD. Ovarian wedge resection though being the first type of surgery to be performed for PCOD is rarely performed nowadays because of the potential complications associated with the procedure.

OVARIAN WEDGE RESECTION

This surgery is performed under general anesthesia. The procedure involved cutting a wedge-like portion from each ovary. The operation was done much more frequently in the previous days when effective ovulation inducing drug treatment had not been discovered. Though the procedure was effective, it may result in the development of adhesions around the ovaries and tubes in about 10–20% of women. It is still not clear why ovulation occurs in women with PCOD following ovarian drilling or wedge resection. The medical treatment with ovulation-inducing agents had nearly replaced the procedure of wedge resection. The surgical approach for the treatment of PCOD was reinvented using a laparoscopic approach, which was adopted by Gjönnaess in 1984.[4] In this study, LOD using electrocautery caused ovulation amongst 92% of the 62 women who were treated.

LAPAROSCOPIC OVARIAN DRILLING

Ovarian drilling is usually done through a laparoscopic incision usually under general anesthesia. The technique of ovarian drilling aims to destroy (cauterize) the testosterone producing tissue of the ovary. Usually the small follicles visible on the surface of the ovary are chosen as the spots to direct the electrical or laser energy, because presumably this is where the hormone production is maximal.[7,8]

PREOPERATIVE PREPARATION

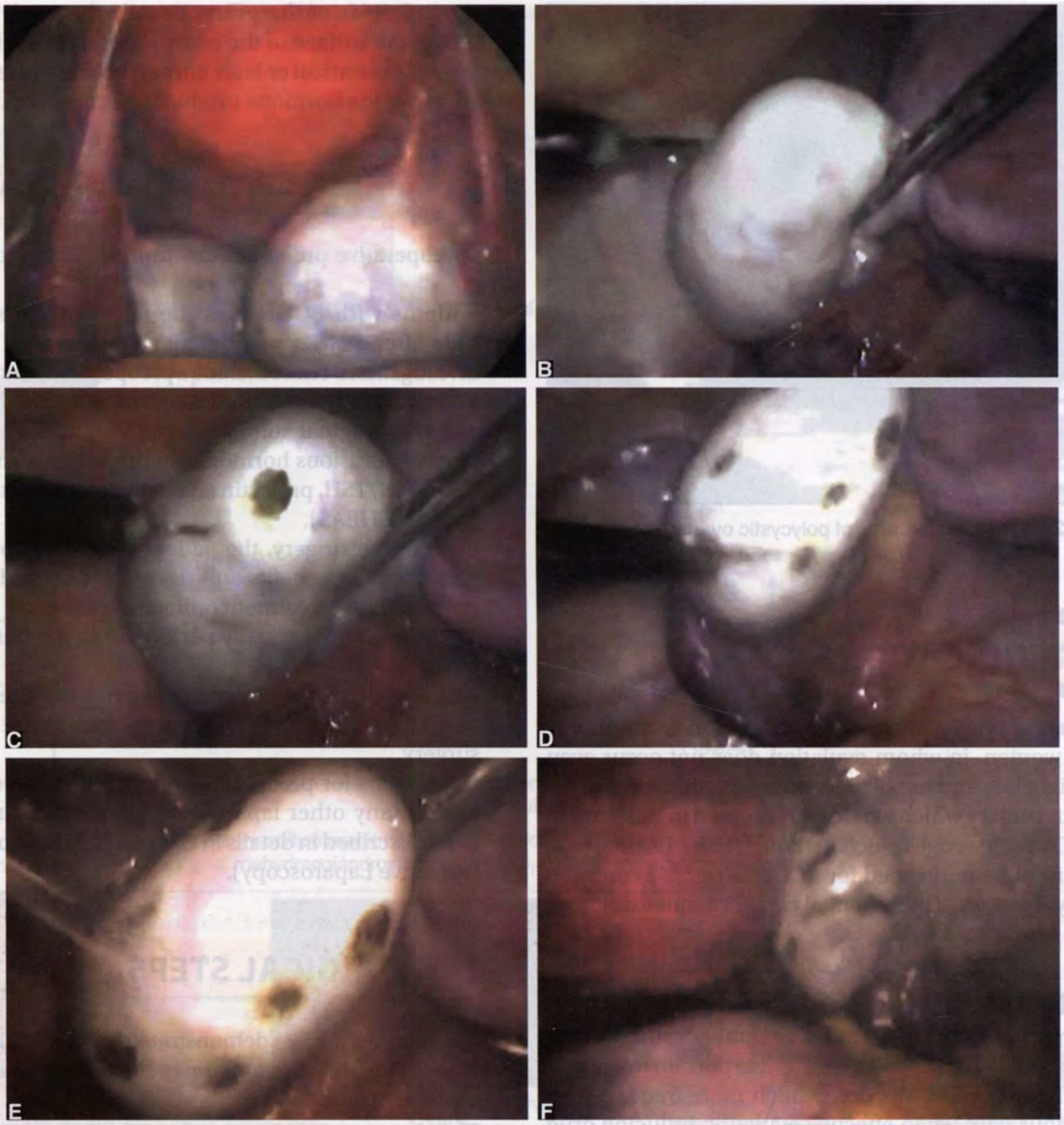
The preoperative preparation comprises of the following steps:

- Patients with PCOD must be taken up for surgery, only after a strict preoperative workup with various investigations. These include a preoperative sonographic examination [both transabdominal sonography (TAS) and transvaginal sonography (TVS)] and estimation of level of various hormones in the blood, such as day 3 FSH, LH, TSH, prolactin and dehydroepiandrosterone sulfate (DHEAS).
- Prior to the surgery, the patient should be counseled regarding the benefits and risks of the procedure and the alternative treatment options available.
- The procedure is usually performed in the immediate postmenstrual phase.
- All cases are performed under general anesthesia.
- Steep Trendelenburg position is used at the time of surgery.
- Other steps for preoperative preparation are same as that for any other laparoscopic procedure and have been described in details in Chapter 32 (Diagnostic and Operative Laparoscopy).

SURGICAL STEPS

The procedure of LOD is demonstrated in Figures 21.3A to F.

- Firstly a pneumoperitoneum is created with the help of a Veress needle.
- Three ports: one 10 mm infraumbilical port and two 5 mm lateral ports, in lower abdomen just above the anterior superior illac spine lateral to inferior epigastric vessels are inserted. These two ancillary ports are placed after charting the vessels by transillumination. A 5 mm suction cannula and a monopolar insulated needle electrode are used for the procedure.
- The laparoscope is introduced through the infraumbilical port.
- Immediately after the insertion of laparoscope, the entire pelvis is inspected in order to rule out other causes of infertility. Chromotubation is done by transcervical injection of the methylene blue dye. The undersurface of the ovaries is inspected for any evidence of endometriosis. Patients with PCOD are associated with a high incidence of müllerian duct anomalies, especially uterine septa of various lengths. Therefore,



Figs 21.3A to F: (A) Laparoscopic visualization of the pelvis in an effort to locate the ovaries; (B) Lifting the ovaries out of the ovarian fossa and placing them over the cervicouterine junction; (C and D) The procedure of laparoscopic ovarian drilling using electrocauterization; (E) Washing the ovary with normal saline following the completion of the procedure; (F) Appearance of the ovary following the procedure

the contour of the uterus must be assessed to look for the presence of any abnormalities in the fundal contour.

- A good uterine manipulator is used to stretch the ovarian ligament and move the uterus to the contralateral side.
- The ovary is then lifted out of the ovarian fossa using a blunt instrument, such as suction irrigation cannula, inserted from the ipsilateral lower abdominal port and placed over the cervicouterine junction, which forms a platform and helps in carrying out the puncture.
- The monopolar needle is inserted from the contralateral lower abdominal port and is introduced at right angles to the ovary, at the same time avoiding injury to the hilum.
- The next question to be answered is how many holes to be made? This is usually decided on the basis of ovarian size and volume and preoperative ultrasound appearance of the ovaries. Usually all bluish subcapsular follicles, which are visible, must be cauterized utilizing pure cutting current. Number of holes varying from 4 to 20 are usually made in each ovary. In moderately enlarged ovaries, 10–12 holes are made. However, if the ovaries are extremely voluminous, i.e. 50–60 mm in size, number of cautery points can be increased. The holes, which are to be made, are usually 3 mm wide and 3–4 mm deep. Though treatment of both ovaries is usually preformed,

reports[9] in which treatment with drilling of only one ovary proved to be successful have also been published.

- The ovarian surface is fulgurated at evenly spaced points. Cautery is maintained until the ovarian capsule and cortex is penetrated, 5–6 seconds at each point using a current with power settings varying between 30 watts and 400 watts.
- Both unipolar needle electrocauterization or a laser can be used for performing ovarian drilling. With the use of cautery 4–8 punctures are usually enough.[10] For laser the number of punctures required are usually higher (about 20–40).[11]
- General principle to be followed at the time of LOD is increasing the amount of thermal energy delivered to the ovarian stroma may increase the efficacy of procedure but at the expense of increasing the risk of ovarian atrophy.
- Routinely after cautery, hysteroscopy is performed, because a large number of patients with PCOD may have a concomitant uterine septum. Septum is then resected hysteroscopically using a resectoscope.
- A thorough suction irrigation and lavage should be now done in order to clear the pelvis of any smoke, blood, clot, debris, etc. Hydroflotation with 500 mL Ringer's lactate can help to minimize postoperative adhesions.
- An underwater examination must be performed to look for any bleeding points and if found, they must be cauterized. While drilling the ovaries, the area close to the ovarian ligament must be avoided in an attempt to ensure that the ovarian blood supply is not damaged. Many surgeons try to make the areas of cautery as far away from the fallopian tube as possible, in order to minimize the chances of tubal scarring. Many others prefer to wrap the ovaries with soluble materials in order to inhibit scar formation. Despite these precautions, adhesions around the tubes and ovaries can occur, but tend to be milder than that associated with the classical bilateral wedge resection. Moreover, these mild adhesions do not appear to affect pregnancy rate.[12,13] Some researchers have reported a small risk of ectopic pregnancy as a result of periovarian or tubo-ovarian adhesions. In order to minimize the formation of adhesions, it is important to achieve proper hemostasis and minimize bleeding, while performing any cautery.[14] There is usually no need for using an adhesion preventing agent. Thorough abdominal and pelvic lavage also helps in preventing the development of periovarian adhesions.

POSTOPERATIVE CARE

Postoperative care is also same as that for other laparoscopic procedures and has been described in details in Chapter 32 (Diagnostic and Operative Laparoscopy). Patients are discharged usually 6–8 hours after LOD. No additional infertility-related treatment is required in the subsequent pregnancies and the patients usually present with spontaneous conceptions. LOD also brings about an improvement in the menstrual rhythm, cycle and amount of menstrual blood flow. Though the cyclical bleeding may not start immediately, positive response usually occurs with the passage of time.

Following ovarian diathermy, women are asked to keep a record of their menstrual cycle.

If the patient experiences menstruation within 6 weeks of the surgery, a blood sample is taken on day 2 of that cycle for measurement of serum concentrations of hormones such as LH, FSH, testosterone, androstenedione and sex hormone-binding globulin. Another blood sample must be taken on day 21 of the same cycle for measurement of serum concentration of progesterone. Ovulation is diagnosed when the progesterone level is more than 30 nmol/L. Two more mid-luteal phase blood samples are taken in the subsequent cycles to measure serum progesterone levels. If spontaneous menstruation does not occur during 6 weeks following surgery, a random blood sample is taken to measure all the above mentioned hormones.

ADVANTAGES

The main advantages associated with the procedure of LOD are enumerated below:

- There is no additional risk of multiple gestation or OHSS, as reported with the use of gonadotropins.
- The procedure is considered to be associated with fewer postoperative adhesions in comparison to laparotomy.
- It is associated with minimum morbidity and no requirement for cyclic monitoring as required with the ovulation-inducing drugs.
- Laparoscopic ovarian drilling yields a better ovulation and pregnancy rate in comparison to other surgical modalities for ovulation induction.
- Laparoscopic ovarian drilling is associated with a low miscarriage rate (14%) in comparison to that associated with ovulation induction, using gonadotropins (50%).[15]

DISADVANTAGES

Factors that may help to predict poor response with LOD are listed in Table 21.1.[16] The procedure of LOD should be preferably avoided in presence of these factors.

COMPLICATIONS

Complications associated with LOD are same as those associated with other laparoscopic procedures. For details, kindly refer to Chapter 32 (Diagnostic and Operative Laproscopy).

Table 21.1: Factors associated with poor response to LOD

- Body mass index (BMI) more than or equal to 35 kg/m^2
- Serum testosterone concentration more than or equal to 4.5 nmol/L
- Free androgen index more than or equal to 15
- Duration of infertility more than 3 years

Some of these are enumerated below:

- Accidental injury to internal organs or major blood vessels from the laparoscope or other surgical instruments.
- Internal bleeding
- Pain after the procedure as a result of pneumoperitoneum
- Problems caused by anesthesia
- *Adhesions*: Adhesion formation was a significant complication of bilateral ovarian wedge resection, which occurred as a result of tissue handling and serosal trauma at the time of laparotomy. Adhesions lead to nonavailability of ovarian surface for ovulation, thereby resulting in anovulation. Moreover, presence of adhesions may interfere with peritoneal ovum transport as well. As a result the procedure which had been performed with the intention of resolving the problem of infertility, may itself become responsible for producing infertility. On the other hand, LOD has a small but definite potential for causing tubal adhesions. The definite etiology of pelvic adhesion formation is not yet clearly known. However, there are some factors which are associated with an increased risk for the development of pelvic adhesions. Some of these factors include intra-abdominal infection, tissue hypoxia or ischemia, tissue drying, manipulation of tissues during surgery, presence of reactive foreign body or presence of intraperitoneal blood.

Some adjuvants which can be used for the prevention of adhesions are described in Table 21.2.

- *Atrophy*: Ovarian atrophy and failure is a rare complication of LOD. Rarely, the ovaries can undergo irreparable damage and experience atrophy.[17] It appears that application of seven or more punctures per ovary represent an excessive amount of thermal energy used and therefore must be discouraged.
  Despite the absence of strong evidence, regarding the association of premature ovarian failure with LOD, precautions should be taken to minimize the chances of causing irreversible damage to the ovaries. These include keeping the dose of ovarian cautery to the minimum effective level and avoiding putting any cautery points close to the ovarian hilum.
- *Hyperprolactinemia*: Hyperprolactinemia after ovarian cauterization can be considered as a possible cause of anovulation in women with polycystic ovaries and improved gonadotropin and androgen levels. The cause of hyperprolactinemia remains unknown. Therefore, determination of levels of prolactin in anovulatory patients after LOD is recommended.

DISCUSSION

Presently ovulation induction using clomiphene citrate is the treatment of choice in patients with PCOD. Pregnancy rate with clomiphene citrate is approximately 40–50% and the abortion rate is about 30–40%. In patients with hyperinsulinemia, resistant to clomiphene citrate, insulin sensitizing agents, such as metformin can be prescribed. Metformin has now become the first line of management in cases of clomiphene citrate resistant women with PCOD. If ovulation does not occur within several months after treatment with metformin, LOD or gonadotropins can be considered as effective option depending upon patient's choice. Usually, the surgical approach is chosen when a patient has already failed to ovulate on clomiphene citrate at maximal doses and has not responded to insulin sensitizing agents. Before undertaking surgery, the patient must be explained all pros and cons related with the procedure. It has been reported that the procedure can result in high rate of spontaneous postoperative ovulation and conception. Moreover, the subsequent ovulation induction, using medicines becomes easier. Studies of women with PCOD have shown that ovarian drilling results in an ovulation rate ranging between 53% and 92% and a pregnancy rate of 70–80%.[4,15] Younger women, especially those having a BMI in the normal range are most likely to benefit from the process of LOD. The success rate for LOD appears to be better for patients at or near their ideal body weight in comparison to those with BMI in the obese range.

Different methods for destruction of ovarian tissues can be used during the procedure of LOD. These may include cautery, laser, electrocoagulation, etc. Patients who experience improvement in their hormonal status in form of reduced levels of testosterone and LH, following LOD are more likely to ovulate and achieve pregnancy in comparison to those without hormonal improvement. The various predictive factors for the success of LOD include the body mass index, serum testosterone concentration, free androgen index and duration of infertility.[11,15] Patients with infertility of more than 3 years duration and high testosterone levels must be managed using gonadotropin therapy and in vitro fertilization. A negative response may be observed in approximately 20–30% patients. An important cause of nonresponse in patients undergoing LOD may be hyperprolactinemia.[18] It is, therefore, important to monitor the patients for prolactin levels after undergoing LOD.

The main drawback with LOD is to estimate the dose of diathermy to be administered to a particular patient. The choice regarding the number of punctures to be applied at the time of LOD is purely empirical. The number of holes made during the procedure is usually proportionate to the ovarian size. Different instruments (needles, scissors, biopsy forceps, etc.) are being used to deliver energy to the ovary.

Table 21.2: Adjuvants which can be used for the prevention of adhesions

Agent	Mechanism of action	Examples
Fibrinolytic agents	Fibrinolysis, stimulation of plasminogen activators	♦ Fibrinolysin ♦ Streptokinase ♦ Urokinase ♦ Hyaluronidase ♦ Chymotrypsin ♦ Trypsin ♦ Pepsin ♦ Plasminogen activators
Anticoagulants	Prevention of clot and fibrin formation	♦ Heparin ♦ Citrates ♦ Oxalates
Mechanical separation (surface separation, hydroflotation)	Prevention of contact between the operated area and the peritoneal surfaces of pelvic organs	*Intra-abdominal instillates* ♦ Dextran ♦ Mineral oil ♦ Silicone ♦ Vaseline ♦ Crystalloid solutions ♦ Carboxymethylcellulose ♦ Hyaluronic acid ♦ Chelated hyaluronic acid ♦ Poloxamer *Barriers* *Endogenous tissues* ♦ Omental grafts ♦ Peritoneal grafts ♦ Bladder strips ♦ Fetal membranes *Exogenous materials* ♦ Fibrin glue ♦ Surgicel® (oxidized regenerated cellulose) ♦ Interceed ♦ Polytetrafluoroethylene ♦ Oxidized cellulose ♦ Oxidized regenerated cellulose ♦ Gelatin ♦ Rubber sheets ♦ Metal foils ♦ Plastic hoods
Anti-inflammatory agents	Reduction of vascular permeability, blocking the adhesiogenic action of prostaglandins, inhibition of platelet aggregation, histamine release, leukocyte migration and phagocytosis, and, stabilization of lysosomes	♦ Corticosteroids ♦ Nonsteroidal anti-inflammatory agents (tolmetin, ibuprofen, etc.) ♦ Antihistamines ♦ Progesterone ♦ Calcium-channel blockers ♦ Colchicine
Antibiotics	Prevention of infection and hence the inflammatory response	♦ Tetracyclines ♦ Cephalosporins

The total amount of energy to be applied is calculated by multiplying the amount of power (watts) with time duration for which the electricity is applied per puncture.

PATHOPHYSIOLOGY OF PCOD

Despite of many years of research, the pathophysiology of PCOD has not been completely understood. Common endocrine abnormalities in PCOD include chronically high levels of LH, thereby resulting in an elevated LH/FSH ratio (usually 2.5 or greater), hyperandrogenism, hyperinsulinemia, insulin resistance and dyslipidemia. These endocrine disturbances interfere with ovarian folliculogenesis and result in anovulation. Moreover, these endocrine disturbances are likely to constitute towards an increased risk for development of cardiovascular diseases and diabetes. The pathophysiology of PCOD has been summarized in Figures 21.1A and B. Elevated LH levels in patients with PCOD result in the hyperplasia of stromal and thecal cells in the ovarian follicles. This ultimately results in an increased androgen production by the adrenal glands (DHEA and DHEAS) and ovarian stroma (androstenedione). High intraovarian androgen levels may further contribute to follicular atresia. This also results in an increased peripheral availability of ovarian testosterone (androstenedione), which get converted in the skin to dihydrotestosterone, with the help of the enzyme 5α-reductase, thereby accounting for acne and hirsutism in these women. Moreover, increased androstenedione secretion results in an increased production of a type of estrogen, principally estrone, by aromatization in the peripheral tissues. This chronically elevated estrogen levels produce a negative feedback at the level of the hypothalamopituitary axis, further resulting in reduced FSH production, which causes an increase in the LH/FSH ratio by 2.5 or more. Thus, the inappropriate gonadotropin secretion is secondary to the abnormal steroid feedback, rather than a primary abnormality at the level of the hypothalamus-pituitary. Low levels of FSH in the follicle prevent induction of aromatase activity and result in the lack of ovarian estrogen production. As granulosa cell mitosis and follicular growth requires an estrogenic follicular microenvironment, follicular maturation gets arrested. This is responsible for producing anovulation.

MECHANISM OF ACTION OF LOD

Several surgical approaches for restoring ovulation in women with PCOD have been studied over the years, for example classical wedge resection, multiple ovarian biopsies, laser vaporization and electrocautery. All types of ovarian surgeries share a common goal of creating ovarian damage and from an endocrine point of view can be seen as equivalent procedures. Mechanism of action of any of these surgical procedures, whether using wedge resection, cautery or laser vaporization in cases of PCOD is yet not understood. Stein and Leventhal[2] were the first ones to propose bilateral wedge resection, as a method of choice for the induction of ovulation in clomiphene resistant PCOD patients. In patients with PCOD, the mechanical crowding of the ovarian cortex by the microcysts, prevents the normal movement of the graffian follicle to the surface of the ovary, thereby preventing ovulation. According to Stein and Levental, the procedure of wedge resection worked by reducing the mechanical crowding of the cortex by cysts, which facilitated the normal movement of graffian follicle to the surface of the ovary. Gjönnaess[4] in his study postulated that ovulation ensues in cases of LOD due to extensive capsular destruction, resulting in the discharge of contents of a number of follicular cysts. Ovulation probably occurs due to a reduction in stromal mass or disruption of parenchymal blood flow leading to a reduction in production of ovarian androgens and the levels of LH. Gladir et al.[15] in their study found that the procedure of LOD resulted in a reduced concentration of LH after LOD. On the other hand, the effect of this procedure on FSH levels was found to be variable. The FSH concentration increases rapidly and thereafter demonstrates a cyclical rise as the ovulatory function gets restored. The increase in the FSH levels is likely to result in the normalization of LH/FSH ratio, causing recruitment of new cohort of follicles, thereby bringing the resumption of ovarian function. The procedure has also been found to be associated with a marked reduction in the circulating levels of androgens, i.e. androstenedione, testosterone and DHEAS and a decrease in LH/FSH ratio. Moreover, LOD in a young woman is supposed to improve intraovarian stromal blood flow, so that the risk of OHSS in the subsequent ovarian induction cycles may be avoided.

Daniell and Miller (1989) have suggested that physical opening of the subcapsular cysts during the process of LOD is likely to cause release of androgen containing follicular fluid, thereby lowering the androgen content of the ovary.[19] Other likely mechanism for the success of LOD could be related to the fact that follicular destruction causes a reduction in the number of atretic follicles and thereby reduced androgen production. There is a reduction in the level of free and total testosterone by about 40–50% of the preoperative levels.[20] Destruction of ovarian stromal elements and release of androgen-rich follicular fluid from the puncture of subcapsular cysts causes a fall in the circulating levels of androgens. Reduction in the level of substrate for follicular aromatase produces a fall in the circulating estradiol levels. This releases the pituitary from the negative feedback inhibition, thereby resulting in an increased production of FSH by the pituitary. Furthermore, there is a fall in the LH levels.[21-24] All these changes result in the normalization of LH/FSH ratio, leading to follicular development followed by ovulation. In summary, the procedure of LOD is able to normalize the hormonal inbalance occurring as a result of PCOD.

OVULATION AND PREGNANCY RATES WITH LOD

In the study by Gjönnaess (1984), the procedure of LOD with multielectrocauterization was associated with an ovulation rate of 92% and pregnancy rate of 69%.[4] The miscarriage rate was reported to be 15% in this study. Therefore, Gjönnaess (1984) proposed electrocauterization as the primary treatment for women with PCOD, undergoing laparoscopy for any reason irrespective of their fertility status.[4] Armar and Lachelin (1993) in their study, followed patients, in whom PCOD was treated with LOD for a period of 3 years.[9] They applied diathermy to each ovary at four places for a period of 4 seconds at a time. The results of the study showed that approximately 86% of the women ovulated within an average time period of 23 days. Of these women, nearly 66% became pregnant. In the study by

Kovacs et al. it was observed that the patients with PCOD treated with electrocauterization at separate points on each ovary, resulted in an ovulation rate of 70% and pregnancy rate of 20%.[24] The efficacy of unilateral versus bilateral diathermy has also been assessed.[25] Unilateral diathermy usually results in ovulation from both the ovaries. Farhi et al. performed a study to evaluate the pregnancy rate, as a result of ovarian electrocauterization in clomiphene citrate resistant PCOD patients.[26] Reduced basal serum LH concentration and normalization of menstrual cycles was observed in 41% of the patients. Tulandi et al. reported effect of ovarian drilling on the ovarian volume, as measured by three-dimensional ultrasound.[27] They found that ovarian drilling resulted in a transient increase, followed by a significant reduction in ovarian volume from a preoperative volume of 12.2 mL to 6.9 mL in 3 weeks after surgery. Amer et al. (2002) studied the long-term impact of ovarian drilling on sonographic findings.[28] There was significant reduction in ovarian volume and the effect was sustained over a period of 9 years.

CONCLUSION

Seventy years after the first report of successful surgical ovarian intervention in PCOD by Stein and Leventhal, 1935 (bilateral ovarian wedge resection), the mechanism behind the reversal of endocrinological dysfunction after ovarian surgery, especially LOD remains unclear. Surgical ovarian intervention for PCOD is sparingly used at the present time, as acceptable ovulation and pregnancy rate are achieved using clomiphene citrate, metformin and gonadotropins. However, some women remain anovulatory or cannot be successfully treated medically and in these cases ovarian surgery serves as a useful alternative option. LOD is a minimally invasive, safe and cost-effective procedure. It seems to offer significant advantages over the medical therapy. A single treatment results in a better rate of ovulation. There is no need of continuous monitoring, as required with hormonal treatment or fear of multiple gestation and OHSS. The use of LOD appears to be as effective as the use of clomiphene citrate in the treatment of PCOD with a lower risk of complications. Moreover, the correction of hormonal levels as a result of LOD helps in preventing miscarriages. LOD is now considered as a treatment of choice in patients with PCOD, who are resistant to clomiphene citrate. The possibility of adhesion formation and other risks and cost factors associated with a surgical process must be taken in to consideration before embarking upon surgery. There is presently insufficient evidence regarding an exact ovulation rate following LOD. Long term trials are also required to find out the possible reason behind ovulation following LOD.

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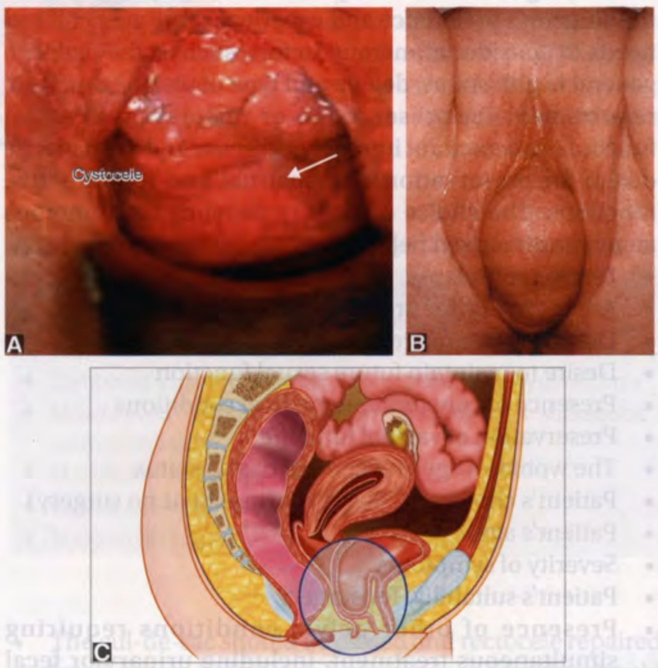
22

CHAPTER

Prolapse Uterus

INTRODUCTION

Uterine prolapse can be described as a descent or herniation of the uterus into or beyond the vagina. Uterine prolapse is best considered under the broader heading of "pelvic organ prolapse," which also includes abnormalities, such as cystocele, urethrocele, enterocele and rectocele. Anatomically, the vaginal vault has three compartments: (1) an anterior compartment (consisting of the anterior vaginal wall), (2) a middle compartment (cervix) and (3) a posterior compartment (posterior vaginal wall). Weakness of the anterior compartment results in cystocele (Figs 22.1A to C) and urethrocele (Fig. 22.2), where as that of the middle compartment in the descent of uterine vault or uterine prolapse (Fig. 22.3) and enterocele (Fig. 22.4). The weakness of the posterior compartment results in rectocele (Figs 22.5A to C).[1] Uterine prolapse usually occurs in postmenopausal and multiparous women, in whom the pelvic floor muscles and the ligaments that support the female genital tract have become slack and atonic. Injury to the pelvic floor muscles during repeated childbirths, causing excessive stretching of the pelvic floor muscles and ligaments acts as a major risk factor for causing reduced tone of pelvic floor muscles.[2] Reduced estrogen levels following menopause is another important cause for atonicity and reduced elasticity of the muscles of pelvic floor. Uterine prolapse can be classified into four stages based on Baden-Walker Halfway system as described in Table 22.1.



Figs 22.1A to C: Cystocele

OVERVIEW OF SURGERY

There is no medical cure for proplase, except that in some cases pessaries can be used to provide temporary relief against symptoms of prolapse. The only definitive cure for prolapse is surgery. Surgery helps in providing relief against symptoms of prolapse by restoring pelvic anatomy, sexual functioning and human physiologic functions (micturition and defecation).[3] Since uterine prolapse is not a life-threatening condition, surgery is indicated only if the patient feels that her condition is severe enough that it warrants correction. Mild prolapse, which is rarely symptomatic, does not require surgical correction. Surgery is usually advised in women over 40 years, unless it is contraindicated or hazardous on account of some medical

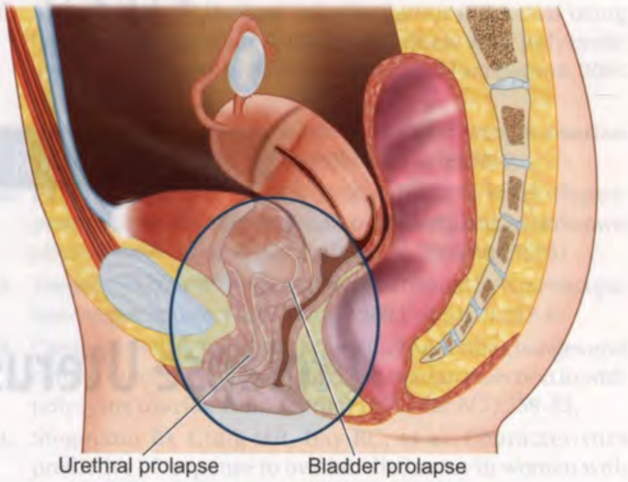


Fig. 22.2: Urethrocele

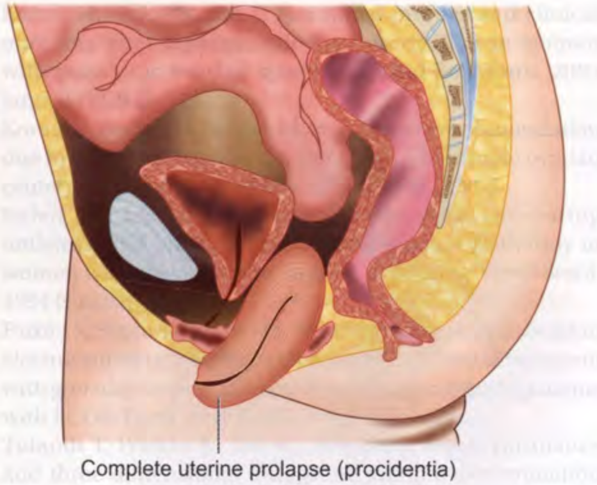


Fig. 22.3: Uterine prolapse

disorders. Various surgical options which can be used in cases of prolapse are enumerated in Table 22.2.

Although the choice of procedure largely depends on the surgeon's preference and experience, the gynecologist needs to consider numerous factors, such as the patient's general health status, degree and type of uterine prolapse, requirement for preservation or restoration of coital function, concomitant intrapelvic disease and the patient's desire for preservation of menstrual and reproductive functions. The choice of surgery depends on numerous factors summarized below:

- Degree of prolapse
- Areas specific for prolapse
- Desire for future pregnancies
- Desire to maintain future sexual function
- Presence of concomitant medical conditions
- Preservation of vaginal function
- The woman's age and general health status
- Patient's choice (i.e. desire for surgery or no surgery)
- Patient's age
- Severity of symptoms
- Patient's suitability for surgery
- Presence of other pelvic conditions requiring simultaneous treatment, including urinary or fecal incontinence
- Presence or absence of urethral hypermobility
- History of previous pelvic surgery.

AIMS OF SURGERY

Aim of surgery is to restore the pelvic anatomy and human physiologic functions, such as micturition, defecation and sexual functioning. A careful preoperative evaluation should be carried out in order to identify all concomitant defects associated with uterine prolapse, which should be repaired in order to avoid recurrence of prolapse in future. In patient with advanced degree of prolpase, additional

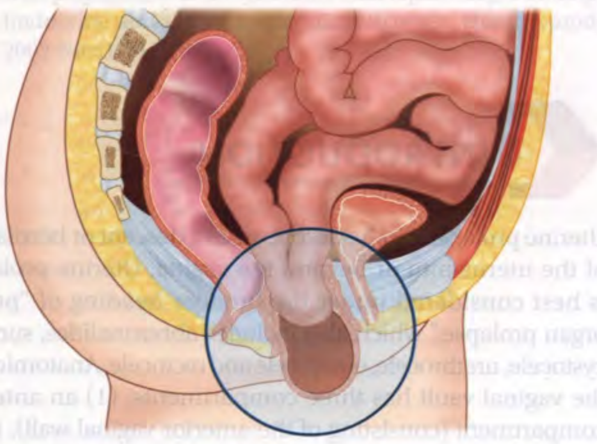


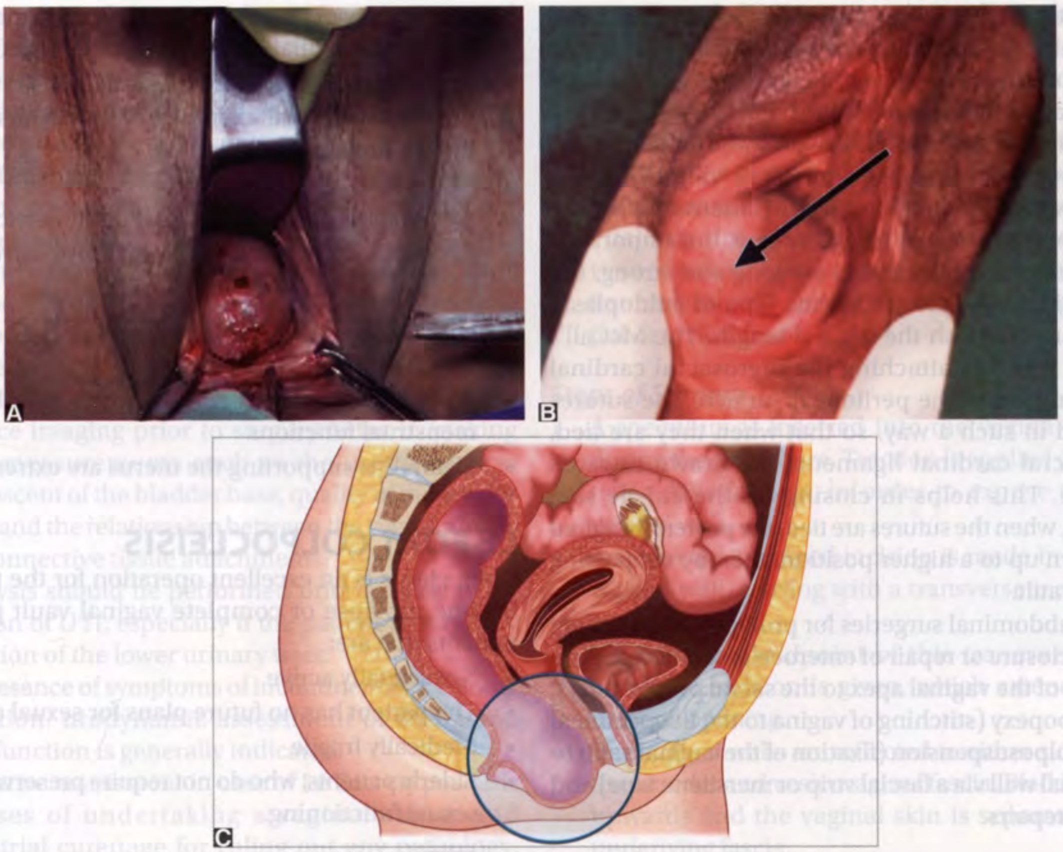
Fig. 22.4: Enterocele

procedures like transvaginal sacrospinous ligament fixation, transabdominal sacral colpopexy or colpectomy with colpocleisis may be required to provide adequate support to the vaginal vault.

PRINCIPLES OF SURGERY FOR PELVIC ORGAN PROLAPSE

The following principles must be taken into consideration, while undertaking surgery for pelvic organ prolapse:

- At the time of clinical examination, when the patient is made to bear down, the site of primary damage appears first, followed by the sites of secondary damage. The gynecologist must take special note of this site of primary damage. The primary site of damage should be identified first and over-repaired in order to reduce the chances of recurrence.
- The gynecologist must repair all relaxations, even if they are minor in order to prevent recurrence in the future.



Figs 22.5A to C: Rectocele

Table 22.1: Baden-Walker Halfway system for evaluation of pelvic organ prolapse

Stage	Definition
Stage 0	Normal position for each respective site
Stage I	Descent of the uterus to any point in the vagina above the hymen
Stage II	Descent of the uterus up to the hymen
Stage III	Descent of the uterus halfway past the hymen
Stage IV	Total eversion or procidentia

Table 22.2: Surgical options which can be used in cases of prolapse

- Vaginal hysterectomy, posterior culdoplasty, colporrhaphy
- Vaginal hysterectomy, closure of enterocele sac, total colpectomy, colporrhaphy, colpocleisis
- Combined vaginal colporrhaphy and abdominal hysterectomy
- Moschcowitz culdoplasty, sacral colpopexy and suprapubic urethrocolpopexy
- Manchester operation
- Vaginal repair and uterine suspension
- Abdominal sling surgery

The strength of the various support structures should be evaluated.

- Even the relatively weak structures can be used, but they must not be used to provide dependable support at the time of reconstruction surgery.
- As far as possible, the surgeon must try to create a normal anatomy. Normal vaginal length should be maintained because a shortened vagina is likely to prolapse again.
- The vagina should be suspended in its normal posterior direction over the levator plate and rectum, pointing into the hollow of the sacrum, towards S3 and S4. The surgeon should avoid suspending the vaginal vault anteriorly to the abdominal wall.
- The cul-de-sac should be closed and rectocele repaired in all cases. A posterior colpoperineorrhaphy should be preferably performed in all cases, where possible. Repair of the lower posterior vaginal wall provides some support to the anterior vaginal wall and also lengthens the vagina.

When performed in properly selected patients, anterior colporrhaphy serves as an effective procedure for treating stress incontinence, which may be commonly associated with anterior cystocele. A vaginal hysterectomy may not always be indicated in a patient, in whom the primary aim is to repair a cystocele. In fact, a vaginal hysterectomy with anterior colporrhaphy may produce a variety of disorders of the bladder function, including stress urinary incontinence, detrusor instability and other voiding difficulties. Removal of uterus helps in facilitating the repair of an enterocele. The choice of surgery for repair of enterocele and massive eversion of vagina includes perineorrhaphy. A hysterectomy with colporrhaphy and colpopexy works well for the patient with prolapse, who wishes to preserve coital interest. Colpocleisis can be considered for patients, in whom preservation of the sexual functioning is not important. When the uterosacral ligaments are long and strong, the addition of McCall or New Orleans type of culdoplasty will help to re-establish the vaginal length. The McCall's culdoplasty involves attaching the uterosacral cardinal ligament complex to the peritoneal surface. The sutures are attached in such a way, so that when they are tied, the uterosacral cardinal ligaments are drawn towards the midline. This helps in closing off the cul-de sac. Additionally, when the sutures are tied, the posterior vaginal apex is drawn up to a higher position, thereby supporting the vaginal vault.

Various abdominal surgeries for prolapse include sling operations, closure or repair of enterocele, sacrocolpopexy (suspension of the vaginal apex to the sacral promontory), anterior colpopexy (stitching of vagina to the ileopectineal ligament), colposuspension (fixation of the vaginal vault to the abdominal wall via a fascial strip or mersilene tape) and paravaginal repairs.

INDICATIONS

HYSTERECTOMY

Indications for hysterectomy in case of prolapse uterus are as follows:
- Removal of a nonfunctioning organ in postmenopausal women
- Concomitant uterine or cervical pathology [e.g. large fibroid uterus, endometriosis, pelvic inflammatory disease (PID), endometrial hyperplasia and carcinoma]
- Bulky uterus
- Patient desires removal of the uterus.

ANTERIOR COLPORRHAPHY

- Presence of cystocele, urethrocele or a cystourethrocele
- Repair of anterior defects.

POSTERIOR COLPOPERINEORRHAPHY

- Presence of a rectocele
- Repair of posterior defects.

MANCHESTER OPERATION

Indications of Manchester operation in cases of uterine prolapse are as described below:
- Childbearing function is not required
- Malignancy of the endometrium has been ruled out, by performing a dilation and curettage (D & C)
- Absence of urinary tract infection (UTI)
- Presence of a small cystocele with only first or second-degree prolapse
- Absence of an enterocele
- Symptoms of prolapse are largely due to cervical elongation
- Patient requires preservation of the menstrual function.

ABDOMINAL SLING SURGERY

- Nulliparous prolapse
- Woman desirous of retaining their childbearing and menstrual functions
- Ligaments supporting the uterus are extremely weak.

LE FORT COLPOCLEISIS

Colpocleisis is an excellent operation for the treatment of uterine prolapse or complete vaginal vault prolapse for patients that are:
- Not sexually active
- The patient has no future plans for sexual activity
- Medically fragile
- Elderly patients, who do not require preservation of their sexual functioning.

PREOPERATIVE PREPARATION

Different types of available surgical options, such as repair of anterior defects, repair of posterior defects, enterocele repair, Manchester repair, abdominal sling surgery and obliterative procedures, such as Le Fort colpocleisis would now be described.[4-8] Vaginal hysterectomy, commonly performed in the cases of uterine descent has been described in details in Chapter 24 (Hysterectomy). Therefore, this procedure would not be discussed here. Before undertaking the surgical treatment for prolapse, the following steps need to be undertaken:
- Medical treatment for chronic cough or constipation must be administered.
- If decubitus ulceration is present over the prolapsed tissue, it first needs to be treated by the application of glycerine acriflavine pack or ring pessaries. Both these strategies help by repositioning the uterus to the normal anatomical position, thereby relieving the kinking of uterine blood vessels, cervical congestion and ulceration. The surgery must be undertaken only when the decubitus ulceration has regressed.
- Surgery must be undertaken only when the associated UTI and PID have been aggressively treated.
- Preoperative estrogen therapy must be given, especially to the elderly postmenopausal patients, in whom vaginal epithelium is thin and inflamed.

- Antiseptic vaginal douches should be administered a day before surgery. Full dose of antibiotics (80 mg of gentamicin, 1 g of ampicillin and 500 mg of metronidazole) must be administered 2 hours before surgery to prevent postoperative pelvic infections.
- **In case of edema of the prolapsed tissues,** glycerine with acriflavine packs can be used for a few days until the edema gets cleared.
- Estrogen cream applied locally for senile vaginitis should be stopped a few days prior to surgery because it may be associated with an increased bleeding during the surgery.
- Recent advances in pelvic imaging such as magnetic resonance imaging prior to surgery helps in making various measurements such as the urethrovesical angle, descent of the bladder base, quality of the levator muscles and the relationship between the vagina and its lateral connective tissue attachments.
- A urinalysis should be performed prior to surgery for evaluation of UTI, especially if the patient reports any dysfunction of the lower urinary tract.
- **In the presence of** symptoms of incontinence or voiding dysfunction, urodynamic assessment of filling and voiding function is generally indicated.
- Preoperative assessment in case of Le Fort colpocleisis comprises of undertaking a vaginal smear and endometrial curettage for ruling out any pathology, particularly malignancy. In long-standing cases, an intravenous pyelogram may be required because of the tendency towards associated hydroureter and hydronephrosis due to kinking of the ureter. Cystoscopy and renal function tests are also essential in long-standing cases to rule out concomitant renal pathology.

SURGICAL STEPS

HYSTERECTOMY

Surgical removal of uterus or hysterectomy can be done via the vaginal route (vaginal hysterectomy) or through the abdomen (abdominal hysterectomy). Both these procedures have been described in details in Chapter 24 (Hysterectomy). Vaginal hysterectomy with pelvic floor repair is suitable for women over the age of 40 years, those who have normal sized uterus and those who have completed their families and are no longer interested in retaining their childbearing and menstrual functions. A Kelly's stitch may be necessary to relieve the patient of her stress incontinence, if it is present.

ANTERIOR REPAIR

Anterior Colporrhaphy

Anterior colporrhaphy operation is one of the most commonly performed surgeries to repair a cystocele and cystourethrocele.[9,10] This surgery is usually performed under general or regional anesthesia.

Principles of Anterior Colporrhaphy

Anterior colporrhaphy comprises the following steps:

1. Excision of a portion of relaxed anterior vaginal wall;
2. Mobilization of bladder;
3. Pushing the bladder upwards after cutting the vesicocervical ligament and
4. Permanently supporting the bladder by tightening the pubocervical fascia.

Steps of Surgery

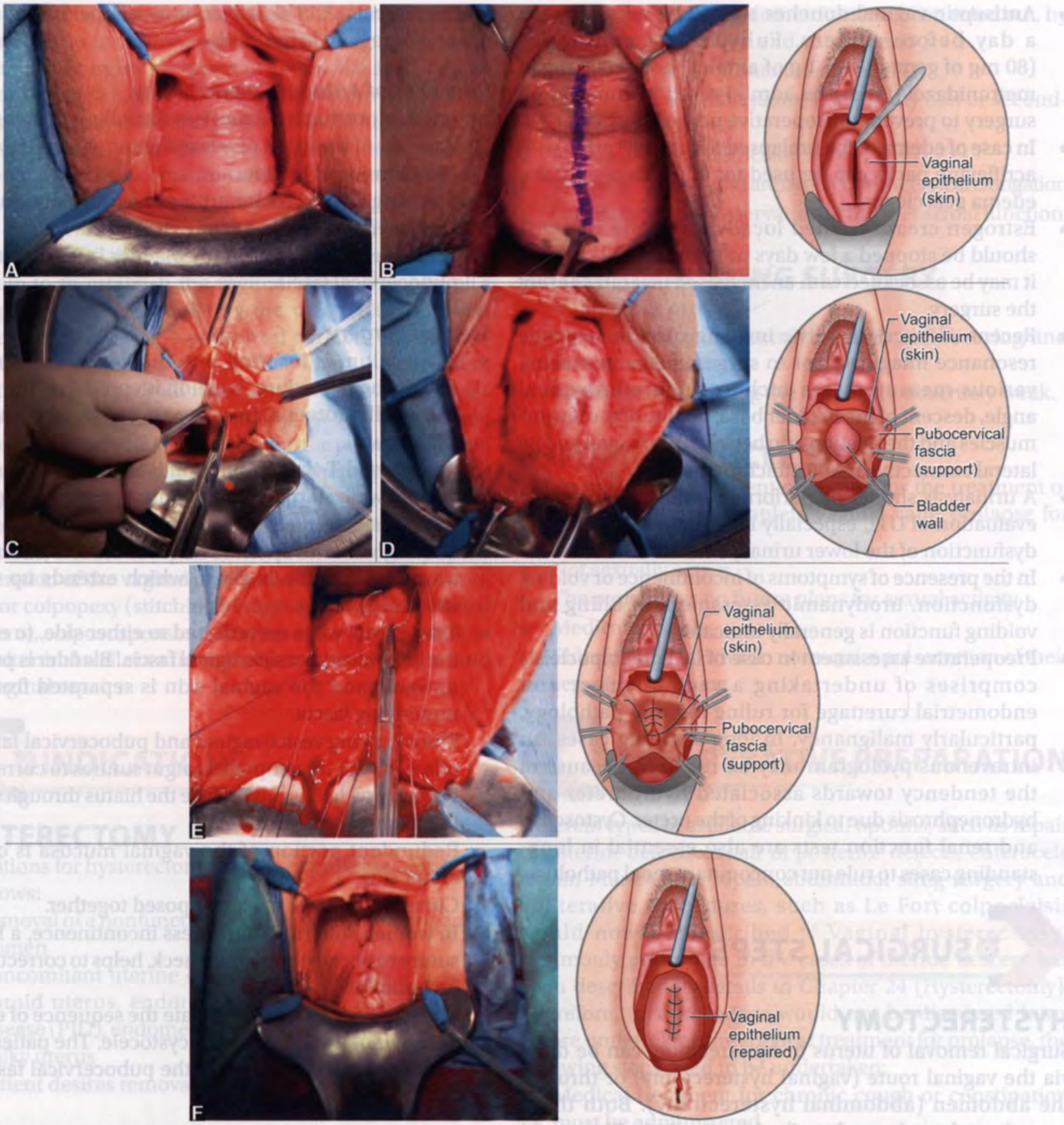
- A speculum is inserted into the vagina to expose it during the procedure. Traction is applied on the cervix using Allis forceps, in order to expose the anterior vaginal wall.
- An inverted T-shaped incision is made in the anterior vaginal wall, starting with a transverse incision on the bladder sulcus.
- Through the midpoint of this transverse incision, a vertical incision is given, which extends up to the urethral opening.
- The vaginal walls are reflected to either side, to expose the bladder and vesicovaginal fascia. Bladder is pushed upwards and the vaginal skin is separated from the underlying fascia.
- The overlying vesicovaginal and pubocervical fascia is plicated with interrupted 0 catgut sutures to correct the vaginal wall laxity and to close the hiatus through which the bladder herniates.
- Redundant portion of the vaginal mucosa is cut on either side.
- Cut margins of vagina are apposed together.
- In women suffering from stress incontinence, a Kelly's suture to plicate the bladder neck, helps to correct stress incontinence.

The Figures 22.6A to F illustrate the sequence of events in the repair of a midline defect cystocele. The patient has a cystocele due to weakness of the pubocervical fascia in the midline.

POSTERIOR REPAIR

Posterior Colporrhaphy and Colpoperineorrhaphy

While repairing the rectocele, most surgeons also perform a posterior colporrhaphy. This process involves nonspecific midline plication of the rectovaginal fascia after reducing the rectocele. The lax vaginal tissue over the rectocele is excised. The medial fibers of the levator ani are then pulled together, approximated and sutured over the top of rectum. This helps in restoring the caliber of the hiatus urogenitalis and strengthening the perineal body. An adequate amount of perineum is also created, which helps in separating the



Figs 22.6A to F: (A) Appearance of cystocele just before giving the incision; (B) Skin incision is given over the skin overlying the cystocele; (C) Dissection of the underlying fascia; (D) Dissection of the underlying fascia is continued until the midline defect in pubocervical fascia is visualized; (E) The tissue under the bladder is plicated and pulled together in the midline, thus reducing the bulge. Following the reduction, excess vaginal skin is then cut off, which can create a shortened or constricted vagina; (F) Closure of the vaginal epithelium

hiatus urogenitalis from the anal canal. Though this surgery is quite effective in the treatment of the rectocele, these patients often suffer from dyspareunia following surgery. The surgical procedure for rectocele repair is illustrated in Figures 22.7A to F.

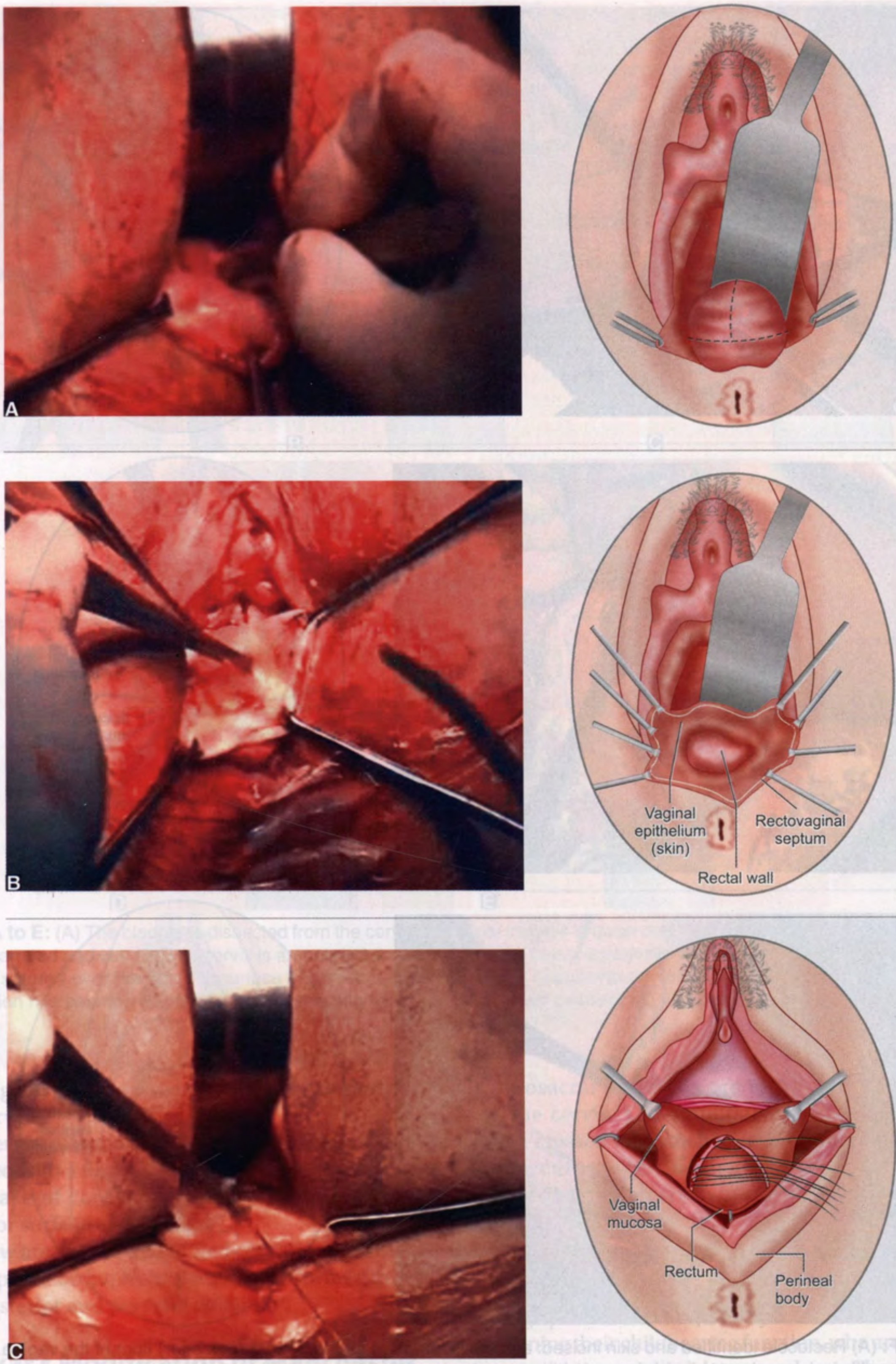
MANCHESTER REPAIR

Manchester repair is performed in those cases, where removal of the uterus is not required.[9,10]

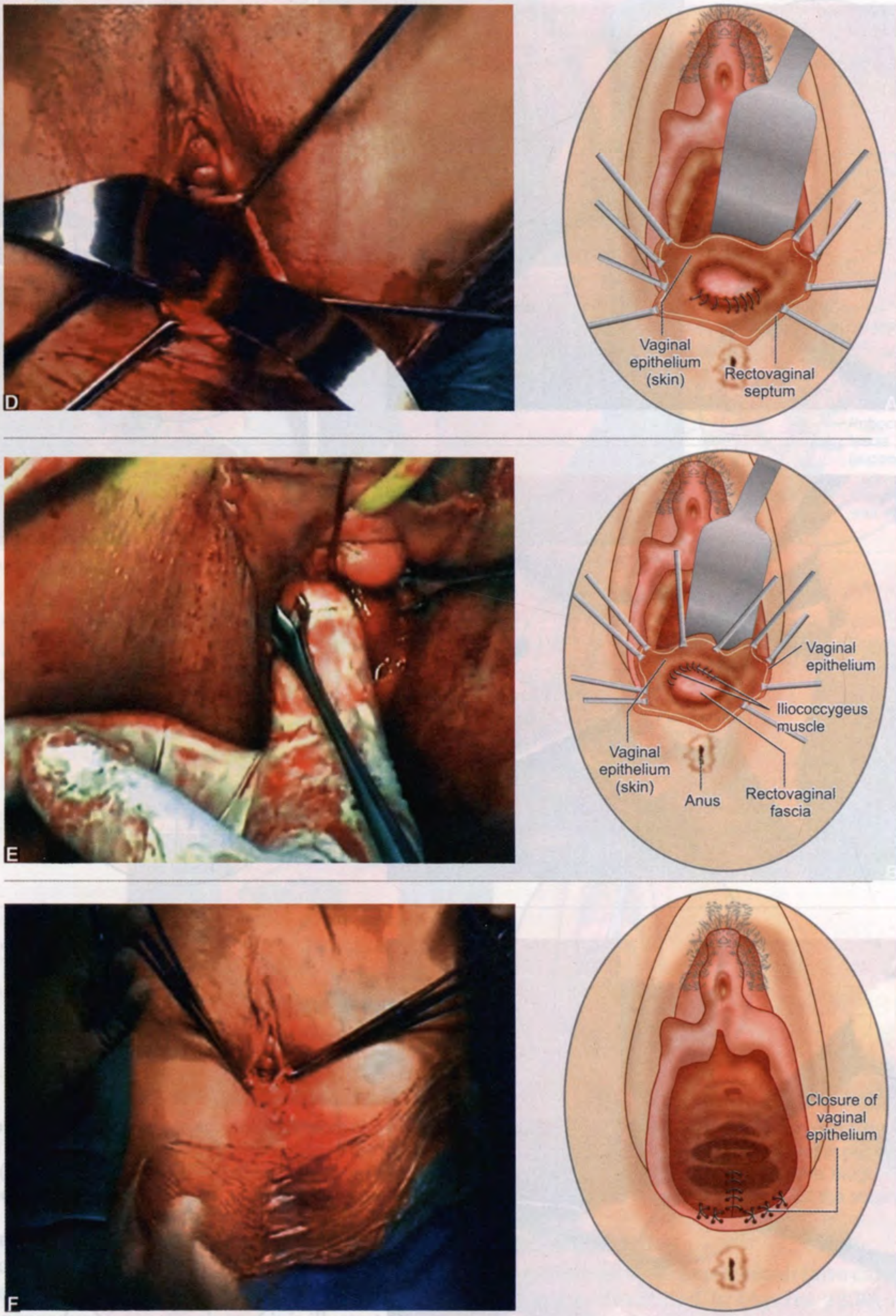
Procedure

The procedure for Manchester repair (also called Fothergill operation) is described in Figures 22.8A to E and it comprises of the following steps:

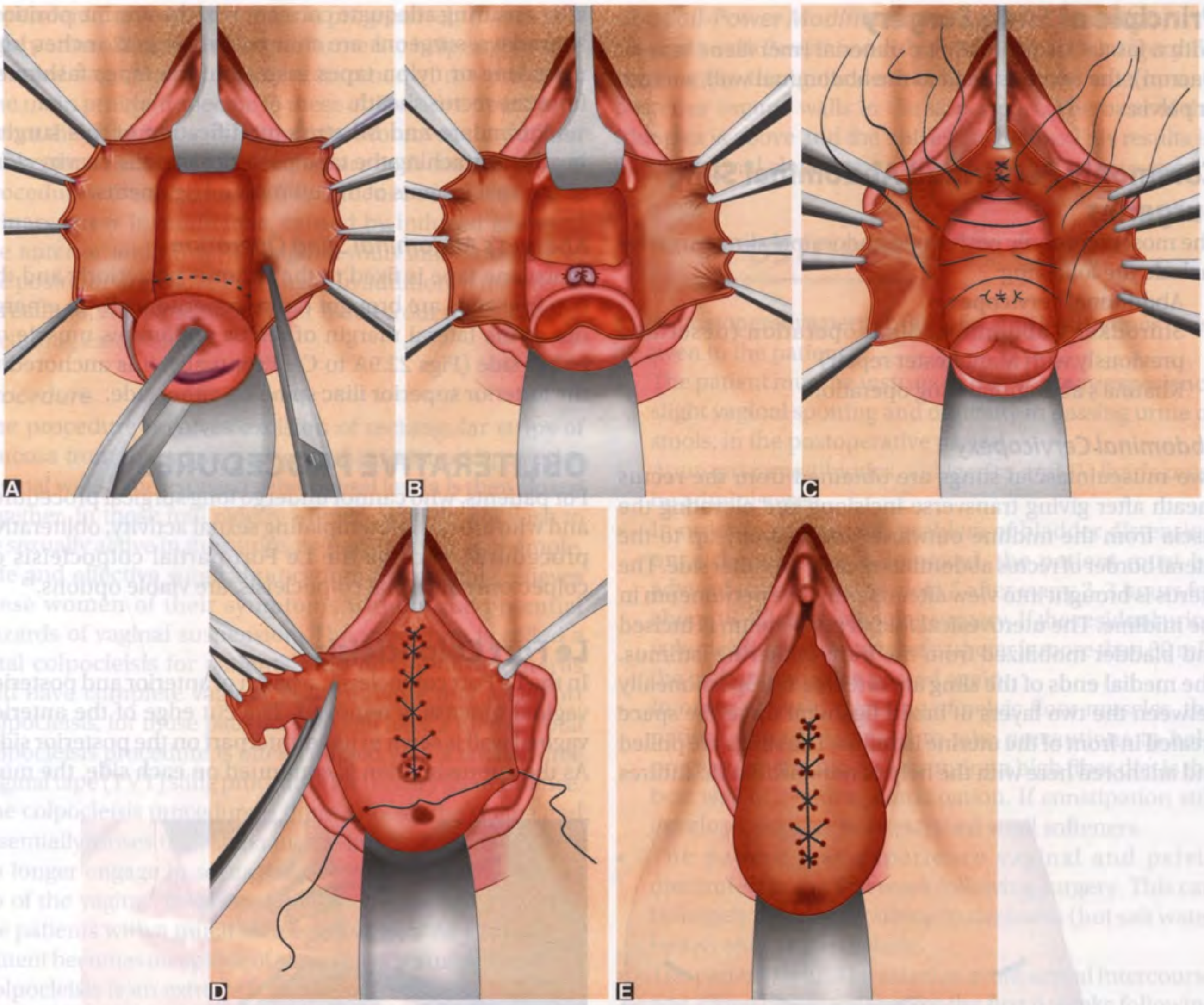
- Anterior colporrhaphy is firstly performed.
- The bladder is dissected from the cervix. A circular incision is given over the cervix.
- The attachment of Mackenrodt ligaments to the cervix on each side are exposed, clamped and cut.



Figs 22.7A to C



Figs 22.7A to F: (A) Rectocele identified and skin incised: a bulge is apparent on the bottom (posterior) floor of the vagina. The dotted line represents the skin incision, about to be performed in this posterior repair procedure; (B) Identification of the fascia break: the rectocele exists because of a break in the supportive layer known as the rectovaginal fascia. The defect is readily identified and the rectal wall is found protruding through this break in the rectovaginal fascia; (C) The rectovaginal fascia is reattached to the perineal body, where the distal defect was located; (D) The rectovaginal fascial defect has been repaired; (E) The rectovaginal fascia is reattached to the iliococcygeal muscles bilaterally with permanent sutures; (F) Closure of the vaginal epithelium (skin) completes the operation



Figs 22.8A to E: (A) The bladder is dissected from the cervix. A circular incision is given over the cervix. The base of cardinal ligament is exposed, clamped and cut; (B) The cervix is amputated and posterior lip of cervix is covered with a flap of mucosa. The base of cardinal ligament is sutured over the anterior surface of cervix; (C) Approximation of pubovesico-cervical fascia in the midline; (D) The fascial approximation has been completed and excessive vaginal mucosa has been excised; (E) Vaginal mucosa has been closed

- The vaginal incision is then extended posteriorly round the cervix.
- The cervix is amputated and posterior lip of cervix is covered with a flap of mucosa.
- The base of cardinal ligament is sutured over the anterior surface of cervix.
- The raw area of the amputated cervix is then covered.
- Colpoperineorrhaphy is ultimately performed to correct the posterior and perineal defects.

Shirodkar's Modification of Manchester Repair

In Shirodkar's modification of Manchester repair, firstly an anterior colporrhaphy is performed. The cardinal ligaments are exposed and the pouch of Douglas is opened.[11] The uterosacral ligaments are identified and divided close to the cervix. The amputated uterosacral ligaments are then crossed and stitched in front of cervix. Since in this procedure the cervix is not amputated, the complications related to childbirth can be largely avoided. A high closure of the peritoneum of the pouch of Douglas is carried out.

ABDOMINAL SLING SURGERY

Sling operations are especially useful in women desirous of retaining their childbearing function, who are suffering from second degree or third degree prolapse. These surgeries aim at buttressing the weakened ligaments (e.g. Mackenrodt and uterosacral ligaments) with help of synthetic tapes such as nylon and Dacron which are used for forming slings to support the uterus.[12]

Principle of Sling Surgery

With a fascial strip/prosthetic material (mersilene tape or Dacron), the cervix is fixed to the abdominal wall, sacrum or pelvis.

Commonly Performed Abdominal Sling Surgeries

The most commonly performed abdominal sling surgeries include the following:

- Abdominal cervicopexy
- Shirodkar's abdominal sling operation (described previously with Manchester repair)
- Khanna's abdominal sling operation.

Abdominal Cervicopexy

Two musculofascial slings are obtained from the rectus sheath after giving transverse incisions and elevating the fascia from the midline outwards and laterally up to the lateral border of rectus abdominis muscle on either side. The uterus is brought into view after opening the peritoneum in the midline. The uterovesical fold of peritoneum is incised and bladder mobilized from the front of uterine isthmus. The medial ends of the sling are directed retroperitoneally between the two layers of broad ligament up to the space created in front of the uterine isthmus. The slings are pulled and anchored here with the help of nonabsorbable sutures after ensuring adequate correction of the uterine position. Nowadays, surgeons are commonly using 12 inches long mersilene or nylon tapes instead of the tapes fashioned from the rectus sheath.

Purandare and Mhatre's modification of this surgery involved attaching the tape posteriorly to the cervix, close to the attachments of the uterosacral ligaments.

Khanna's Abdominal Sling Operation

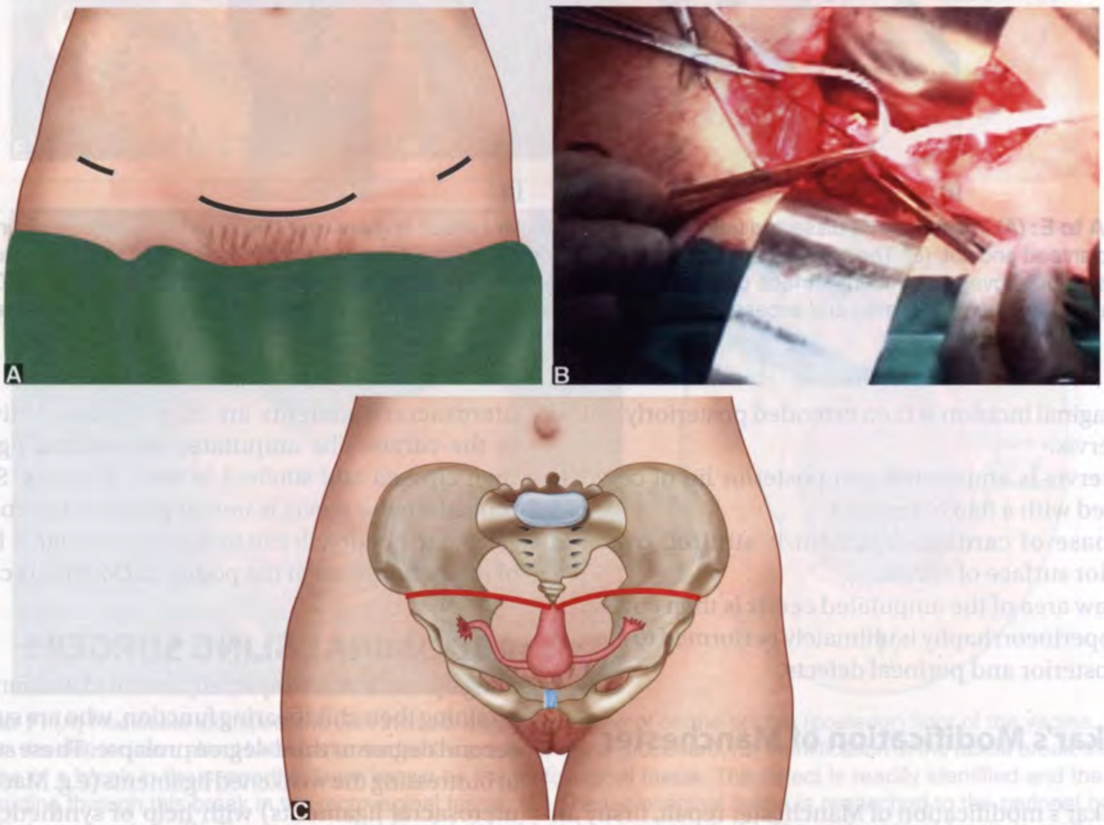
Mersilene tape is fixed to the isthmus posteriorly and the two free ends are brought out retroperitoneally to emerge out at the lateral margin of rectus abdominis muscle on either side (Figs 22.9A to C). Eventually, it is anchored to the anterior superior iliac spine on either side.

OBLITERATIVE PROCEDURES

For patients, who cannot undergo long surgical procedures and who are not contemplating sexual activity, obliterative procedures, such as the Le Fort partial colpocleisis or colpectomy and total colpocleisis, are viable options.[13]

Le Fort Colpocleisis

In the Le Fort colpocleisis, a patch of anterior and posterior vaginal mucosa is removed. The cut edge of the anterior vaginal wall is sewn to its counterpart on the posterior side. As the approximation is continued on each side, the most



Figs 22.9A to C: Khanna's abdominal sling operation: (A) Incisions given for Khanna's sling operation; (B) Attachment of the mersilene tape to the uterine isthmus posteriorly; (C) Diagrammatic representation of the completed Khanna's sling surgery

dependent portion of the mass is progressively inverted. A tight perineorrhaphy is also performed to help support the inverted vagina and prevent recurrence of the prolapse. The main problem specific to these obliterative operations is that they limit the coital function. Moreover, they do not correct an enterocele because they are both extraperitoneal procedures. Also, there is a 25% incidence of postoperative urinary stress incontinence, caused by induced fusion of the anterior and posterior vaginal walls and flattening of the posterior urethrovesical angle. In addition, if the uterus is retained, the patient can later bleed from many causes, including carcinoma.

Procedure

The procedure involves excision of rectangular strips of mucosa from the upper portions of anterior and posterior vaginal walls. The exposed submucosal fascia is then closed together. In those frail elderly women, who do not wish to be sexually active in the future, colpocleisis acts as a simple, safe and effective surgical procedure that reliably relieves these women of their symptoms without the potential hazards of vaginal suspension. The procedure is called a total colpocleisis for patients, who do not have a uterus and have complete vaginal vault prolapse and a Le Fort colpocleisis, for those patients who still have a uterus. Total colpocleisis procedure is often coupled with a tension-free vaginal tape (TVT) sling procedure for urinary incontinence. The colpocleisis procedure is done through the vagina and essentially closes the vagina on the inside. The patient can no longer engage in sexual intercourse due to the closing up of the vagina. The completed procedure usually leaves the patients with a much shortened vagina. As a result, the patient becomes incapable of engaging in sexual intercourse. Colpocleisis is an extremely effective operation, which has the advantages listed in Table 22.3. The surgical technique of colpocleisis is shown in Figures 22.10A to E. The procedure is associated with disadvantages, such as loss of sexual activity and development of stress or urge incontinence. Le Fort's procedure should only be used, when there is a good reason not to perform any of the usual procedures for prolapse. This operation is recommended only to the patients, who are neither sexually active nor have plans for future sexual intercourse. The procedure should never be done before the woman and her partner fully understand that the procedure would result in termination of intravaginal sexual intercourse.

Table 22.3: Advantages of colpocleisis

- Closes the vagina together
- Inhibits the patient from future sexual intercourse
- 90% to 95% cure rate
- Can be performed using local anesthesia, epidural or spinal
- No requirement for general anesthesia
- A quick procedure which takes only 45 minutes to perform
- Minimal pain or complications
- Can be coupled with TVT sling (incontinence) operation

Abbreviation: TVT, tension free vaginal tape

Goodall-Power Modification of Le Fort Operation

Goodall and Power modified the Le Fort's surgery by creating two triangular denuded areas on the anterior and posterior vaginal walls in the upper part. The base of the triangles is above and the apices are below. This results in partial vaginal closure thus allowing sexual intercourse.

POSTOPERATIVE CARE

In the postoperative period, the following instructions must be given to the patient:

- The patient must be instructed that she may experience slight vaginal spotting and difficulty in passing urine or stools, in the postoperative period.
- Appropriate antibiotics, analgesics and IV fluids must be administered.
- In order to prevent the problem of bladder distension once the catheter is removed, the patient must be advised to void "by the clock," after every 2–3 hours for about 15–20 days following surgery. If the residual urine volume after the removal of catheter is more than 50 mL, the catheter must be passed again.
- In order to avoid straining of pelvic floor muscles, the patient must be advised to take precautions to help prevent constipation. Consuming a high fiber diet is the best way of avoiding constipation. If constipation still develops, she can be prescribed stool softeners.
- The patient may experience vaginal and pelvic discomfort in the first week following surgery. This can be largely avoided by sitting in sitz baths (hot salt water baths) once or twice daily.
- The patient should be asked to avoid sexual intercourse and lifting heavy weights for the first 6 weeks following surgery.
- The patient is instructed to come for a follow-up visit at 15 days and then again after 6 weeks to assess, if the surgical wound has properly healed and whether the patient can resume her normal day-to-day activities.

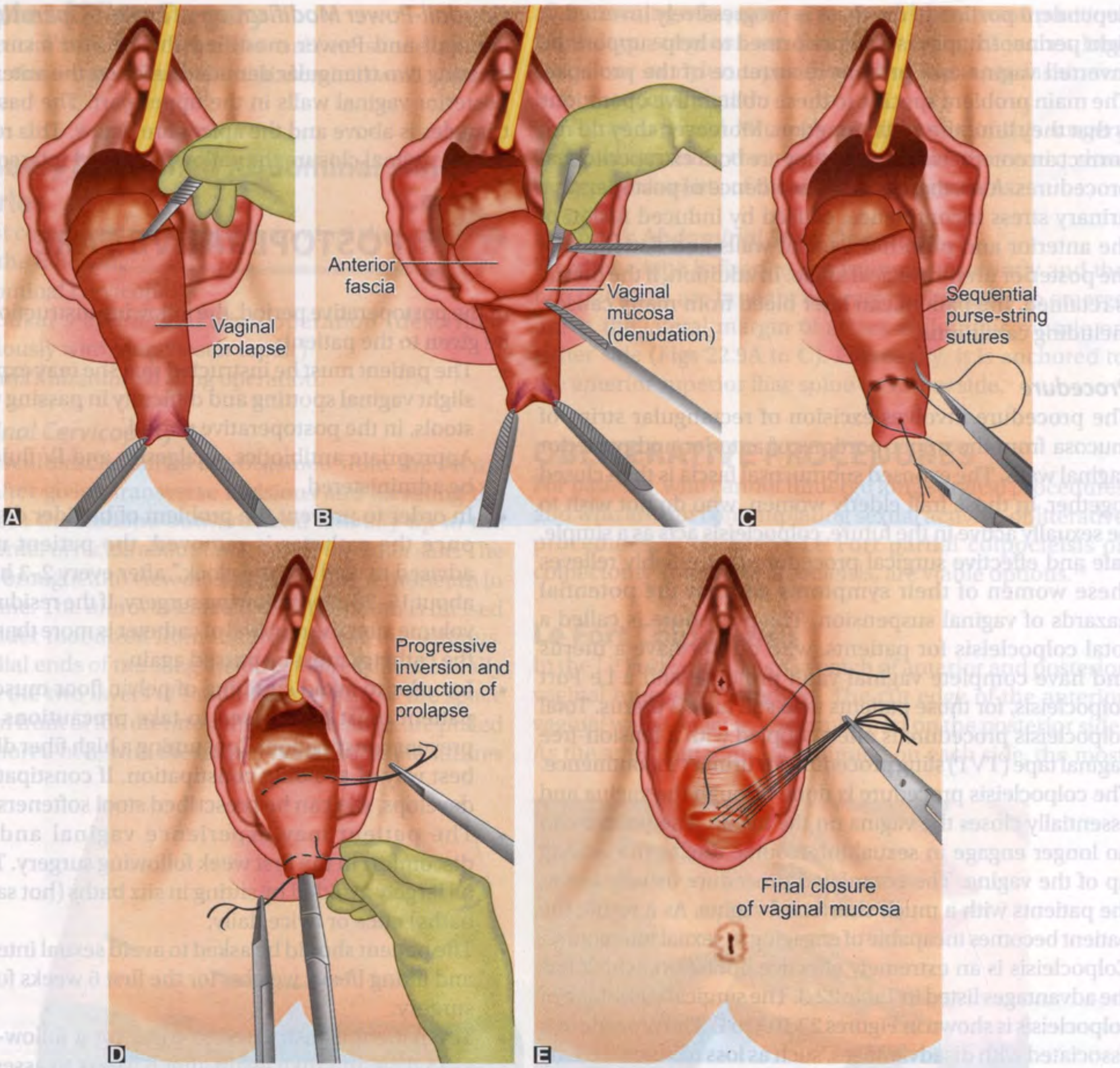
ADVANTAGES

The various surgeries help in correction of the anatomical defect and restoration of normal physiological functions (such as micturition and defecation). These surgeries (with the exception of colpocleisis) allow the patient to resume her normal sexual activities, once the healing is complete.

COLPOCLEISIS

The procedure of colpocleisis is associated with the following advantages:

- Closes the vagina together
- Inhibits the patient from future sexual intercourse



Figs 22.10A to E: Le Fort colpocleisis: (A) Incision over the mucosa of anterior vaginal wall; (B) Incision and removal of skin: mucosa is removed from the prolapse to expose the anterior fascia (pubocervical fascia) and posterior fascia (rectovaginal fascia); (C) Suturing: the mucosa has been removed and the underlying strong tissues (pubocervical and rectovaginal fascia) are identified. The tissue is sewn together in a circular fashion (like the drawstrings on a purse); (D) Reducing the prolapse: the most protruding portion of the vagina is inverted (pushed in upon itself) and the last suture placed is tied. The suture holds the rest of the vagina from coming back out or prolapsing; (E) Final closure of vaginal mucosa. After multiple circular sutures are placed and the prolapse is progressively reduced, the prolapse is completely reduced back into the patient's vagina and pelvis. The skin edges from the original incision are then closed using sutures

- 90–95% cure rate
- Can be performed using local, epidural or spinal anesthesia
- No requirement for general anesthesia
- A quick procedure which takes only 45 minutes to perform
- Minimal pain or complications
- Can be coupled with TVT sling (incontinence) operation.

DISADVANTAGES

Anterior colporrhaphy is still today the most commonly performed procedure to treat cystoceles, despite of the several disadvantages. Some of these are as follows:

- Failure rate in the range of 30–50%
- It has poor cure rate
- Requirement for a repeat procedure

- The surgery can result in constriction of vagina
- Constriction and/or shortening of vagina can result in dyspareunia. The surgery is not a true repair; it is just a compensatory procedure, associated with plication of the weakened tissue
- Tightening of tissue under the bladder neck can result in voiding dysfunction.

COMPLICATIONS

COMPLICATIONS DUE TO UTERINE PROLAPSE

Uterine prolapse if not corrected, can interfere with bowel, bladder and sexual functions and result in the development of the following complications:

- Ulceration
- Infection/sepsis (including due to pessary use)
- Urinary incontinence
- Constipation
- Fistula formation
- Postrenal failure
- Decubitus ulceration.

INTRAOPERATIVE COMPLICATIONS OF ANTERIOR COLPORRHAPHY

Excessive bleeding, requiring blood transfusion may occur. Development of a hematoma in the anterior vagina (especially after vaginal or paravaginal repair).

- Injury to the bladder or urethra in the course of dissection.
- Ureteral damage or obstruction occurs rarely (0-2% incidence) usually with very large cystoceles or with apical prolapse.
- Other rare complications include intravesical or urethral suture placement and fistula formation (either urethrovaginal or vesicovaginal).
- Development of erosions, draining sinuses or chronic areas of vaginal granulation tissue, especially if permanent sutures or mesh material is used for the repair.
- Urinary tract infections can commonly occur.
- Voiding difficulty can occur after anterior vaginal wall prolapse repair. Treatment comprises of bladder drainage or intermittent self-catheterization until spontaneous voiding resumes, usually within 6 weeks.
- Sexual function may be positively or negatively affected by vaginal operations for anterior vaginal wall prolapse.

COMPLICATIONS OF LE FORT COLPOCLESIS

- Bladder, urethral injury
- Rectal injury
- Urinary incontinence
- Mucocolpos: This may occur due to the collection of secretions in the upper part of the vagina if the drainage is inadequate
- Detection of vaginal or cervical carcinoma at a late stage, in case they occur.

DISCUSSION

SUPPORTS OF THE UTERUS

A basic knowledge of pelvic anatomy and uterine supports is essential for the gynecologist in order to understand the mechanism of prolapse and the methods of correcting it. Thus, the various pelvic supports would be discussed now. The various support structures of the pelvis are attached to the bony pelvis, which is formed by the pelvic bones (comprising of the pubic bone, ilium and ischium) anteriorly and on either side and posteriorly by sacrum and coccyx. Various pelvic structures, including urinary structures (bladder, urethra), genital structures (vagina, cervix, uterus, fallopian tubes and ovaries) and the rectum are present within this "supporting structure." The failure of the pelvic support system allows for descent of one or more of the pelvic organs into the potential space of the vagina and at its most severe degree, outside the vaginal opening. The vagina can be divided into proximal (deep), middle and distal (superficial) thirds. Depending upon the anatomical location of different parts of vagina, three levels of support for vaginal tissues can be defined. Level I support, suspends the upper vagina and mainly comprises of the cardinal and the uterosacral ligaments. Level II support, attaches the mid-vagina along its length to the arcus tendineus fascia of the pelvis. Level III support, on the other hand results from the fusion of the distal vagina to the adjacent structures and mainly comprises of levator ani and perineal muscles. The supports for different parts of vagina have been summarized in Table 22.4.

In the supine position, the upper vagina lies almost horizontal and superior to the levator plate. The uterus and vagina have two main support systems. Active support is provided by the levator ani (level III support). On the other hand, passive support is provided by the condensations of the endopelvic fascia (i.e. the uterosacral cardinal ligament

Table 22.4: Different levels of support for vaginal tissue

Different levels of support of vagina	Support elements
♦ Level I (for proximal one-third of vagina)	♦ Cardinal and the uterosacral ligaments
♦ Level II (for middle one-third of vagina)	♦ Paravaginal fascia
♦ Level III (for distal one-third of vagina and the introitus)	♦ Levator ani and perineal muscles

complex, the pubocervical fascia and the rectovaginal septum) and their attachments to the pelvis and pelvic sidewalls through the arcus tendineus fascia (level I and level II support).[14] The contraction of the levator plate creates a flap-valve effect, in which the upper vagina is compressed against it during the periods of increased intra-abdominal pressure. When the tone of levator ani muscles decreases, the vagina drops from a horizontal to a semivertical position. This causes the widening of the genital hiatus, thereby predisposing the prolapse of pelvic viscera.

Level I Support

Level I support comprises of the attachments of the cardinal (transverse cervical ligaments) and uterosacral ligament to the cervix and upper vagina (Fig. 22.11). Cardinal ligaments fan out laterally and attach to the anterior border of the greater sciatic foramen and ischial spines and the parietal fascia of the obturator internus and piriformis muscles. The cardinal ligaments contain the uterine arteries and provide attachment of uterus to the pelvic side walls. The uterosacral ligaments provide attachment of the cervix to the bony sacrum at the level of S2-S4. Together, this dense visceral connective tissue complex helps in maintaining vaginal length and horizontal axis. It allows the vagina to be supported by the levator plate and positions the cervix just superior to the level of ischial spines.

Some other important ligament supports, which help maintain the relationships between the urethra, bladder, vagina and uterus within the bony pelvis, include the pubourethral ligaments, the urethropelvic ligaments and the vesicopelvic ligaments. The pubourethral ligaments provide support to the middle portion of the urethra, by anchoring it to the undersurface of the pubic bone. The urethropelvic ligaments are composed of the levator fascia. This ligament provides support to the urethra, by helping in its attachment to the tendineus arch. On the other hand,

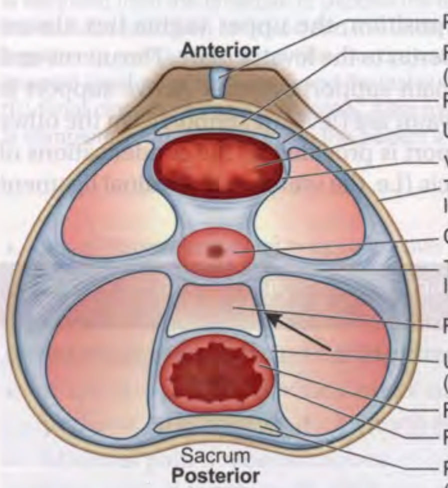


Fig. 22.11: Different ligamentous support of the uterus

the vesicopelvic ligament provides support to the bladder, by facilitating its attachment to the tendineus arch.

There are some peritoneal attachments, which act as ligaments which help in supporting the uterus and comprise of the following:

Ovarian ligament: The ovarian ligament extends from the proximal part of the ovary to the uterus, being posteroinferior to the uterotubal junction. The round ligament of the uterus attaches anterior inferior to this junction.

Broad ligament: This is a double layer of the peritoneum which extends from the lateral sides of the uterus to the pelvic side walls and the floor of pelvis. This ligament helps in keeping the uterus in position. The two layers of the broad ligament are continuous with each other at a free edge, which surrounds the uterine tube. Between the layers of the broad ligament on each side of the uterus, the ligament of ovary lies posterosuperiorly and the round ligament of the uterus lies anteroinferiorly.

Level II Support

This consists of paravaginal attachments that are contiguous with the cardinal/uterosacral ligament complex at the ischial spine. These comprise of the connective tissue attachments of the lateral vagina anteriorly to the arcus tendineus fascia of the pelvis and posteriorly to the arcus tendineus rectovaginalis. Detachment of this connective tissue from arcus tendineus leads to lateral or paravaginal anterior vaginal wall prolapse.

Level III Support

The perineal body along with superficial and deep perineal muscles of the pelvic floor comprises the level III support structures. Together, these structures support the distal one-third of the vagina and the introitus. The perineal body is not only essential for providing support to the distal vagina, it is also required for the proper functioning of the anal canal. Damage to level III support structures results in anterior/posterior vaginal wall prolapse, gaping introitus and perineal descent.

MUSCLES OF THE PELVIC FLOOR

These can be grouped into three layers (Fig. 22.12):

1. Muscles of the pelvic diaphragm (levator ani muscle)
2. Muscles of the urogenital diaphragm (deep transverse perineal muscle)
3. Superficial muscles of the pelvic floor (superficial transverse perineal muscle, external anal sphincter and bulbospongiosus).

Levator Ani Muscle

The levator ani muscle constitutes the pelvic diaphragm and supports the pelvic viscera. The levator ani muscle creates a hammock-like structure, by extending from the left tendineus arch to the right tendineus arch. The muscle has openings, through which the vagina, rectum and urethra traverse. Contraction of the levator muscles tends to pull the rectum and vagina inwards towards the pubic symphysis.[15] This causes narrowing and kinking of both vagina and rectum. The origin of levator ani muscles is fixed on the anterior end, because the muscle arises anteriorly either from the bone or from the fascia, which is attached to the bone. As a result, the anterior attachment of the muscle largely remains immobile. On the other hand, the levator ani muscles posteriorly get inserted into the anococcygeal raphe or into the coccyx, both of which are movable. Thus the contraction of levator ani muscles tend to pull the posterior attachment towards the pubic symphysis.

The pelvic diaphragm consists of two levator ani muscles, one on each side. Each levator ani muscle consists of three main divisions: (1) pubococcygeus, (2) iliococcygeus and (3) ischiococcygeus (Figs 22.13A and B). The pubococcygeus muscle originates from the posterior surface of the pubic bone. It passes backwards and lateral to the vagina and rectum, to be inserted into the anococcygeal raphe and the coccyx. The inner fibers of this muscle, which come to lie posterior to the rectum are known as the puborectalis portion of the muscle. These form a sling around the rectum and support it (Fig. 22.14). Some of the inner fibers of puborectalis fuse with the outer vaginal wall, as they pass lateral to it. Other fibers decussate between the vagina and rectum in the region of perineal body. The decussating fibers divide the space between the two levator ani muscles into an anterior portion (hiatus urogenitalis), through which pass the urethra and vagina and a posterior portion (hiatus rectalis), through which passes the rectum.

The iliococcygeus is fan-shaped muscle, which arises from a broad origin along the white line of pelvic fascia. It passes backwards and inwards to be inserted into the coccyx. The ischiococcygeus muscle takes its origin from the ischial spine and spreads out posteriorly to be inserted into the front of coccyx. The superior and inferior surfaces of the levator muscles are covered with tough fibrous tissue known as pelvic fascia, which separates the muscles from the cellular tissues of the parametrium above and from the fibrous and fatty tissues of ischiorectal fossa below. This fascia is composed of two components: (1) pelvic component (also known as the endopelvic fascia) and (2) the vaginal component (also known as periurethral fascia at the level of the urethra and the perivesical fascia, at the level of the bladder). The "pelvic component" fuses with the "vaginal component," to get inserted into the tendineus arch. Within the two components of the levator fascia are present the various pelvic organs, such as the urethra, bladder, vagina and uterus, to which it provides support.

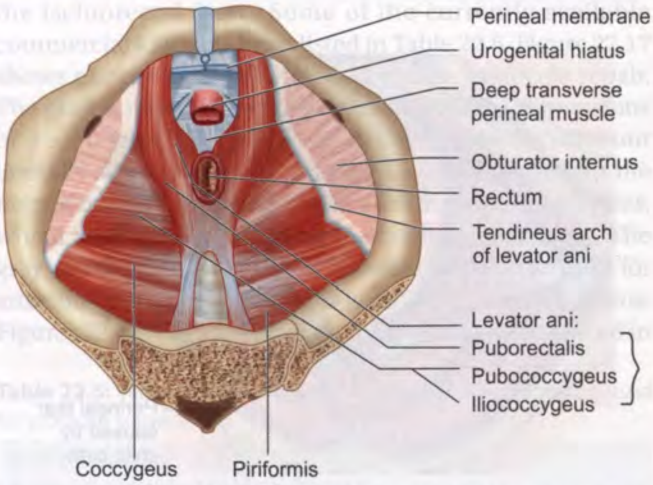
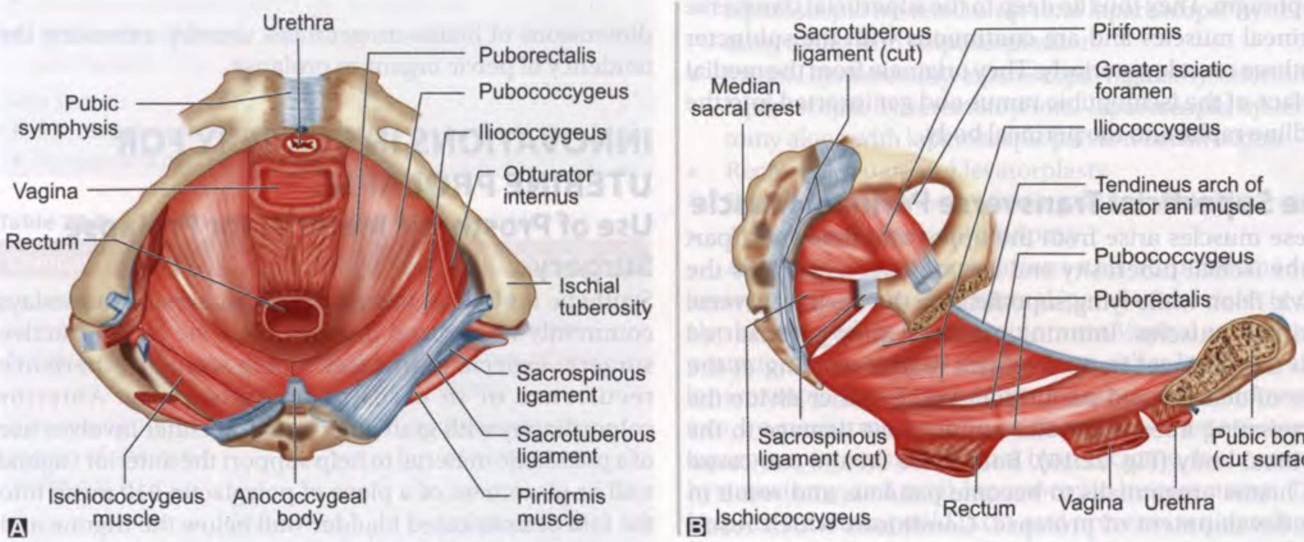


Fig. 22.12: Muscles of the pelvic floor



Figs 22.13A and B: Levator ani muscle. (A) Inferior view; (B) Lateral view

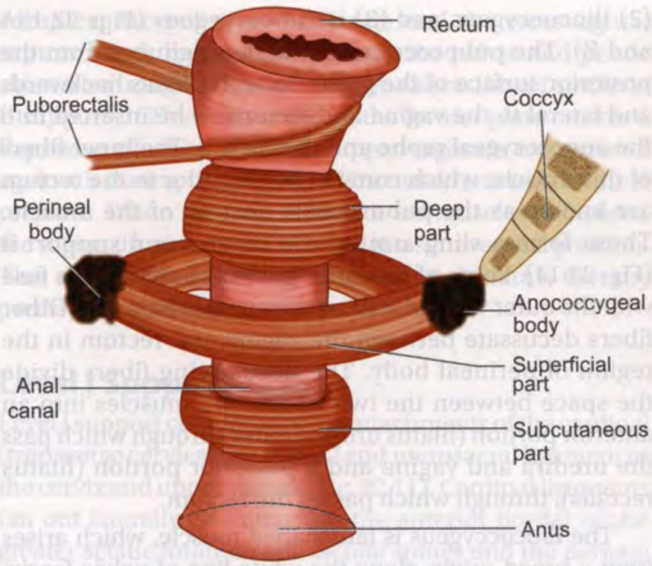


Fig. 22.14: Sling formed by levator ani muscles

The Central Tendineus Point of the Perineum or the Perineal Body

The perineal body is a pyramid-shaped fibromuscular structure, lying at the midpoint between the vagina and the anus. It lies at the level of the junction between the middle-third and lower one-third of the posterior vaginal wall. Perineal body assumes importance in providing support to the pelvic organs, as it provides attachment to the following eight muscles of the pelvic floor: superficial and deep transverse perineal muscles, and the levator ani muscles of both the sides, bulbocavernosus anteriorly and the external anal sphincter posteriorly (Fig. 22.15).

The Deep Transverse Perineal Muscle

The deep transverse perineal muscles run transversely across the pelvic floor and lie within the urogenital diaphragm. They thus lie deep to the superficial transverse perineal muscles and are continuous with the sphincter urethrae muscle anteriorly. They originate from the medial surface of the ischiopubic ramus and get inserted into the midline raphe and the perineal body.

The Superficial Transverse Perineal Muscle

These muscles arise from the upper and innermost part of the ischial tuberosity and run transversely across the pelvic floor, while lying superficial to the deep transverse perineal muscles. Running medially, they get inserted into the perineal body. Perineal tears occurring at the time of delivery and parturition tend to either divide the decussating fibers of levator ani or cause damage to the perineal body (Fig. 22.16). Both these factors can cause the hiatus urogenitalis to become patulous and result in the development of prolapse. Conditions which result in reduced tone of levator muscles tend to increase the dimensions of hiatus urogenitalis, thereby increasing the tendency of pelvic organs to prolapse.

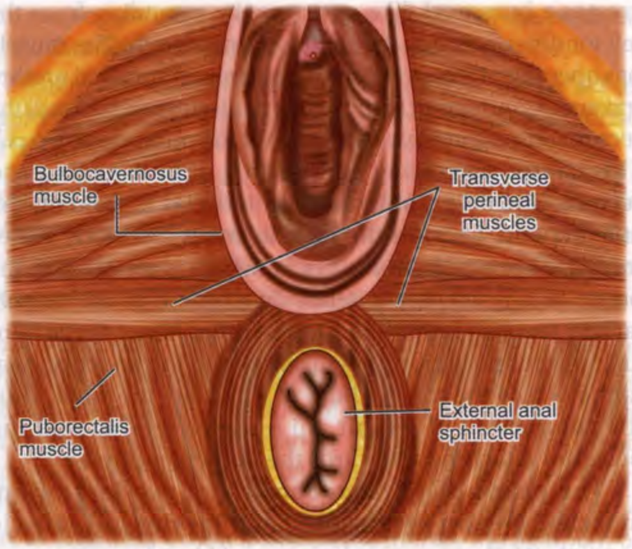


Fig. 22.15: Perineal body

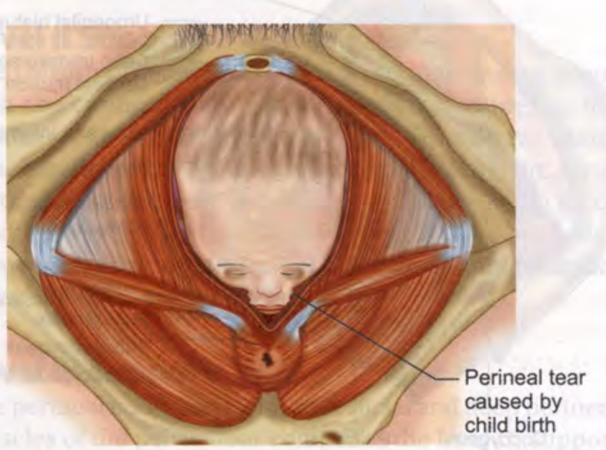


Fig. 22.16: Damage caused by the childbirth to the muscles of pelvic floor

INNOVATIONS IN SURGERY FOR UTERINE PROLAPSE

Use of Prosthetic Material for Prolapse Surgery

Synthetic and biological prosthetic material is nowadays commonly being used in cases of pelvic reconstructive surgery, especially in cases where women experience recurrence or in cases of repeat surgery. Anterior colporrhaphy with graft augmentation either involves use of a prosthetic material to help support the anterior vaginal wall or placement of a piece of polyglactin 910 mesh into the fold of imbricated bladder wall below the trigone and apical portion of the vaginal vault.[16]

Vaginal or paravaginal repair can also be carried out with graft augmentation. The various types of prosthetic material which is being used for prolapse surgery has been listed in Table 22.5. The objective of paravaginal defect repair for anterior vaginal wall prolapse is to reattach the detached lateral vaginal wall to its normal place of attachment at the level of the white line or "arcus tendineus fasciae pelvis" done using a vaginal or retropubic approach. Transobturator tension-free vaginal mesh techniques can also be used for management of anterior vaginal wall prolapse. These techniques facilitate a tension-free placement of an allograft, xenograft or polypropylene mesh implant without trimming of the vagina or suturing of the mesh to the vagina. The involved "systems" allow selective application of anterior, posterior or total vaginal implants. Therefore, the requirement for hysterectomy is potentially eliminated. The mesh implants have arms that are delivered with trocars or special devices through anatomical landmarks via the obturator membrane or the ischiorectal fossa. Some of the currently available commercial kits have been listed in Table 22.6. Figure 22.17 shows perigee system for transobturator cystocele repair. The graft is depicted in the center and has the dimensions of 5 × 10 cm. The graft has four arms, which come out laterally and are attached to the pelvic sidewalls with the help of needles. The pink needles are the superior needles, which are used for attaching the bladder neck arms. The gray needles are the inferior needles, which are used for attaching the apical arms of the graft to the arcus tendineus. Figures 22.18A and B show that the graft has been placed in position under the bladder. It provides an entire new floor of support for the bladder from side-to-side. The skin of vagina is closed over the graft. The tissue in growth occurs rapidly causing the graft to get incorporated and soon become a part of patient's anatomy. High rate of anatomical cure due to the use of TVT have been demonstrated in the uncontrolled short-term case studies. These techniques are still awaiting safety and efficacy studies. Nevertheless, they are still increasingly being used in clinical practice.[17] Before undertaking the procedure, the patients must be counseled regarding the serious adverse results of transvaginal mesh repair including pain, dyspareunia, etc.

Table 22.5: Various types of prosthetic material which is being used for prolapse surgery

Synthetic Material ♦ Nonabsorbable (Marlex, prolene) ♦ Absorbable polygalactin (vicryl)
Biological Materials ♦ Autologous material (rectus fascia, fascia lata) ♦ Xenografts (porcine dermis or porcine small intestine submucosa)
New Systems ♦ Polypropylene tapes (Fig. 22.19) ♦ Apogee and perigee

Table 22.6: Commercial transvaginal mesh kits available

Company	Device	Implant material
American Medical Systems Inc., Minnetonka, MN	Apogee/ Perigee	Intepro polypropylene InteXen porcine dermis
Gynecare/Ethicon, Johnson & Johnson, Somerville, NJ	Anterior Prolift	Gynemesh-PS polypropylene
CR Bard Inc., Murray Hill, NJ	Avaulta-Plus	Polypropylene + Porcine collagen

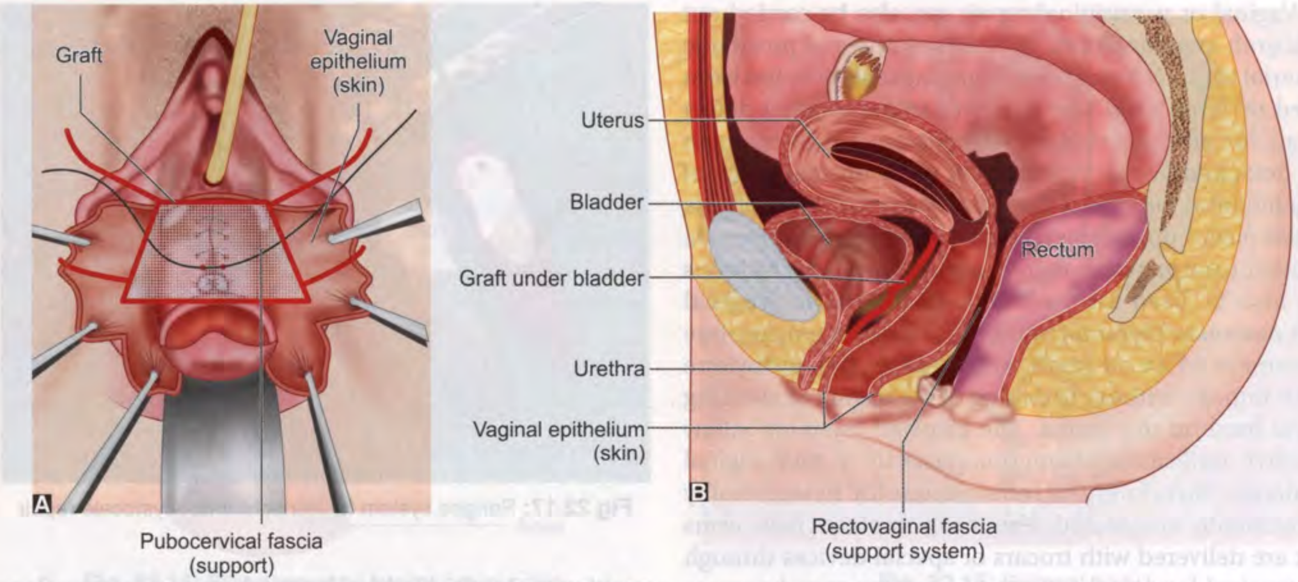
Fig 22.17: Perigee system for transobturator cystocele repair

Laparoscopic Surgery for Prolapse

Nowadays laparoscopic procedures are commonly being performed for the cases of prolapse. Some of these include:

- Cervicopexy/sling operations with or without laparoscopic paravaginal repair/vaginal repair
- Vaginal hysterectomy/laparoscopic vaginal hysterectomy/ laparoscopic hysterectomy/total laparoscopic hysterectomy along with colposuspension
- Vaginal hysterectomy/laparoscopic vaginal hysterectomy/ laparoscopic hysterectomy/total laparoscopic hysterectomy along with laparoscopic pelvic reconstruction
- Rectocele repair and levatorplasty
- Enterocele repair with suturing of uterosacral ligaments
- Anterior or posterior colpopexy.

All types of sling operations can be performed by laparoscopy. Associated vaginal/paravaginal defects can also be repaired via laparoscopic route. Vaginal anterior and posterior colporrhaphy can be done either before or after laparoscopy. Laparoscopic vault suspension culdoscopy can be performed along with vaginal hysterectomy, laparoscopic-assisted vaginal hysterectomy, laparoscopic hysterectomy and total laparoscopic hysterectomy. This helps in correcting mild laxity and prevents vault prolapse. Advantages of laparoscopic surgery for prolapse include



Figs 22.18A and B: Graft has been placed in position under the bladder. (A) Front view; (B) Side view

Fig. 22.19: Polypropylene mesh

small incision, better view, minimal packing, minimal bowel and tissue handling, short recovery period, less pain and insignificant scar tissue formation.

CONCLUSION

Genital organ prolapse is a common problem encountered among the multiparous women. Diagnosis of prolapse is mainly made on pelvic examination. The most important risk factor for the development of prolapse is the obstetric trauma associated with multiple vaginal deliveries. In menopausal women, loss of strength of pelvic support structures due to estrogen deficiency is another cause for prolapse.[18] Unfortunately, the only cure for this disorder is the surgical correction of the anatomy of the pelvic floor and supports of the uterus. Since uterine prolapse is not a life-threatening condition, surgery is indicated only if the patient feels that her condition is so severe that it warrants correction. Mild prolapse, which is rarely symptomatic, does not require surgical correction. Expectant management, including the pelvic floor exercises (Kegel exercises) and vaginal pessaries are currently the mainstay of nonsurgical management amongst patients with mild degree uterine prolapse, with no or minimal symptoms. In young women who are desirous of retaining childbearing functions, conservative surgical procedures are commonly performed. However, in women who have completed their families, vaginal hysterectomy with the repair of pelvic floor is the procedure of choice. Presently prosthetic materials are commonly being used for supplementing the weakened tissues. This is likely to prevent recurrence of prolapse. However, it may be associated with high cost factors.

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23

CHAPTER

Tubal Sterilization Procedures

INTRODUCTION

In today's time, surgical sterilization for both men and women has become a popular and well-established method of contraception. Tubal sterilization is a method of permanent sterilization, which causes sterility by blocking a woman's fallopian tubes. Occlusion of the fallopian tubes has been considered as the most popular method of female sterilization all over the world. As a result of the blockage of tubes, the sperm cannot fertilize the ovum, thereby preventing the occurrence of pregnancy.

OVERVIEW OF SURGERY

Dr J Blundell from London was the first to perform tubal ligation in 1823.[1] Prior to the 1960s, female sterilization in the United States was generally performed only for medical indications (when conception was likely to be risky for the mother). Since 1970s, tubal sterilization is increasingly being used as a method of contraception due to the adoption of a small family norm. During the same decade, surgical advances resulted in safe, minimally invasive female sterilization procedures, when childbearing was no longer desired.[2] Laparoscopy was commonly used for performance of sterilization procedures. Currently, approximately 700,000 bilateral tubal sterilizations are performed annually in the United States. Of these, approximately 50% are performed as postpartum procedures and the remaining 50% are performed as ambulatory interval procedures.[3] Invention and use of a spring clip that could be applied via a laparoscopic approach was introduced by Jaroslav Hulka in 1973.[4] In Europe, Filshie introduced a titanium and silicone clip in 1981, which was widely used for the purpose of laparoscopic sterilization. However, it was only after a decade that this surgery gained popularity in the United States.

Depending upon the time when the procedure is to be performed, these procedures can be classified into two: (1) those performed at the time of delivery or shortly thereafter; and (2) those performed at another time, also known as the interval sterilization procedures. Two different approaches can be used for these procedures: (1) minilaparotomy approach employing the use of different methods of tubal ligation, such as Uchida, Pomeroy, or Parkland technique; and (2) the laparoscopic method, either involving the use of electrocoagulation to desiccate a part of tube or mechanical occlusion of the tube using devices, such as Falope rings, Hulka clips, etc. Minilaparotomy approach is the most commonly employed procedure in the immediate postpartum period, following vaginal delivery and is performed via a periumbilical incision. The main reason for this being that in the immediate postpartum period, the uterine fundus is in close proximity to the umbilicus, which helps in facilitating this approach.[5] However, the main disadvantage of performing sterilization immediately after delivery is a much higher incidence of poststerilization grief associated with the procedure.

On the other hand, the laparoscopic approach may be used at any time other than the postpartum period and involves either a single umbilical 10-mm port or a secondary suprapubic port, through which the various devices are introduced.[6]

AIM OF SURGERY

Tubal sterilization is a surgical procedure involving occlusion of the tubes. This can be achieved either by resection of a tubal segment or blocking of the fallopian tube using rings or clips. This can be achieved by any of the following three routes: (1) abdominal tubectomy, (2) vaginal tubectomy or (3) laparoscopic sterilization.

The isthmic portion of the fallopian tube is the site for all sterilization procedures that depend on intra-abdominal tubal occlusion. When a segment of tube is removed, as in the Pomeroy or Uchida technique, the isthmus is the preferred site of excision because of the relative ease of reanastomosis, should the procedure be reversed in the future.

INDICATIONS

Tubal sterilization is indicated for women, who want a permanent method of contraception and are free of any gynecologic pathology that would otherwise dictate an alternative procedure. Tubal sterilization is also indicated for women, in whom pregnancy could represent a significant clinical and medical risk.

PREOPERATIVE PREPARATION

A preoperative workup comprises of adequate history taking, general physical examination, urine analysis and hematocrit with a complete blood count.[7]

Preoperative Counseling

Counseling is essential prior to the procedure. Patients, especially those who are young, require preoperative patient counseling. Myths and misinformation related to the procedure need to be removed. The risk of surgery failure and ectopic pregnancy needs to be explained to the patient. Tubal ligation is not a temporary method of contraception and must be considered as an irreversible procedure. Although in dire circumstances, the reversal can be attempted, it has been found to be successful only in about 50–80% of the cases.

The patient must be screened for risk indicators of postoperative regret. Some such indicators include young age, low parity, single parent status or marital instability.

Written and Informed Consent

After adequate counseling of the patient, written and informed consent is essential in most countries. National norms must be followed. The surgeon must document the informed consent process in the patient's medical records. However, this consent cannot be obtained if the patient is younger than 21 years, in labor, under the influence of drugs and alcohol or mentally incompetent. The patient's preoperative history should be reviewed and a physical examination be performed to determine if any contraindications exist for elective surgery.

Confirming that the Patient Is Nonpregnant

This is usually done by performing a urine human chorionic gonadotropin (hCG) test. Under normal circumstances, the test usually becomes positive approximately 1 week after conception. The test can detect hCG levels as low as 20 mIU/mL. The test should be ideally performed on the day of surgery. There is a possibility that despite the test being negative, the patient may still be pregnant. Therefore, the procedure of sterilization should preferably be done in the first few days of the menstrual cycle to be totally sure that the patient is not pregnant.

Other Investigations

Other investigations, which need to be performed, are as follows:

- *Papanicolaou test*: A Papanicolaou test should be performed within 6 months of the procedure.
- *Urinalysis and hemogram*: This should be performed as per the protocol of surgical unit.
- *Gonorrhea and chlamydia screening*: Sterilization using any technique is contraindicated in the presence of active pelvic infection.
- *Imaging studies*: Ultrasonography is indicated, when a pelvic mass is detected during the preoperative clinical examination or when a pelvic examination is inadequate (i.e. morbid obesity).

SURGICAL STEPS

ANESTHESIA

Majority of tubal ligation procedures in the United States are performed using general or spinal anesthesia. In our setup, we normally use general anesthesia for interval procedures and regional anesthesia for postpartum procedures. For the hysteroscopic approach, local anesthesia is the standard approach and it may be supplemented by oral or IV sedation as needed. In mass camps, local anesthesia is preferable. In case of local anesthesia, premedication with injection pentazocine 30 mg and phenergan 50 mg intramuscular is to be given atleast 20 minutes prior to the surgery and the incisional area is infiltrated with 1% lignocaine.

SURGICAL APPROACH

Various surgical approaches, which can be used for female sterilization, include laparoscopy, hysteroscopy, laparotomy (concurrent with cesarean delivery), minilaparotomy and vaginal approaches. Although subumbilical minilaparotomy is the most common approach worldwide for postpartum procedures, laparoscopy is used most commonly for interval procedures in the United States. Hysteroscopic procedures are also rapidly gaining popularity.

Incision

In puerperal cases, where the uterus is felt per abdomen, the incision is made approximately 1 inch below the fundus. In interval ligations, the incision is made two-finger breadths above the pubic symphysis. This incision could be midline, paramedian or transverse.

Delivery of the Tubes

In case of laparotomy or minilaparotomy, the index finger is introduced through the incision and is passed across the posterior surface of the uterus and then to the posterior leaf of the broad ligament from where the tube is hooked out. The tube is identified by the fimbrial end and the mesosalpinx containing utero-ovarian anastomosing vessels.

Tubal Ligation

Tubal ligation is then performed by one of the following techniques:

- Pomeroy's technique
- Modified Pomeroy's technique
- Parkland technique
- Uchida technique
- Fimbriectomy
- Irving technique
- Madlener's technique (No longer used due to a high failure rate).

Pomeroy's Technique

This technique involves the following steps (Figs 23.1A to D):

- The mid portion of the oviduct is grasped with a Babcock clamp, creating a loop, which is tied with no. 1 plain catgut or no. 0 chromic catgut sutures.

Figs 23.1A to D: Pomeroy's technique of tubal sterilization: (A) The fallopian tube is grasped with Babcock clamp; (B) A loop is created, which is tied with no. 1 plain catgut sutures; (C) Excision of the loop; (D) Several months later, the ends of the tube get fibrosed, retracting from one another

- Segment of the tube having a length of about 1.2–1.5 cm, distal to the ligature is excised.
- The surgeon must then inspect the segment of the loop that has been removed to ensure that the wall has not been partially resected.
- The same procedure is then repeated on the other side.
- Specimens are then submitted for histopathological examination.
- The rationale for this technique is based on the principle that over a period of time, the cut ends of the tube become independently sealed off, thereby retracting from one another. This occurs due to prompt absorption of the suture ligature with subsequent separation of the cut ends of the tube, which then become sealed by spontaneous reperitonealization and fibrosis. This technique is highly successful and the failure rate varies between 0.1% and 0.5%.

Modified Pomeroy's Technique

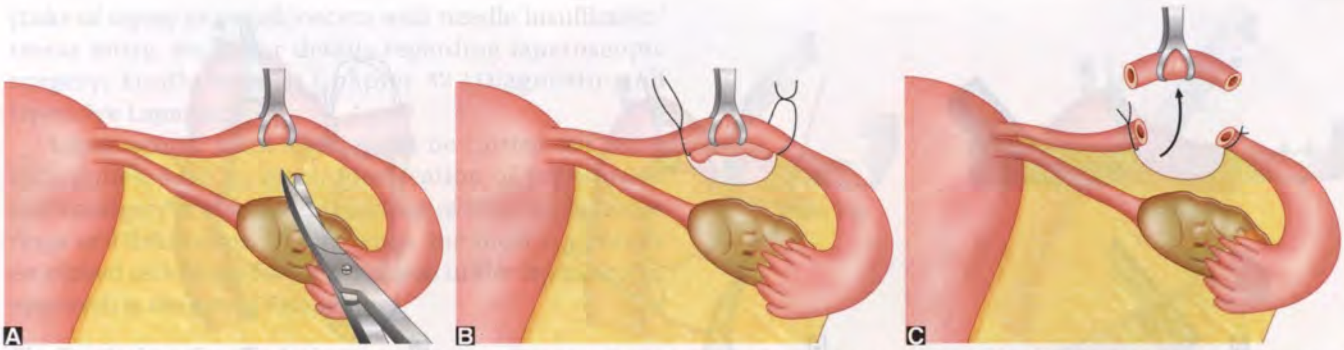
Many modifications of the Pomeroy's technique have been described. These modifications aim at reducing the failure rate associated with Pomeroy's technique. The most commonly performed modification involves doubly ligating each loop. Another modification involves putting a silk suture of moderate thickness near and medial to the stump ligature, on both the sides of the cut loop segment, after performing the Pomeroy's technique. This modification is supposed to cause the necrosis of intervening portion of the tube, thereby reducing the chances of failure.

Parkland Technique

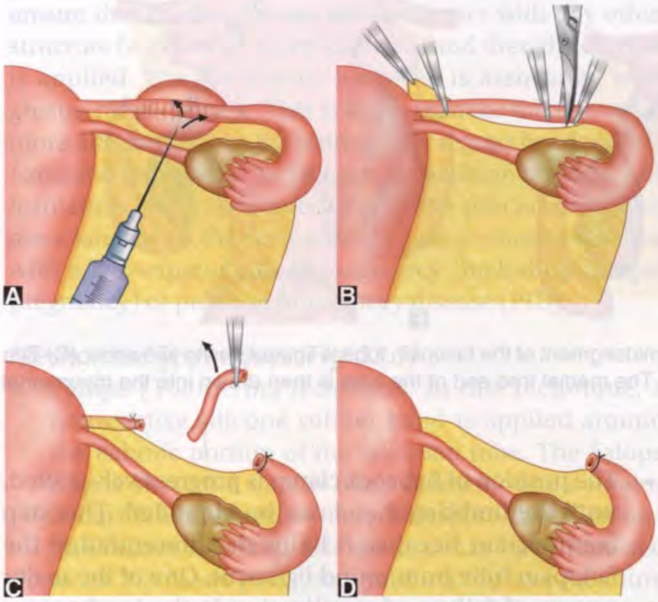
The Parkland technique is similar to the Pomeroy's technique, except that in this case midsegment resection is performed, involving the excision of 1–2 cm tubal segment, which is then submitted for a histopathological examination (Figs 23.2A to C). Following this, each limb of the loop is tied separately with a no. 0 chromic catgut suture. The Parkland technique was designed to avoid the intimate approximation of the tubal cut ends, which may occur with the Pomeroy's technique. As a result, the risk of subsequent recanalization is considerably reduced. Failure rates are reported to be 1 case out of 400 patients.

Uchida Technique[8] (Figs 23.3A to D)

In this technique, a relatively long (5 cm) segment of tubal muscularis is pulled out after giving an incision in the mesosalpinx. This portion of the tube is then ligated proximally and distally with a no. 0 plain catgut suture and resected. The serosal edges are then reapproximated, burying the medial exposed tubal end within the leaves of the broad ligament. The distal end is left exposed. During the puerperium, Uchida modified the sterilization procedure by including fimbriectomy. The combination of excision of such a large segment of tube along with a fimbriectomy is responsible for a low failure rate of this



Figs 23.2A to C: Parkland technique of tubal sterilization: (A) The fallopian tube is grasped with Babcock clamp; (B) The mesosalpinx is incised and midsegmental portion of the fallopian tube is ligated at the two ends; (C) The midportion of the tube between the two ligatures is resected



Figs 23.3A to D: Uchida technique of tubal sterilization: (A) Mesosalpinx is infiltrated with local anesthetic and is then incised; (B) The midsegment of the fallopian tube is ligated on the two ends; (C) The midportion of the tube between the two ligatures is resected; (D) The medial free end of the tubal stump is then buried in the leaves of broad ligament

technique. For all practical purposes, this combination can be considered equivalent to salpingectomy.

Irving Technique (Figs 23.4A to F)

In this technique, a small portion of the tube, approximately 1–2 cm in length, approximately 4 cm from the uterotubal junction, is doubly ligated with no. 0 or 00 absorbable sutures and resected. The sutures on the proximal end are left long. The surgeon may need to dissect the tube free from the mesosalpinx in order to mobilize it. A small nick is made into the serosa on the posterior (or anterior) uterine wall near the uterotubal junction. This nick is then deepened to a thickness of about 1–2 cm. The free ends of the proximal stump ligature are then brought deep into the myometrium tunnel and out through the uterine serosa. The proximal tubal stump is drawn deep into the myometrial tunnel, following which the sutures are tied. The serosal opening of the tunnel is then closed around the tube with fine absorbable sutures. According to the original technique described by Irving, the distal end of the tube was also buried between the leaves of the broad ligament. This technique is associated with failure rates of less than 1 case per 1,000 patients.

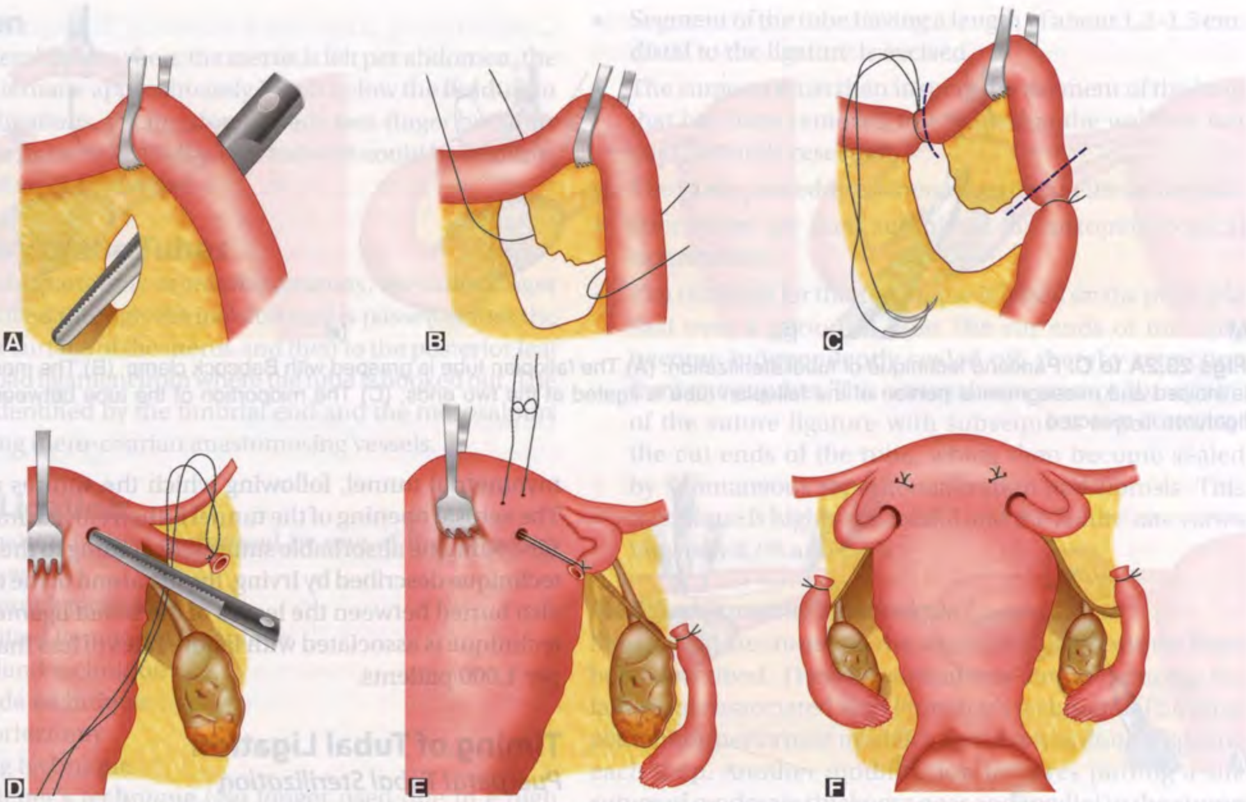
Timing of Tubal Ligation

Puerperal Tubal Sterilization

- *Tubal sterilization following normal vaginal delivery:* Tubal sterilization following completion of a vaginal delivery is usually performed 24–48 hours after delivery. The optimal time of surgery is within 6 hours. Nevertheless, it must be performed within 48 hours. The main advantage of choosing this timing is that at this point of time the surgery is technically simple, because the uterine fundus is at the level of umbilicus. As a result, the fallopian tubes are readily accessible through a small periumbilical abdominal incision. Moreover, if the surgery is performed during this period, postoperative and postpartum convalescence periods would coincide, so hospitalization is minimally increased. In comparison with interval sterilization, subumbilical minilaparotomy, following delivery in the early puerperium is convenient, simple and cost effective. However, if maternal or infant complications exist sterilization should be delayed.
- *Tubal sterilization following cesarean delivery:* Bilateral tube ligation (BTL) may be performed after closure of the uterine incision during cesarean delivery.

Interval Ligation

The operation can be performed beyond 6 weeks following delivery or abortion. Ideal time for undertaking surgery is the postmenstrual phase during the early proliferative phase. In case the sterilization is performed in the premenstrual phase, the women must be counseled regarding the possibility of pre-existing conception and must be advised to come for a mandatory follow-up during the anticipated time of next menstrual period.



Figs 23.4A to F: Irving technique of tubal sterilization: (A and B) The midsegment of the fallopian tube is ligated on the two ends; (C) The midportion of the tube between the two ligatures is resected; (D to F) The medial free end of the tube is then drawn into the myometrial tunnel, following which the sutures are tied

Postabortal Ligation

Sterilization can be performed along with the medical termination of pregnancy or even following spontaneous abortion under antibiotic coverage, provided anemia and infection have been ruled out.

Types of Surgical Approaches

Minilaparotomy

As the name suggests, minilaparotomy involves giving a small incision about half to three-fourths inches in size. The size of the incision is usually smaller than 5 cm and is usually given in the suprapubic area. The procedure is usually performed under local anesthesia with sedation. The operation can be performed either as an interval procedure, few months after delivery or within the first 48 hours after delivery. It consists of the following steps:

- After giving the incision, the skin is stretched with the help of Allis forceps.
- Dissection is carried down up to the level of the fascia, which is then opened transversely.
- The peritoneum is exposed, which can then be entered sharply.
- Once the uterus is visualized, it is manipulated and retracted, in order to visualize the fallopian tubes, which are then grasped with a Babcock clamp.
- The position of Babcock clamp is progressively shifted, until the fimbriated end can be identified. This step is important because it helps in differentiating the fallopian tube from round ligament. One of the major causes of failure of sterilization is the inadvertent ligation of the round ligament, which is mistakenly identified as the fallopian tube.
- After performing tubal ligation on both sides, the minilaparotomy incision is closed in layers. The various methods of tubal ligation have previously been described. In our setup, the Pomeroy's technique of tubal ligation is most commonly used.
- Patient is usually discharged within 24–48 hours of surgery.

Laparoscopy

Tubal ligation using laparoscopic approach has been practiced since 1970s. Presently, it has become the most commonly used approach for tubal ligation. The major advantage of laparoscopic sterilization procedure is that it is a minimally invasive technique, involves use of small incision, reduced duration of hospital stay, rapid recovery and the ability to inspect the pelvis and upper abdomen at the time of surgery. However, the major disadvantage of the procedure is the complications associated with general anesthesia and those associated with laparoscopic surgery (risks of injury to vessel/viscera with needle insufflation/trocar entry, etc.). For details regarding laparoscopic surgery, kindly refer to Chapter 32 (Diagnostic and Operative Laparoscopy).

Laparoscopic tubal ligation can be carried out using techniques, such as electrodesiccation of tubes using electrosurgery or mechanical blockage of tubes using Falope rings or Filshie clips. In our setup, the most commonly employed technique for tubal ligation under laparoscopic approach is the use of Falope rings.

Electrodesiccation Technique

This procedure involves electrodesiccation of the tube in the mid isthmic region, at least 2.5–3 cm lateral to the uterotubal junction, using the bipolar forceps. The tube is elevated to ensure that the forceps are not in contact with any other structure (e.g. bowel, pelvic sidewall) and then the current is applied. The technique, however, is associated with greater tubal damage. This is likely to make tubal reversal more difficult, in case the patient later regrets her decision. Extensive damage to the tissue may facilitate future fistula formation and encourage failure. The procedure is also associated with the formation of tuboperitoneal fistula, with a subsequent risk of pregnancy (including ectopic pregnancy) or pelvic inflammatory disease (PID).

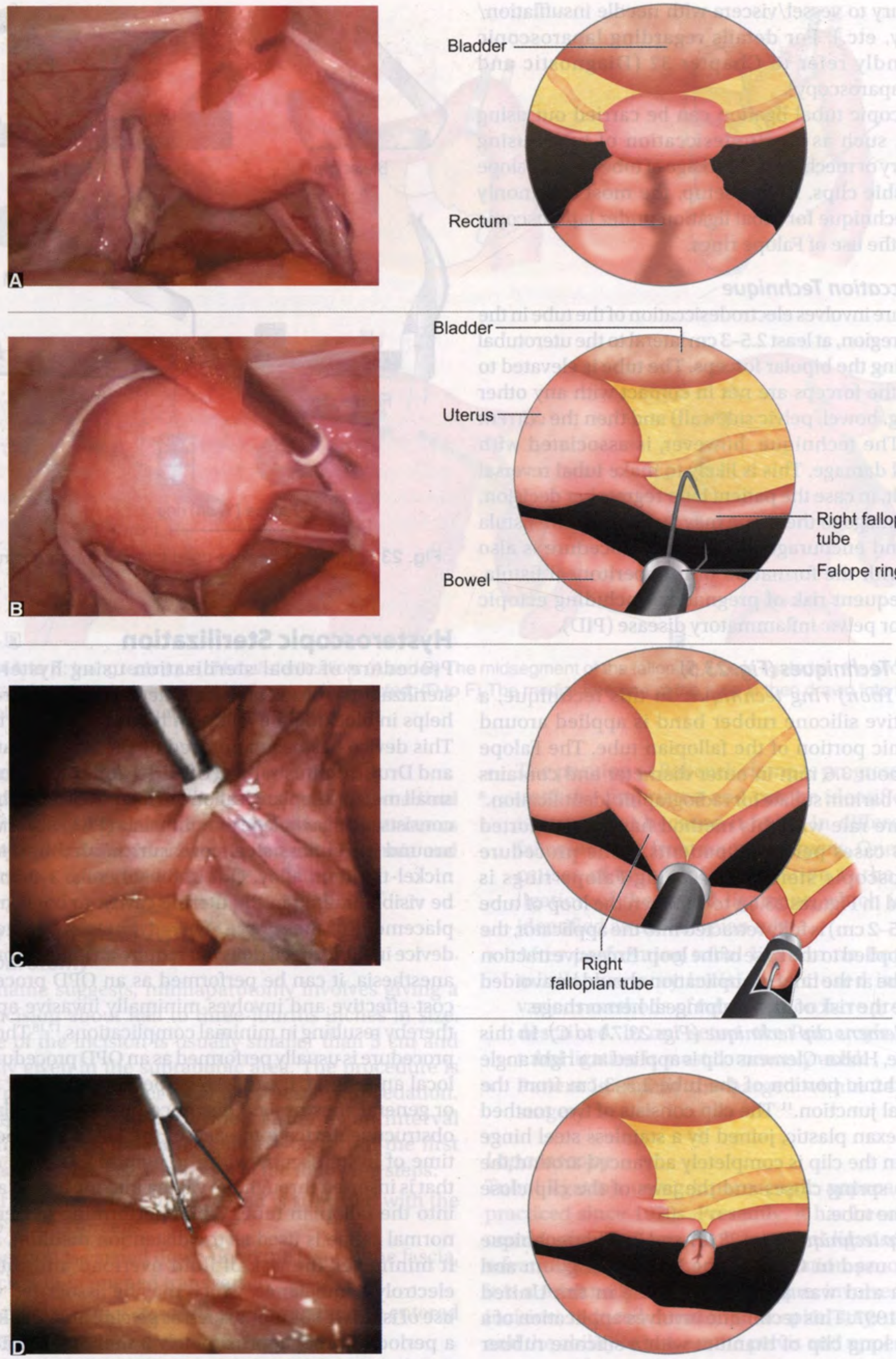
Mechanical Techniques (Fig. 23.5)

a. *Falope (Yoon) ring technique*: In this technique, a nonreactive silicone rubber band is applied around the isthmic portion of the fallopian tube. The Falope ring is about 3.6 mm in outer diameter and contains about 5% barium sulfate for radiographic identification.[9] The failure rate with this method has been reported to be 3.3 cases per 1,000 patients.[10] The procedure of laparoscopic sterilization using Falope rings is illustrated in Figures 23.6A to D. When the loop of tube (about 1.5–2 cm) is fully retracted into the applicator, the band is applied to the base of the loop. Excessive traction on the tube at the time of application should be avoided to reduce the risk of mesosalpingeal hemorrhage.
b. *Hulka-Clemens clip technique (Figs 23.7A to C)*: In this technique, Hulka-Clemens clip is applied at a right angle to the isthmic portion of the tube 2.5–3 cm from the uterotubal junction.[11] The clip consists of two toothed jaws of Lexan plastic, joined by a stainless steel hinge pin. When the clip is completely advanced around the tube, the spring closes and the jaws of the clip close around the tube.
c. *Filshie clip technique (Figs 23.8A and B)*: This technique is widely used in Canada, the United Kingdom and Australia and was approved for use in the United States in 1997. This technique involves application of a 12.7 mm long clip of titanium with a silicone rubber lining.[12] The clip is applied laparoscopically with an applicator at right angles to the isthmus approximately 2–2.5 cm from the uterotubal junction.

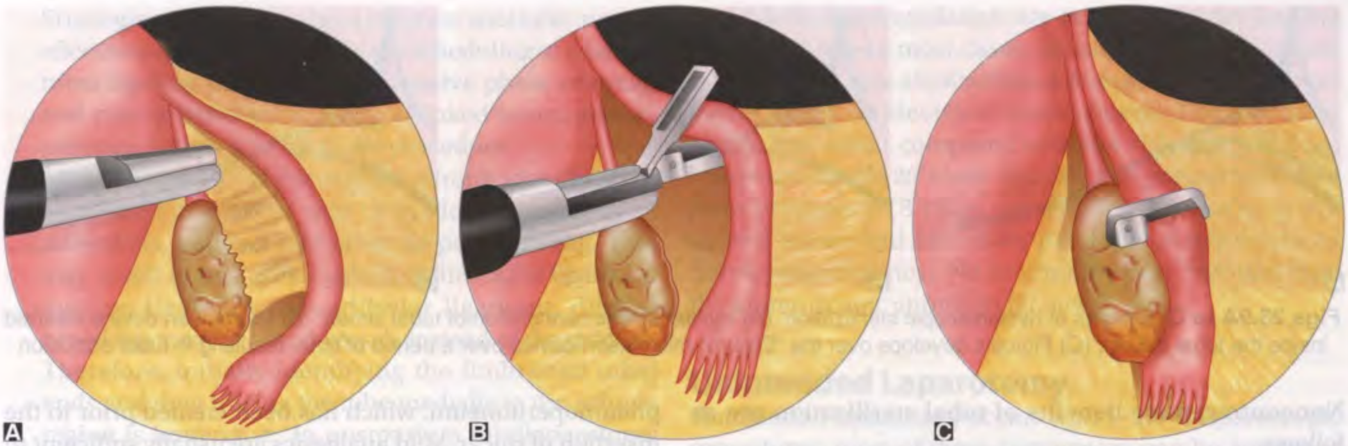
Fig. 23.5: Different devices used for mechanical obstruction of the tubes

Hysteroscopic Sterilization

Procedure of tubal sterilization using hysteroscopic sterilization is based on using a new device, "Essure", which helps in blocking the fallopian tubes (Figs 23.9A to C).[13-16] This device has been approved by the United States Food and Drug Administration (US FDA) and consists of using a small metallic implant, called the Essure System. The device consists of polyethylene terephthalate (PET) fibers wrapped around a stainless steel core, surrounded by 24 coils of nickel-titanium alloy. Out of the 24 coils, 3–8 coils must be visible trailing in the uterine cavity, to confirm proper placement of the device. The advantages of placing this device include that it does not require an incision or general anesthesia, it can be performed as an OPD procedure, is cost-effective and involves minimally invasive approach, thereby resulting in minimal complications.[17,18] Though the procedure is usually performed as an OPD procedure under local anesthesia, it can also be performed under regional or general anesthesia. This procedure involves placing an obstructive device into each of the fallopian tubes at the time of hysteroscopy with the help of a special catheter that is inserted through the vagina into the uterus and then into the fallopian tube. While performing hysteroscopy, normal saline is used as the distention medium, because it minimizes the risk of fluid overload and the risk of electrolyte imbalance, which may be associated with the use of isotonic solutions, such as glycine and sorbitol. Over a period of time, approximately 3 months, fibrous tissue develops over the implant, blocking the fallopian tube, thereby preventing fertilization of the egg by the sperm. Following the hysteroscopic sterilization, a low pressure



Figs 23.6A to D: (A) The uterus is anteflexed by manipulating and the fallopian tubes are visualized; (B) The fallopian tubes are grasped with the tongs of the silastic band instrument, which has been previously loaded with a Falope ring; (C) The fallopian tube is drawn into silastic band applicator, and the Falope ring is pushed off the applicator onto a knuckle of tube; (D) The knuckle of tube is released from the grasping tongs



Figs 23.7A to C: Application of Hulka clips to the fallopian tubes: (A) Surgeon approaches the fallopian tube with a loaded clip applier next to the fallopian tube; (B) The surgeon opens the clip by activating the shaft retractor at the end of the clip applier. The same mechanism is used to close the clip and lock it into position with its metallic spring; (C) The clip has been applied to the fallopian tube. It is released from the clip applier when the surgeon withdraws the shaft to the extreme position

Figs 23.8A and B: Application of Filshie clip to the fallopian tube

hysterosalpingogram is mandatory, in order to confirm correct placement and to document tubal occlusion. Being radiopaque, the Essure microinserts are clearly visible on hysterosalpingography. Data from the Phase II trials have demonstrated that the device is safe and is associated with high patient-satisfaction rates. No unintended pregnancy was reported in this trial. Though no major complications have been found to be associated with the procedure, some studies have reported perforation of the fallopian tube due to forceful insertion. This, however, has yet not been proven by randomized studies. Moreover, the procedure is associated with same complications as those associated with diagnostic hysteroscopy.

In a recent review by Levy et al., 64 pregnancies out of an estimated 50,000 procedures of hysteroscopic sterilization were reported to the device manufacturer from 1997 through December 2005.[19] Most cases of unintended pregnancies occurred in patients who did not have appropriate follow-up. The risk of unintended pregnancy with hysteroscopic sterilization can be reduced if the patients are appropriately educated regarding the necessity of a follow-up examination, warranting that patients use effective contraception before and after the device placement, follow the instructions for use, and adhere to the hysterosalpingography protocol.

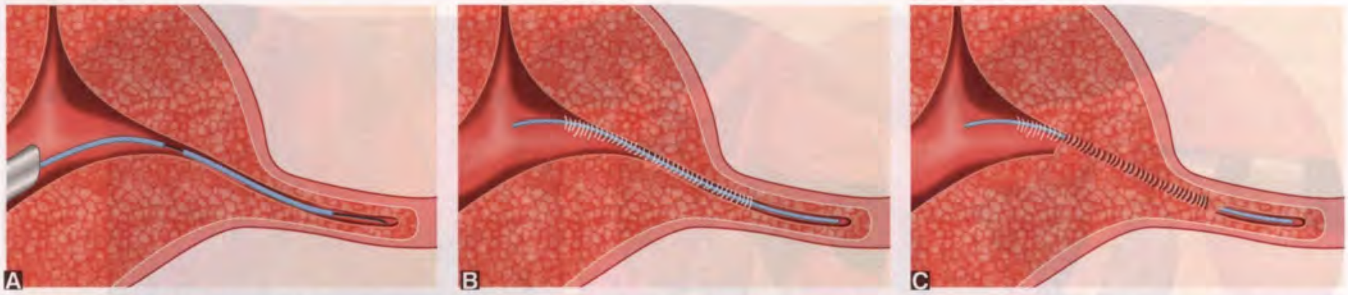
POSTOPERATIVE CARE

The postoperative care comprises of the following steps:

- A discharge card containing detailed notes and postoperative findings, and dates for follow-up visit must be given to each patient at the time of discharge.
- After undergoing tubal sterilization, the patient must be instructed to come for a follow-up visit at 1–2 weeks postoperatively. This visit should involve examination of the surgical site and removal of nonabsorbable sutures.
- The patient should be instructed to report immediately in case of any missed period, in order to rule out the possibility of pregnancy.
- All women who have undergone sterilization must be explained in details, regarding the signs and symptoms of intrauterine as well as ectopic pregnancy and instructed to seek immediate medical attention, if such signs and symptoms occur.
- The woman must also be instructed to notify her health care provider, in case she develops fever (38°C or 100.4°F), increasing or persistent abdominal pain, or bleeding, or purulent discharge from the incision site.
- Patients who have undergone hysteroscopic sterilization must be counseled to use an alternate form of contraception for 3 months. After 3 months the woman must undergo a hysterosalpingogram, in order to confirm the device placement and bilateral tubal occlusion.

ADVANTAGES

Besides causing contraception, tubal sterilization is also associated with certain noncontraceptive benefits.



Figs 23.9A to C: Process of hysteroscopic sterilization: (A) Hysteroscopic cannulation of tubal lumen; (B) Microinsert device inserted inside the tubal ostium; (C) Fibrosis develops over the "Essure" microinsert device over a period of time, resulting in tubal occlusion

Noncontraceptive benefits of tubal sterilization are as follows:

- *Protective effect in ovarian cancer*: Several studies have reported a protective effect of sterilization against ovarian cancer, with a relative risk ranging from 0.2 to 0.8.[20,21] Protection is hypothesized to result from reduced exposure of the ovaries to potential environmental carcinogens and infectious sources of malignant transformation (e.g. oncogenic viruses).
- *Pelvic inflammatory disease*: Although tubal ligation does not protect against the acquisition of sexually transmitted disease, sterilization has been demonstrated to reduce the spread of organisms from the lower genital tract to the peritoneal cavity and thus provide some degree of protection against PID. Studies have reported that PID is less common in women, who are sterilized compared with women, who have not undergone bilateral tubal ligation. However, this protection is not absolute because there have been reports regarding occurrence of PID in sterilized women within 4–6 weeks or even several years following surgery. Infection happening within weeks of surgery is likely to occur due to the manipulation of the cervix, uterus or oviducts, all of which are likely to exacerbate a chronic infection (e.g. chlamydial or gonococcal) or facilitate the ascent of bacteria from the lower genital tract at the time of surgery.

COMPLICATIONS

The procedure of tubal sterilization may be associated with certain complications, as given below.[22-26]

Effects of Anesthesia

Though the procedure is usually performed under local anesthesia, sometimes the procedure may also be performed under general anesthesia. In these cases, the woman is at risk of complications inherent to general anesthesia.

Pain

After undergoing laparoscopic sterilization, the woman may experience some degree of chest and shoulder pain due to pneumoperitoneum, which has been created prior to the insertion of trocar. Mild analgesics are usually sufficient to control this pain.

Bleeding and/or Infection

The laparoscopic procedure may be associated with complications such as infection and bleeding. The procedure of minilaparotomy can be rarely associated with complications, such as wound infections, hematoma and severe infection, such as PIDs.[27] The use of prophylactic antibiotics prior to the procedure is usually not recommended. Hemorrhage is a rare complication, which usually occurs following injury to a major vessel at the time of laparoscopic entry. It may also occasionally occur following injury to mesosalpingeal vessels during the occlusion procedure.

Injury to the Body Organs

There is a risk of causing injury to the body organs such as gastrointestinal and genitourinary tract and major vessels, especially when the procedure is performed under laparoscopic guidance.[28] For details regarding the various complications associated with laparoscopic procedures, kindly refer to Chapter 32 (Diagnostic and Operative Laparoscopy).

Failure of the Procedure

Although sterilization is highly effective and considered the definitive form of pregnancy prevention, it has a failure rate of 0.1–0.8% during the first year.[29] At least one-third of these are ectopic pregnancies. This is usually caused by an incomplete closure of the tubes.[30]

Causes of Failure of Tubal Ligation

Various causes of failure of bilateral tubal ligation are as follows:

- *Pregnancy in the luteal phase*: Luteal phase pregnancy is defined as a pregnancy in which conception occurs before bilateral tubal ligation, but pregnancy is diagnosed after the procedure of interval tubal sterilization. This has been reported to occur at a rate of 1–15 cases per 1,000 interval sterilizations.[29]

Strategies to reduce its incidence include: use of effective contraceptive methods; scheduling of bilateral tubal ligation during the proliferative phase of cycle; and preoperative urine enzyme-linked immunoassay pregnancy testing, prior to the procedure.
- *Misidentification of the oviduct*: Wrong identification of oviduct can occur due to inadequate exposure, adhesions, adnexal pathology or poor lighting. This may result in mistaken ligation of the round ligament, ovarian ligament, infundibular ligament, dilated broad ligament or blood vessels instead of the oviduct. Therefore, initially identifying the fimbriated tubal ends and then tracing the tube medially to the isthmic region is imperative. In postpartum minilaparotomy during bilateral tubal ligation, Babcock clamp should be placed sequentially along the oviduct until the fimbria is visualized.
- *Incomplete occlusion of the oviduct*: This occurs because of poorly placed mechanical clips or the use of mechanical devices on the dilated tubes. When silastic rings are used, the tubal serosa, but not the tubal lumen may be pulled into the ring. This may result in the incomplete blockage of the tubes. Incomplete tubal occlusion with electrocoagulation is generally associated with too brief an application of current. Improper technique occurs with the use of the wrong sutures or failure to preserve a 2 cm proximal tubal segment.

Ectopic Pregnancy

The failure of the procedure of tubal sterilization is associated with high likelihood of ectopic pregnancy, in comparison to the intrauterine pregnancy.[30] Though increased incidence of ectopic pregnancy has been associated with various approaches for tubal ligation, hysteroscopic approach has yet not been found to be associated with an increased risk of ectopic pregnancy.

Complications Associated with Diagnostic Hysteroscopy

Though the hysteroscopic approach has not been presently found to be associated with any major complications, the procedure may be associated with complications inherent to diagnostic hysteroscopy, such as uterine perforation, bleeding, excessive absorption of distention media, infection, etc. For details regarding the complications associated with hysteroscopic procedure, kindly refer to Chapter 31 (Diagnostic and Operative Hysteroscopy).

Mortality

The risk of death from tubal sterilization is 1–2 cases per 100,000 procedures; most of these are due to complications of general anesthesia. The most common cause of death during laparoscopic bilateral tubal ligation appears to be hypoventilation related to anesthesia. Cardiopulmonary arrest and hypoventilation are reported as the leading cause of death in most cases. Sepsis as a cause of death from laparoscopic sterilization is directly related to bowel perforations or electrical bowel burns. The mortality rate is low, when compared with the risk of death from hysterectomy (5–25 cases per 100,000 procedures) and from pregnancy (8 cases per 100,000 live births in the United States and 500 cases per 100,000 live births in developing countries). No deaths have been reported from the hysteroscopic approach till now.

Unintended Laparotomy

Unintended laparotomy occurs with 1–2% of laparoscopic procedures; most of these conversions can be attributed to the technical inability to complete the laparoscopic procedure rather than due to complications of the procedure per se.

Patient Regret

Sterilization is intended to be permanent, but patient regret can commonly occur.[31,32] Poststerilization regret is a complex condition often caused by unpredictable life events. Risk factors for regret that may be useful in presterilization counseling include young age, low parity and single parent status or being in an unstable relationship. It has been observed that as many as 6% of women, who are sterilized report regret or request information about tubal reversal within 5 years of the procedure. Postoperative regret has been observed to be more commonly expressed by women aged 30 years or younger at the time of tubal ligation in comparison to women older than 30 years at the time of procedure. Approximately 0.2% of women undergo microsurgical tubal reanastomosis in the first 5 years after bilateral tubal ligation.

Post-Tubal Ligation Syndrome

Proposed in 1951, this syndrome is a constellation of symptoms, including pelvic discomfort, ovarian cystic changes and menorrhagia. These are likely to occur as a result of disruption of the utero-ovarian blood supply, with resultant disturbances of ovulatory function after bilateral tubal ligation. Often, these patients have a history of these problems before undergoing sterilization or have been taking birth control pills, which may have masked their symptoms. The occurrence of this syndrome is presently controversial. The US Collaborative Review of Sterilization (CREST) is the landmark prospective, multicenter, observational study regarding the use of tubal sterilization, which was conducted by the Centers for Disease Control and Prevention with support from the National Institute for Child Health and Human Development. Data from the CREST study has indicated that the incidence of various menstrual abnormalities, such as intermenstrual bleeding, cycle irregularity, menstrual pain, amount of blood loss, etc. in women who have undergone tubal sterilization is not significantly different from normal women, who have not undergone this procedure.[29]

DISCUSSION

Despite the availability of a large number of surgical approaches, currently laparoscopic method using the application of Falope rings or Filshie clip is the most popular method of female sterilization in nonpregnant women. Performance of tubal ligation by means of Pomeroy's or Parkland technique, using a periumbilical minilaparotomy approach is the most commonly performed surgical procedure for tubal sterilization following childbirth. Hysteroscopic sterilization based on using a new device, "Essure system" has recently gained acceptance by the US FDA. However, the researchers continue to explore the possibility of using various substances that can be introduced through the cervix to occlude the tubal lumen. Several attempts have been made in the past to achieve transcervical tubal blockage using substances, which can cause tubal obstruction through mechanical occlusion or by causing fibrosis. The various techniques that have been used include radiofrequency, chemical scarring using quinacrine or the injection of liquid silicone. However, none of these methods have been shown to be safe or efficacious.

Before taking the decision to perform this surgery in any woman, the surgeon must be totally convinced that there are no contraindications for the procedure. Presence of contraindications is likely to result in failure of the surgery at a later date. Sterilization must never be undertaken in women, who are not entirely sure regarding whether they want the procedure or not. Patient ambivalence regarding sterilization is an important reason resulting in the request for undergoing surgical reversal of the tubal occlusion procedure at a later date. Even though surgically reversing the tubal occlusion at a later date is technically possible, the surgery is costly and technically specialized involving microsurgical procedure. The decision to perform tubal ligation must be undertaken, only when the patient makes the request herself, she is of sound mind and does not appear to be acting under external pressure, and is completely convinced that her family is complete. In case the patient has even a little doubt regarding, whether she may want to conceive in the near future, she must be offered other long-term, but not irreversible methods of contraception, such as intrauterine contraceptive device (IUCD), etc. The procedure of tubal sterilization in the puerperal period must be postponed, if maternal or infant complications exist during the puerperium. Since even when the mother and baby are completely healthy, sterilizations performed in the immediate postpartum period are accompanied by a high incidence of regret and request for reversal at a later date, many physicians recommend that all sterilizations must be performed as an interval procedure. Moreover, in presence of a gynecological condition (e.g. uterine prolapse, malignancy, ovarian tumors, etc.) for which a hysterectomy is indicated, there is no need to perform tubal sterilization.

CONCLUSION

Surgical sterilization in women involving the surgical ligation of fallopian tubes has become a well-established method for achieving permanent contraception. This method is highly effective in protecting the women against pregnancy. The most commonly used approach for performing interval tubal sterilization in nonpregnant women is laparoscopic approach, using application of Falope rings. Periumbilical minilaparotomy, involving the ligation of tubes using Pomeroy's technique has become the most widely practiced method in women undergoing tubal ligation in the immediate postpartum period. Both these procedures are associated with a very low risk of complications, when performed according to the accepted medical standards. Being a safe and simple technique, laparoscopic technique can be also carried out as an outpatient procedure. Adequate patient counseling and the patient's informed consent is essential prior to the procedure, this being a permanent method of sterilization. Although the procedure of tubal ligation is associated with a very low failure rate when performed using an appropriate technique by an experienced clinician, it continues to be an extremely effective long-term form of contraception.

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24

CHAPTER

Hysterectomy

INTRODUCTION

Abdominal hysterectomy is a commonly performed gynecological procedure utilized for removal of the uterus in cases of benign and malignant gynecological diseases. This surgical operation can be performed with the preservation or removal of the ovaries on one or both sides in case of benign disease of the uterus. Frequently, in malignant disease, no choice exists but to remove the tubes and ovaries, since they are frequent sites of micrometastases. In November 1843, Charles Clay performed the first hysterectomy in Manchester, England.[1] This was a subtotal hysterectomy, where the body of the uterus was removed while the cervix remained intact. In 1929, Richardson, MD, performed the first total abdominal hysterectomy (TAH), in which the entire uterus along with the cervix was removed. The most important physiological change associated with the removal of the uterus is the elimination of menstrual flow. If the ovaries are removed along with the uterus, the predominant physiologic change noted is premature menopause due to the loss of the ovarian steroid sex hormone production.

OVERVIEW OF SURGERY

Hysterectomy is the second most commonly performed surgery among women; the first most common being delivery via cesarean section. Hysterectomy is usually performed by gynecologists for indications such as severe menorrhagia, fibroid uterus, endometrial malignancy, etc.

There are several types of hysterectomies, which are as follows:[2]

Total Hysterectomy

Total hysterectomy involves the removal of the entire uterus and the cervix. This is the most common type of hysterectomy. In many cases, surgical removal of the ovaries (oophorectomy) is also performed along with a hysterectomy. The surgery is then known as TAH with bilateral salpingo-oophorectomy (TAH-BSO).

Partial Hysterectomy

Partial hysterectomy involves removal of the upper portions of the uterus, leaving behind the cervix. There is a small risk of developing cervical cancer if the cervix is retained. The removal of cervix is strongly recommended in patients with a history of abnormal Papanicolaou test results.

Panhysterectomy

Panhysterectomy is hysterectomy along with bilateral salpingo-oophorectomy.

Radical Hysterectomy

Radical hysterectomy is usually performed for cancer of the endometrium or cervix and it involves removal of the uterus along with the cervix, ovaries of both the sides, the upper-third of the vagina, adjacent parametrium and draining lymph nodes of the cervix. Radical hysterectomy can be further classified, based on the structures removed as described in Chapter 29 (Surgery for Cancers).

Depending on the route through which the hysterectomy is performed, it can be classified as abdominal hysterectomy (performed through an abdominal incision), a vaginal hysterectomy (VH) (performed through the vaginal route), or as a laparoscopic procedure (laparoscopic hysterectomy) or laparoscopic assisted VH (VH assisted by laparoscopy). The preferred surgery is usually a total hysterectomy, unless there is a sufficient reason to retain the cervix. Subtotal or supracervical hysterectomy is usually performed in the following cases:

- Difficult to remove tubo-ovarian masses
- Pelvic endometriosis involving the rectovaginal septum
- Obstetric causes for cesarean hysterectomy
- Sudden deterioration of the patient's general condition either due to blood loss or anesthetic complications while contemplating to perform a total hysterectomy.

AIMS OF SURGERY

As described previously, hysterectomy involves surgical removal of the uterus along with the adjacent surrounding structures, depending on the type of hysterectomy and the specific indication for which it is being performed. Depending on the medical history, findings of clinical examination and the exact pathology for which the removal of the uterus is desirable, the surgeon decides which type of hysterectomy would be most appropriate for the patient.

INDICATIONS

Hysterectomy is commonly performed for the following indications:[3]

- Fibroid uterus (especially the symptomatic fibroids associated with symptoms such as menorrhagia or dysfunctional uterine bleeding).
- Malignancies of the genital tract, especially endometrial cancer; cancer of the cervix or severe cervical dysplasia (CIN grade III); and cancer of the ovary.
- Endometriosis: When medication and minimal invasive surgery fails to cure endometriosis, a hysterectomy is often recommended.
- Persistent vaginal bleeding (abnormal or dysfunctional uterine bleeding or menorrhagia): If the menstrual bleeding is persistently heavy or irregular or lasts for many days and medication does not help to control the bleeding, a hysterectomy may be required.
- Moderate or severe prolapse of the uterus: In many cases of uterine prolapse, especially in elderly women who have completed their families, hysterectomy is often performed along with the repair of the prolapsed structures.
- Complications during childbirth (like uncontrollable postpartum hemorrhage): Hysterectomy may be performed as an emergency procedure to control atonic primary postpartum hemorrhage.

PREOPERATIVE PREPARATION

Preoperative evaluation includes the following:

- *A complete history and physical examination*: Prior to surgery, a complete history must be taken and a physical examination must be performed. The history must include detailed gynecological, urological and medical history. This is important because history of previous surgery in genitourinary or gastrointestinal systems may make the procedure of abdominal hysterectomy difficult due to the presence of adhesions. Medical history helps in ruling out comorbid conditions such as diabetes mellitus, hypertension, cardiac disease or asthma. Use of medications such as aspirin, oral hypoglycemic agents, heparin or warfarin should be documented. Assessment of cardiovascular and respiratory systems must also be done as abnormalities in these systems may result in difficulty at the time of giving anesthesia.
- *Routine preoperative investigations*: Routine preoperative investigations such as complete blood count with platelet count, fasting blood glucose, kidney function test and liver function test must be performed. Routine human immunodeficiency virus and hepatitis-B surface antigen screening must also be performed.
- *Other preoperative investigations*: Other preoperative investigations, which need to be performed in certain cases, include tests such as endometrial biopsy or aspiration, Pap smear and ultrasound examination. Endometrial biopsy helps in ruling out pre-invasive or invasive lesions of the uterine cavity. Pap smears (Papanicolaou test) help in ruling out cervical cancer. Ultrasound examination helps in the assessment of pelvic anatomy and evaluation of the uterine size. ECG and chest radiograph to assess the cardiac and respiratory systems may be performed in the women especially above the age of 40 years.
- *Informed consent*: The patient must be explained about the procedure and written informed consent must be obtained from the patient prior to the surgery.
- *Nil per orally*: It is recommended that the patient should not take either food or water by mouth for at least 6 hours prior to the time of scheduled surgery. In our set up, the patients are usually made to fast after midnight if the operation is planned in the first few hours of the morning.
- *Analgesics and antibiotics*: Painkillers, mild sedatives and antibiotics may be prescribed before the procedure.
- *Part preparation*: The abdomen and genital area may be shaved and prepared for the surgery. Instead of shaving, the pubic hair may be just clipped.

- *Bowel preparation*: An enema may be administered to the patient prior to performing the surgery. Sometimes a laxative may be given to clear the bowels on the previous night.
- *Anesthesia*: Abdominal hysterectomy can be performed under spinal or general anesthesia.
- *Patient position*: The patient is placed in the dorsal lithotomy position, and an adequate pelvic examination is performed with the patient under anesthesia. The patient is then put in approximately a 15° Trendelenburg position for the surgery.
- *Cleaning and draping*: Under all aseptic precautions the lower abdominal area (below the level of umbilicus), the genital area and upper parts of the thighs are cleaned and draped using sterile aseptic technique.
- *Foley's catheter*: The bladder is catheterized with the help of a Foley's catheter.

SURGICAL STEPS

In this section, steps of three main types of hysterectomies, abdominal, vaginal and laparoscopic assisted VH would be discussed:

ABDOMINAL HYSTERECTOMY

The procedure of abdominal hysterectomy comprises of the following steps:[3]

- *Choice of abdominal incision*: Due to good cosmetic results, transverse incisions in the abdomen (Pfannenstiel incision) are usually preferred (Figs 24.1 and 24.2). Since the transverse incisions may not provide adequate exposure, they are usually reserved for benign uterine pathology, when the uterus is not very large in size. In general, cases where an increased exposure is required (e.g. presence of a malignant disease), either a midline subumbilical incision or modifications of transverse incision (Maylard's or Cherney's incision) may be performed. These types of incisions would result in an increased exposure, thereby allowing accurate staging and adequate exposure to the upper abdomen and aortic lymph nodes. Moreover, there is a possibility for extension of the abdominal incision around and above the umbilicus for provision of appropriate exposure in cases where required. Self-retaining retractors are placed in the abdominal incision, and the bowel is packed off with warm, moist gauze packs. Some surgeons prefer placing a no. 0 synthetic absorbable suture in the fundus of the uterus in order to provide adequate uterine traction.
- Once the peritoneal cavity is entered, intestines must be pushed back by packing the abdomen. Placement of Kelly's clamp across each uterine cornu, running down along the sides of uterus help in the elevation of the uterus (Fig. 24.3).

Fig. 24.1: Pfannenstiel transverse abdominal incision

Fig. 24.2: Opening of the rectus sheath

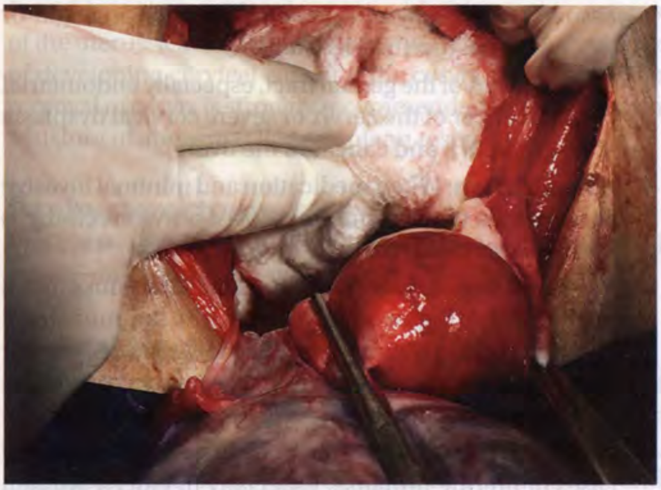
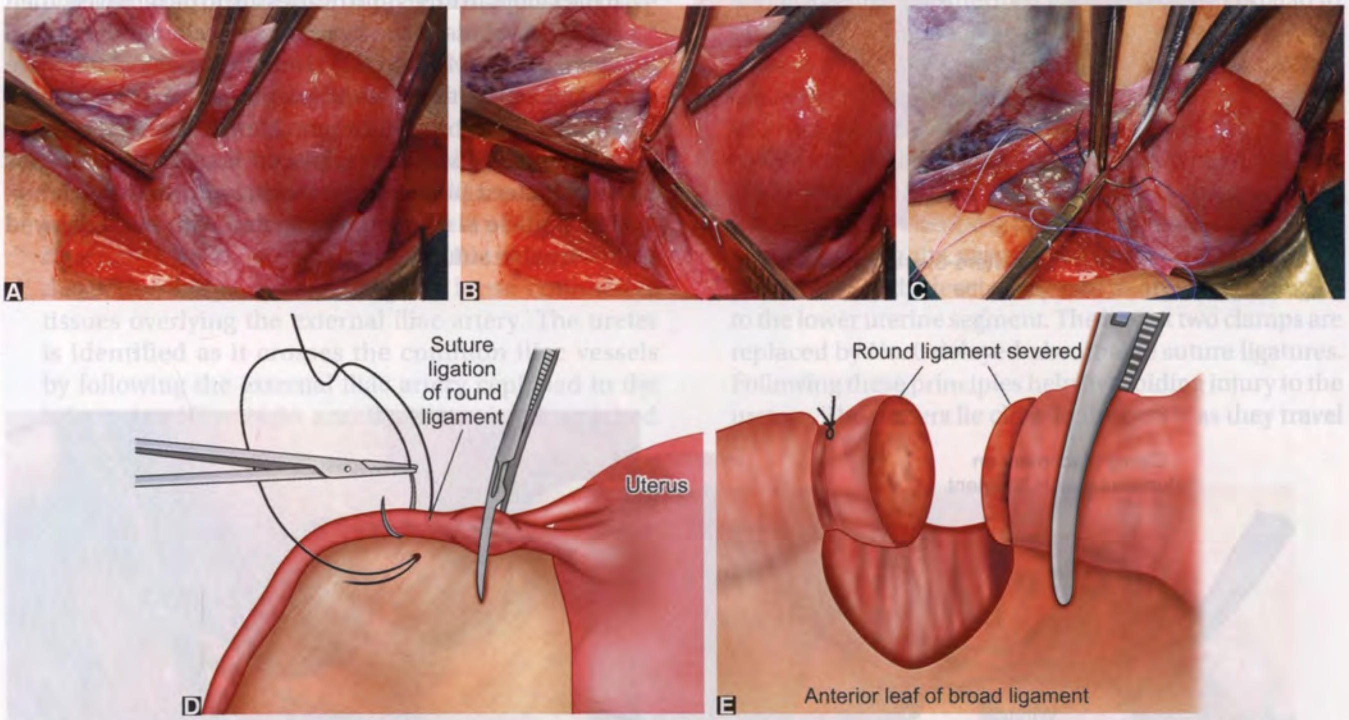


Fig. 24.3: Intestines pushed back by packing the abdomen

- *Clamping, cutting and ligation of the round ligaments*: The uterus is then manually deviated to the left side, thereby stretching the round ligament. Following this, the round ligaments are clamped, cut and ligated (Figs 24.4A to E).

- *Clamping, cutting and ligation of the infundibulopelvic ligaments/fallopian tubes and utero-ovarian ligaments (Figs 24.5 and 24.6)*: The next step depends on whether the tubes and ovaries have to be preserved or removed. Ovaries are usually preserved if they appear normal and the patient is below 40 years of age. If the woman is more man the age of 40 years, the ovaries are removed after taking the woman's consent in order to prevent the occurrence of ovarian carcinoma at a later date. If tubes and ovaries have to be conserved, the fallopian tube and the utero-ovarian ligament are clamped, cut and ligated close to the uterus (Fig. 24.6). The uterus is retracted toward the pubic symphysis and deviated to one side with the infundibulopelvic ligament, tube and ovary on tension. A finger should be inserted through the peritoneum of the posterior leaf of the broad



Figs 24.4A to E: (A) Round ligaments clamped; (B) Round ligaments are cut; (C) Round ligaments are ligated; (D) Diagrammatic representation of clamping and ligating the round ligaments; (E) Round ligament is transected and the anterior leaf of broad ligament is incised and opened

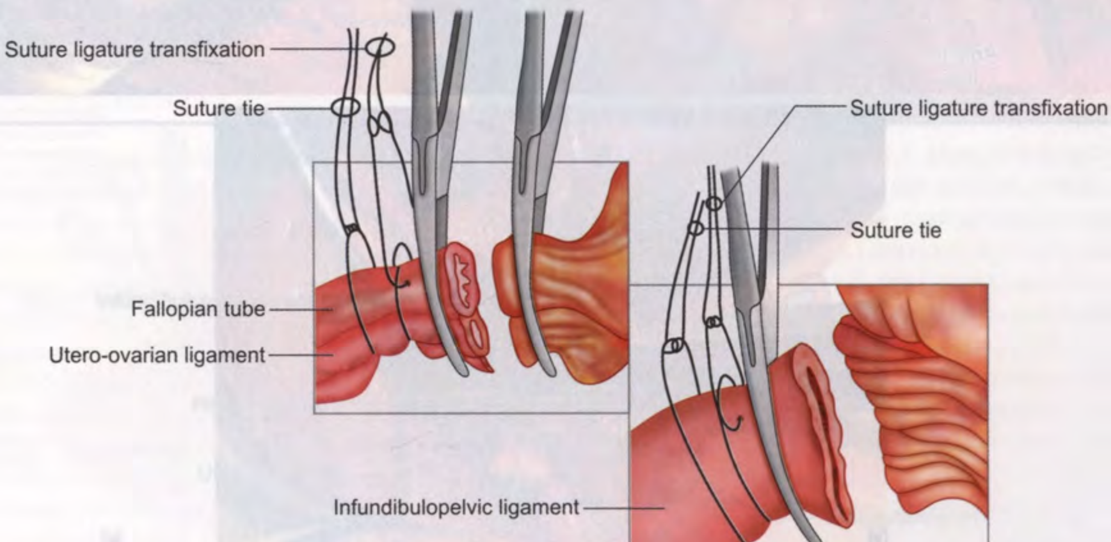


Fig. 24.5: Diagrammatic representation of transection of utero-ovarian and infundibulopelvic ligaments

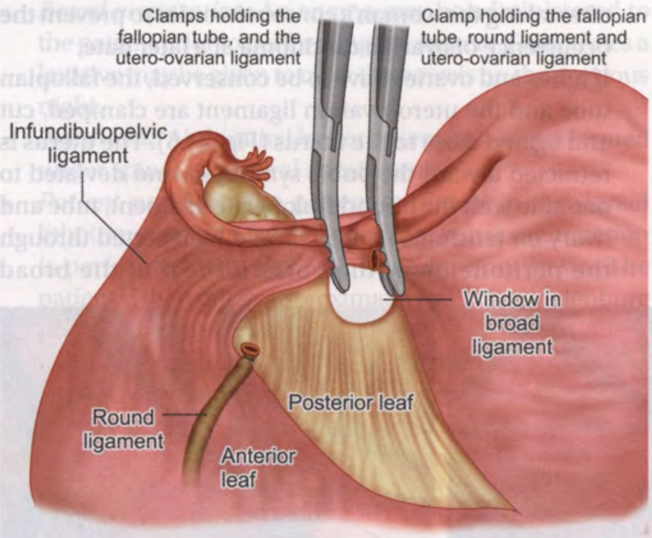
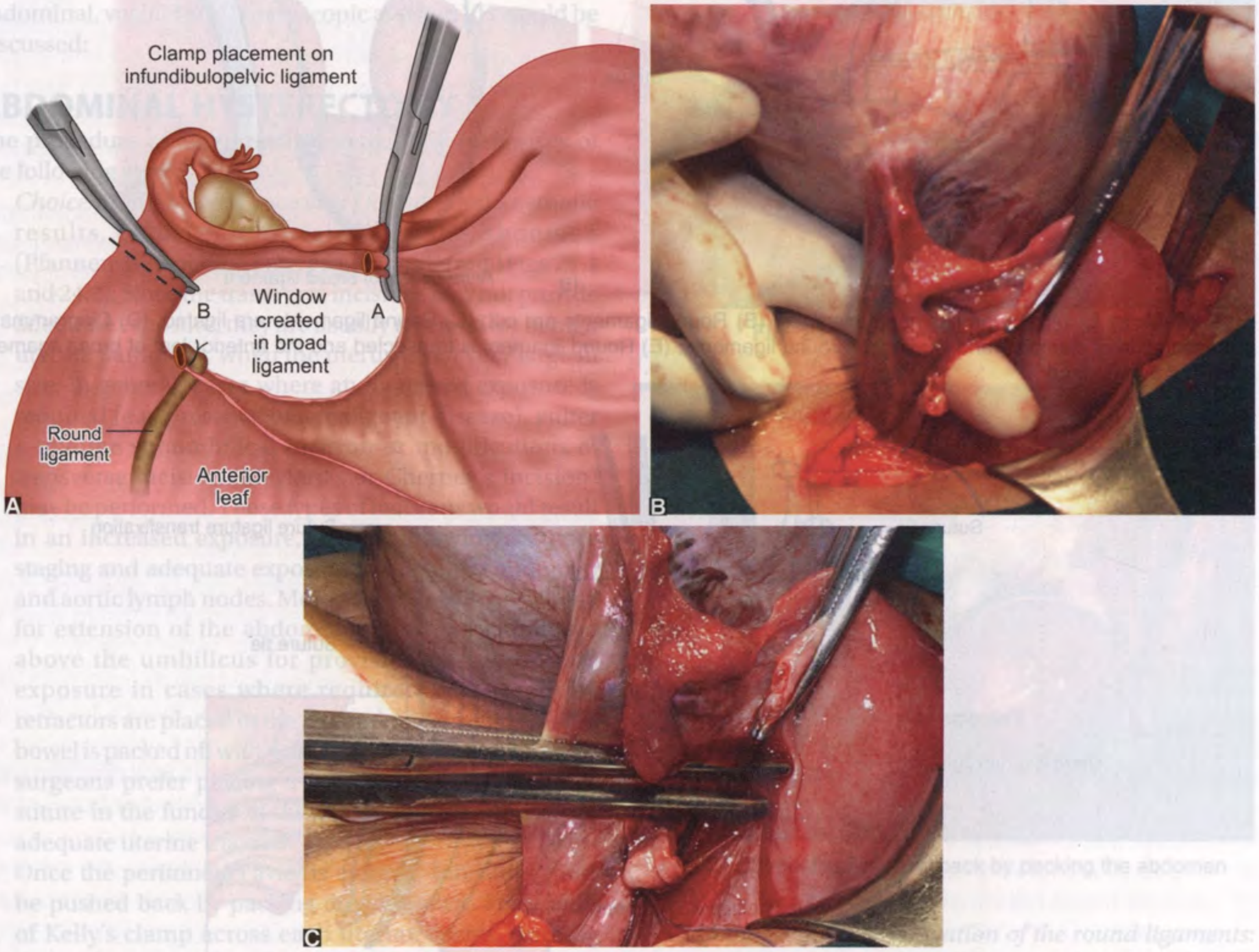


Fig. 24.6: Transection of the utero-ovarian ligament and fallopian tube

ligament under the suspensory ligament of the ovary and fallopian tube. Three Ochsner's clamps are placed across the tube and utero-ovarian ligaments as close to the uterus as possible. An incision is made between the middle and medial clamp. As a free tie is placed lateral to the lateral-most clamp, the pedicle is completely surrounded and the vessels are occluded. The middle clamp is replaced by a transfixation suture ligature that is tied securely around both sides of the pedicle.

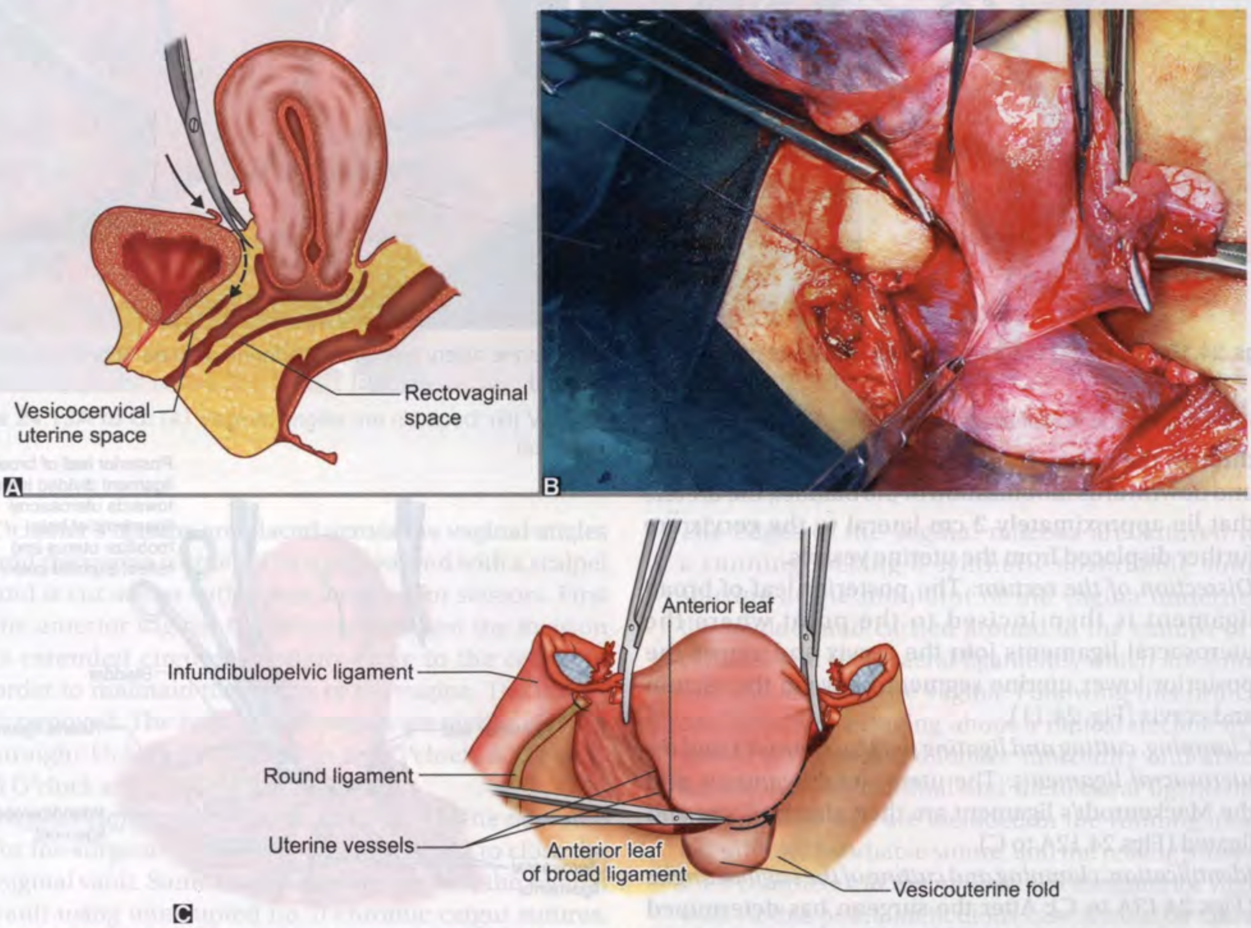
If the fallopian tubes and ovaries are to be removed, then the infundibulopelvic ligaments are clamped, cut and ligated (Figs 24.7A to C). Three Oschner's clamps are placed across the infundibulopelvic ligament, using a window in the broad ligament. After the ureter is located, the lateral most clamp is placed first. The ligament is then incised between the medial and middle clamp. The pedicle is then doubly ligated with no. 0 delayed absorbable suture.



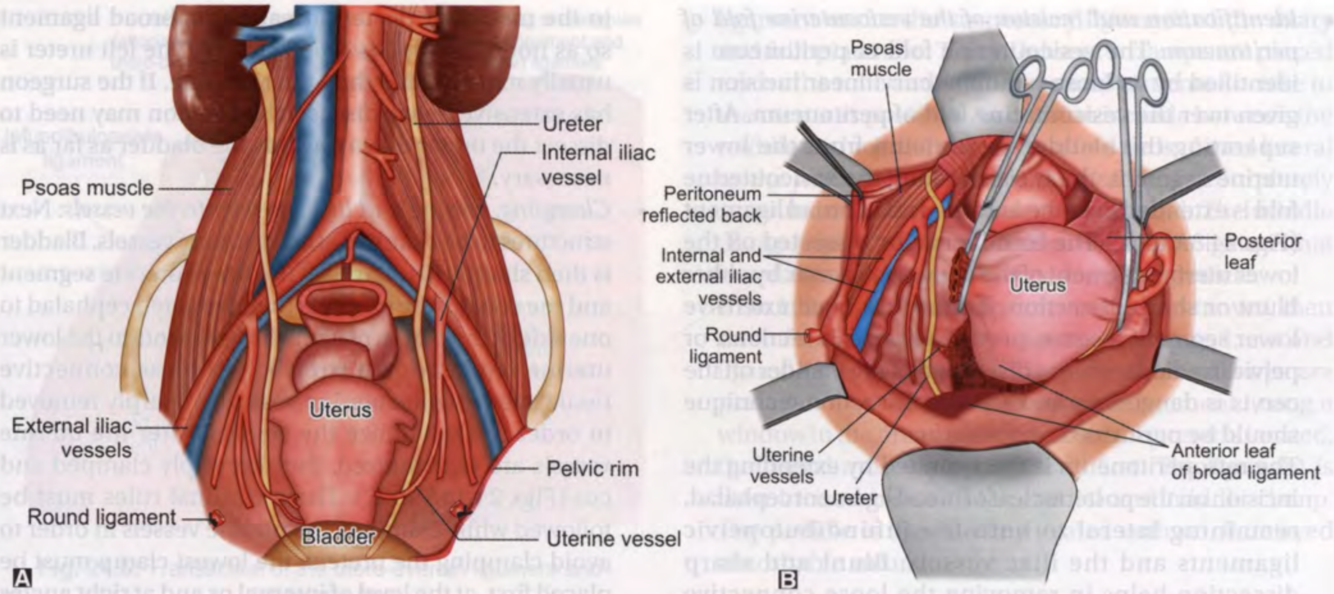
Figs 24.7A to C: (A) Diagrammatic representation of ligation of the infundibulopelvic ligament; (B) Identifying the infundibulopelvic ligament; (C) Infundibulopelvic ligament clamped and later cut and ligated

- *Identification and incision of the vesicouterine fold of peritoneum*: The vesicouterine fold of peritoneum is identified by its loose nature. A curvilinear incision is given over the vesicouterine fold of peritoneum. After separating the bladder peritoneum from the lower uterine segment, the incision along the vesicouterine fold is extended over the anterior leaf of broad ligament (Figs 24.8A to C). The bladder can be dissected off the lower uterine segment of the uterus and cervix by either blunt or sharp dissection. If there has been extensive lower segment disease, previous cesarean sections, or pelvic irradiation, blunt dissection of the bladder off the cervix is dangerous, and a sharp dissection technique should be performed.

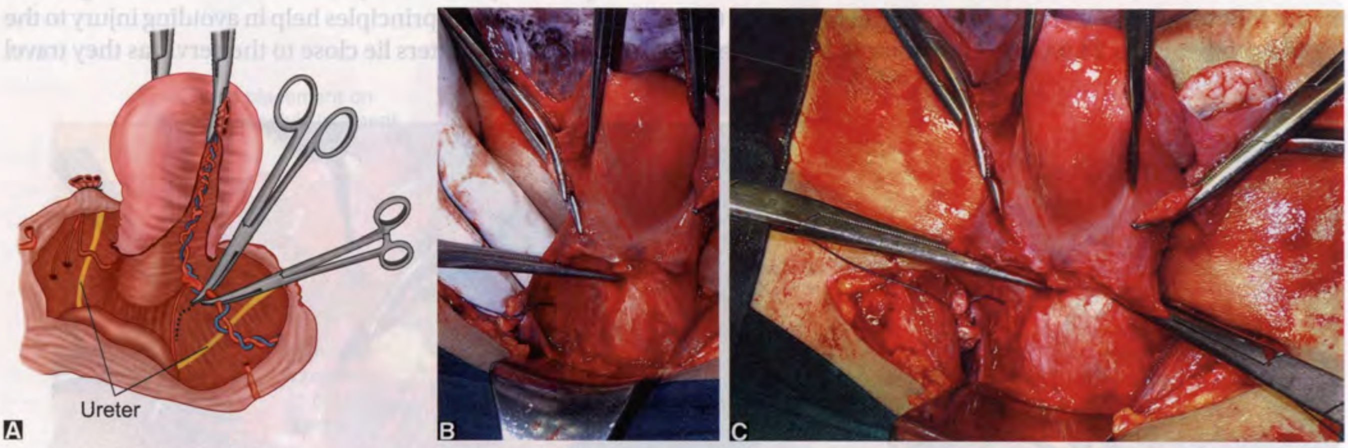
  The retroperitoneum is then entered by extending the incision on the posterior leaf of broad ligament cephalad, remaining lateral to both the infundibulopelvic ligaments and the iliac vessels. Blunt and sharp dissection helps in removing the loose connective tissues overlying the external iliac artery. The ureter is identified as it crosses the common iliac vessels by following the external iliac artery cephalad to the bifurcation (Figs 24.9A and B). Ureter is left attached to the medial or posterior leaf of the broad ligament so as not to disrupt its blood supply. The left ureter is usually more medial than the right one. If the surgeon has extensive pelvic disease, the surgeon may need to dissect the ureter down towards the bladder as far as is necessary.
- *Clamping, cutting and ligating the uterine vessels*: Next structures to be clamped are the uterine vessels. Bladder is then sharply dissected off the lower uterine segment and the cervix. The uterus is then retracted cephalad to one side of the pelvis, placing the ligaments in the lower uterine segment on a stretch. Any loose connective tissue overlying the uterine vessels is sharply removed in order to skeletonize the vessels. After the uterine vessels are skeletonized, they are triply clamped and cut (Figs 24.10A to C). Three cardinal rules must be followed while clamping the uterine vessels in order to avoid clamping the ureters: the lowest clamp must be placed first, at the level of internal os and at right angles to the lower uterine segment. The lowest two clamps are replaced by No. 0 delayed-absorbable suture ligatures. Following these principles help in avoiding injury to the ureters. The ureters lie close to the cervix as they travel



Figs 24.8A to C: (A) Dissection of the vesicouterine plane to mobilize the bladder; (B) Uterovesical fold identified by the loose fold following which it is incised; (C) The incision in the anterior leaf of broad ligament is extended along the uterovesical fold



Figs 24.9A and B: (A) Anatomy of the pelvic retroperitoneum; (B) Identification of the ureter in the retroperitoneal space



Figs 24.10A to C: (A) Diagram showing ligation of uterine vessels; (B) Uterine artery ligation; (C) Uterine arteries of both the sides have been clamped

through the pelvis. By gentle upwards uterine traction and downwards mobilization of the bladder, the ureters that lie approximately 2 cm lateral to the cervix are further displaced from the uterine vessels.

- *Dissection of the rectum*: The posterior leaf of broad ligament is then incised to the point where the uterosacral ligaments join the cervix and across the posterior lower uterine segment between the rectum and cervix (Fig. 24.11).
- *Clamping, cutting and ligating the Mackenrodt's and the uterosacral ligaments:* The uterosacral ligaments and the Mackenrodt's ligament are then clamped, cut and ligated (Figs 24.12A to C).
- *Identification, clamping and cutting of the vaginal angles (Figs 24.13A to C):* After the surgeon has determined with certainty that the bladder and rectum have been completely dissected away from the vagina, curved

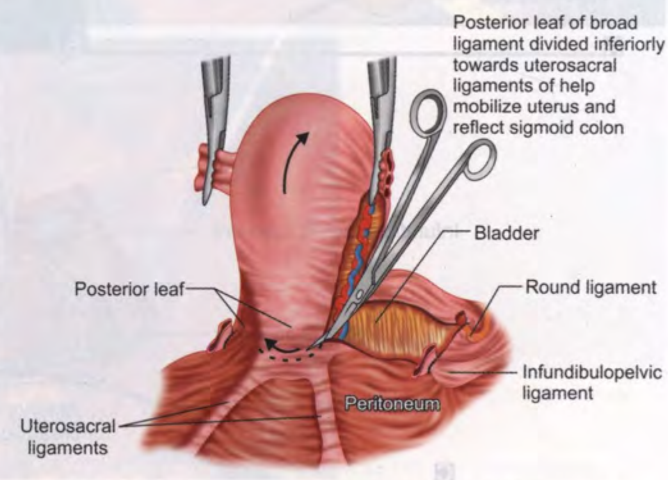
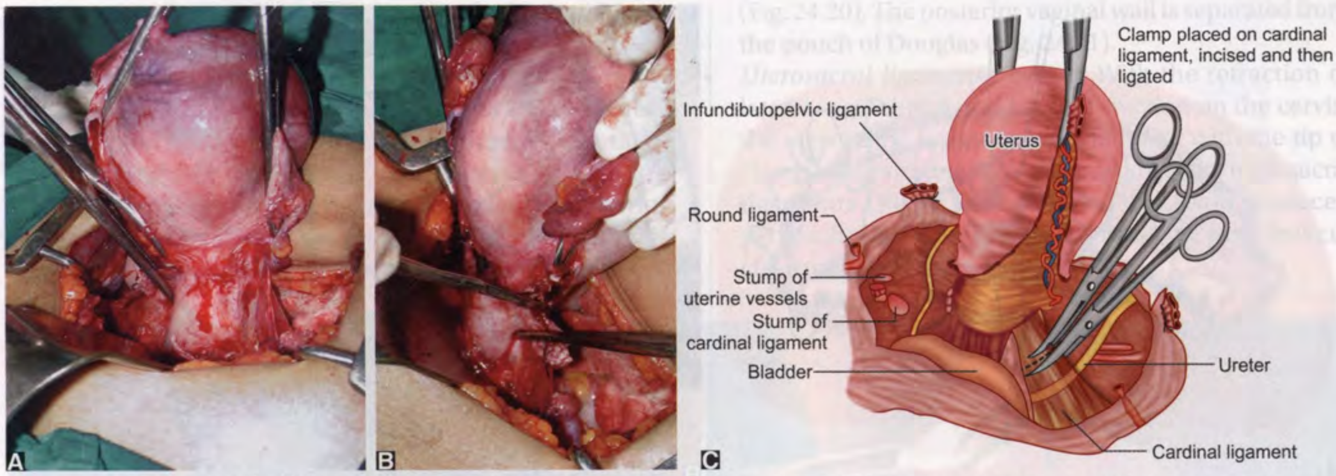
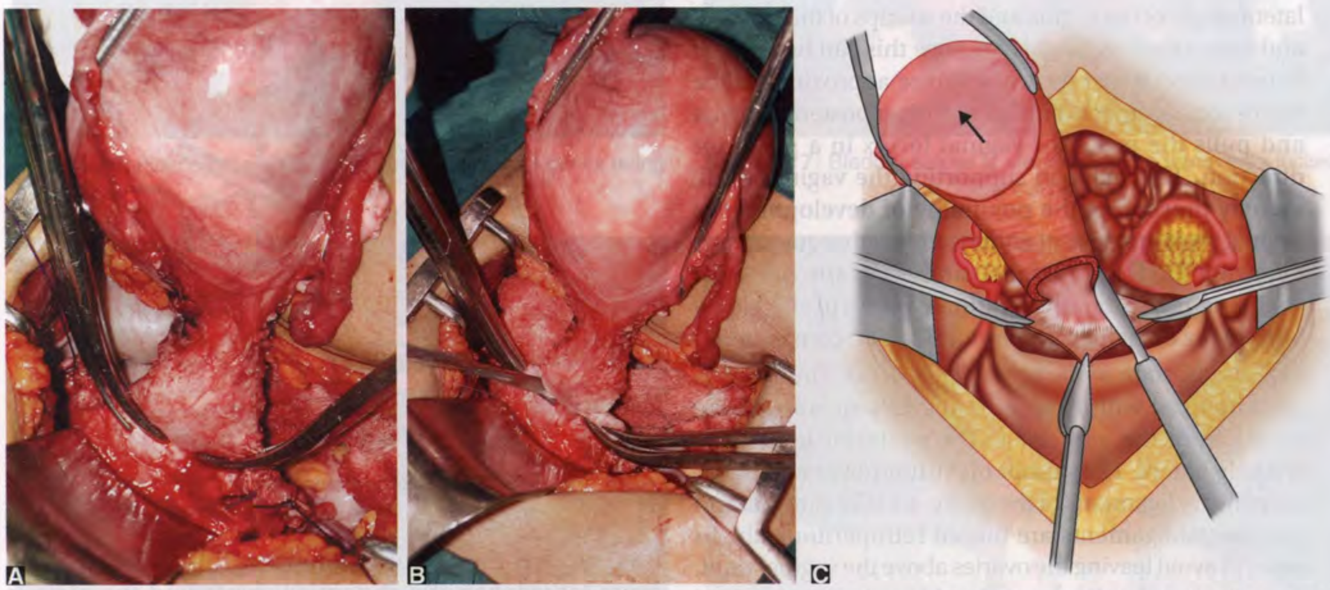


Fig. 24.11: Incision of the rectouterine peritoneum and mobilization of the rectum from the posterior cervix



Figs 24.12A to C: (A) Mackenrodt's ligament are identified; (B) Mackenrodt's ligaments are clamped; (C) Diagrammatic representation of clamping and cutting the cardinal ligaments

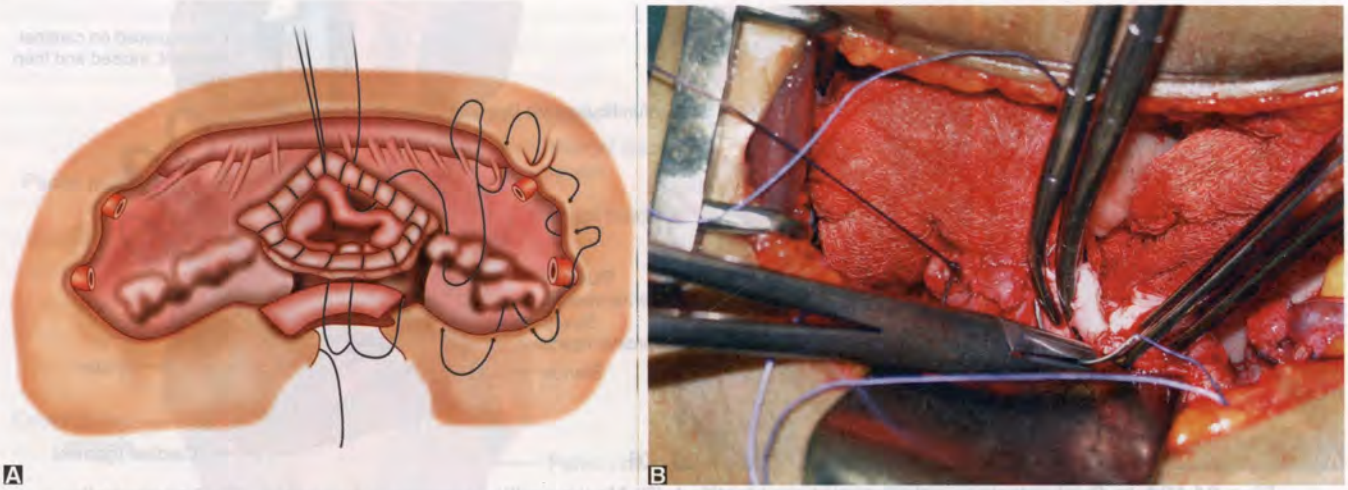


Figs 24.13A to C: (A) Vaginal angles are clamped; (B) Vaginal angles are cut (C) Diagrammatic representation of cutting the cervix from the vaginal vault

Ochsner's clamps are placed across the vaginal angles and the vagina is entered by a stab wound with a scalpel and is cut across with either a scalpel or scissors. First the anterior vaginal fornix is opened and the incision is extended circumferentially close to the cervix in order to maintain the length of the vagina. The uterus is removed. The edges of the vagina are picked up with straight Ochsner's clamps in a 3 O'clock, 6 O'clock, 9 O'clock and 12 O'clock positions.

- *Vaginal cuff closure (Figs 24.14A and B):* The next step for the surgeon to decide is whether or not to close the vaginal vault. Some surgeons prefer to close the vaginal vault using interrupted no. 0 chromic catgut sutures. However, in our setup, the vaginal cuff usually is not closed.

The edges of the vaginal mucosa are sutured with a running locking 0 synthetic absorbable sutures starting at the midpoint of the vagina underneath the bladder and carried around to the stumps of the cardinal and uterosacral ligaments, which are sutured into the angle of the vagina. Following this principle has helped in bringing about a radical decline in the rate of postoperative febrile morbidity and abscess formation. The cardinal and uterosacral ligaments of the opposite side are included in the running locking 0 synthetic absorbable suture, and the reefing process is then completed to the midpoint of the anterior vaginal wall. At this point, meticulous care should be taken to ensure that the lateral angle of the vagina is adequately secured and that hemostasis is complete between the



Figs 24.14A and B: (A) Vaginal cuff is left open with a running locking stitch sutures placed along the cut edge of the vaginal mucosa; (B) Closure and support of the vaginal vault

lateral angle of the vagina and the stumps of the cardinal and uterosacral ligaments because this can be a site of hemorrhage. When tied, this suture approximates the uterosacral ligaments behind the upper posterior vagina and pulls the posterior vaginal fornix in a posterior direction. This helps in supporting the vaginal vault, thereby preventing the possibility of development of vaginal vault prolapse or enterocele in subsequent years following TAH. If additional support of the posterior vagina is required, obliteration of the cul-de-sac by Moskowitz or Halban's technique can be considered.

- *Reperitonization of the pelvis (Fig. 24.15)*: The pelvis is reperitonized with running 2–0 synthetic absorbable suture from the anterior to the posterior leaf of the broad ligament. The stumps of the tubo-ovarian, round, suspensory ligaments of the ovary, and the cardinal and uterosacral ligaments are buried retroperitoneally. In order to avoid leaving the ovaries above the vaginal vault, the utero-ovarian ligament should be extraperitonized as separate sutures. Retroperitonization is completed by suturing the bladder peritoneum to the cul-de-sac peritoneum with 3–0 delayed absorbable sutures. The ovaries are placed over the omentum. If there is a tendency for the ovaries to fall into the cul-de-sac, then the surgeon may elect to close the cul-de-sac with Moskowitz procedure or to suspend the ovaries to the round ligament.
- *Abdominal closure*: Prior to closing the abdomen, all the stumps must be inspected for hemostasis. The pelvis is thoroughly washed with sterile saline solution. Meticulous care is taken to ensure that hemostasis is present throughout the dissected area.

VAGINAL HYSTERECTOMY

In a VH, the steps of surgery are based on the same principle as that in abdominal hysterectomy described previously, it is just that the uterus is removed through the vaginal route rather than the abdominal route and the various steps as described previously with abdominal route are now performed vaginally. The surgery comprises of the following steps:[4,5]

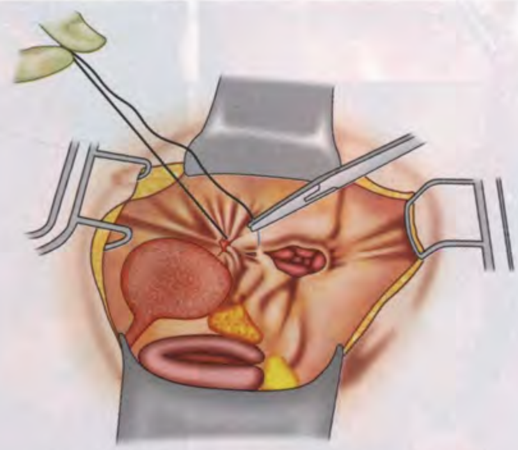


Fig. 24.15: Reperitonization of the pelvis

- The anterior and posterior lips of the cervix are grasped with a single- or double-toothed tenaculum (Fig. 24.16).
- *Grasping and circumscribing the cervix*: Traction in downwards direction is applied on the cervix after grasping its anterior and posterior lips. A circumferential incision is made in the vaginal epithelium at the junction of the cervix just below the bladder sulcus (Fig. 24.17).
- After making the incision below the bladder sulcus, the vaginal epithelium may be dissected sharply from the underlying tissues or pushed bluntly with an open sponge. The vesicouterine fascia is dissected away (Fig. 24.18).
- The circular incision over the vagina is extended posteriorly and laterally (Fig. 24.19). The bladder is again advanced out. After the initial incision is made,

the vaginal epithelium may be sharply dissected from the underlying tissues or pushed bluntly with an open sponge.

- *Entry into the posterior cul-de-sac:* The peritoneal reflection of the posterior cul-de-sac can be identified by stretching the vaginal mucosa and underlying connective tissues with forceps. To open the posterior peritoneum, the uterus is pulled up. The peritoneum is grasped with surgical forceps and opened with scissors (Fig. 24.20). The posterior vaginal wall is separated from the pouch of Douglas (Fig. 24.21).
- *Uterosacral ligament ligation:* With the retraction of lateral vaginal wall and counter traction on the cervix, the uterosacral ligaments are clamped, with the tip of clamp incorporating the lower portion of the uterosacral ligaments (Figs 24.22A to D). The clamp is placed perpendicular to the uterine axis, and the pedicle is cut close to the clamp and sutured.

Fig. 24.16: Holding the anterior and posterior lips of cervix using tenaculum

Fig. 24.17: Bladder sulcus is identified and a transverse incision is made below the bladder sulcus

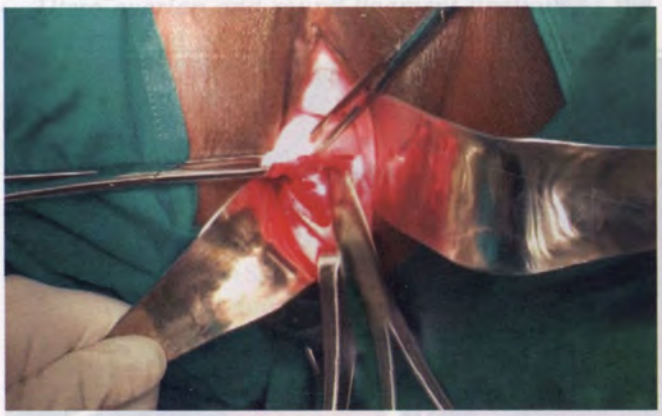


Fig. 24.18: Cutting the vesicouterine fascia

Fig. 24.19: The circular vaginal incision is extended posteriorly and laterally

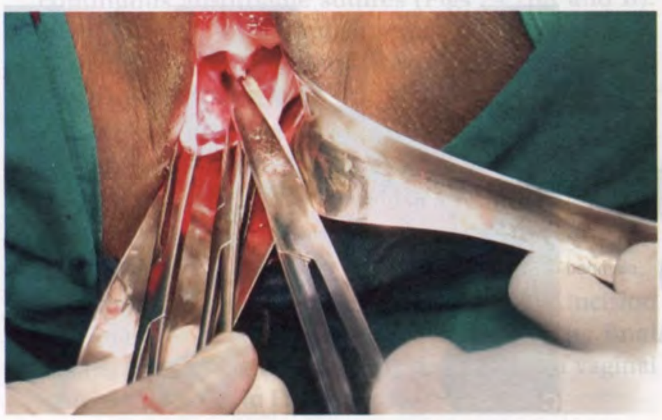
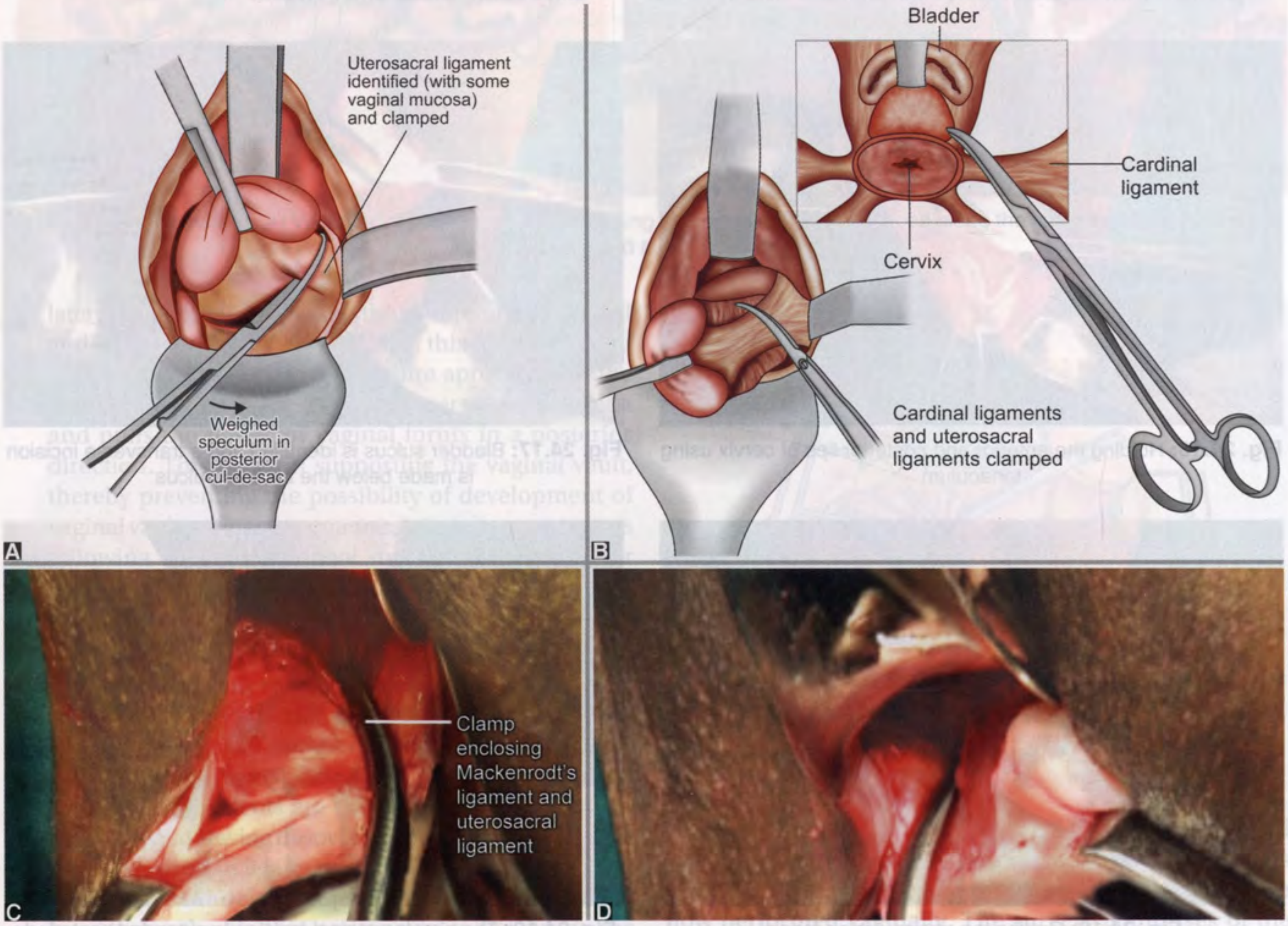


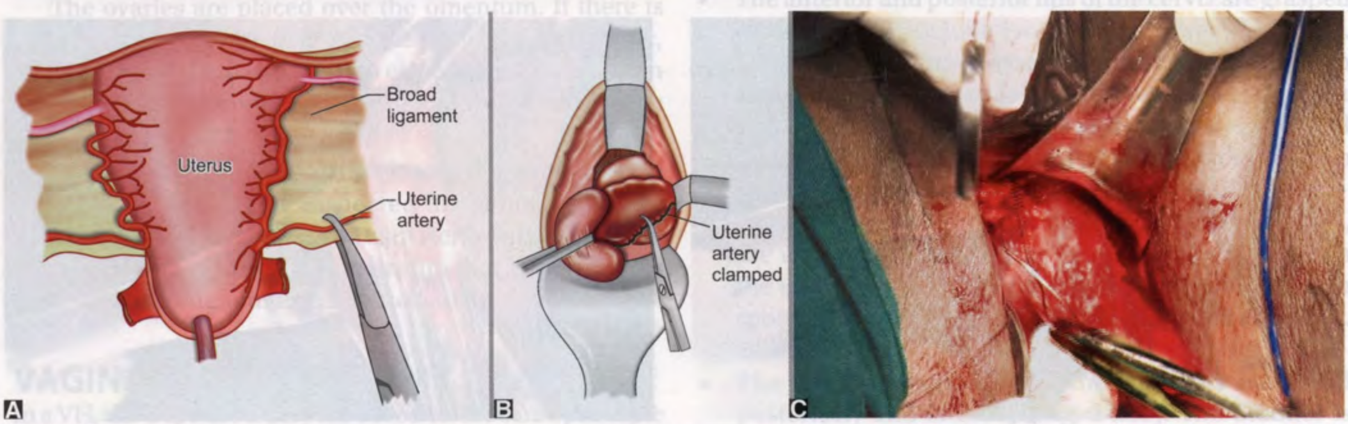
Fig. 24.20: Identifying and incising the pouch of Douglas

Fig. 24.21: Separating the posterior vaginal wall from pouch of Douglas

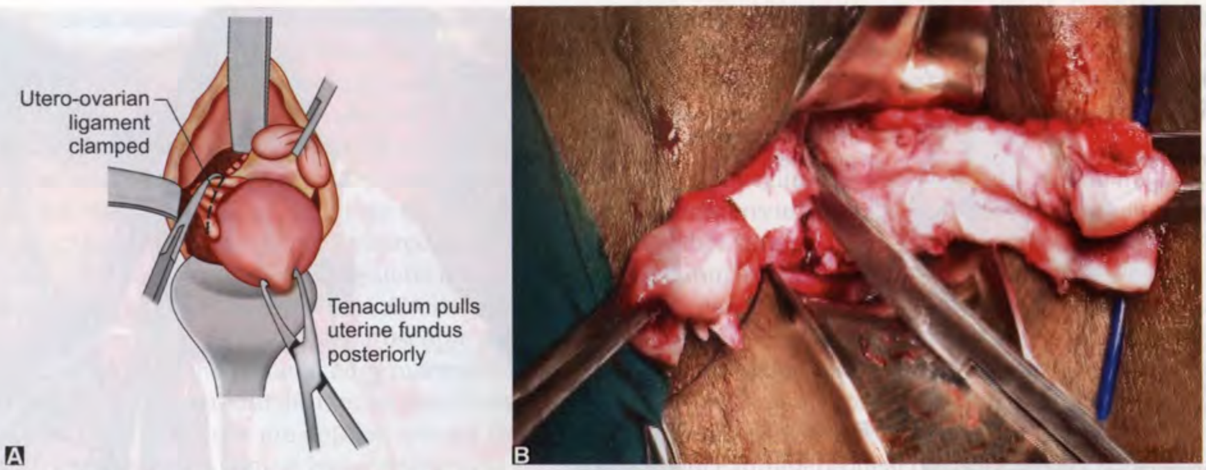
- With the continuing traction on the cervix, the cardinal ligaments are identified, clamped, cut and suture ligated.
- *Uterine artery ligation*: Contralateral and downwards traction is applied on the cervix with an effort to incorporate the anterior and posterior leaves of the visceral peritoneum. The uterine vessels are identified, clamped, cut and suture ligated (Figs 24.23A to C). A single suture, single clamp technique is adequate because it decreases the potential risk of ureteral injury.
- *Entry into the vesicovaginal space*: The anterior fold of peritoneum must be identified just before or after clamping and suture ligation of uterine arteries. The anterior peritoneal cavity must not be opened blindly because of increased risk of bladder injury. The peritoneum is grasped with forceps and opened with



Figs 24.22A to D: The uterosacral and Mackenrodt's ligaments are clamped, cut and ligated



Figs 24.23A to C: Uterine vessels are then clamped, cut and ligated



Figs 24.24A and B: (A) Delivery of uterine fundus posteriorly; (B) Bisecting an enlarged uterus before removal

the help of scissors with the tip pointing towards the uterus.

- A tenaculum is placed onto the uterine fundus in a successive fashion in order to deliver the fundus posteriorly (Figs 24.24A and B). The surgeon can use his/her index finger to identify the utero-ovarian ligament and place the clamp.
- *Utero-ovarian and round ligament ligation*: As the anterior and posterior peritoneum are opened, the remainder of broad ligament, utero-ovarian ligaments and round ligament are clamped, cut and ligated.
- *Removal of the ovaries*: If the ovaries have to be removed, a Heaney's clamp is placed across the infundibulopelvic ligaments and the ovaries and tubes are excised (Fig. 24.25).
- *Peritoneal closure*: Since the pelvic peritoneum does not provide support and usually reforms within 24 hours after surgery, many surgeons do not reapproximate the peritoneum as a routine procedure. If the peritoneal closure is performed, the anterior edge of peritoneum is identified and grasped with forceps. The peritoneum is reapproximated in a purse-string fashion using continuous absorbable sutures (Figs 24.26A and B). High posterior reperitonealization is performed as it shortens the cul-de-sac and prevents the formation of enterocele in the future.
- *Closure of the vaginal mucosa (Fig. 24.27):* The vaginal mucosa can be reapproximated in a vertical or horizontal manner using either interrupted or continuous sutures.
- The uterus and cervix are then removed from the top of the vagina.
- The upper part of the vagina where the surgical incision was made is closed with suture material. The final appearance of vagina following the closure of vaginal mucosa is shown in Figure 24.28.

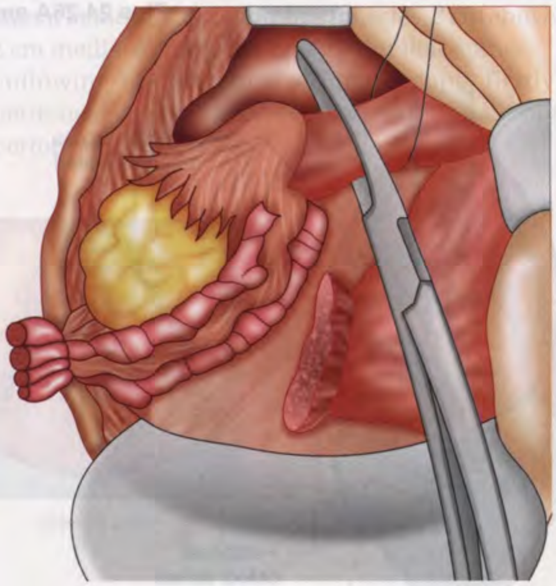
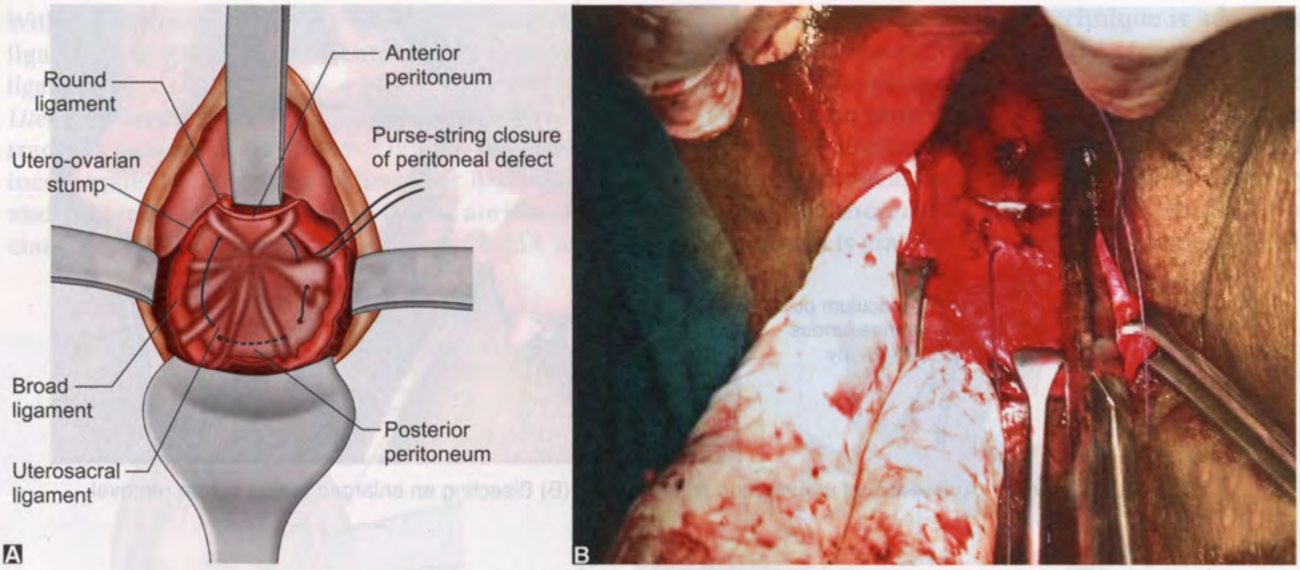


Fig. 24.25: Removal of the fallopian tubes and ovaries by clamping across the infundibulopelvic ligament

MINIMALLY INVASIVE TECHNIQUE IN HYSTERECTOMY

Performance of laparoscopic hysterectomy by Harry Reich in 1989[6] stimulated a great interest in proper scientific evaluation of all forms of hysterectomy. Since then various techniques for hysterectomy using laparoscopy have been developed.

Classification system of laparoscopic hysterectomy proposed by Johns and Diamond is described in Table 24.1.[7] The procedure is termed stage 3 or laparoscopic-assisted vaginal hysterectomy (LAVH) if the steps of hysterectomy until the dissection of bladder from the uterus is carried via laparoscopic route and uterine vessels are secured



Figs 24.26A and B: Closure of the peritoneum

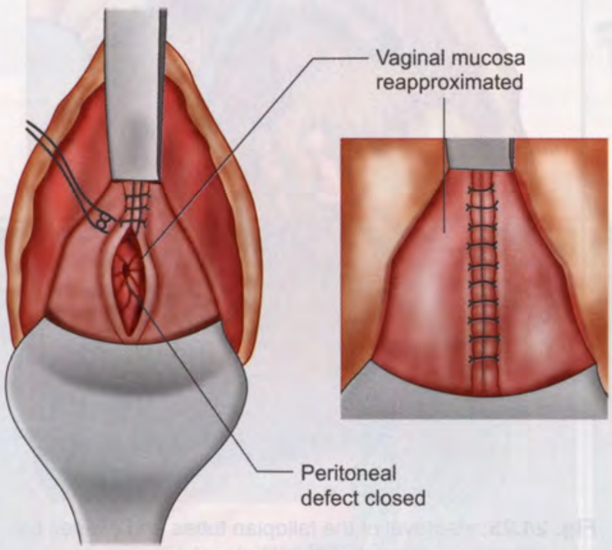


Fig. 24.27: Reapproximation of the vaginal mucosa

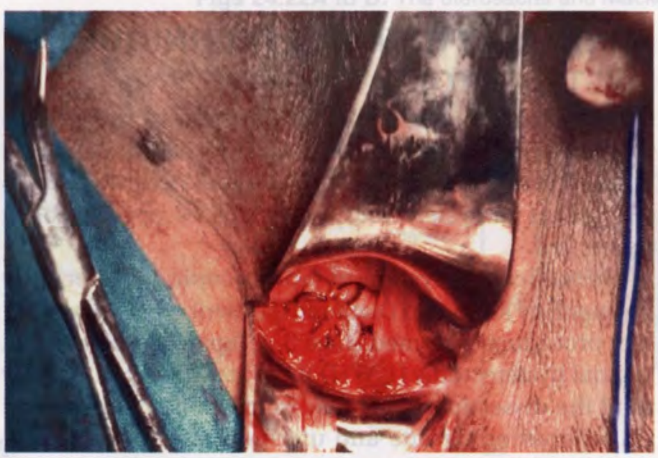


Fig. 24.28: Final appearance of vagina following closure

Table 24.1: Johns and Diamond classification system of laparoscopic hysterectomy[7]

Stage	Definition
Stage 0	Diagnostic laparoscopy performed, but no laparoscopic surgery required before a vaginal hysterectomy (VH)
Stage 1	Laparoscopic adhesiolysis or excision of endometriosis before VH
Stage 2	Either one or both adnexa, including the infundibulopelvic ligaments are freed laparoscopically prior to VH
Stage 3 [Laparoscopic-assisted vaginal hysterectomy, (LAVH)]	Bladder dissected from the uterus laparoscopically prior to VH
Stage 4 [Laparoscopic hysterectomy, (LH)].	All the above including transection of uterine arteries prior to VH
Stage 5 [Total laparoscopic hysterectomy, (TLH)]	Anterior and posterior colpotomy and freeing of the whole uterus performed laparoscopically

through the vaginal route (Fig. 24.29). The procedure is termed as stage 4 or laparoscopic hysterectomy (LH) if the steps of hysterectomy until the ligation of uterine vessels are carried out via laparoscopic route (Fig. 24.30). However, if the ligation and transection of uterosacral and cardinal ligaments is also carried out via laparoscopic route and the cervix is completely freed from the vagina using laparoscopic techniques, the procedure is known as stage 5 or total laparoscopic hysterectomy (TLH) (Fig. 24.31).

Another type of laparoscopic hysterectomy is laparoscopic supracervical hysterectomy (LSH) which was first described in 1990 (Fig. 24.32). LSH is done in a manner similar to TLH. However, following the occlusion of uterine vessels via laparoscopic route, the cervix is also amputated in a conical fashion via laparoscopic route, commencing at the level of the internal os, extending into the endocervical canal. Another type of laparoscopic hysterectomy similar to LSH is the classic abdominal SEMM hysterectomy (CASH); first described by Kurt Semm.[8] The CASH procedure utilizes a combined vaginal and laparoscopic approach. An instrument called the serrated edge macromorcellator (SEMM) is used for cutting out the uterine canal from below. Simultaneously, endoloops are applied around the lower segment of the uterus to control bleeding from the uterine vessels. Upper pedicles are suture ligated via laparoscopic route.

Laparoscopically Assisted Vaginal Hysterectomy

The procedure of LAVH is quite similar to the procedure of VH described previously, but in this case laparoscopy is used for better dissection of the abdominal tissues. The procedure is performed under general anesthesia and comprises of the following steps (Figs 24.33A to L):[6,9-13]

- Patients are placed in a dorsal lithotomy position with pneumoboots.
- LAVH begins with several small abdominal subumbilical incisions to allow the insertion of the laparoscope and other surgical tools. Three ports are usually made: one 5 mm infraumbilical port for a 30° scope and two lateral ones for Babcock's and tripolar electrosurgery unit on either side. For detailed description about insertion of laparoscope, kindly refer to Chapter 32 (Diagnostic and Operative Laparoscopy). Pneumoperitoneum is created by inserting a Veress needle into the peritoneal cavity. Once intraperitoneal pressure has reached 15 mm Hg, an optical trocar is inserted through the umbilicus under direct vision. The lower quadrant trocar sleeves are placed under direct vision. These trocars are placed lateral to the rectus abdominis muscles, 2 cm above and 2 cm medial to the anterior superior iliac spine.
- Following the insertion of laparoscope, firstly the peritoneal cavity is surveyed and lysis of adhesions is performed, if necessary.

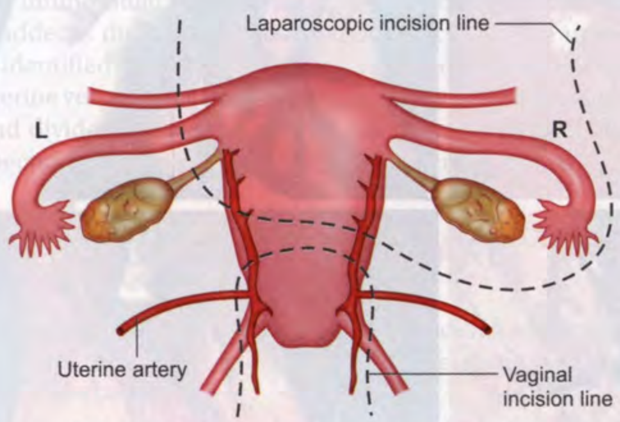


Fig. 24.29: Stage 3 laparoscopic hysterectomy

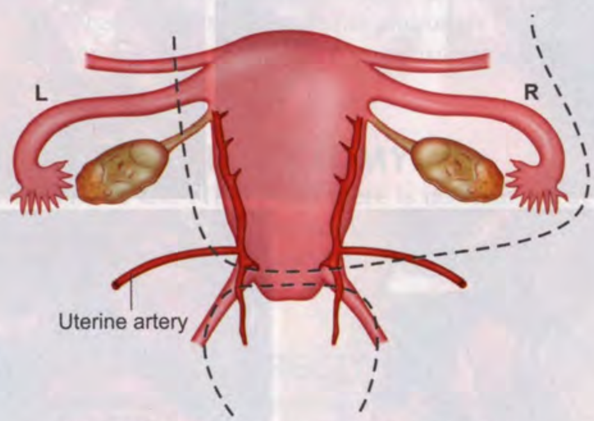


Fig. 24.30: Stage 4 laparoscopic hysterectomy

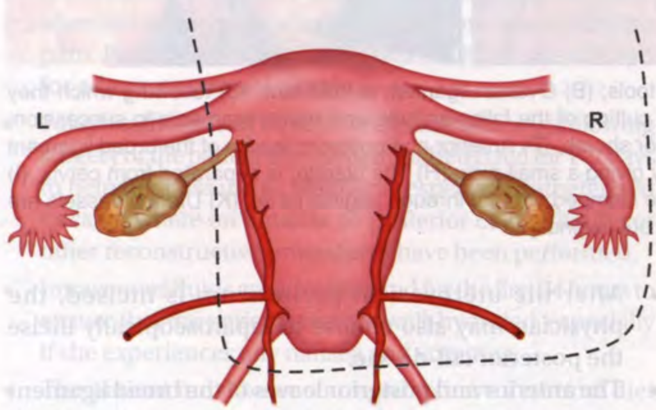


Fig. 24.31: Stage 5 laparoscopic hysterectomy

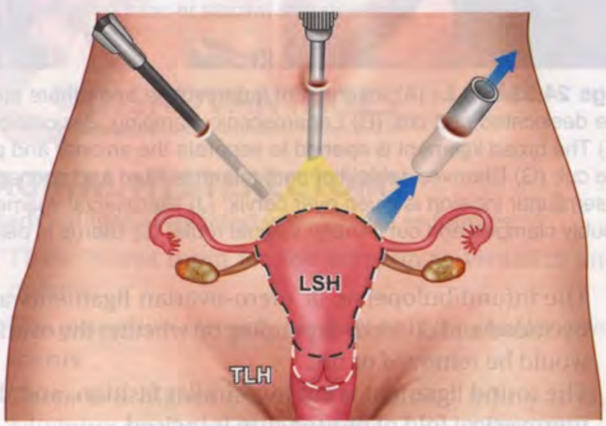
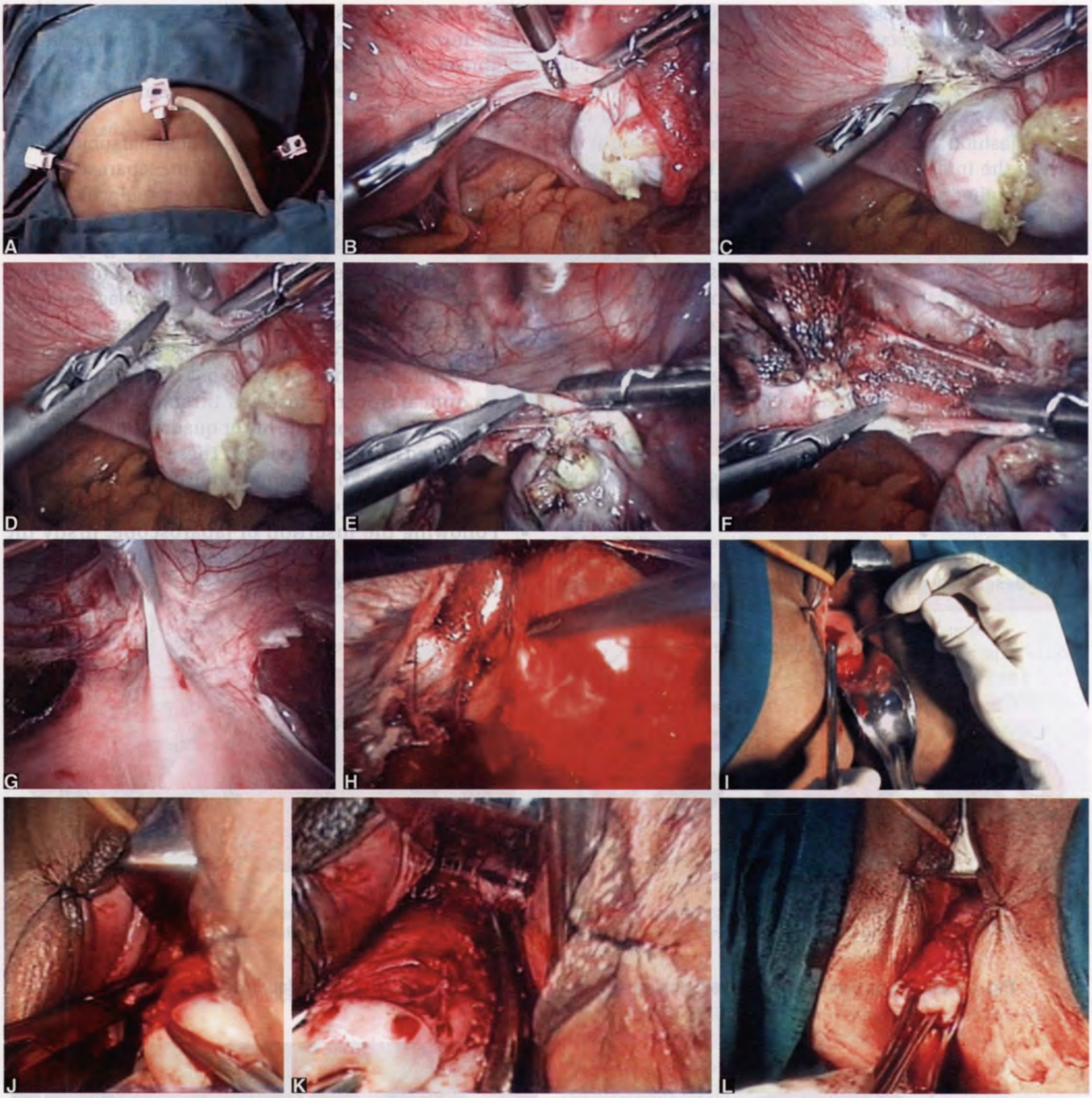


Fig. 24.32: Laparoscopic supracervical hysterectomy (LSH)
Abbreviations: TLH, total laparoscopic hysterectomy



Figs 24.33A to L: (A) Insertion of laparoscope and others surgical tools; (B) Ovarian ligament is held taut, (C) following which they are desiccated and cut; (D) Laparoscopic clamping, desiccation and cutting of the fallopian tube and round ligaments in succession; (E) The broad ligament is opened to separate the anterior and posterior sheath; (F) Anterior and posterior leaves of the broad ligament are cut; (G) Uterovesical fold of peritoneum is lifted and opened up by giving a small nick; (H) The bladder is separated from cervix; (I) A semilunar incision is given over cervix; (J) Uterosacral ligaments are clamped and cut through vaginal route; (K) Uterine vessels are doubly clamped and cut through vaginal route; (L) Uterus is delivered out vaginally

- The infundibulopelvic or utero-ovarian ligaments are occluded and divided, depending on whether the ovaries would be removed or not.
- The round ligament is cut in a similar fashion, and the uterovesical fold of peritoneum is incised.
- After the uterovesical peritoneum is incised, the physician may also choose to laparoscopically incise the posterior cul-de-sac.
- The anterior and posterior leaves of the broad ligament are separated with the help of a harmonic scalpel.

The vesicouterine peritoneal fold is identified and the bladder is mobilized off the lower uterine segment.
- Rest of the procedure of hysterectomy is carried out vaginally. The uterus and cervix are separated from the vaginal apex. The uterus and cervix are then removed through the vagina, and the top of the vaginal cuff is sutured. If the uterus is too large to come out through the vagina, it can be carefully morcellated transvaginally prior to the removal. The closure of the vaginal cuff is also performed vaginally. Following the closure of vaginal cuff, the pelvis can then be irrigated and hemostasis at all sites assured.

The port sites are then closed. Cystoscopy is not performed as a routine procedure, but in selected cases, where bladder injury is suspected, cystoscopy may be performed after vaginal closure to check ureteral patency and to look for any signs of bladder injury.

Laparoscopic Hysterectomy

The procedure of LH is initially performed similar to the procedure of LAVH; the only difference being that the entire hysterectomy is performed through the laparoscopic route. Following the occlusion, ligation and division of the infundibular, utero-ovarian, and round ligaments, the bladder is dissected off the uterus anteriorly. The ureter is identified and dissected along its entire course, and the uterine vessels and uterosacral ligaments are then occluded and divided. After the posterior cul-de-sac is incised, the specimen is removed vaginally, and the cuff is closed.

POSTOPERATIVE CARE

The postoperative steps for the three procedures, abdominal hysterectomy, VH and LAVH, are the same and are described below:
- The patient must be closely observed for the signs of hemorrhage for the first few hours following the surgery.
- Intravenous and oral painkiller medications are used after the surgery to provide relief from postoperative pain. Patient controlled analgesia (PCA) can be utilized for adequate control of pain.
- Foley's catheter may be removed in the morning following surgery or the patient may remain catheterized for 1–2 days to help her pass urine. Bladder is especially catheterized in cases where an anterior or posterior colporrhaphy or other reconstructive procedures have been performed.
- Intravenous fluids are administered for the first 24 hours to ensure that the patients remain well-hydrated, especially if she experiences any nausea and vomiting.
- The patient must be encouraged to have a normal diet as soon as possible after the bowel function returns.
- Ambulation and deep breathing is encouraged.
- Lifting of heavy weights or vaginal sexual intercourse must be discouraged for at least 4–6 weeks until the vaginal cuff heals completely.
- If the oophorectomy has been performed in premenopausal women, the patient may experience symptoms of premature menopause such as hot flashes, vaginal dryness, mood disturbances and osteoporosis. Treatment with hormonal replacement therapy may be required in these cases.
- Skin sutures are removed on 7th–10th postoperative day.
- On discharge, the patient must be instructed to resume the normal daily activity as quickly as possible. Walking and climbing up the stairs is encouraged.
- The patient must be instructed to report immediately if she experiences increased pain, persistent nausea and vomiting, heavy bleeding or signs of infection.

ADVANTAGES

ABDOMINAL HYSTERECTOMY

Advantages of abdominal hysterectomy are as follows:
- The surgeon can see the uterus and other organs and has more room to operate in comparison to the vaginal procedure.

VAGINAL HYSTERECTOMY

Advantages of the VH are that there is no visible scar in VH and healing is faster in comparison to abdominal hysterectomy. It is also associated with reduced overall morbidity and mortality.

SUBTOTAL HYSTERECTOMY

Advantages of subtotal hysterectomy are as follows:
- Reduced operative and postoperative morbidity
- Reduced vaginal shortening and vault prolapse
- Increased rate of sexual satisfaction.

DISADVANTAGES

VAGINAL HYSTERECTOMY

Disadvantages associated with VH are as follows:
- There is less room for the surgeon to visualize and operate.
- The procedure can only be used only for smaller sized uterus.
- There is a higher chance for causing injury to the adjoining organs such as bladder.

ABDOMINAL HYSTERECTOMY

Disadvantages of abdominal hysterectomy are as follows:
- Longer duration of hospital stay
- Greater discomfort than following a vaginal procedure
- A visible scar on the abdomen.

COMPLICATIONS

Hysterectomy is a common, routine surgery, which is generally safe and is associated with comparatively rare serious complications. A prospective cohort study, the VALUE study has evaluated 37,298 women undergoing hysterectomy in various NHS and private hospitals in England, Wales and Northern Ireland.[14] According to this study, the overall operative complication rate for VH was found to be 3.07%; 3.57% for abdominal hysterectomy and 6.07% for women treated by LAVH. This study also showed that laparoscopic techniques tend to be associated with higher complication rate in comparison to other methods. Major concern is towards urinary tract injuries, such as bladder and ureteric injury. Younger women having more vascular pelvis, undergoing hysterectomy, especially laparoscopically assisted vaginal surgery for symptomatic fibroids, are at a high risk of developing severe complications both operatively and postoperatively.

Few complications which can be associated with hysterectomy are enumerated next.[14,15]

IMMEDIATE

Perioperative Period

The following complications can occur in the immediate perioperative period:
- Hemorrhage: Primary and reactionary
- Injury to adjacent structures such as bladder, intestines and ureter can occur especially with the laparoscopic procedure[16-19]
- Anesthetic complications.

Postoperative Period

The following complications can occur in the immediate postoperative period:
- Shock such as hypovolemic shock
- Urinary complications such as retention, cystitis and anuria
- Incontinence such as overflow, stress or true incontinence
- Pyrexia more than 100.8°F, commonly due to infection
- Hemorrhage, secondary
- Hematoma: Cuff or rectus sheath hematoma
- Wound dehiscence
- Paralytic ileus and intestinal obstruction
- Phlebitis
- Deep vein thrombosis and pulmonary embolism.

REMOTE

The complications which can occur in remote future are as follows:
- Vault granulation
- Vault prolapse
- Prolapse of fallopian tubes
- Incisional hernia[20]
- Postoperative adhesion formation
- High mortality rate
- Early surgical menopause in case of salpingo-oophorectomy.

DISCUSSION

DECIDING THE ROUTE OF SURGERY: ABDOMINAL VERSUS VAGINAL HYSTERECTOMY OR LAVH

Hysterectomy is one of the most commonly performed surgical procedures, with over 1 lakh procedures being performed in the UK and 6 lakhs in the US, annually. Of these hysterectomies, nearly 70–80% are performed by the abdominal approach except in cases of uterovaginal prolapse, where the vaginal route is more commonly used. Vaginal hysterectomies have been performed successfully for almost past two centuries, and more recently Reich and colleagues have introduced LH.[11,12] However, despite the advent of these minimally invasive procedures, and numerous advantages associated with the vaginal route, abdominal hysterectomy remains the most commonly used surgical approach, with well over half of hysterectomies being performed via this route. The decision regarding the route of surgery is taken by the surgeon, based on the factors such as the most suitable option for the patient and absence and presence of various contraindications.

Vaginal and laparoscopic hysterectomies have been thought to be associated with reduced blood loss, shorter duration of hospital stay, speedier return to normal activities, and fewer abdominal wall infections when compared with abdominal hysterectomies. The complication rate with abdominal hysterectomy is 70% higher than that with VH. VALUE study has shown that laparoscopic techniques may be associated with higher rate of complications in comparison to both abdominal and vaginal hysterectomy.[13] This could be due to the fact that may surgeons are still not technically conversant with the technique of laparoscopic hysterectomy. Injury to the urinary tract has been considered as a major concern with the laparoscopic route.

Postoperative fever/sepsis is more common in the abdominal group. The requirement for blood transfusion during surgery is also highest with the abdominal procedure. Wound infection is unlikely after VH. Higher rate of wound infection is associated with longer duration of hospital stay in case of abdominal hysterectomy. The overall mortality rate is also higher for the abdominal group in comparison to the VH. While the maximum mortality rate has been found to be associated with abdominal hysterectomy, least mortality rate has been found to be associated with LAVH.

Mean duration of surgery has been found to be significantly longer for LAVH when compared with VH and TAH.[21] This, again is related to operator inexperience. Both vaginal and abdominal hysterectomies are associated with reduced operative time in comparison to LAVH, thereby resulting in reduced healthcare costs. On the other hand, hospital stay for VH and LAVH are similar, both of which are significantly shorter in comparison to abdominal hysterectomy.

In summary, VH has been found to be associated with the quickest operating time, fewer complications, smaller duration of hospital stay and the lowest healthcare costs. Moreover, VH is associated with a reduced rate of bowel complications, morbidity and mortality. Abdominal complications such as pain, discomfort and paralytic ileus are also reduced due to minimal handling of the bowel. The vaginal procedure is also associated with a reduced incidence of pulmonary complications (atelectasis, pneumonia, pulmonary embolism), and thrombophlebitis. Also, there is no abdominal scar or adhesion formation with the vaginal procedure. Overall, VH is better tolerated by elderly and high-risk patients resulting in a reduced risk for the development of hernia, adhesions and wound dehiscence.

From the above discussion, the balance for the most favorable procedure seems to tip in favor of VH.[22] The absence of prolapse is not a contraindication for vaginal route, nor is the presence of prolapse a prerequisite for the vaginal route. Only in cases where the vaginal route is not possible, should a surgeon consider LAVH or abdominal route. Whenever a hysterectomy is decided, every gynecologist must first consider using the vaginal route, which is the least invasive. Abdominal hysterectomy must be reserved only for cases where the vaginal route is contraindicated and LAVH is either difficult or risky. If the hysterectomy is possible by all the three routes in the best interests of the patient, the order of preference would be vaginal, LAVH followed by the abdominal route. The reason behind the reduced usage of LH in the clinical practice could be attributed to various factors such as insufficient experience and training and lack of hospital equipment.

Despite the above listed advantages, the main disadvantage associated with VH is that it cannot be performed in presence of certain complications. These include:

- Uterus greater than 12 weeks in size, with the uterine volume being greater than 250-300 cm^3
- Invasive cancer of the cervix
- Vesicovaginal fistula, rectovaginal fistula
- Inaccessible cervix: This could be due to the formation of dense adhesions between the uterine surface, the bladder and lower abdominal wall which make the cervix unapproachable by the vaginal route. This situation commonly occurs in cases where the woman has undergone uterine surgery in the past.
- Uterine pathology: Endometriosis with severe adhesions or presence of large uterine myomas or adenomyosis.

Presence of adhesions as a result of previous surgeries performed on the uterus such as cesarean section, myomectomy, etc. or endometriosis cannot be considered as a contraindication for VH, especially if the uterus is freely mobile with normal adnexae. In case of doubt, a laparoscopic evaluation or examination under anesthesia can be carried out to enable the surgeon to make the decision. Abdominal hysterectomy serves as a good choice in cases where the uterus is an abdominal organ or there is an associated adnexal pathology (e.g. presence of a malignancy) and there is a genuine need to visualize the abdominopelvic organs. According to the American Congress of Obstetricians and Gynecologists (ACOG) guidelines, LAVH must be performed in the cases requiring lysis of adhesions.[23] It may also be performed for treatment of pelvic endometriosis or uterine fibroids where it may be difficult to perform the ligation of infundibulopelvic ligaments, or removal of ovaries via the vaginal route. Laparoscopy may also help in the evaluation of pelvic or abdominal cavity before hysterectomy.

RETENTION OR REMOVAL OF OVARIES

The removal of ovaries along with the uterus can frequently result in significant physical strain and psychological stress. Thus, prior to the decision of hysterectomy, the gynecologist should have detailed discussion with the patient regarding the advantages and disadvantages of the surgical procedure, its impact on sexual feelings, fertility and bladder function, probable treatment of complications, the woman's expectations and issues related to menopause and their psychological impact. Removal of healthy ovaries should not be routinely undertaken during the surgery. Amidst all controversies, it appears rational to preserve the ovaries in premenopausal women if they are found to be healthy.[24,25] Removal of ovaries should only be undertaken with the express wish and consent of the woman and may be considered in the young women below 40 years of age with a significant family history of breast or ovarian cancer or those suspected of developing future ovarian malignancy. Ovaries may also be removed in the young premenopausal women below 40 years of age, where they appear to be diseased due to an inflammatory process or are involved with a neoplastic condition. While performing hysterectomy in women beyond 45 years of age, most surgeons prefer to remove the ovaries.

Retention of the ovaries is associated with the following advantages:

- Menopausal symptoms are reduced in intensity.
- Ovarian function continues till the expected time of spontaneous menopause, thereby reducing the incidence of early osteoporosis and atherosclerosis.

However, the retention of ovaries at the time of hysterectomy may result in the following disadvantages:

- Development of malignancy or benign neoplasm in future
- Development of residual ovarian syndrome, chronic pelvic pain and dyspareunia and a requirement for a repeat laparotomy in future.

CONCLUSION

There has been a continuing debate regarding whether the uterus should be removed vaginally or through the abdominal route. The advent of LAVH has further ignited this debate. The common dictum to be followed is that all uteri that can be removed vaginally can also be removed by either abdominal route or LAVH. However, the reverse of this situation does not hold true.

In the present scenario, VH can be considered as the procedure of choice because it is associated with a shorter duration of hospital stay and the lowest rate of complications at the lowest cost. LAVH can be considered as an alternative to abdominal hysterectomy. It is associated with shorter duration of hospital stay and reduced analgesic requirements. At the same time, there is a higher rate of complications (such as bladder injuries) and increased operative time in comparison to the vaginal hysterectomy. However, these problems associated with LAVH are likely to get alleviated as the surgeons gain more and more experience in the use of this procedure.

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CHAPTER

Surgery for Infertility

INTRODUCTION

Infertility is defined as the inability to conceive even after trying with unprotected intercourse for a period of 1 year for couples in whom the woman is under 35 years, and 6 months of trying for couples in whom the woman is over 35 years of age. Infertility commonly results due to the diseases of the reproductive system, either in males or in females, which inhibits the woman's ability to conceive and deliver a child. Approximately 6.1 million people in the United States or around 10–15% of the individuals belonging to the reproductive age group are affected by infertility. Approximately one in six couples are infertile, and there are a number of factors, both male and female that can cause the condition. In fact, in around 50% of cases the cause is attributed to the female (35% due to pelvic and tubal pathology and 15% due to ovulatory dysfunction; in 35% to the male; in 5% the cause can be attributed to unusual causes and in remaining 10% of cases the causes are unknown.[1] In this chapter the surgical treatment of tubal factor infertility would primarily be discussed. Use of various assisted reproductive techniques for treatment of an infertile couple are discussed in Chapter 26. The evaluation for infertility must focus on the couple as a whole and not on one of the partners. Both the partners must be encouraged to attend the clinic at the time of each appointment.

OVERVIEW OF SURGERY

Increase in the incidence of sexually transmitted pelvic infections such as *Chlamydia trachomatis*, *Neisseria gonorrhoeae* and *Mycoplasma hominis* has led to an increase in the incidence of both tubal factor infertility and tubal pregnancy in the past few decades.[2] In the past, reconstructive tubal surgery was the only option available for infertile women with damaged fallopian tubes. However, with the advent of in vitro fertilization (IVF) and assisted reproductive technology (ART) now, this is no longer the case. Currently, the two main treatment options available for treatment of infertility related to tubal factors are: (1) reconstructive surgery and (2) IVF. Presently, a combined laparoscopic and hysteroscopic examination has become the gold standard investigation for the evaluation of cases of infertility. Nowadays, several hysteroscopic and laparoscopic therapeutic procedures are being utilized for treatment of various pathologies which may be responsible for causing infertility.

AIMS OF SURGERY

The main indication for surgical treatment is the tubal factor infertility. The choice of treatment is dependent on various factors. In case of a woman with inoperable fallopian tubes or presence of a concomitant factor responsible for infertility, IVF may serve as the only practical treatment option. Reconstructive tubal surgery may appear to be a more reasonable treatment option for patients in whom surgical treatment is likely to improve their fertility or increase the success rate of an IVF cycle. In case, the reconstructive surgery proves to be unsuccessful, IVF may be tried as the only treatment option to achieve pregnancy. Hysteroscopic and laparoscopic surgery is increasingly being utilized for treatment of various pathologies, which may be responsible for causing infertility.

SURGICAL EQUIPMENT USED

Microsurgery can be used both at the time of endometriotic surgery as well as tubal reconstruction surgery. This surgery aims at the surgical reconstruction and restoration of the anatomical relationship between the tubes and the ovaries.[3] As the name implies, microsurgery refers to surgery, which is performed under magnification. Microsurgery is based on the following principles:[4]

- *Minimal damage to the tissues*: The tissues must be delicately handled at the time of surgery. Heparinized Ringer's lactate solution must be used for intraoperative irrigation. This helps in keeping the mucosal surfaces moistened and in preventing desiccation.
- *Accurate hemostasis*: If proper and complete hemostasis is not achieved, it can result in the development of intraperitoneal adhesions. Instruments, such as bipolar cautery, CO_2 laser, etc., help in attaining perfect hemostasis.
- Prevention of the foreign body contamination of the peritoneal cavity
- Identification of proper planes of cleavage
- Complete excision of abnormal tissues
- Proper alignment and approximation of the tissue planes
- Use of magnification for identification of abnormal morphological changes and recognition of any area of surgical damage
- Use of fine microsurgical instruments and suture materials
- Performing a thorough pelvic lavage at the time of closure of peritoneal cavity to remove any blood clots, debris, etc.

Use of magnification and microsurgical instruments and sutures help the surgeon to recognize even minor tubal abnormalities. The application of microsurgery to the tubal surgery procedures has greatly helped in improving outcome. Microsurgical techniques are equally applicable with both laparotomy and laparoscopy.[5] When laparotomy is used for gaining access to the pelvis, magnification can be obtained by the use of an operating microscope.

Hysteroscopic and laparoscopic equipments have been described in details in Chapters 31 and 32 respectively.

INDICATIONS

Indications for Surgery

The indications for tubal surgery are as follows:

- Tubal factor infertility (as an alternative to IVF)
- In patients with endometriosis presenting with infertility (detailed discussion regarding the various surgical procedures used for the treatment of endometriosis has been done in Chapter 27).

Indications for Using Hysteroscopy

Diagnostic

- Used as a routine procedure in patients prior to undergoing ART: Hysteroscopic dilatation of the cervical canal prior to in vitro fertilization-embryo transfer (IVF-ET) results in easier ET and improved pregnancy rate in patients with cervical stenosis and history of difficult ET.[6,7]
- Patients having an abnormal result on hysterosalpingography or sonohysterography
- Patients with infertility associated with Asherman's syndrome (related to abdominal tuberculosis, pelvic inflammatory disease, etc.)
- Women presenting with secondary infertility due to recurrent abortions.

Therapeutic

- Effective removal of submucous fibroids, endometrial polyps and polypoidal endometrium
- For performing tubal cannulation (fallopian tube recanalization) and reversal of the tubal block
- Diagnosis as well as treatment of various Müllerian anomalies such as septate, subseptate or bicornuate uterus
- Hysteroscopic adhesiolysis in cases of Asherman's syndrome
- Management of severely stenosed cervix
- Removal of a foreign body from the uterine cavity
- Hysteroscopic embryo transfer.

Indications for Using Laparoscopy

Diagnostic

- Assessment of tubal patency (laparoscopic chromopertubation)
- Identification of pelvic pathology
- *Salpingoscopy*: This is a transfimbrial approach allowing visualization from the ampullary-isthmic junction to the fimbriae, thereby enabling the visualization of the tubal lumen.[8]

Therapeutic

Ovarian factor: Treatment for ovarian factor infertility can include the following procedures:

- Polycystic ovary syndrome—Ovarian drilling[9]
- Endometriosis—Ablation
- Ovarian cysts—Excision or cystectomy.

Tubal factor: Treatment for tubal factor infertility can include the following procedures:[10]

- Distal tubal occlusion—Fimbrioplasty, neosalpingostomy
- Proximal tubal obstruction—Transcervical tubal recanalization, reversal of sterilization.

Uterine factor: Treatment for uterine factor infertility can include the following procedures:

- Asherman's syndrome—Adhesiolysis
- Congenital anomalies—Metroplasty, excision of rudimentary horn[11]
- Fibroids—Myomectomy.

Ovarian factor: Treatment for ovarian factor infertility can include the following procedure:
- Adnexal adhesions—Adhesiolysis.[12]

PREOPERATIVE PREPARATION

The preoperative care comprises of the following steps:
- *Preoperative investigations*: Investigations for various factors for infertility are important prerequisites before undertaking any kind of treatment. The various investigations, which must be performed prior to surgery include the following:
  - Routine blood hemogram
  - X-ray chest
  - Husband's semen analysis
  - Endometrial biopsy to rule out endometrial tuberculosis
  - Hysterosalpingogram or laparoscopy with chromotubation to confirm the tubal blockage.
  - Other tests, which can be performed to assess tubal function include selective salpingography and tubal cannulation, salpingoscopy, falloposcopy, laparoscopy, etc.
- *Counseling*: The woman and her partner must be counseled prior to the surgery. They must be explained in details about the procedure along with the likely rate of success. The provision of accurate information by the gynecologist enables the couple to make the correct decision, whether they want IVF or tubal reconstructive surgery. The other factors, which need to be taken into consideration include age, cost and the wishes of the couple. In women with advanced reproductive age due to a marked decline in fecundity, the option of reconstructive surgery may appear to be more appropriate because it offers the option of multiple cycles during which the conception can occur. Therefore, the younger women must be given the option of surgery first and then IVF if the surgery fails. While in older women (37-40 years), IVF must be offered as the first option and reconstructive surgery as the second option in case the first one fails. Women above the age of 35 years must be counseled about their reduced fertility and an increased risk of fetal abnormalities.

SURGICAL STEPS

The procedures, which would be discussed include salpingo-ovariolysis, fimbrioplasty, salpingostomy and tubotubal anastomosis (for reversal of sterilization) for repair of proximal tubal disease. Surgery for endometriosis would be discussed separately in Chapter 27.

SALPINGO-OVARIOLYSIS

Pelvic inflammatory disease can result in the development of pelvic and peritoneal adhesions. Since periadnexal adhesions can commonly occur in coexistence with other types of tubal diseases, salpingo-ovariolysis has become an integral part of other reconstructive procedures as well. When salpingo-ovariolysis is performed using a laparotomy approach, lysis of adhesions can begin by defining the distal margins of the adhesions.[13] In order to avoid damage to the adjacent peritoneum, it is important to divide adhesions layer by layer by cutting one layer at a particular time.

Before cutting the adhesions, it is important to enter between the two layers and expose the demarcation between the adhesion and the mesothelium of the adjacent structure. Each layer of adhesion is stretched using a toothed forceps, the line of demarcation identified and the adhesions are then transected.

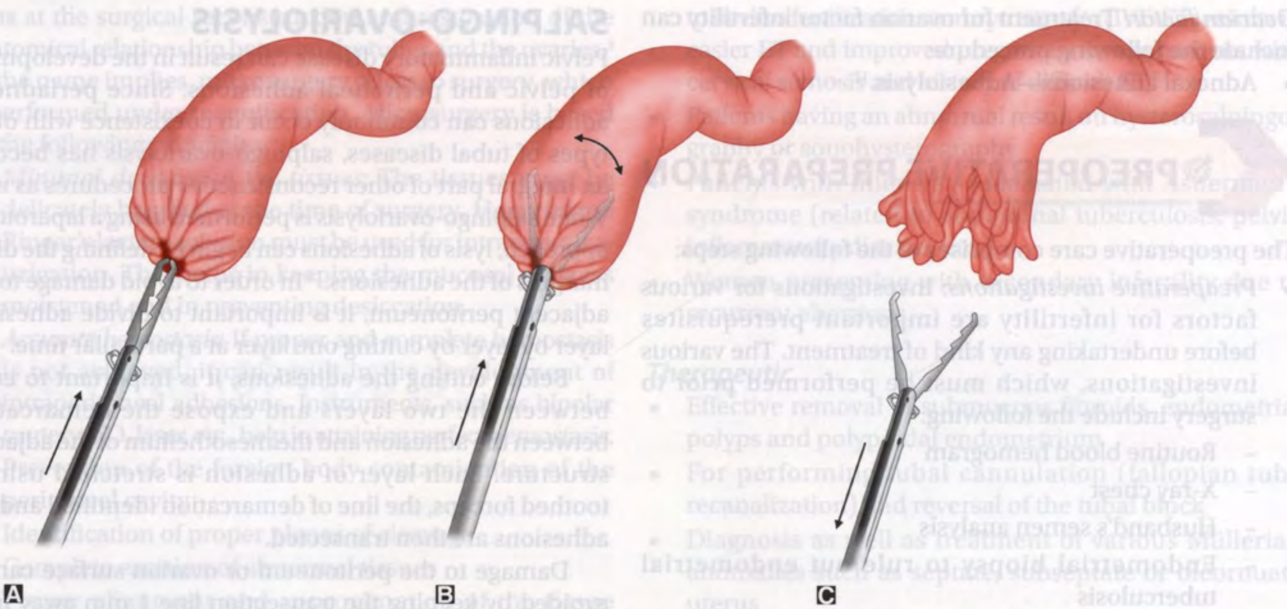
Damage to the peritoneum or ovarian surface can be avoided by keeping the transection line 1 mm away from the surface. Electrocoagulation of prominent vessels along the transection line is performed. The broad ligaments are excised and removed from the pelvis.[14] Usually, a laparotomy is not performed solely for the purpose of salpingo-ovariolysis. The procedure of adhesiolysis is usually performed at the time of diagnostic laparoscopy.

FIMBRIOPLASTY

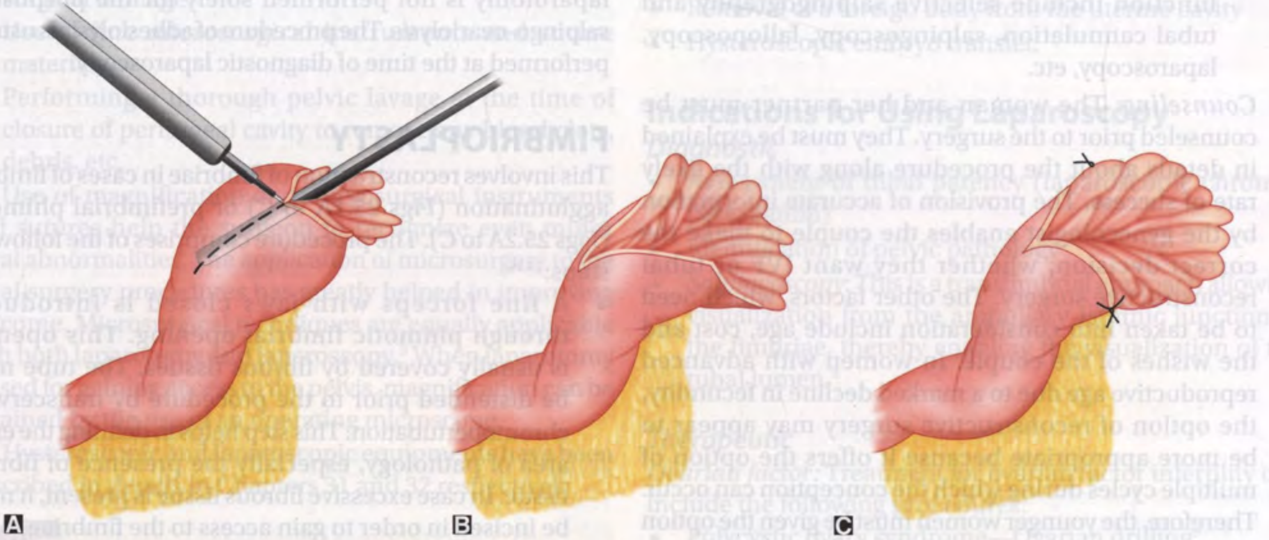
This involves reconstruction of fimbriae in cases of fimbrial agglutination (Figs 25.1A to C) or prefimbrial phimosis (Figs 25.2A to C). The procedure comprises of the following steps:[15,16]
- A fine forceps with jaws closed is introduced through phimotic fimbrial opening. This opening is usually covered by fibrous tissues. The tube must be distended prior to the procedure by transcervical chromopertubation. This step helps in defining the exact area of pathology, especially the presence of fibrous tissue. In case excessive fibrous tissue is present, it must be incised in order to gain access to the fimbriae.
- Deagglutination is achieved by opening the jaws of the forceps within the tubal lumen and then gently withdrawing the forceps. This movement is then repeated several times.

SALPINGOSTOMY

This involves creation of a new stoma in a tube with a completely occluded distal end (Figs 25.3A to E). Often, presence of adhesions in these cases may require the performance of a salpingo-ovariolysis first. The occluded terminal end of tube is inspected under magnification which helps in the identification of the relatively avascular zones radiating from a central punctum. Using a microelectrode or a microsurgical scissors, an incision is made over this central point and then extended towards the ovary in



Figs 25.1A to C: Deagglutination of the fimbriae: (A) Introduction of an alligator jawed forceps through the stenosed opening; (B) Opening of the jaws of forceps within the tube; (C) Withdrawing the forceps gently while keeping the jaws open



Figs 25.2A to C: Correction of prefimbrial phimosis: (A) Placing an incision along the antimesosalpingeal border of the tube; (B) Extending the incision; (C) Everting the flaps

accordance with the avascular line until a satisfactory stoma is created.[17-24]

The flaps, which have been created are then everted by securing them to the ampullary seromuscularis using interrupted no. 8-0 Vicryl sutures.

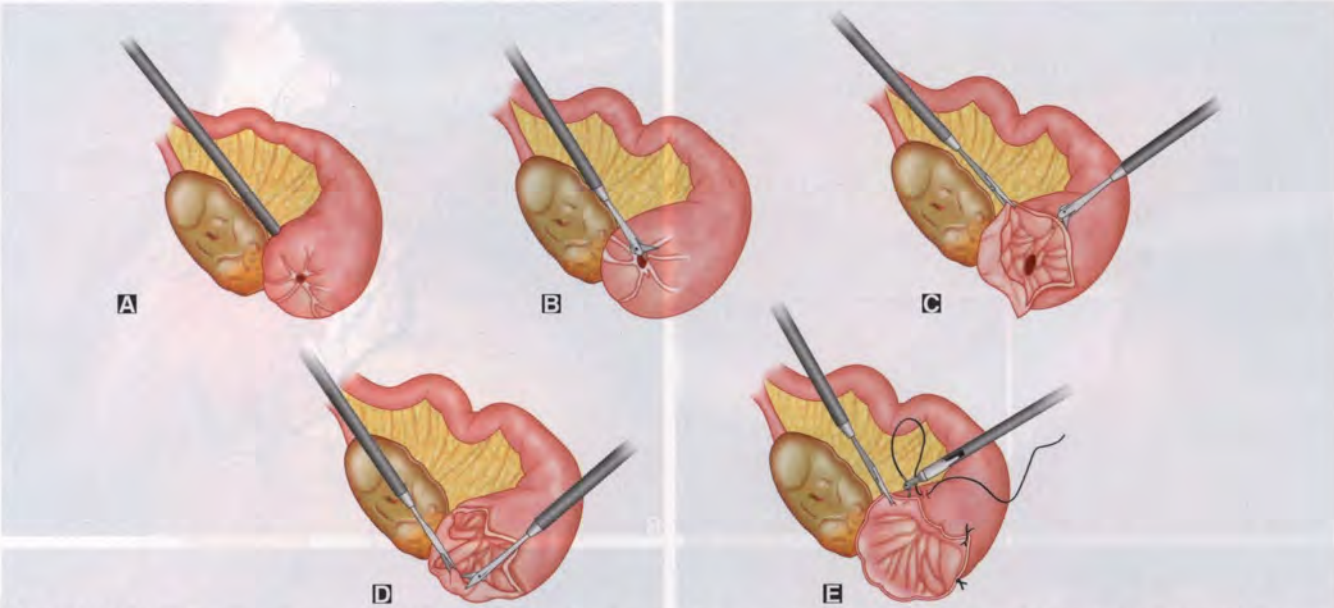
TUBOTUBAL ANASTOMOSIS

This anastomosis is usually performed to reverse the previous tubal sterilization or for reconstruction of tubes after removal of lesions, which are occlusive and affect the tube at sites other than the fimbriated end.[25-27] Depending upon the tubal segments that are approximated, tubotubal anastomosis can be intramural-isthmic, intramural-ampullary, isthmic-isthmic, isthmic-ampullary or ampullary-infundibular.[28,29]

Procedure

The procedure comprises of the following steps (Figs 25.4A to F):

- The surgery is performed under general anesthesia.
- Bladder catheterization is performed.
- A no. 14 Foley's catheter is inserted inside the uterine cavity and the bulb is inflated. The catheter is then withdrawn to fix the inflated bulb at the ectocervix.

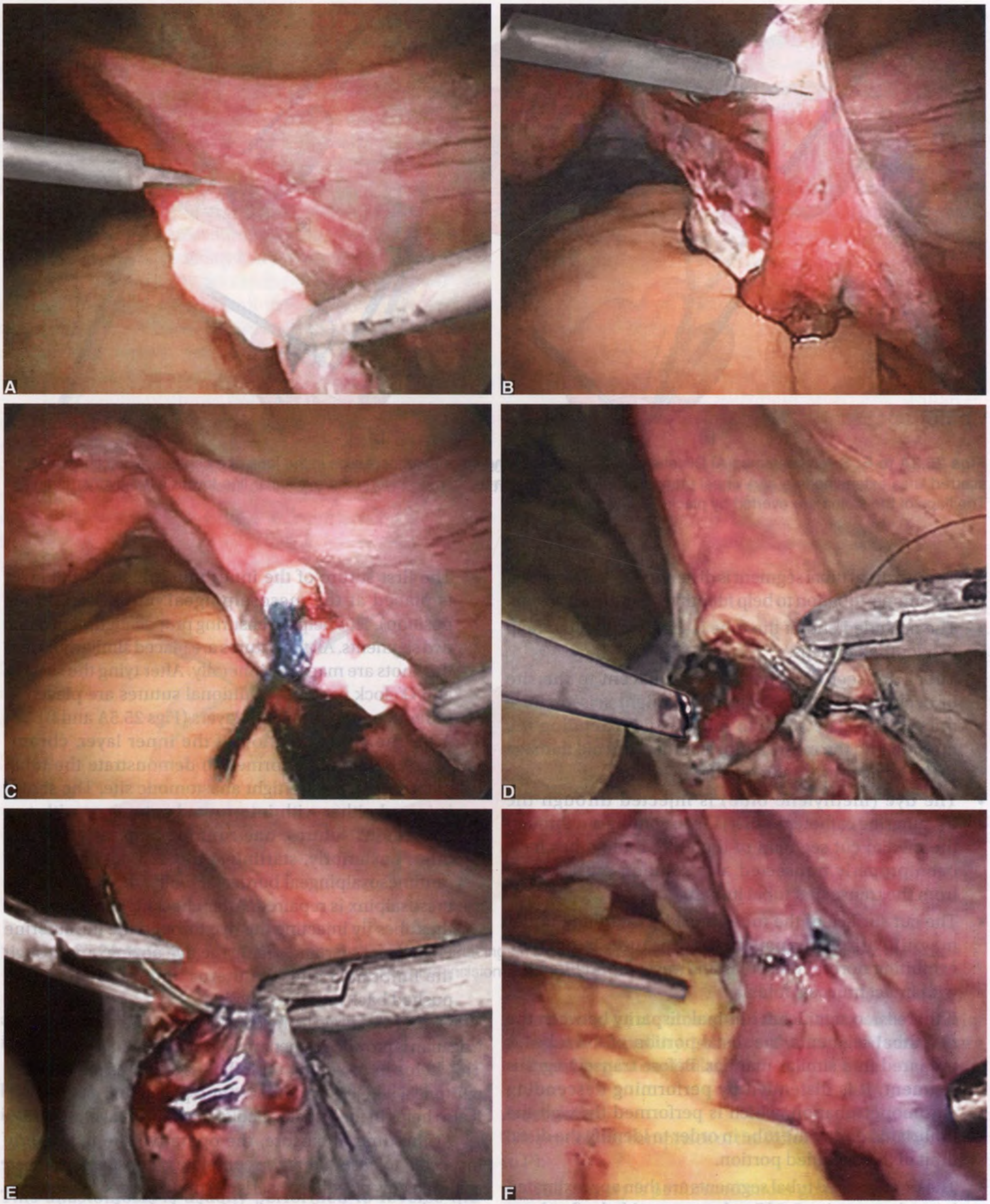


Figs 25.3A to E: Salpingostomy: (A) Distal end of the tube showing the area of occlusion in the form of a centrally avascular area with scarred lines extending in a cart-wheel manner; (B and C) Incision being made along the avascular line towards the ovary; (D and E) The flaps of the stoma are everted by placing a few sutures

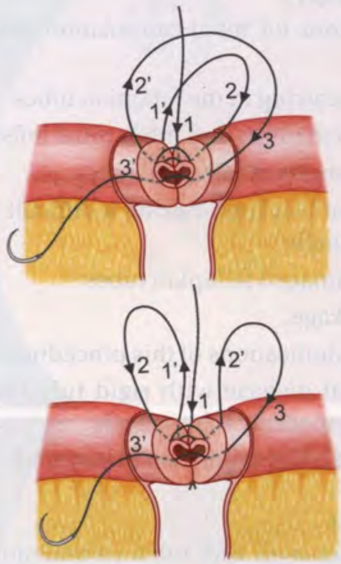
- The proximal tubal segment is distended by transcervical chromopertubation to help identify the site of occlusion.
- The occluded end of the tube is grasped with the help of a toothed forceps.
- Tubal transection is performed adjacent to the site of occlusion with the help of a straight scissors or a microblade. The surgeon must avoid extending the incision into the mesosalpinx in order to avoid damage to the adjacent vascular arcade.
- The dye (methylene blue) is injected through the intrauterine catheter until it is seen coming out through the medial cut segment of the tube. If the tubes have been properly transected, dye solution must escape from the transected tubal lumen.
- The cut surface of the tubes must be examined under magnification to ensure that the tube is normal, exhibiting normal muscular and vascular architecture with intact mucosal folds.
- If there is no significant luminal disparity between the two tubal segments, the distal portion of the tubes is prepared in a similar manner. Before transecting this segment, it is distended by performing descending chromopertubation, which is performed through the fimbriated end of the tube in order to identify the distal limit of the occluded portion.
- The two prepared tubal segments are then approximated in two layers using 8-0 Vicryl sutures, with the first layer joining the epithelium and muscularis and the second layer joining the serosa.
- The first suture of the inner musculoepithelial layer is placed at the mesosalpingeal border (6 O'clock position). This helps in ensuring proper alignment of the two segments. All the sutures are placed similarly so that the knots are made peripherally. After tying the sutures at 6 O'clock position, additional sutures are placed in order to appose the inner layers (Figs 25.5A and B).
- After the approximation of the inner layer, chromopertubation is performed to demonstrate the tubal patency and a watertight anastomotic site. The serosa is joined either with interrupted sutures or with two continuous sutures, one running anteriorly and the other posteriorly, starting at the 12 O'clock position (antimesosalpingeal border). Finally, the defect in the mesosalpinx is repaired. After checking the patency of the tubes by injecting the dye through the intrauterine Foley's catheter and seeing the dye oozing out through the fimbriated end, the uterus and tubes are gently pushed back into the pelvis.

During the surgical procedure, continuous intraoperative irrigation is provided by heparinized lactated Ringer's solution. This helps in providing periodic irrigation of the exposed peritoneal surfaces and ovaries and preventing desiccation. It also helps in the visualization of the individual bleeders.

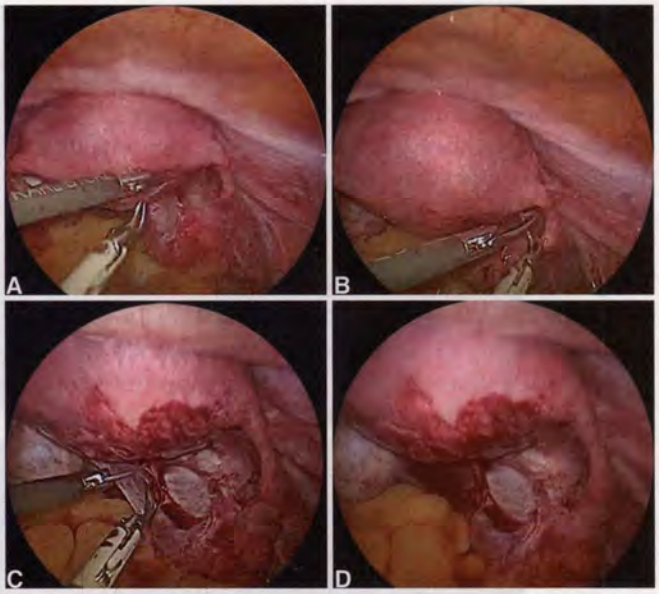
At the time of closure, the operative site is properly inspected to ensure that the complete hemostasis has been achieved. Any bleeding vessel is electrodesiccated. A thorough pelvic lavage is performed with the help of an irrigation solution until the irrigated fluid remains clear. This helps in removing blood clots or debris from the peritoneal cavity.



Figs 25.4A to F: Steps of tubotubal anastomosis: (A) Grasping the portion of the tube in which tubal ligation had been performed; (B) Transecting the blocked portion of the tube; (C) Chromopertubation performed to check the patency of the proximal segment; (D) Stitching the cut segments; (E) Stitching the cut at the ends of the tube; (F) Appearance of tube following the completion of recanalization procedure



Figs 25.5A and B: (A and B) Tubotubal anastomosis: placement of sutures using a single strand of sutures as a continuous series of loops



Figs 25.6A to D: Laparoscopic salpingo-ovariolysis

In case the periadnexal adhesive disease is the only pathology present, laparoscopic salpingo-ovariolysis at the time of initial diagnostic laparoscopy appears to be the most feasible option (Figs 25.6A to D). Fimbrioplasty may be required in cases of fimbrial phimosis or agglutination of the fimbriae. This procedure can be performed via laparoscopic route. Distal tubal occlusion or hydrosalpinx can be removed surgically. Salpingostomy involves creation of a new stoma in a fallopian tube with complete distal tubal occlusion. The rate of live birth following microsurgical salpingostomy ranges from 20% to 37%.[30] The results of microsurgical salpingostomy are much less in comparison with other tubal surgical procedures. In case of patients undergoing reversal of tubal sterilization, the available tubal segments are usually normal. In these cases, the microsurgical anastomosis helps in achieving an anatomically normal, but a shortened fallopian tube. As a result, the outcome of the procedure is usually good with the rate of intrauterine pregnancy being as high as 70–75% and most of the pregnancies occurring within 1–2 years of surgery.[31]

HYSTEROSCOPIC TUBAL CANNULATION

Hysteroscopic tubal cannulation can be useful in cases of proximal tubal blocks. This procedure serves as a diagnostic as well as a therapeutic procedure. The major impediments towards successful tubal cannulation include stenotic internal uterine ostium, presence of cornual polyps, synechiae, adhesions etc. Proximal tubal occlusion is responsible for nearly 25–30% cases of tubal pathology.

The previously used conventional methods for assessment of tubal patency, such as hysterosalpingography or laparoscopic chromopertubation, did not allow differentiation between an insufficient filling of the tubes, tubal spasm or a true mechanical obstruction. The selective tubal cannulation technique with hysteroscopic guidance is highly useful in the diagnosis of tubal patency. This helps in the confirmation of partial or total proximal tubal disease.[32] If one or both tubes are not found to be patent during laparoscopy, selective tubal insufflation is performed with the help of hysteroscopic cannulation. This procedure helps in precisely differentiating between the diagnoses of the tubal obstruction due to the presence of a true pathology or simple functional blockage or blockage secondary to tubal spasm. Moreover, this procedure also works as a therapeutic procedure by allowing the lysis of lax adhesions and the removal of the amorphous material, which obstructs the tube and permitting tubal catheterization.

In about 50% of the infertile patients with proximal tubal block, the occlusion may be as a result of tubal plugs formed due to the accumulation of amorphous material. Remaining 50% of the patients have true pathological block. Until the recent past, laparotomy with microsurgical reconstruction was the only treatment of choice for overcoming proximal tubal occlusion. Though tubal reconstruction and tubocornual anastomosis through microsurgery is associated with successful pregnancy rate of nearly 57%, it is a prolonged surgery which is associated with significant postoperative morbidity, and prolonged hospital stay. Following the introduction of operative hysteroscopy, hysteroscopic cannulation for proximal tubal occlusion has nowadays become a lucrative option.

Laparoscopy must be done simultaneously at the time of proximal tubal cannulation to confirm the status of the distal fallopian tubes. Diagnostic laparoscopic survey of the pelvic cavity helps in ruling out pathologies like tubo-ovarian adhesions, etc. It also helps in the evaluation of distal tubes. Only if the distal tubes appear normal, hysteroscopic cannulation should be performed because diseased distal tubes are associated with poor outcome of the hysteroscopic cannulation.

Procedure

The procedure of hysteroscopic cannulation is illustrated in Figures 25.7A to G and comprises of the following steps:

- After dilating the cervix with no. 8 Hegar's dilator, the operating channel with the 4-mm hysteroscope is introduced inside the uterine cavity with continuous flow of saline to distend the uterine cavity.
- One-sided tubal ostium is identified and the tip of the hysteroscope is brought in near proximity to the ostium. Simple cannula with the guidewire inside is then introduced through the operating channel.
- The tip of the cannula is advanced near the ostium under constant hysteroscopic visualization. Guidewire is then advanced into the ostium for about 1–1.5 cm to negotiate the intramural portion of the tube.
- After introduction of the guidewire into the intramural portion, the cannula is railroaded over the guidewire to fix the tip of the cannula into the proximal part of the intramural portion. Guidewire is then removed and 10 mL of methylene blue dye is injected through the proximal portion of the cannula. Simultaneous visualization by laparoscopy can identify the exit of the dye through the fimbrial end of the tube. Cannula is then removed and the same procedure is repeated on the other side.

Advantages

- Hysteroscopic tubal cannulation not only serves as a diagnostic procedure, but also serves as a therapeutic procedure, thereby permitting the lysis of lax adhesions and removal of amorphous material, facilitating catheterization.
- The procedure allows differentiation between the spasm of the tube, true pathological block and the functional block.
- It is associated with low cost and low rate of complications.
- It provides valuable information about the proximal and distal tubes.

Results

With the help of hysteroscopic cannulation, recanalization is achieved in 80–90% of tubes, and pregnancy rates are in the range of 40%.[33] Compared to hysterosalpingography, the procedure gives better results and is minimally invasive. The rates of ectopic pregnancy are also much lower in comparison to tubal microsurgery.

Contraindications

Contraindications for tubal cannulation may include the following:

- Extensive scarring in the fallopian tubes
- Genital tuberculosis and other tubal infections
- Previous surgery of fallopian tubes
- Severe tubal blockage making it difficult for a catheter to pass through
- Severely damaged fallopian tubes
- Distal blockage.

Relative contraindications of this procedure include:

- Distal tubal disease with rigid tubes as a result of infection, especially tuberculosis
- Presence of hydrosalpinx on ultrasound.

Complications

Some risks associated with tubal cannulation include the following:

- Failure to restore fallopian tube function
- Perforation of the fallopian tube wall
- Peritonitis.

POSTOPERATIVE CARE

The postoperative care is similar to any other laparoscopic or laparotomy procedure. In case the patient is unable to conceive even after 1 year of active intercourse following surgery, IVF is the only option which may help the patient conceive and this must be offered to her.

ADVANTAGES

Advantages associated with hysteroscopic and laparoscopic surgeries have been described in Chapters 31 and 32 respectively.

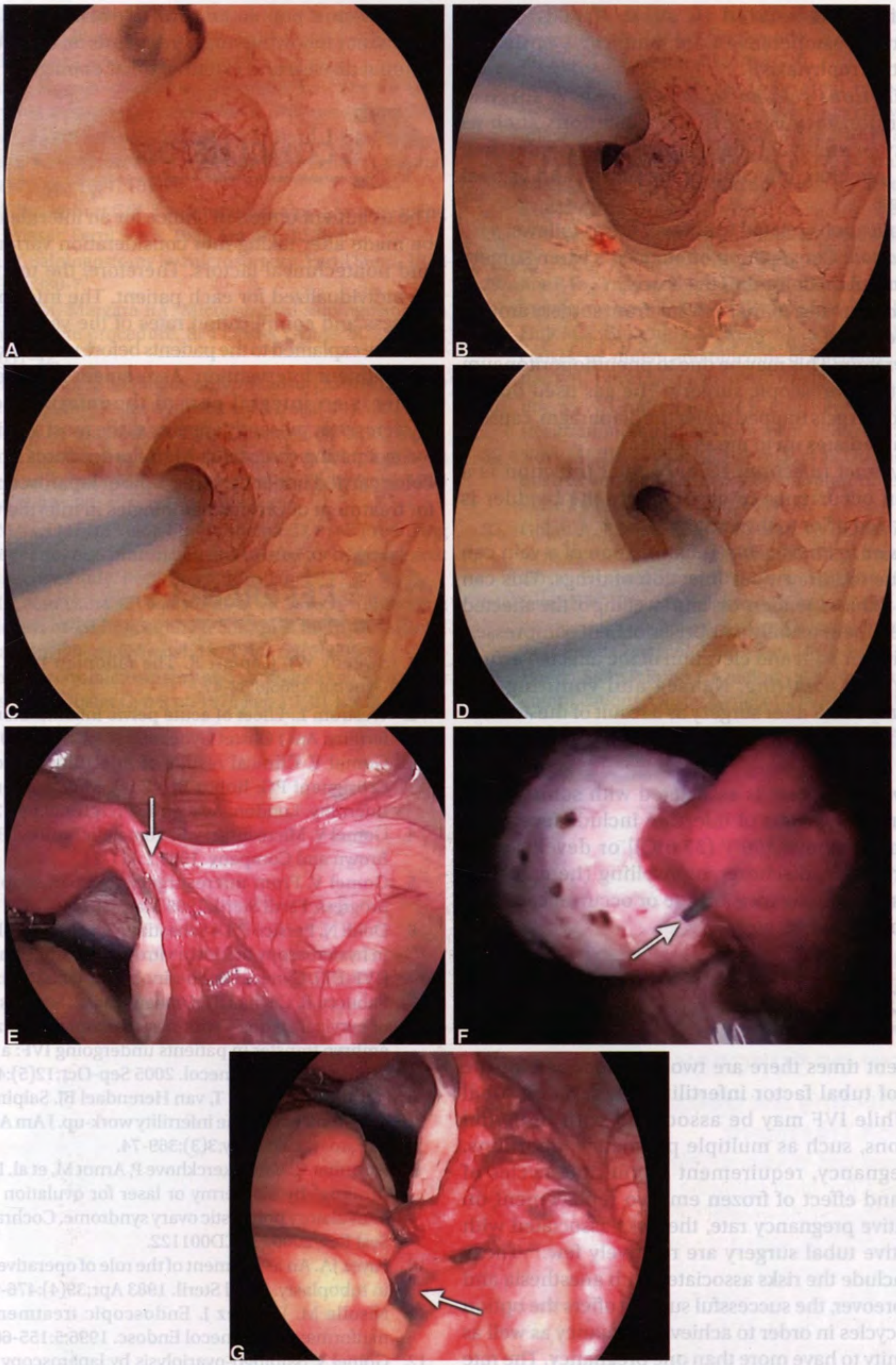
DISADVANTAGES

Disadvantages associated with hysteroscopic and laparoscopic surgeries have been described in Chapters 31 and 32 respectively.

COMPLICATIONS

The following complications can occur in relation to the previously mentioned surgical procedures for infertility:[34,35]

- Complications related to laparoscopy [refer to Chapter 32 (Diagnostic and Operative Laparoscopy)].



Figs 25.7A to G: Hysteroscopic tubal cannulation: (A) Right-sided tubal ostium is identified with the help of hysteroscope; (B) Simple cannula with the guidewire inside is introduced through the operating channel; (C) The tip of the cannula is then advanced near the ostium under constant hysteroscopic visualization; (D) Guidewire is advanced into the ostium to negotiate the intramural portion of the tube; (E and F) Appearance of tube and adnexa under laparoscopic visualization showing the advancement of hysteroscopically directed catheter via the fallopian tube out through the fimbrial end of the tube; (G) Dye seen ejecting out from the fimbrial end of the tube

- Complications related to anesthesia [refer to Chapter 4 (Postoperative Care, Surgical Asepsis and Antibiotic Prophylaxis)].
- *Complications related to laparotomy*: A surgical intervention may result in complications such as difficulty in emptying the bladder, wound infection, urinary infection, infection of the uterus and vaginal discharge.

Other complications related to surgery are as follows:

- *Constipation*: Constipation often occurs when surgery is performed on or around the bowel.
- *Diarrhea*: Diarrhea may also result from surgery around or on the bowel.
- *Shoulder pain*: This may be due to pneumoperitoneum related to laparoscopic surgery. The gas used during surgery often gets trapped under the diaphragm, causing pain that radiates up to the shoulder.
- *Urinary tract infection*: Urinary tract infection is a common occurrence in cases where the bladder is catheterized prior to the surgery.
- *Phlebitis or irritated veins*: Inflammation of a vein can occur due to intravenous injection of drugs. This can result in redness, tenderness and swelling of the affected arm. Treatment usually comprises of heat compresses, analgesics for pain and elevation of the affected arm.
- *Nausea and vomiting*: Nausea and vomiting can commonly occur after surgery as a result of the adverse effect of anesthetic medications and/or painkillers.
- Pain
- *Infection*: All surgery is associated with some risk of infection. Some signs of infection include fever [oral temperature above 100°F (37.8°C)] or development of any redness, discharge or swelling (hematomas, seromas, etc.) at the incision site or occurrence of discharge per vaginum, etc.

DISCUSSION

In the present times there are two main options for the treatment of tubal factor infertility, i.e. IVF and tubal surgery. While IVF may be associated with potential complications, such as multiple pregnancy, abortions, ectopic pregnancy, requirement of multiple cycles of treatment and effect of frozen embryo replacement on the cumulative pregnancy rate, the risks associated with reconstructive tubal surgery are relatively few.[23] These primarily include the risks associated with anesthesia and surgery. Moreover, the successful surgery offers the option of multiple cycles in order to achieve pregnancy as well as an opportunity to have more than one pregnancy. The rate of abortion following reconstructive surgery is same as that of the normal population. The rate of live birth and ectopic pregnancy following surgery depends on the specific nature of tubal disease and extent of tubal damage.

CONCLUSION

The treatment option of choice for an infertile couple must be made after taking into consideration various technical and nontechnical factors. Therefore, the treatment must be individualized for each patient. The information about success and complication rates of the various procedures must be explained to the patients before undertaking any kind of treatment intervention. Assessment of the endometrial cavity is an integral part of the infertility evaluation. Hysteroscopy presently appears as the most sensitive method for evaluating the cavity. Many procedures are nowadays being carried under hysteroscopic or laparoscopic guidance for treatment of various pathologies in infertile women.

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26

CHAPTER

In Vitro Fertilization

INTRODUCTION

The various techniques of in vitro fertilization (IVF) and its modifications are together termed as assisted reproductive techniques (ART). ART now accounts for nearly 1–3% of live births in the US and Europe. IVF is the result of scientific developments and advancements in the field of obstetrics and gynecology. In this process, the ovaries are stimulated by the use of fertility medicines, following which one or more oocytes are aspirated from the ovarian follicle. The fertilization of male and female gametes occurs in the laboratory after which one or more embryos are transferred inside the uterine cavity.

Following the first IVF pregnancy, which was reported by Steptoe and Edwards in 1976, more than 4 million pregnancies have been achieved worldwide due to IVF.[1,2]

OVERVIEW OF SURGERY

Factors Affecting the Outcome of In Vitro Fertilization Treatment

- *The woman's age*: Woman should be informed that the chances of a live birth following IVF treatment reduce with an increase in the woman's age and that the optimal female ages range for achieving a successful IVF treatment is 23–39 years. Chances of a live birth per treatment cycle are greater than 20% for women aged 23–35 years; 15% for women aged 36–38 years; 10% for women aged 39 years; 6% for women aged 40 years or older. IVF does not reverse the age-dependent decline in infertility in the older women, particularly those above the age of 40 years.[3]
- *Adequacy of ovarian reserve*: The success rate of IVF procedure can be predicted by the concentrations of follicle-stimulating hormone (FSH) and estradiol levels. High day 3 levels of FSH and estradiol serve as poor prognostic factors because they may be associated with rapid premature follicle recruitment and reduced oocyte numbers.[4]
- *Number of embryos to be transferred*: The more the number of embryos is transferred, greater would be the chances of success. However, in order to reduce the chances of multifetal gestation, number of embryos transferred has been limited to two at most of the IVF centers. The present trend is towards transferring a single high quality embryo.
- *Number of previous treatment cycles*: The chances of conception greatly reduce after three cycles of IVF.
- *Pregnancy history*: Treatment is more effective in women who have previously been pregnant and/or had a live birth.
- *Presence of hydrosalpinx*: This is associated with a poor outcome of the IVF procedure.
- *Alcohol, smoking and caffeine consumption*: Couples should be informed that maternal and paternal smoking can adversely affect the success rate of assisted reproduction procedures, including IVF treatment.[5]
- *Body mass index*: Women should be informed that a female body mass index (BMI) outside the normal range (19–30) is likely to reduce the success rate of assisted reproduction procedures.
- *Leiomyomas*: While the presence of submucosal myomas may reduce the success rate of IVF, the subserosal myomas do not appear to have any effect.
- *Previous history of unsuccessful IVF cycles*: Lack of success in the previous IVF cycle does not reduce the success rate during subsequent treatment cycles until approximately the fourth IVF cycle.

INDICATIONS

Indications for IVF include the following (Fig. 26.1):

- Tubal factor infertility (in case of completely blocked tubes, IVF serves as the primary therapy)[6]
- Damage/absence of fallopian tubes
- Uterine factor infertility (severe cases of Asherman's syndrome, irreparable distortion of the uterine cavity, etc.)
- Uterine malformations (e.g. unicornuate uterus)
- Severe pelvic adhesions
- Severe endometriosis, which is unresponsive to medical or surgical treatment
- Male factor infertility: Severe oligospermia or a history of obstructive azoospermia in the male partner (Intrauterine insemination can work in mild to moderate cases. However, in severe cases the primary therapy is IVF)
- Diminished ovarian reserve/premature ovarian failure
- Gonadal dysgenesis including Turner's syndrome
- Bilateral oophorectomy
- Ovarian failure following chemotherapy or radiotherapy.

All other cases of infertility where less invasive therapy has failed (e.g. endometriosis, ovulatory dysfunction, unexplained infertility).

PREOPERATIVE PREPARATION

Following steps must be undertaken prior to surgery:

- A complete evaluation of infertility (both male and female cause infertility) must be performed on both the partners before embarking upon surgery.
- Treatable causes of subfertility must be treated prior to initiating IVF.
- In the absence of any absolute indication for IVF (bilateral blocked tubes and severe male factor infertility), the couple must be offered 3–6 cycles of superovulation and intrauterine insemination before proceeding to IVF.
- Young couples having no obvious cause of infertility must be advised to have one complete year of unprotected intercourse and conventional therapy since 88% of the couples are expected to conceive within 1 year and a further 50% during the 2nd year. A shorter time period is preferred in older couples. Infertile couples where the woman is greater than 40 years of age may be offered IVF as the primary treatment option.
- Alternative treatment options must be considered first before resorting to IVF while counseling the woman with male factor infertility and tubal factor infertility (where tubes are not completely blocked).

SURGICAL STEPS

In vitro fertilization consists of retrieving preovulatory oocytes from the ovary and fertilizing them with sperms in the laboratory, with subsequent embryo transfer within the endometrial cavity. The procedure of IVF comprises of the following steps (Figs 26.2A to E):

- Ovarian stimulation for in vitro fertilization
- Follicular aspiration
- Oocyte classification
- Sperm preparation and oocyte insemination
- Embryo culture
- Embryo transfer.

OVARIAN STIMULATION FOR IN VITRO FERTILIZATION

The success of IVF is related to the patient's age and the number of embryos transferred into the endometrial cavity. Without the use of stimulating medications, the ovaries can

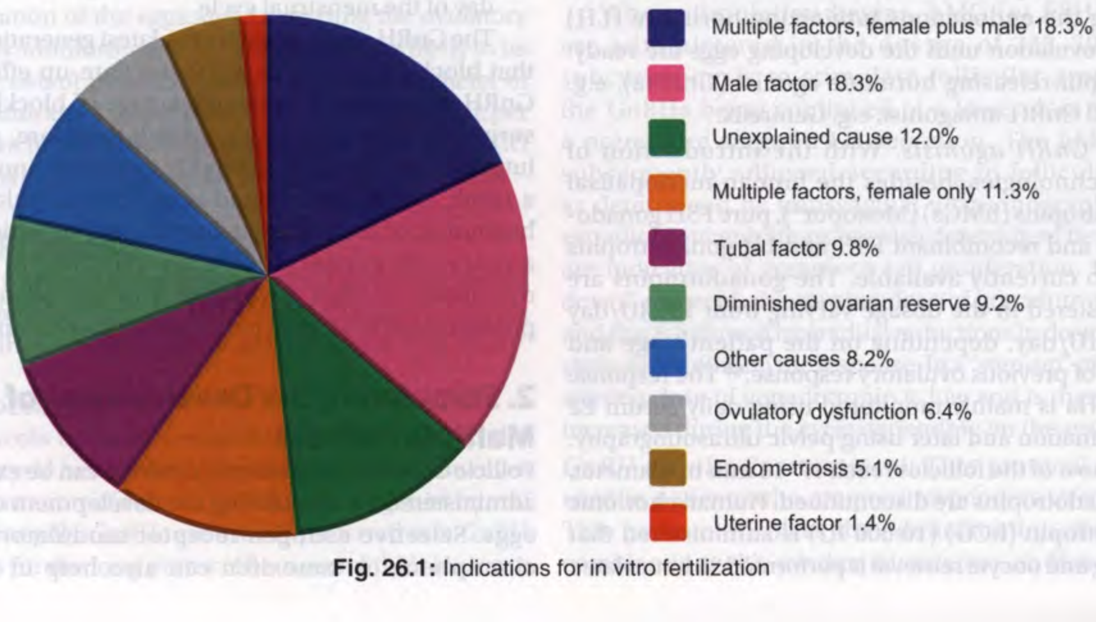
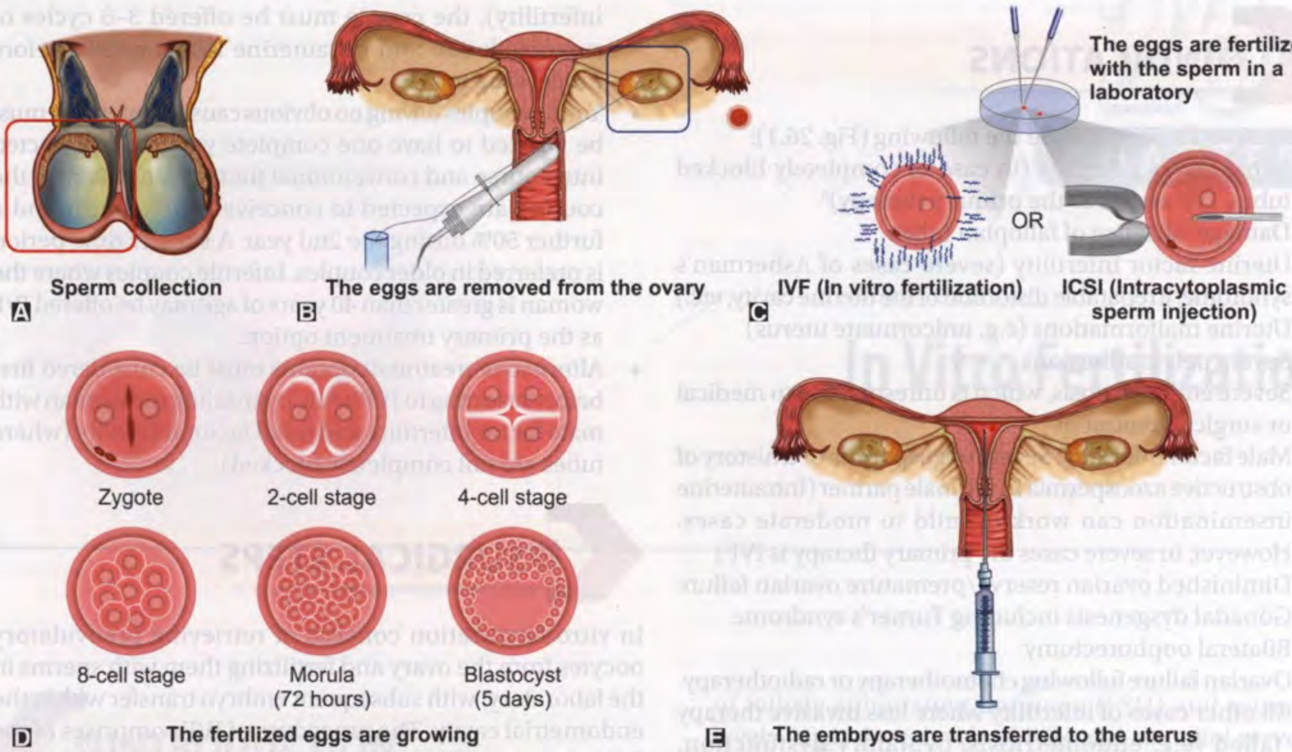


Fig. 26.1: Indications for in vitro fertilization



Figs 26.2A to E: The procedure of IVF. (A) Collection of sperms; (B) Retrieval of eggs from the ovary; (C) Fertilization of sperm with ovum in a laboratory; (D) Formation of an embryo; (E) Transfer of embryos inside the uterine cavity

create and release only one mature egg per menstrual cycle. Therefore, nowadays, most clinicians use ovarian stimulation strategies to obtain synchronous development of multiple follicles. The strategy of transferring multiple embryos at one time is likely to ensure that at least one of them implants and produces a live birth. IVF stimulation protocols generally involve the use of drugs for the three following purposes:[7]

1. Prevention of the Endogenous LH Surge

There are mainly two classes of medications used for preventing the endogenous luteinizing hormone (LH) surge and ovulation until the developing eggs are ready: gonadotropin-releasing hormone agonist (GnRHa), e.g. Lupron and GnRH-antagonist, e.g. Ganirelix.

1. *Use of GnRH agonists:* With the introduction of new technologies, besides the human menopausal gonadotropins (hMGs) (Menopur®), pure FSH gonadotropins and recombinant FSH and LH gonadotropins are also currently available. The gonadotropins are administered in the dosage varying from 150 IU/day to 450 IU/day, depending on the patient's age and history of previous ovulatory response.[8,9] The response to GnRHa is mainly monitored using daily serum E2 determination and later using pelvic ultrasonography. Once most of the follicles reach 17–18 mm in diameter, the gonadotropins are discontinued. Human chorionic gonadotropin (hCG) (10,000 IU) is administered that evening and oocyte retrieval is performed 35 hours later.
2. *Use of GnRH antagonists*: The GnRH antagonists can be used for ovulation induction in two protocols known as the flare-up protocol and the luteal-phase protocol. In the flare-up protocol, high doses of GnRH antagonists are administered during the early follicular phase of the cycle. The flare-up protocol has the advantage of causing transitory elevation of FSH, which occurs during the first 4 days of the follicular phase. This elevation helps in the follicular recruitment process. In the luteal-phase protocol, GnRH antagonist is started on the 17th or 21st day of the menstrual cycle.

The GnRH antagonists are the latest generation of drugs that block LH secretion without a flare-up effect. Use of GnRH antagonists has the advantage of blocking the LH surge at the periovulatory period; therefore, premature luteinization or spontaneous LH surge does not occur. As a result, the pituitary gland is not downregulated at the beginning of the menstrual cycle, due to which smaller amounts of gonadotropins are required to stimulate ovulation. Another advantage with this protocol is the prevention of ovarian hyperstimulation syndrome (OHSS).

2. Stimulating the Development of Multiple Follicles

Follicle-stimulating hormone products can be exogenously administered for stimulating the development of multiple eggs. Selective estrogen receptor modulators, such as clomiphene or tamoxifen can also help in achieving development of multiple follicles. These drug protocols are described as follows:

- *Clomiphene citrate protocol*: In the clomiphene citrate only protocol, clomiphene citrate is administered in the doses of 50–150 mg for 5–7 days, starting from the 2nd day of the menstrual cycle. The ovarian response is monitored using pelvic ultrasonography and serial determinations of serum E2 and LH levels. Oocyte retrieval must be performed within 24–26 hours after the LH surge. The advantages of the clomiphene citrate protocol include low cost and a very low risk of development of OHSS. The major disadvantages associated with this protocol include low oocyte yield (1–2 per cycle), high cancellation rate (25–50%) and low pregnancy rate.
- *Use of clomiphene citrate with hMG protocol*: The combination of clomiphene citrate and hMG protocol is also sometimes used. This has an advantage of increasing the number of recruited follicles.[10] The dose of clomiphene citrate is similar to that described above, while that of hMG is 150 IU, administered for a period of 2–7 days after the clomiphene citrate. Frequent monitoring with pelvic ultrasonography and daily determinations of E2 and LH levels are performed. When the follicle reaches a size of 17–18 mm, hCG (10,000 IU intramuscularly) must be administered in order to complete the oocyte maturation. Oocyte aspiration should be performed 35 hours after the hCG injection. The advantage of the combined protocol is an increase in the number of recruited follicles. The disadvantages of the protocol are premature luteinization, spontaneous LH surge (20–50%) and high cancellation rate (15–50%).
- *Use of hMG only*: The protocol comprising of hMGs only involves the administration of hMG for ovarian stimulation.

3. Initiation of Ovulation

Human chorionic gonadotropin is used for initiating the final maturation of the eggs and for starting the ovulatory cascade. It is administered when the follicles are likely to be mature (i.e. two or more follicles with a mean diameter of 18 mm or more and a serum estradiol level of 200 pg/mL per co-dominant follicle). Both urinary and recombinant hCG preparations and GnRHa can be used to trigger ovulation.[11]

Various Protocols

Depending on the time duration for which various ovulation inducing agents are administered, the stimulation protocols could be either long protocol or short protocol (Fig. 26.3).

Long Protocols

Long protocols involve commencing medications in the menstrual cycle before the IVF cycle. This usually involves the administration of either a GnRHa or antagonist or oral contraceptive pills. GnRHa are usually preferred over GnRH antagonists for the long protocol because of their low cost.

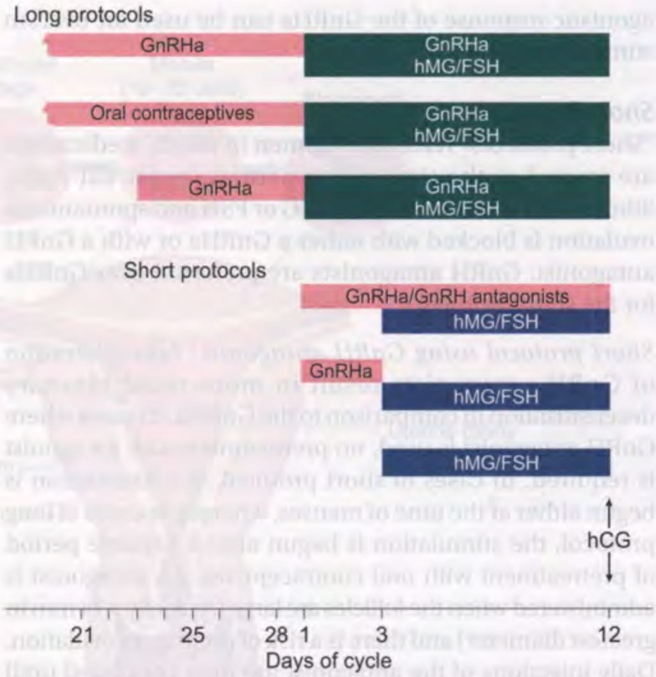


Fig. 26.3: Diagrammatic representation of short and long protocols
Abbreviations: FSH, follicle-stimulating hormone; hMG, human menopausal gonadotropin; GnRHa, gonadotropin releasing hormone agonist; GnRH, gonadotropin releasing hormone

Long protocol using GnRH agonist: In this the GnRHa is administered daily for about 2 weeks or until downregulation is complete. Administration of GnRHa helps in inhibiting the production of pituitary gonadotropins, thereby maximizing control of the cycle. Pituitary suppression of LH secretion helps in preventing the surge of endogenous LH prior to full maturation of the cohort of ovarian follicles. The most commonly used GnRHa in the United States is leuprolide acetate in the daily dosage of 0.5–1 mg subcutaneously. Measurement of estradiol levels (< 30 pg/mL) help in verifying the occurrence of downregulation.

When stimulation begins, hMG (or FSH), or both are administered in the dosage of 225–300 IU/day subcutaneously to stimulate follicular growth, with the GnRHa being continued at a lower dose to prevent a premature surge in LH secretion. The hMG dose is subsequently adjusted according to follicular growth as determined by transvaginal ultrasonography. Serum estradiol concentrations are also determined because they are indicative of granulosa cell proliferation. In a "step-down" protocol, the starting dose of gonadotropin is high and this is followed by gradual reductions in dose during the cycle depending on the response. In a "step-up" protocol, the starting dose of gonadotropin is low and is then gradually increased during the cycle depending on the response.

GnRH agonist flare protocol: This protocol is usually used in patients who are poor responders to stimulation. This protocol involves the administration of GnRHa in combination with ovarian stimulation, so that the initial agonistic response of the GnRHa can be used for ovarian stimulation.

Short Protocols

"Short protocols" refer to a regimen in which medications are started at the time of the natural menstrual cycle. Stimulation is achieved with hMG or FSH and spontaneous ovulation is blocked with either a GnRHa or with a GnRH antagonist. GnRH antagonists are preferred over GnRHa for the short protocol.

Short protocol using GnRH antagonist: Administration of GnRH antagonists result in more rapid pituitary desensitization in comparison to the GnRHa. In cases where GnRH antagonist is used, no pretreatment with an agonist is required. In cases of short protocol, the stimulation is begun either at the time of menses, whereas in cases of long protocol, the stimulation is begun after a variable period of pretreatment with oral contraceptives. An antagonist is administered when the follicles are large (typically > 14 mm in greatest diameter) and there is a risk of premature ovulation. Daily injections of the antagonist are then continued until hCG has been administered.

FOLLICULAR ASPIRATION

Oocytes are aspirated from the ovary 34-36 hours following administration of hCG. Initially all aspirations were performed under laparoscopic guidance. However now, follicular aspirations are commonly performed under ultrasonographic guidance, both transabdominal as well as transvaginal. The transvaginal route for follicular aspiration has presently become the preferred procedure in most IVF programs.

The procedure of follicular aspiration comprises of the following steps:

- The oocyte aspiration is usually performed under heavy sedation, while the patient has been placed in the dorsal lithotomy position. Some type of analgesia/anesthesia (most commonly, intravenous propofol) is commonly used.
- The vaginal wall is washed with saline, following which a 5-9 MHz ultrasonographic probe with a sterile cover and attached needle guide is inserted inside the vagina. This helps in localizing the ovaries and the follicles.
- A 17-gauge needle is subsequently passed via the needle guide through the vaginal fornix into the ovaries in order to aspirate the follicular fluid.
- Once the fluid has been aspirated out, it is sent to the IVF laboratory as soon as possible.

OOCYTE CLASSIFICATION

Following their aspiration, the oocytes are graded according to the appearance of the corona-cumulus complex. The presence of a polar body (metaphase II stage) and/or germinal vesicle (prophase stage) is a determining factor for the short preincubation time prior to the insemination. The degenerated oocytes are those which are atretic or have a fractured zona. The last category must constitute fewer than 15% of the total oocytes obtained.

SPERM PREPARATION AND OOCYTE INSEMINATION

A semen sample is obtained after a 3-5 days period of sexual abstinence immediately prior to the oocyte retrieval. The procedure of sperm preparation involves removal of certain components of the ejaculate (i.e. seminal fluid, excess cellular debris, leukocytes, morphologically abnormal sperms, etc.) along with the retention of the motile fraction of sperms. For most specimens, the motile portion of the sperms is separated via the process of centrifugation through a discontinuous density gradient system. The sperms are incubated for 60 minutes in an atmosphere of 5% carbon dioxide in air. Finally, the supernatant containing motile fraction of sperms is removed. Sperm concentration and motility are determined. A final number of 200,000 motile sperms in a small volume of culture media with a layer of mineral oil on top is added to the oocytes in order to achieve fertilization in vitro. The optimum number of hours for which the sperm and oocytes must be incubated has yet not been determined.

EMBRYO CULTURE

The inseminated oocytes are incubated in an atmosphere of 5% carbon dioxide in air with 98% humidity. Fertilization of the oocyte is confirmed when two pronuclei and extrusion of the second polar body can be observed within the zygote nearly 18 hours after insemination. The fertilized embryos are transferred into growth media and placed in the incubator. No further evaluation is performed over the next 24 hours. A 4-8 cell stage, pre-embryo is observed approximately 36-48 hours after insemination. Since the individual cells of each embryo or "blastomeres" divide every 12-14 hours, the embryo reaches an approximately 8-cell stage within 72 hours following the retrieval of the eggs.[12] Embryos between days 2 and 4 are called "cleavage stage embryos." The blastocyst stage is reached by about day 5 after retrieval (Fig. 26.4), and implantation is expected by day 7 after egg retrieval. The in vitro implantation of the fertilized embryo should therefore occur prior to this.

In the naturally occurring process of "hatching", an embryo expands and eventually breaks through the zona pellucida in order to implant on the surface of the endometrium. If this process is artificially simulated in vitro, it is known as "assisted hatching", which presently is a controversial procedure.[13,14] In this procedure, the zona pellucida is mechanically or chemically opened at about day-3 embryo stage to help the embryo in hatching from the zona and get implanted over the endometrium.

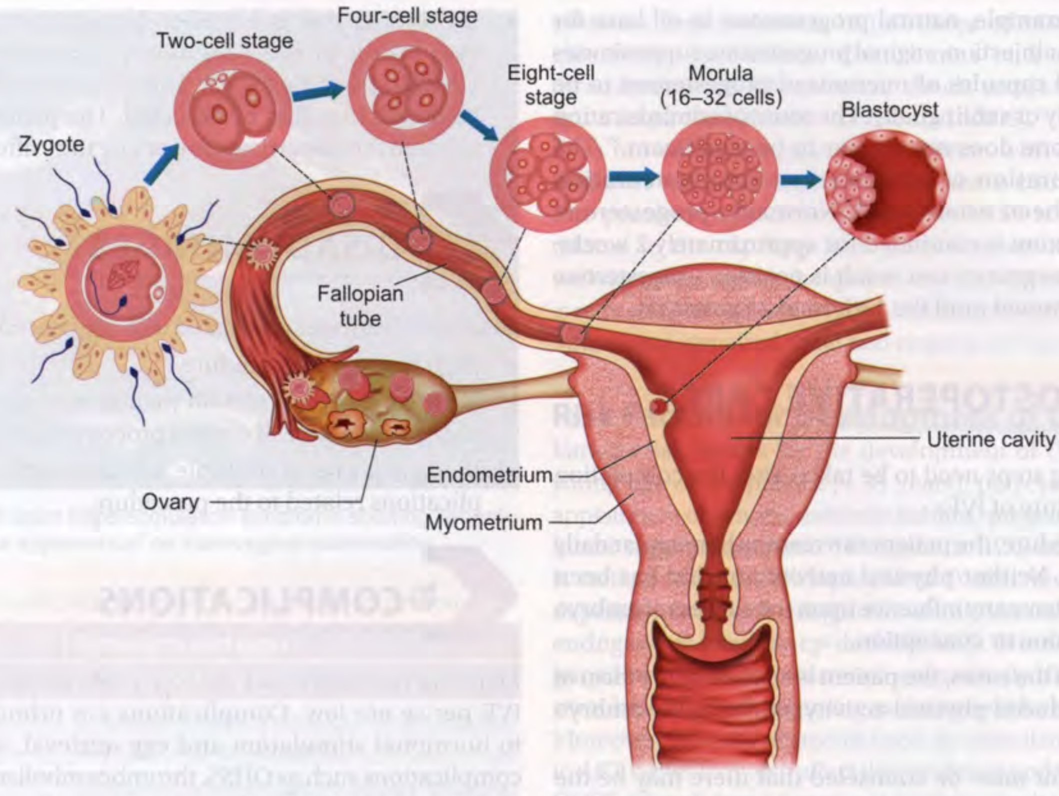


Fig. 26.4: Formation of the blastocyst stage of the embryo

EMBRYO TRANSFER

The procedure of embryo transfer is performed within 72 hours after oocyte insemination, when the embryo has become approximately 8–16 cells in size. The next most common time for transfer is the day 5 transfer at the blastocyst stage. Major advantages of blastocyst stage transfer are the ability to perform preimplantation genetic diagnosis and the reduction in the rate of multiple gestations with single blastocyst transfer.

The embryo transfer is usually performed transcervically under the guidance of transabdominal ultrasound. The embryos should be loaded with 15–20 μL of culture media at the time of transfer. The catheter is advanced up to the fundus of the endometrial cavity, and then withdrawn slightly. The embryos are ejected into the miduterine cavity, approximately 1–2 cm away from the fundus. Touching the catheter to the top uterine cavity is thought to induce uterine cramping, thereby reducing the success rate of the procedure. Subsequent to the embryo transfer, the patient must be on bed rest for 30–60 minutes.

The usual number of embryos transferred depends on a number of factors including maternal age, the number of oocytes retrieved and availability of embryos for cryopreservation.[15,16] While transferring more than one embryo increases the chance for a pregnancy, it also increases the chance of multiple gestation. No more than two embryos should be transferred in a young woman.[17] According to the American Society for Reproductive Medicine, no more than three or four embryos must be transferred in 38- and 39-year-old women and no more than five embryos be transferred in women 40 years of age or older. However, presently this remains a controversial topic and some clinicians advise transferring of no more than two embryos regardless of maternal age.[18,19] Some countries have restricted by law the number of embryos that may be transferred at one time. As would be subsequently discussed, the present trend is towards transferring a single high-quality embryo.

Cryopreservation: Cryostorage of supernumerary embryos can be offered if there are more than two embryos. Embryos in excess of those which would be safely transferred can be cryopreserved for future use.[20] Both slow freezing and vitrification (ultrarapid freezing) have been found to be safe and effective methods of cryopreservation.

Management of the Luteal Phase

Once the embryo has reached the endometrial cavity, endometrial receptivity plays a major role in determining the success or failure of embryo implantation after IVF. Following 36–72 hours after oocyte retrieval, the endometrium must be supplemented with progesterone in order to maintain the luteal phase.[21-26] Supplementation with exogenous progesterone is especially required because superovulation and follicular aspiration at the time of oocyte retrieval is likely to have induced an abnormal endocrine milieu. Several progesterone preparations are available for use; for example, natural progesterone in oil base for intramuscular injection; vaginal progesterone suppositories and gels and capsules of micronized progesterone to be used vaginally or sublingually. The route of administration of progesterone does not appear to be significant.[27] The optimum duration of progesterone supplementation has yet not been established. Normally, progesterone supplementation is continued for approximately 2 weeks. In case the pregnancy test result is positive, progesterone must be continued until the 12th week of gestation.

POSTOPERATIVE CARE

The following steps need to be taken after the completion of the procedure of IVF:

- Postprocedure, the patient can resume her regular daily activities. Neither physical activity nor diet has been shown to have any influence upon the success of embryo implantation or conception.
- In most of the cases, the patient is advised some form of rest or reduced physical activity following the embryo transfer.
- The patient must be counseled that there may be the passage of a small amount of clear or bloody fluid from the vagina shortly after the procedure. She must be assured that this is normal and not a sign that the embryos are being expelled.
- She may also experience minor symptoms such as breast tenderness and engorgement, bloating, constipation, etc. These may occur due to the elevated levels of hormones associated with ovarian stimulation, and due to the supplemental hormones used for luteal phase support.
- Mild cramping and abdominal bloating can commonly occur. However, the woman must be counseled to immediately consult her clinician in cases of moderate or severe pain because this may be related to infection, ovarian torsion, other causes of abdominal pain (such as appendicitis, OHSS, etc.). Doppler ultrasound may be required to establish the diagnosis in these cases. Pelvic pain occurring weeks after IVF should be evaluated as in any woman with acute pain.
- Monitoring for pregnancy: Pregnancy is diagnosed by identifying rising serum hCG levels after the embryo transfer. If pregnancy occurs, hCG levels start rising approximately 1–2 days following implantation, which normally occurs within 7–8 days following oocyte retrieval. Serial hCG measurements are performed to monitor whether the rise is normal and consistent with a normal developing intrauterine pregnancy.
- Negative hCG levels, even14 days after oocyte retrieval is a strong indication of a failed IVF cycle. In these cases, the luteal phase supplementation is stopped. Menstruation commonly occurs after 1–3 days.
- If the hCG test is found to be positive, ultrasound evaluation of the pregnancy is usually begun at 6 weeks of gestational age. This is the time when the fetal heartbeat may first be detected. The patient is usually referred for obstetrical care at any time after that.

DISADVANTAGES

Some disadvantages associated with the procedure include:

- High cost of the procedure.[28]
- Administration of certain medications to the woman and performance of certain procedures on her.
- Increased rate of multiple gestation and other complications related to the procedure.

COMPLICATIONS

Maternal morbidity and mortality rate directly related to IVF per se are low. Complications are primarily related to hormonal stimulation and egg retrieval, and include complications such as OHSS, thromboembolism, infection, abdominal bleeding, adnexal torsion, allergic reaction, anesthetic complications, ectopic pregnancy, etc. If the IVF cycle proves to be successful, the woman is at risk of usual pregnancy-related complications (e.g. preeclampsia/eclampsia, hemorrhage, amniotic fluid embolism, thromboembolism, sepsis, etc.). Some of the complications associated with ART/IVF are as follows:[29,30]

OVARIAN HYPERSTIMULATION SYNDROME

Ovarian hyperstimulation syndrome is an iatrogenic condition that occurs in patients undergoing ovulation induction with hMG or controlled ovarian hyperstimulation for assisted reproductive technologies (Fig. 26.5). The incidence rate fluctuates from 0.1% to 30%. The pathophysiology of the disease is not well understood, but is associated with massive extravascular accumulation of fluid. This causes severe depletion of the intravascular volume resulting in dehydration, hemoconcentration and electrolyte imbalance (i.e. hyponatremia, hyperkalemia, etc.). Schenker and Weinstein have classified OHSS into three main categories—mild, moderate and severe[31] (Table 26.1).

Mild Hyperstimulation

The mild form of OHSS is associated with symptoms such as abdominal heaviness, abdominal swelling and pain. The ovaries may be enlarged bilaterally with each ovary measuring up to 6 cm in diameter. Each ovary is characterized by presence of multiple follicular and corpus luteum cysts.

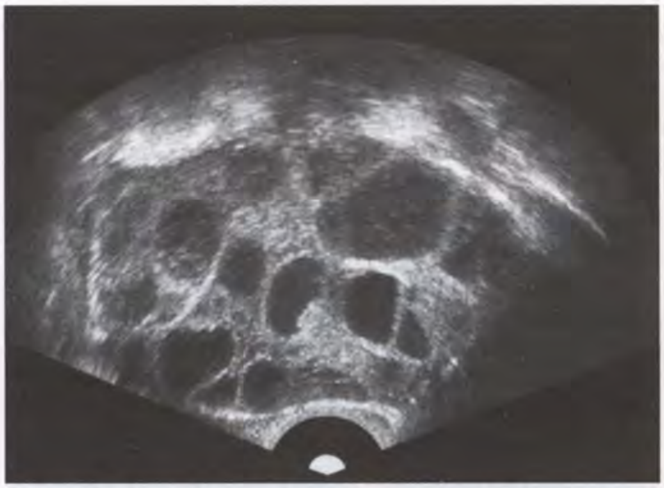


Fig. 26.5: Ovarian hyperstimulation syndrome showing "wheel-spoke appearance" on transvaginal examination

Table 26.1: Classification of ovarian hyperstimulation syndrome

Degree	Symptoms and signs
Mild form	
Stage A	Chemical hyperstimulation: 17β-estradiol levels of 1,000–1,500 pg/mL
Stage B	Chemical hyperstimulation: ovaries enlarged up to 6 cm in diameter
Moderate form	
Stage A	17β-estradiol levels > 4,000 pg/mL; ovaries enlarged up to 6–12 cm
Stage B	Presence of ascites on ultrasound examination, findings as in stage A with gastrointestinal symptoms such as vomiting and diarrhea
Severe form	
Stage A	17β-estradiol levels > 4,000 pg/mL; ovaries enlarged to > 12 cm plus clinical evidence of ascites and/or hydrothorax and breathing difficulties
Stage B	Presence of all the above plus change in the blood volume, increased blood viscosity due to hemoconcentration, coagulation abnormalities and diminished renal perfusion and function

Moderate Hyperstimulation

In these cases the abdominal discomfort is more pronounced. Gastrointestinal symptoms such as nausea, vomiting and diarrhea may be present. There is some weight gain and an increase in abdominal circumference. The ovaries are enlarged up to 12 cm in diameter, and some ascitic fluid is detected by ultrasonography.

Severe Hyperstimulation

Severe OHSS is a serious iatrogenic complication of ovulation induction in an otherwise healthy woman. The clinical manifestations may include pleural effusion, pericardial effusion, hypovolemia, impairment of renal function, electrolyte imbalance, disturbance in liver function, thromboembolic phenomena, shock, tension ascites and acute respiratory distress syndrome (ARDS).[32] If conception does not occur, the patient's condition with severe OHSS improves within several days when she is correctly treated. The presence of ascites in cases of OHSS is a major sign related to the capillary leak phenomenon. As a result of various pathological changes occurring due to OHSS, there is reduced preload to the heart, leading to decreased cardiac output and impaired renal and respiratory function.

Risk Factors for Development of OHSS

Various risk factors for the development of OHSS include young age of the patient (< 35 years), polycystic ovary-like appearance of ovaries, asthenic habitus, pregnancy and hCG luteal supplementation.[33] Exogenous hCG administration is critical for the development of OHSS. Severe OHSS is dependent on both exogenous administration of hCG or endogenous pregnancy-derived hCG. Human chorionic gonadotropin is administered exogenously during ovarian stimulation for both triggering ovulation and for luteal support. Moreover different protocols used for stimulation of ovaries in ART cycles may also affect the incidence and the severity of OHSS. Stimulation of ovaries is likely to result in high serum estradiol levels and development of multiple follicles.

Pathogenesis

The exact pathogenesis of OHSS is yet not clear. It is thought to occur as a result of increased vascular permeability.[34] The exact substances responsible for this have yet not been identified. The likely pathogenesis of OHSS has been described in Figure 26.6. Mechanism of fluid shift occurring in cases of OHSS is shown in Flow Chart 26.1.

Management of OHSS

No active form of treatment is required for mild OHSS. Patient observation and maintenance of hydration by the oral route usually works for such patients. Close observation and hospitalization is usually required for moderate grade OHSS, since these patients may rapidly undergo a change of status, particularly when conception occurs. Patients with severe OHSS may require immediate hospitalization and treatment. During hospitalization, careful monitoring of hemodynamic stability is required. Large volume crystalloid infusion is recommended for renewal of the depleted intravascular volume. However, these patients must be closely monitored, as this can result in sequestration of fluid in the third space. Management of OHSS is summarized in Flow Chart 26.2. Monitoring of induction of ovulation is the most reliable method in the prevention of OHSS. When the peak plasma estradiol levels are greater than 2,000 pg/mL, or an abnormal increase in the serum estradiol levels (doubling during 2 or 3 days) occurs, hCG should be withheld.

Complications of OHSS

The most serious complications of OHSS are both arterial and venous thromboembolic phenomena.[35] Arterial thromboembolic phenomena may result in cardiovascular accidents and sometimes even death.

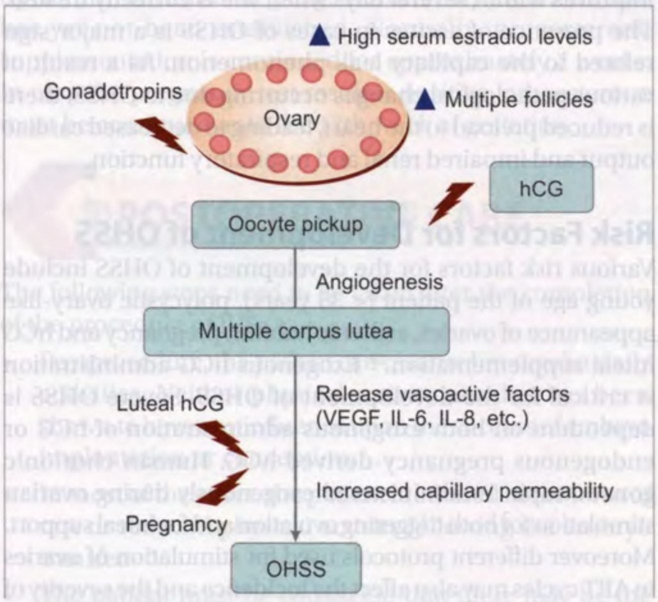


Fig. 26.6: Pathogenesis of ovarian hyperstimulation syndrome (OHSS)
Abbreviations: hCG, human chorionic gonadotropin; VEGF, vascular endothelial growth factor; IL, interleukin

ECTOPIC PREGNANCY

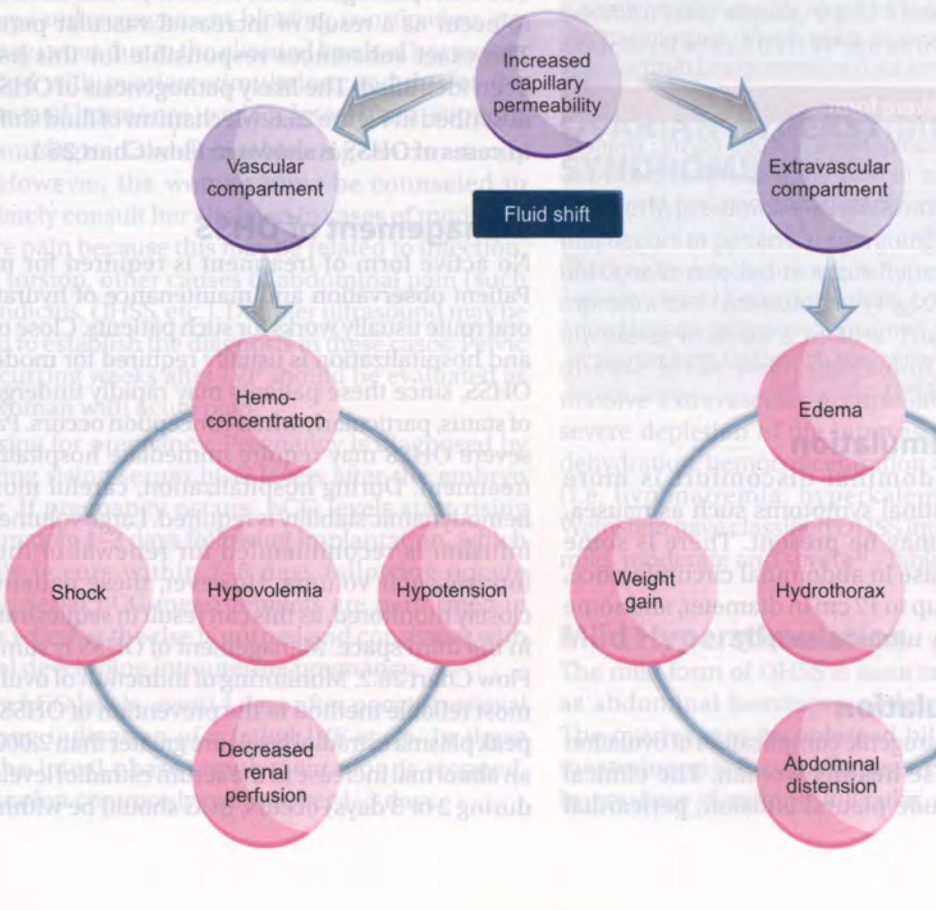
Ectopic pregnancy is another complication, which can occur as a result of ART with an incidence of 1–3% of pregnancies being ectopic following assisted reproduction. Ectopic pregnancy has been described in details in Chapter 18. An ectopic pregnancy can be diagnosed when there is lack of visualization of a gestational sac in the uterine cavity above the discriminatory threshold of hCG.

An ectopic should also be suspected when β-hCG titers are not rising normally. Generally, the mean doubling time for the β-hCG titer in a normal pregnancy is 48 hours. An abnormal rise, plateau or decline the β-hCG levels may be associated with ectopic pregnancy.[36] Ectopic pregnancy can be managed with nonsurgical management using methotrexate in selective patients and traditional laparoscopic salpingectomy or salpingostomy in symptomatic patients. Various surgical options for the management of ectopic pregnancy have been described in details in Chapter 18.

IATROGENIC MULTIPLE PREGNANCY

Widespread use of assisted reproductive technology over the past few decades has been associated with an increase in the iatrogenic multifetal gestations. Since multifetal gestations are associated with their own risks and complications, their occurrence in association with infertility treatment has to be regarded as an adverse outcome. Some fetal complications associated with multifetal gestations include a higher

Flow Chart 26.1: Mechanism of fluid shift occurring in ovarian hyperstimulation syndrome (OHSS)



Flow Chart 26.2: Management of OHSS

Management of a patient with OHSS

Patient monitoring

Monitoring of the following:

- Vital signs
- *Fluid balance:* Fluid intake, urinary output
- Daily measurement of the patient's weight and abdominal girth
- Central venous pressure monitoring
- *Blood tests:* Complete blood count, hematocrit, serum electrolytes and proteins, liver function tests, coagulation profile, acid-base balance, blood gases
- Urine osmolarity
- *Imaging:* Ultrasonography (abdomen, chest), computed tomography (abdomen, chest)

Patient treatment

- *Maintenance of blood volume:* Plasma expanders
- *Reduction of capillary permeability:* Indomethacin, angiotensin converting enzyme inhibitors
- *Prevention of thromboembolic phenomenon:* Heparin
- *Surgery:* Only in cases of torsion/rupture of ovarian cysts

incidence of miscarriage, preterm deliveries, congenital malformations, discordancy and intrauterine growth restriction, all of which increase the perinatal morbidity. Multifetal gestations may also be associated with a higher incidence of maternal complications such as preeclampsia, anemia, labor difficulties, postpartum hemorrhage, failed lactation, psychological disturbances in a woman, etc.

Strategies to Reduce the Risk of Multiple Pregnancy

Some of the strategies which have been adopted to reduce the risk of multiple pregnancy during assisted reproductive technologies are as follows:

Elective Single Embryo Transfer

Recently, transfer of one embryo has been found to be associated with a high chance of live birth. As a result elective single embryo transfer (eSET) has been recommended as the standard of care in the ART cycles.[37-43] Unfortunately this approach is not being widely followed due to the availability of conflicting evidence at present. Despite the risks of transferring multiple embryos, presently there continues to be low use and acceptance of eSET.

Excess Oocyte Aspiration and Vitrification

Results of a recent meta-analysis has shown that the cycles with three or four follicles do not result in any substantial gain in pregnancy rate, but are associated with an increased rate of multiple pregnancy. A less aggressive ovarian stimulation serves as an effective method for preventing excessive multifollicular growth and therefore reducing the risk of multiple pregnancy in ovarian stimulation. The application of excess oocyte retrieval and vitrification (oocyte cryopreservation) may further improve the cost-effectiveness of stimulated IUI by effectively reducing the rate of multiple pregnancy rate, at the same time offering additional chances of pregnancy.

Multifetal Pregnancy Reduction

Multifetal pregnancy reduction (MFPR) techniques have been promoted to reduce high-order pregnancies to twin gestation, with the aim of improving perinatal outcomes.

The technique of MFPR appears to work as an effective treatment option by reducing the rate of pregnancy loss, antenatal complications, preterm birth, cesarean delivery, low birthweight babies and neonatal death.

Other strategies for prevention of multiple pregnancy as a result of ovulation stimulation include cycle cancelation, coasting, aspiration of follicles before the administration of hCG and switching to IVF in an IUI cycle. Coasting is a method involving withdrawal of exogenous gonadotropins until there is a decline in serum estradiol levels.

ONCOGENIC RISK RELATED TO ASSISTED REPRODUCTIVE TECHNOLOGY

Recently there have been reports showing increased prevalence of perinatal problems associated with ART. Evidence obtained from animal experiments raises concerns that infertility and its treatment with ART (processes such as ovarian stimulation, culture of gametes and embryos) may be associated with an increased oncogenic risk (ovarian cancer, breast cancer, etc.) in both women and their offsprings.[44,45]

Although there appears to be a possible risk of ART treatment causing oncogenesis, this has not been proven. The oncogenic risks are minimal, especially with the use of short stimulation protocols nowadays. Nevertheless, long-term studies and follow-up are required to reach any definitive conclusion.

DISCUSSION

OUTCOME

The cause of infertility affects IVF outcome. Rate of live birth is the highest in women having ovulatory dysfunction and lowest amongst those with diminished ovarian reserve.

Success rate of IVF appears to vary depending upon the patient's race and ethnicity. IVF amongst the black, Asian, and Hispanic women has been found to be associated with lower live birth rate in comparison to the white women. In 2011 in the United States, amongst all fresh nondonor ART cycles 29% resulted in a live birth.[46] This is higher than the fecundability of natural conception cycles in the general population, where the live birth rate per natural cycle is about 27.7 %.

FAILURE OF THE PROCEDURE

Failure can occur during any step in the IVF process, and often the reason for failure is not known. There may be inadequate development of ovarian follicles due to poor ovarian reserve or improper stimulation of ovulation. It might be difficult to retrieve a mature oocyte due to technical difficulties. Fertilization may fail due to abnormalities in the sperms or lack of penetration of the zona pellucida, failure of activation of an oocyte, or a defect in the oocyte.[47] Another important cause of failed IVF procedure could be failure of implantation. This could be due to poor embryo quality, which may be as a result of diminished ovarian reserve, advanced maternal age, suboptimal ovarian stimulation, suboptimal laboratory culture conditions, poor endometrial receptivity, improper placement of embryos, uterine abnormalities (submucosal myomas, uterine septum, etc.), presence of a hostile environment (e.g. infection), etc.

POOR RESPONDERS TO OVARIAN STIMULATION

Increasing attention is now being focussed on women who are unable to produce an optimal number of follicles in response to ovulation induction. Such women are also termed as "poor responders".

Though the definition of a poor responder has not been universally defined, it generally includes women who are unsuccessful in producing an optimal number of follicles (usually less than or equal to 3, having a diameter of greater than or equal to 18 mm) in response to induction of ovulation.

In a first practical attempt at standardizing the definition of poor ovarian responders (POR), the European Society of Human Reproduction and Embryology (ESHRE) working group has proposed a standardized, simple, and reproducible definition for POR, which has been published in the recent issue of the journal, Human Reproduction.[48] This criteria for defining POR is also known as the Bologna criteria. In accordance with the Bologna Criteria, at least two of the following three features must be present:

1. Advanced maternal age or any other risk factor for POR
2. A previous POR
3. An abnormal ovarian reserve test (ORT).

Apart from the above three criteria, in the absence of advanced maternal age or abnormal ORT, the patient can be defined as a poor responder if she has two episodes of POR even after maximal stimulation.

Although one stimulated cycle is necessary for diagnosing POR, patients with advanced age or abnormal ORT may be considered as poor responders, because both the factors suggest the possibility of decreased ovarian reserve. They, therefore, serve as markers of poor stimulation cycle outcomes. Such patients should be classified as "expected poor responders".

The Group reached the conclusion that such a comprehensive criteria is likely to assist the researchers in selecting a homogenized population for future studies, having a lower bias due to spurious POR definitions. This would facilitate the comparison of results for reaching precise decisions.

Strategies for Poor Responders

Presently there is inadequate evidence supporting the routine use of any particular intervention, in form of pituitary downregulation with either GnRHa or anatagonists, ovarian stimulation or adjuvant therapy for the management of poor responders to controlled ovarian stimulation in IVF.[49,50] Better evidence from good quality randomized, double-blinded multicentric trials would be required in future to arrive at a definite conclusion.

OTHER TECHNIQUES

Natural Cycle IVF

Natural cycle (unstimulated) IVF refers to IVF without the use of exogenous gonadotropins to induce growth of multiple follicles. Though in developed world, natural cycle IVF is rarely used, it is still being commonly used in the developing countries. Although unstimulated IVF or natural cycles are associated with a reduced risk of complications such as OHSS and multiple gestation, the standard IVF protocol employing the use of ovarian stimulation is associated with a higher likelihood of a successful pregnancy.[51]

In Vitro Maturation

About 20% of oocytes retrieved from stimulated cycles are immature. In vitro maturation of these immature oocytes is presently an emerging technology.[52] One of the major advantages of this technique is that it helps in avoiding large doses of gonadotropins. This would help in avoiding high costs associated with its use and various associated complications such as risk of OHSS, etc. Presently, the development of the technique and assessment of its role in fertility treatment is ongoing.

CONCLUSION

In vitro fertilization consists of retrieving a preovulatory oocyte from the ovary; fertilizing it with a sperm in the laboratory, and subsequently transferring the embryo within the endometrial cavity. With increasing developments in the field of science and technology, IVF is now being recognized as an established treatment for infertility. The results of IVF now slightly exceed the fecundability of natural conception cycles in general population. The most important factors affecting the success rate of IVF are number of oocytes retrieved from the ovary and the number of high quality embryos derived from them in the laboratory. Embryos obtained in excess can be cryopreserved for future use. The main causes for failure to achieve pregnancy with IVF are poor embryos, poor receptivity of the endometrium and poor efficiency of embryo transfer. Besides its advantages, assisted reproductive technology has been found to be associated with several complications such as OHSS, multiple gestations, ectopic pregnancy, etc.

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27 CHAPTER

Surgery for Endometriosis

INTRODUCTION

Endometriosis, which is an important cause of infertility, is a clinical entity characterized by the presence of ectopic endometrial glands and stroma outside the uterine cavity. The common sites of endometrial implants include the pelvic cavity, ovaries, uterine ligaments, rectovaginal septum, parietal peritoneum, intestinal serosa, etc. (Fig. 27.1). This disease can be associated with a varied clinical presentation. There can be pelvic symptoms (e.g. dysmenorrhea, dyspareunia, chronic pelvic pain, sciatica, premenstrual spotting, etc.); gastrointestinal symptoms (e.g. constipation, diarrhea, dyschezia, tenesmus, hematochezia, etc.); urinary symptoms (e.g. flank, abdominal and back pain, urinary urgency, frequency and hematuria); infertility and pulmonary symptoms (e.g. hemoptysis, chest pain, pneumothorax, etc.). Endometriosis may be responsible for nearly 20% cases of infertility. Approximately 20–40% of women with endometriosis are infertile.

The mechanisms by which endometriosis can cause infertility are still not clear.[1] The disease can produce an inflammatory response, which can have a harmful effect on the tubal function. It can cause mechanical interference for the migration of sperm and ova by producing pelvic adhesions, chronic salpingitis, altered tubal motility, distortion of tubo-ovarian relationship and impaired oocyte pickup. There can be impaired peristaltic activity of the fallopian tube. The presence of endometrial implants is often associated with the markers of inflammation, such as impaired concentration of prostaglandins, increased number of activated macrophages, and impaired production of cytokines. All these may result in an increased phagocytosis of sperms. Endometriosis can also produce hormonal or ovulatory dysfunction, which can result in defective folliculogenesis, hyperprolactinemia, luteal phase deficiency and luteinized unruptured follicle syndrome. It can cause a failure of fertilization or implantation. Abnormalities in immune response can also cause injury to the gametes and production of autoantibodies against the endometrium.

Endometriosis can be categorized into four stages: stage 1 to stage 4 (Figs 27.2A to D). Before initiating treatment for endometriosis, it is important to classify the disease as minimal, mild, moderate or severe. The American Fertility Society's revised staging for endometriosis is currently the most widely used staging system.[2] In this scoring system, point scores are assigned based on the number of lesions, their bilaterality, size of the lesions, depth of endometrial implants, presence and extent of adnexal adhesions, and degree of obliteration of the pouch of Douglas. It, however, does not take into account the complaints like infertility or pelvic pain. This classification is a fairly accurate method of recording laparoscopic findings and can help standardize the patient's findings and documenting the patient's baseline condition and subsequent progress.

OVERVIEW OF SURGERY

A laparoscopic examination is required if the hormonal treatment used for treatment of mild or moderate cases of endometriosis fails, or if endometriosis is severe or debilitating. Patients presenting with symptoms indicative of endometriosis require visual inspection of the pelvis at the time of laparoscopy, and histologic confirmation of at least one lesion.

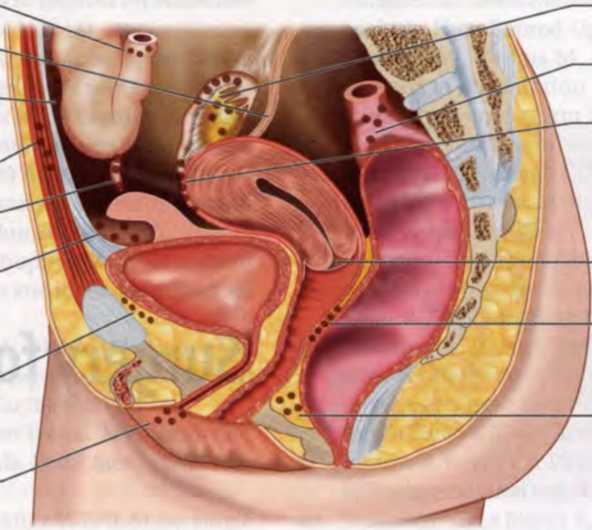
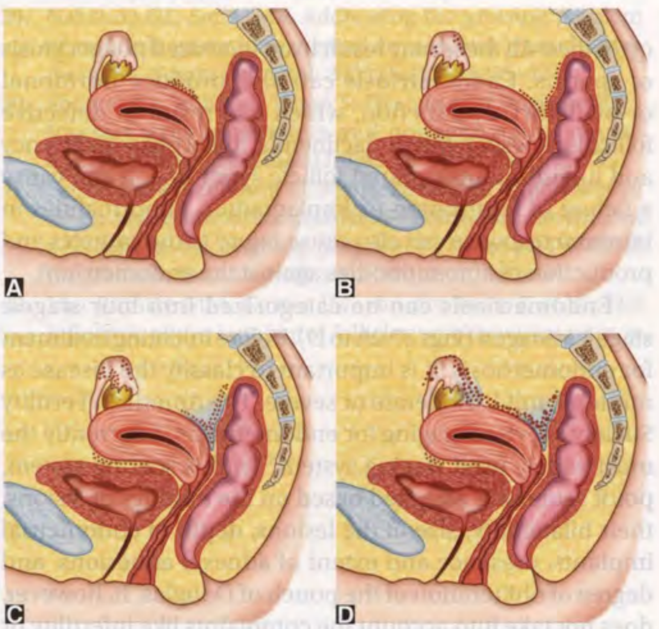


Fig. 27.1: Common sites of endometrial implants



Figs 27.2A to D: Stages of endometriosis. (A) Stage 1 (minimal); (B) Stage 2 (mild); (C) Stage 3 (moderate); (D) Stage 4 (severe)

Presently laparoscopy has become the gold standard test for diagnosing endometriosis in clinical practice.[3-7] Endometriotic implants may show varied appearance. The lesions may appear as black, dark-brown or bluish implants or deposits, although red, serous and even clear vesicles have been reported (Fig. 27.3). Endometriotic nodules or lesions having blue-black or a powder burned appearance (Figs 27.4A and B and 27.5) are a late consequence related to cyclic growth and regression of the lesions resulting in bleeding and hemosiderin staining of the tissues. Endometriosis can also be detected by the presence of either blood (Fig. 27.6) or endometriotic deposits in cul-de-sac, and its obliteration due to adhesions. Various morphological lesions indicative of endometriosis include vesicles, flat plaques, raised lesions, polypoid structures, peritoneal defects and adhesions (Figs 27.7A to C, 27.8 and 27.9). Yellow, brown, blue or black discoloration of endometriotic lesions is proportional to the amount of hemosiderin deposition. Endometriotic lesions of the ovary can result in the formation of ovarian cysts, which are often referred to as "endometriomas" and/or "chocolate cysts" (Fig. 27.10).

Diagnosing endometriosis exclusively on visual identification, however, can result in both misdiagnosis as well as overdiagnosis. Biopsy helps in confirming the diagnosis and reveals endometrial glands and fibrous stroma. Near-contact laparoscopy, which results in up to an eightfold magnification of lesions can help to identify atypical implants as small as 400 µm.

AIMS OF SURGERY

Surgery for endometriosis aims at destroying all visible endometriotic lesions and any associated adhesions. However, there may be no correlation between the amount of visible endometriosis seen at the time of surgery and the extent of symptoms. Surgery in case of patients presenting with infertility may involve the following:[3]

- Removal or destruction of endometrial implants
- Removal or destruction of ovarian endometriomas
- Removal, lysis or destruction of adhesions
- Removal of deep rectovaginal and rectosigmoid endometriosis
- Dissection of ovaries from cul-de-sac or pelvic sidewall, freeing tubal adhesions

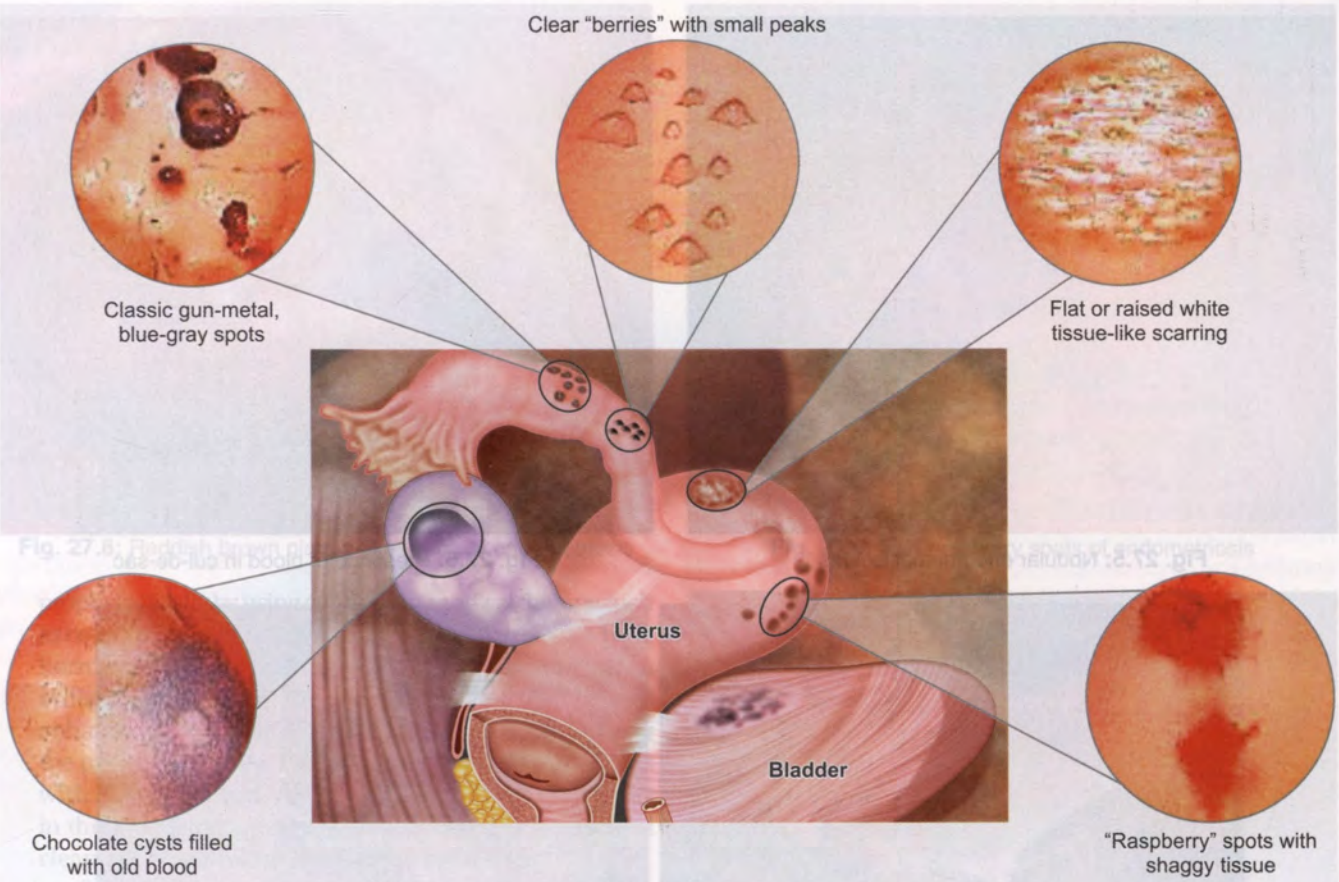
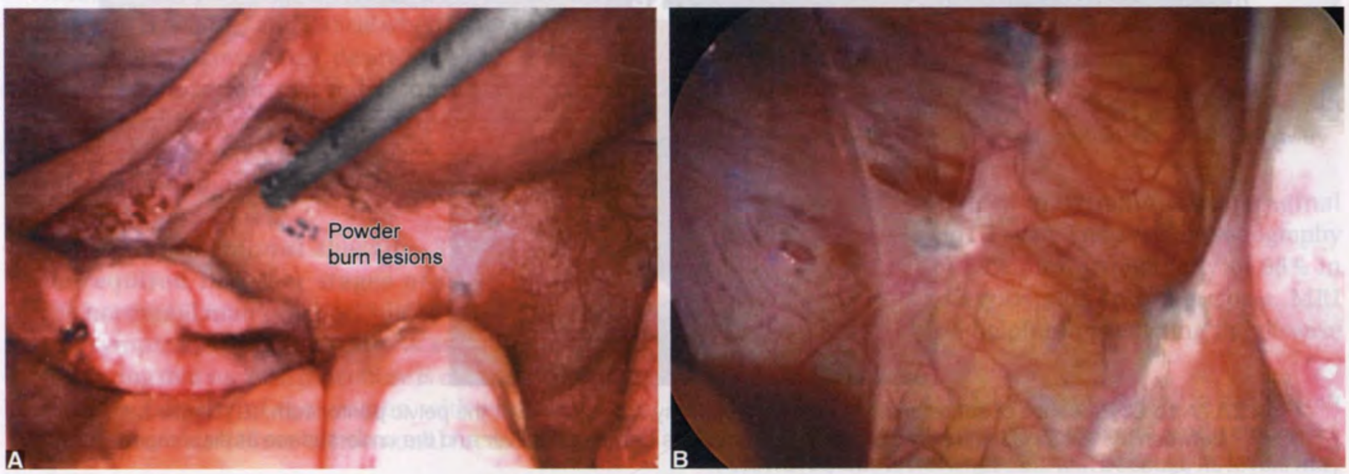


Fig. 27.3: Diagrammatic representation of various endometriotic lesions



Figs 27.4A and B: Powder burn lesions

- Uterosacral nerve ablation or presacral nerve resection for chronic pelvic pain.

Parietal and visceral peritoneal adhesions to pelvic organs, bowel and omentum can be carefully dissected using atraumatic forceps and aquadissection or blunt dissection. Thick or fibrous bands may require cauterization and sharp dissection.

Mild to moderate endometriosis is treated by ablation or cauterization of the endometriotic deposits. Diathermy, yttrium-aluminium-garnet (YAG) or carbon dioxide laser and helium thermal coagulator (Helica) are the three electrosurgical devices available. Coagulation can be achieved with help of monopolar or bipolar cautery (bipolar cautery is associated with lesser tissue damage in comparison to monopolar cautery), thermocoagulation or laser therapy (CO_2 laser is more accurate than fiber laser). In Stage III or IV endometriosis, conservative surgery to excise or ablate all endometriotic lesions is recommended.

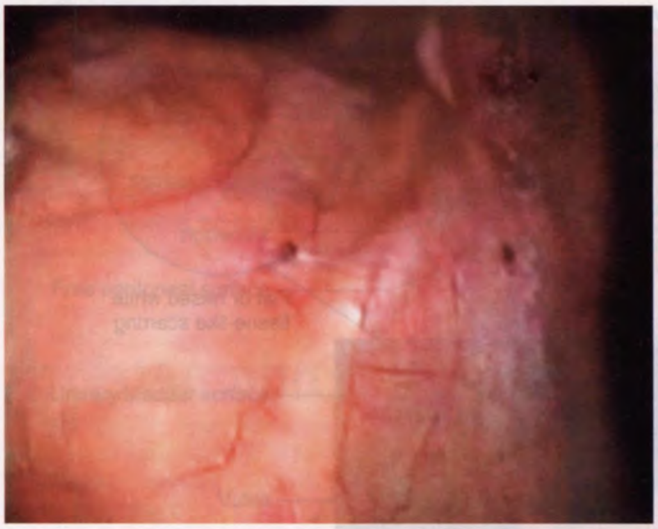


Fig. 27.5: Nodular endometrial lesions

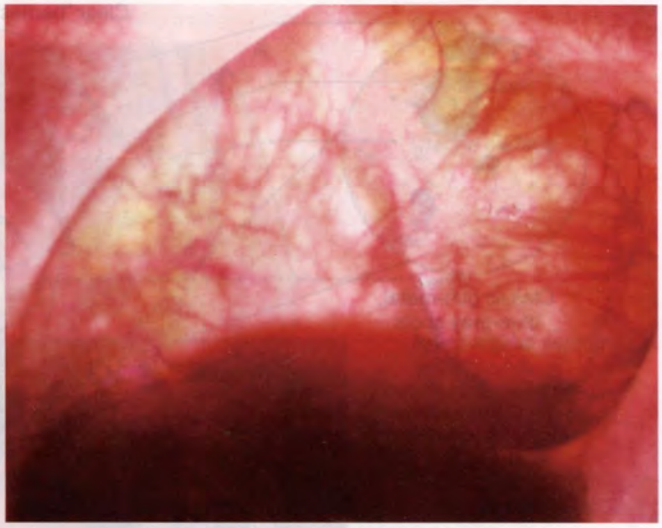
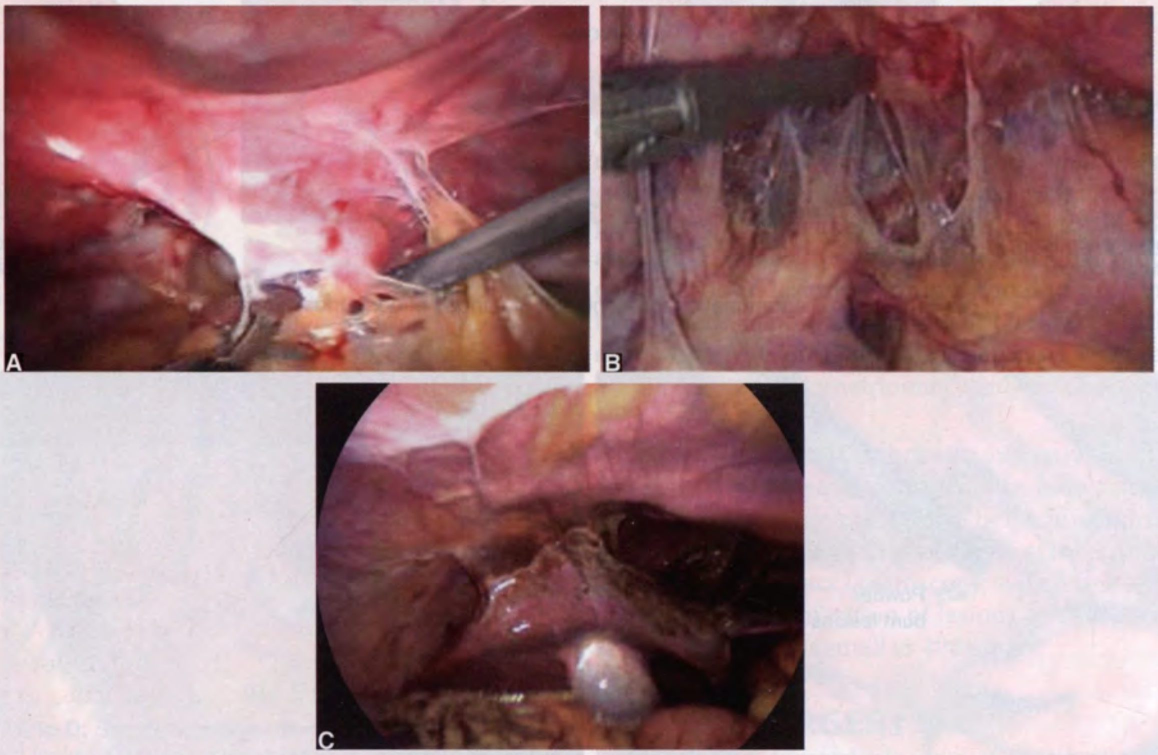


Fig. 27.6: Presence of blood in cul-de-sac



Figs 27.7A to C: Presence of adhesions: (A) Presence of flimsy adhesions over the pelvic peritoneum; (B) Dense adhesions between the intestines and pelvic organs; (C) Adhesions between the liver and the undersurface of diaphragm

Genitourinary and gastrointestinal lesions are best operated by advanced laparoscopic surgeons as involvement of the bladder, ureter, intestine and rectum is common.

INDICATIONS

Indications for surgery include the following:

- *Patients desiring fertility*: In patients with endometriosis desiring fertility, surgical treatment is usually preferred over the medical treatment. The likelihood of subsequent conception can significantly be increased by undertaking surgery in patients with endometriosis presenting with infertility. Moreover, medical treatment has not been shown to help the patients with endometriosis conceive. Furthermore, pregnancy is contraindicated in patients receiving medical treatment and is in fact unlikely, because the drugs that are used may interfere with ovulation and endometrial implantation. However, some authorities do believe that endometriosis should be suppressed

Fig. 27.8: Reddish brown plaque-like lesion of endometriosis

Fig. 27.9: Red raspberry spots of endometriosis

prophylactically by using continuous medical therapy such as combined oral contraceptives, gonadotropin-releasing hormone analogs, medroxyprogesterone or danazol in order to cause regression of asymptomatic disease and enhance subsequent fertility. Surgical treatment remains the preferred approach for treatment of infertile patients with advanced endometriosis. The benefit of surgery in these patients may be entirely due to the mechanical clearance of adhesions and obstructive lesions.

Surgical care can be broadly classified as conservative when reproductive potential is retained, semiconservative when reproductive ability is eliminated but ovarian function is retained and radical when both the uterus and ovaries are removed. Age, desire for future childbearing and deterioration of quality of life are the main considerations when deciding on the extent of surgery.

- *Extensive pelvic endometriosis:* Correction of pain, infertility or other symptoms in patients with extensive pelvic endometriosis.
- *Failure of hormonal therapy:* Surgery may also be required in lesser stages of the disease when the hormonal manipulation fails to adequately reduce the symptoms of pain. There is sufficient evidence indicating that surgical procedure is effective in relieving pain in majority of the women with endometriosis, where there is a failure of hormonal method.[8]

PREOPERATIVE PREPARATION

The preoperative care is similar to any other laparoscopic or laparotomy procedure. In cases of endometriosis, the following investigations may be required:

- *Diagnostic laparoscopy:* Diagnostic laparoscopy is the gold standard investigation for establishing the diagnosis of endometriosis. Findings of laparoscopy must be validated by peritoneal and tissue biopsy.

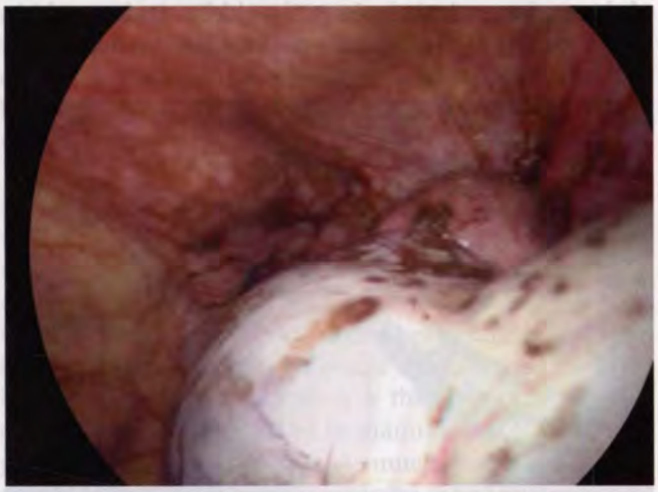


Fig. 27.10: Portion of a large endometrial cyst of the left ovary

- *Imaging studies:* These may include transvaginal sonography, MRI and CT scan. Transvaginal sonography has a sensitivity of 83% and a specificity of 98% in establishing the diagnosis of endometriosis. MRI examination may be helpful in predicting the disease extension.
- *CA 125 levels:* CA 125 levels are raised to more than 35 U/mL in more than 80% cases of endometriosis. However, this is not a specific test because its levels may also be raised in presence of other pathologies such as pelvic inflammatory disease, malignant ovarian tumors, abdominal tuberculosis, etc.
- *Cystoscopy:* A cystoscopic examination may be required to identify extension to the bladder.
- *Sigmoidoscopy:* Preoperative sigmoidoscopy with intravenous pyelography is recommended in patients having symptoms suggestive of deep invasive endometriosis of the posterior cul-de-sac and rectovaginal septum.

SURGICAL STEPS

SURGICAL EQUIPMENT USED

Microsurgery can be used both at the time of endometriotic surgery as well as tubal reconstruction surgery. Microsurgical tubal reconstruction surgery has already been described in details in Chapter 26. Laparoscopic instruments used at the time of laparoscopic surgery are described in Chapter 32.

SURGERY FOR ENDOMETRIOSIS

Laparoscopic surgery is nowadays considered for most of the cases of endometriosis (Figs 27.11 to 27.13A and B) unless there is difficulty in establishing the appropriate tissue planes or dissection, or unless improved access is required for the atraumatic manipulation of the involved organs.[9] The decision regarding whether surgical resection of the endometriotic lesions should be performed via laparoscopic route or laparotomy is usually not dependent on the disease stage. Specific endoscopic procedures, which can be performed, include ablation of endometriotic implants, adhesiolysis, ovarian cystectomy, oophorectomy and salpingectomy. Laparoscopy is associated with reduced duration of hospital stay as well as health care expenses.[10]

Laparoscopy also helps in providing better visualization of the cul-de-sac by enabling higher degree of magnification of the peritoneal surfaces, which helps in the identification of the subtle disease as well. Moreover, laparoscopic approach is associated with minimal bleeding and minimal risk of adhesion formation and reduced duration of hospital stay. Several endoscopic techniques, which can be used for ablation of endometriotic lesions, include excision, coagulation and vaporization. Coagulation can be attained by monopolar or bipolar cautery, thermocoagulation or laser.

Small peritoneal endometriotic lesions, which are less than 5 mm in diameter can be treated with laser or bipolar coagulation while application of constant irrigation. Deep lesions or more extensive peritoneal disease must be excised

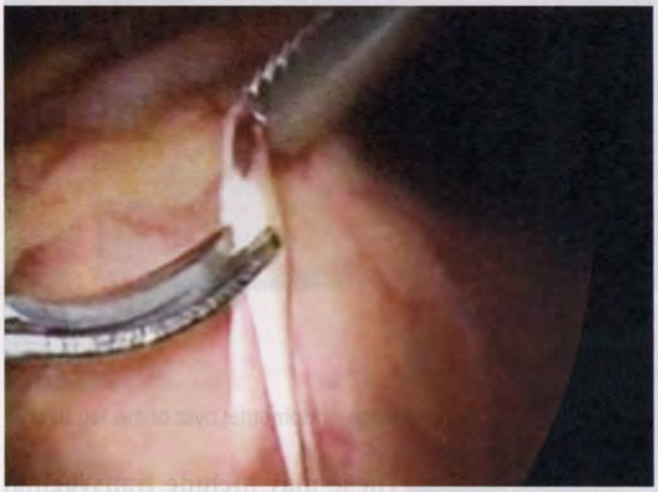
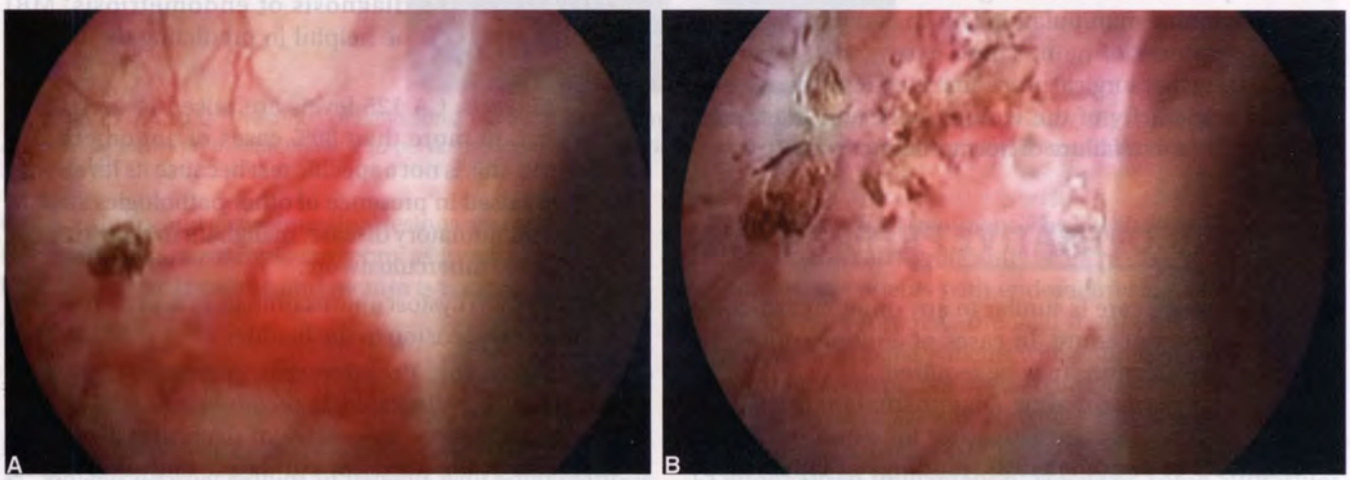


Fig. 27.11: Laparoscopic excision of nodular endometrial lesions overlying the round ligament

Fig. 27.12: Laser ablation of endometriotic lesions



Figs 27.13A and B: Appearance of the uterine surface after the ablation of endometriotic lesions

with a tissue margin of 2-4 mm because microscopic lesions may be present along with the macroscopic lesions. The identification and isolation of the ureter must be performed just before the dissection of pelvic sidewall.

Laparoscopic Management of Endometriosis

Mild to moderate endometriosis: The endometriosis spots are destroyed by diathermy, where an electric current is passed down a fine probe. Some surgeons use laser to evaporate the endometriosis. Fine adhesions can be cut using small scissors. It has been found that laparoscopic destruction of lesions results in a 13% increase in pregnancy rate.[11]

Moderate to severe endometriosis: Laparoscopic option can also be used in cases of moderate to severe endometriosis, where there is severe scarring or adhesion formation or presence of an ovarian endometrioma.[12] In women with moderate endometriosis, one can expect pregnancy success rates of around 60%, whereas with more severe disease the pregnancy rate is around 35%.[13] If a pregnancy does not occur within 2 years of surgery for endometriosis, the chances of success are poor, and referral for in vitro fertilization should be made.

Laparotomy

This is the usual method of approaching the more severe degrees of endometriosis, particularly where endometriomas are large, and there is more extensive scarring involving the bowel and bladder. Conservative resection of the disease by laparotomy is most commonly performed in the following cases:

- Extensive, dense pelvic adhesions
- Endometriomas greater than 5 cm in size
- Deep involvement of the rectovaginal septum
- Invasion of bowel/bladder musculature
- Endometriotic infiltration in the region of uterine vessels and ureter.

Hysterectomy or oophorectomy should be considered in patients with severe endometriosis not desiring fertility.[14] The rather extreme surgical treatment of hysterectomy with bilateral salpingo-oophorectomy serves an option in older women past their childbearing age, or for women who suffer from intractable pelvic pain. In this procedure, care should be taken to ensure that all visible endometriotic tissues are removed. Bilateral salpingo-oophorectomy also results in improved pain relief.

Uterine suspension techniques have been devised to reduce adhesion formation at the denuded peritoneal surfaces of the posterior cul-de-sac, uterine serosa and broad ligament. The most commonly used technique is the modified Gilliam's procedure. Elevation of the adnexa may prevent adhesion reformation of the fallopian tube or ovary at a site where the existing adhesions have been excised. This procedure is especially indicated in cases of dyspareunia after the resection of posterior cul-de-sac endometriosis. The modified Gilliam's procedure offers advantages over other forms of uterine suspension procedures due to its ability to maintain the normal anatomical relationships. In this procedure, the uterus is elevated and a 2-0 absorbable suture is placed around each round ligament about 3-4 cm from its insertion into the uterus.

Management of Ovarian Endometriosis

The treatment of ovarian endometriosis depends on the type of lesion and its size. Superficial ovarian implants can be destroyed by coagulation or vaporization. Endometriomas less than 2 cm in diameter may be coagulated, laser ablated or excised using scissors or biopsy forceps. All visible lesions and scars must be coagulated or excised from the ovarian surface to prevent recurrence. Small ovarian endometrial cysts can also be punctured and drained. The inner lining of the cyst can be destroyed by coagulation or vaporization. Large ovarian cysts greater than 3 cm in diameter can be excised, or drained and coagulated. It is recommended that large ovarian cysts greater than 3 cm in diameter be excised rather than drained and coagulated.

In case of the excision of an ovarian endometrioma, an incision must be made on the ovarian cortex in such a way that the normal anatomical relationships of the ovary remain preserved. A shallow longitudinal incision is made over the endometrioma with a monopolar microneedle, scalpel or a laser.[15] Dissection can be performed with the help of a blunt curved scissors or a flat probe or a knife handle.[16] Care must be taken at the time of dissection of the hilar region in order to maintain hemostasis and preserve primordial follicles. As much of normal ovarian cortex as possible must be preserved. The reconstruction of ovaries can be performed by placing one to two purse-string sutures of polyglycolic acid or polygalctin in order to eliminate the dead space and to maximize hemostasis. Placing an adhesion barrier, such as interceed, between the raw peritoneal surfaces helps in improving the healing process and preventing the development of adhesions. Ovarian endometriomas less than 4-5 cm in diameter can be removed laparoscopically. However, in case of lesions greater than this, it may be difficult to remove them laparoscopically due to the presence of dense adhesions.

Cystectomy (Figs 27.14A to K) is recommended for endometriomas of or greater than 2 cm diameter. This is especially important in these cases because simply draining the endometrioma or even partial resection of the cyst wall can cause recurrence due to presence of functional residual tissue in the remaining tissue. The cyst is punctured and the contents aspirated with the suction probe (Figs 27.14B to E). The cyst wall should be separated and peeled off entirely from the ovarian stroma to prevent recurrence (Figs 27.14F and G). Any bleeding vessels from the stroma should be coagulated (Fig. 27.13H). The ovarian wall usually does not require closure, but if the defect is greater than 5 cm, laparoscopic suturing with 4-0 or 5-0 absorbable nonreactive material may be required to approximate the edges (Fig. 27.14I and J). The knots of these sutures must be placed internally to diminish the possibility of its becoming the nidus of adhesion formation. Smaller ovarian defects must be left to heal spontaneously because ischemia associated with suture placement can aggravate adhesion formation. Sometimes such large defects can be approximated with help of fibrin sealants in order to reduce the formation of adhesions.[17]

Laparoscopic Uterine Nerve Ablation and Laparoscopic Presacral Neurectomy

Laparoscopic uterine nerve ablation (LUNA) and laparoscopic presacral neurectomy (LPSN) are two procedures that involve cutting the nerves from the uterus to the brain in order to relieve chronic pain.[18] Presacral neurectomy, involves the interruption of sympathetic innervation of the uterus and central pelvis at the level of the superior hypogastric plexus. This may be performed either by laparoscopy or by laparotomy and serves as an adjunctive procedure to eliminate the uterine component of dysmenorrhea.

Second-Look Laparoscopy

This has been suggested as an appropriate option for lysis of pelvic adhesions in patients who have undergone a laparotomy or laparoscopy for the resection of endometriosis. It is usually scheduled 8 days to 6 weeks after the initial dissection. It allows separation of any remnant adhesions, which may still be filmy in consistency.

Laparoscopic Helium Plasma Coagulation

Laparoscopic helium plasma coagulation (Helica) is a more recent minimally invasive procedure in which the endometrial deposits are vaporized using an ionized beam of helium gas directed at the endometrial deposits.[19] However, presently there is lack of current evidence regarding the safety and efficacy of this procedure. Therefore, this procedure is used only under research settings. The presently available evidence does not suggest any major safety concerns associated with laparoscopic helium plasma coagulation for the treatment of endometriosis. (NICE, 2006). Until date, there has not been any comparative trial to measure the efficacy of ablation using Helica with that of other electrosurgical devices.

POSTOPERATIVE CARE

The postoperative care is similar to any other laparoscopic or laparotomy procedure. In case the patient is unable to conceive even after 1 year of active intercourse following surgery, IVF is the only option, which may help the patient conceive and this must be offered to her. Most clinicians do not recommend the use of postoperative hormonal therapy in patients suffering from pain, undergoing surgery for endometriosis. Presently, there is no evidence regarding the benefit of postoperative treatment with hormonal therapy in patients suffering from pain, undergoing surgery for endometriosis.[20-24]

ADVANTAGES

The advantages of using minimal invasive surgery such as laparoscopic surgery have been described in Chapter 32. Besides the general advantages of laparoscopic surgery, in case of surgery for endometriotic lesions, use of laparoscope is associated with the following advantages:

- High degree of magnification provided by laparoscope allows for better visualization of cul-de-sac and peritoneal surfaces.
- High degree of magnification also helps in identification of subtle disease.

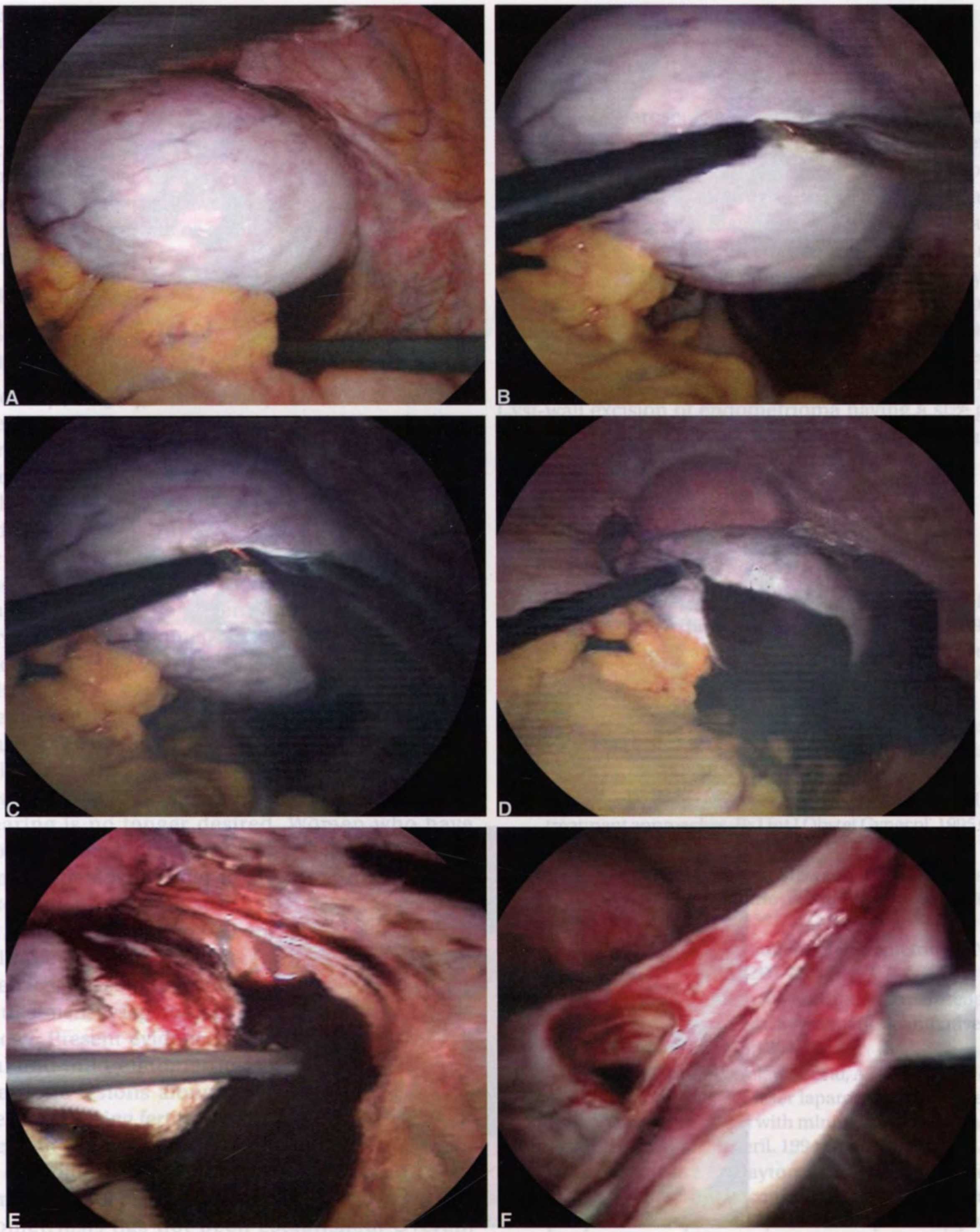
COMPLICATIONS

The following complications can occur in relation to the above-mentioned surgical procedures for infertility:[23,25]

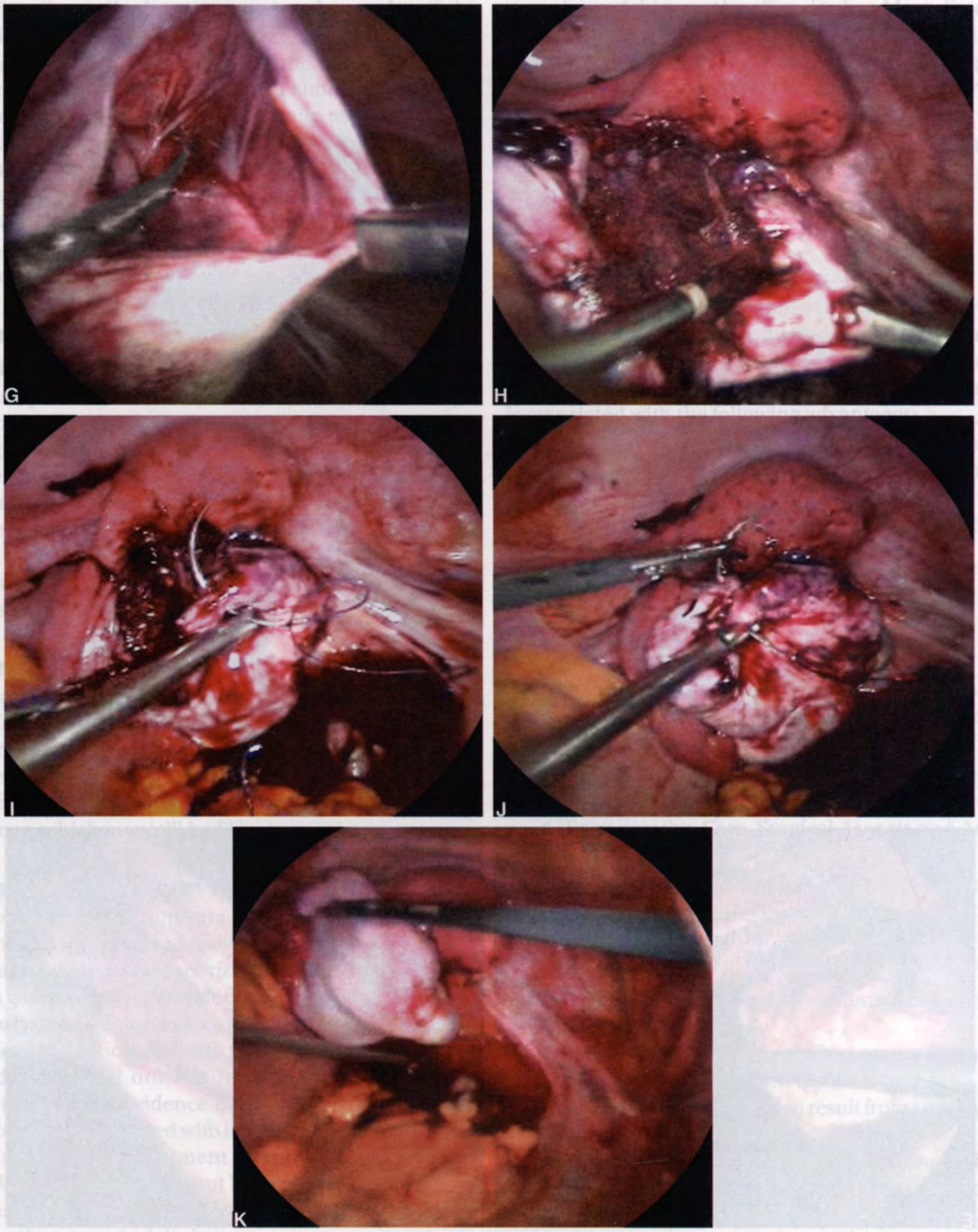
- Complications related to laparoscopy [refer to Chapter 32 (Diagnostic and Operative Laparoscopy)].
- Complications related to anesthesia [refer to Chapter 4 (Postoperative Care, Surgical Asepsis and Antibiotic Prophylaxis)].
- *Complications related to laparotomy:* A surgical intervention may result in complications such as difficulty emptying the bladder, wound infection, urinary infection, infection of the uterus and vaginal discharge.

Other complications related to endometriotic surgery are as follows:

- *Constipation:* Constipation often occurs when surgery is performed on or around the bowel.
- *Diarrhea:* Diarrhea may also result from surgery around or on the bowel.
- *Shoulder pain:* This may be due to pneumoperitoneum related to laparoscopic surgery. The gas used during surgery often gets trapped under the diaphragm, causing pain that radiate up to the shoulder.
- *Urinary tract infection:* Urinary tract infection is a common occurrence in cases where the bladder is catheterized prior to the surgery.
- *Phlebitis or irritated veins:* Inflammation of a vein can occur due to intravenous injection of drugs. This can result in redness, tenderness and swelling of the affected arm. Treatment usually comprises of heat compresses, analgesics for pain, and elevation of the affected arm.



Figs 27.14A to F



Figs 27.14G to K

Figs 27.14A to K: Laparoscopic cystectomy of an endometrioma cyst: (A) Endometrial cyst of the right ovary; (B) The cyst wall is punctured; (C and D) Contents of the endometrioma spilling into the pelvic cavity; (E) The spilled contents aspirated with the suction probe; (F) The cyst wall is separated and peeled off from the ovarian stroma; (G) The cyst has been completely removed from the ovarian stroma; (H) Any bleeding vessels from the stroma should be coagulated; (I and J) Suturing of the defect in the ovarian wall with a single layer of sutures to approximate the edges; (K) The reconstruction of the ovary is complete

- *Nausea and vomiting:* Nausea and vomiting can commonly occur after surgery as a result of the adverse effect of anesthetic medications and/or painkillers.
- Pain.
- *Infection:* All surgery is associated with some risk of infection. Some signs of infection include fever [oral temperature above 100°F (37.8°C)] or development of any redness, discharge or swelling (hematomas, seromas, etc.) at the incision site or occurrence of discharge per vaginum, etc.

DISCUSSION

Until recently, surgery in infertile patients with limited endometrial disease was thought to be no better than expectant management. However, according to the recent evidence, surgery has been found to significantly improve the fertility rates among infertile women with minimal or mild endometriosis.[11] When the diagnosis of endometriosis is made at laparoscopy, surgical ablation of the lesions is frequently performed. Surgical treatment improves pregnancy rate and is the preferred initial treatment for infertility caused by endometriosis. Surgery also appears to provide better long-term pain relief in comparison to the medical treatment. Infertile patients with documented endometriosis can also benefit from the reproductive techniques such as superovulation, in vitro fertilization, etc.[12] Bilateral oophorectomy and hysterectomy are treatment options for patients with intractable pain, if childbearing is no longer desired. Women who have undergone oophorectomy must be treated with estrogen replacement therapy in order to prevent the side effects related to premature menopause.

Two modalities found to be beneficial and supported by evidence-based medicine for the treatment of endometriosis-associated infertility are conservative surgical treatment by laparoscopy and assisted reproductive technology. Present evidence indicates that in cases of minimal and mild endometriosis, surgical ablation of endometriotic lesions along with adhesiolysis is very effective in improving fertility in about 40–70% cases, and improvement in fertility is inversely proportional to the severity of endometriosis. However, in moderate to severe cases, improvement of fertility rate after surgical treatment of endometriosis has not been established. Overall, pregnancy rate are highest 6–18 months after surgical treatment of endometriosis.

The treatment option of choice for an infertile couple must be made after taking into consideration various technical and nontechnical factors. Therefore, the treatment must be individualized for each patient. The information about success and complication rate of the various procedures must be explained to the patients before undertaking any kind of treatment intervention.

CONCLUSION

Diagnostic laparoscopy has now become the gold standard investigation of choice for the diagnosis of endometriosis. It is also useful for treatment of endometriosis. However, visual identification, although usually adequate, can lead to misdiagnosis, and histologic confirmation of at least one lesion is considered ideal. Besides removing the endometriotic lesions, the minimally invasive surgery is also useful in restoration of patient's fertility and in improving the woman's chances of conception. Complete ablation of endometriotic lesions help in reducing disease-related pain, enhancing fertility and reducing the chances of recurrence. Cyst-wall excision of endometrioma having a size greater than or equal to 2 cm is essential for reducing recurrence and providing better pain relief.

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28

CHAPTER

Surgery for Uterine Malformations

INTRODUCTION

Congenital uterine anomalies may arise from malformations at any step of the Müllerian developmental process. Buttram and Gibbons (1979) were the first ones to propose a classification system of the congenital uterine anomalies based on the degree of failure of the Müllerian ducts to develop normally.[1] The groups were decided based on the similarity of clinical manifestations, treatments and prognosis. This was revised and modified first in 1983 and then in 1988 by the American Society for Reproductive Medicine (ASRM) formerly known as the American Fertility Society.[2] This classification system, which is described in Figure 28.1 and Table 28.1, is now most widely accepted and is used worldwide. This classification system comprises of seven groups, some of which may have further subdivisions. In group I, agenesis and hypoplasia may involve the vagina, cervix, fundus, tubes or any combination of these structures. Mayer-Rokitansky-Küster-Hauser (MRKH) syndrome is the most common example belonging to this category.

In the cases of unicornuate uterus, only one of the paired Müllerian ducts is present, while the other one does not develop at all or even if it does develop, it is in a rudimentary state. In the patients with unicornuate uterus, when an associated rudimentary horn is present, this class is subdivided into: communicating type and noncommunicating type.

Communicating type: This includes the cases where there is an evidence of continuity with the main uterine cavity.

Noncommunicating type: This includes the cases where there is no continuity with the main uterine cavity.

The noncommunicating type is further subdivided on the basis of presence of an endometrial cavity in the rudimentary horn. These malformations are invariably accompanied by other abnormalities such as ipsilateral renal and ureter agenesis.

Bicornuate uterus occurs due to abnormality of the fusion process in the upper parts of Müllerian ducts. As a result, there is a single cervical canal in the lower part, but the upper part is bifurcated, having two horns. Complete bicornuate uterus is characterized by the presence of a uterine septum that extends from the uterine fundus up to the cervical os. In cases of partial bicornuate uterus, there is a septum, which is located at the fundus. In both variants, the vagina and cervix each have a single chamber.

A septate uterus shows the presence of a complete or partial midline septum within a single uterine cavity.

Uterus didelphys is characterized by the presence of a double uterus along with two separate cervices and a double vagina. This occurs due to the failure of the fusion of Müllerian ducts.

OVERVIEW OF SURGERY

Three main Müllerian abnormalities and their surgical corrections would be discussed in this chapter. These include: (1) class I (vaginal agenesis), (2) class IV abnormality (bicornuate uterus) and (3) class V abnormality (septate uterus).

The bicornuate uterus is formed when the Müllerian ducts incompletely fuse at the level of the uterine fundus. In this anomaly, the lower uterus and cervix are completely fused, resulting in two separate but communicating endometrial cavities, a single-chamber cervix and vagina. Adverse obstetric outcomes, such as preterm deliveries and

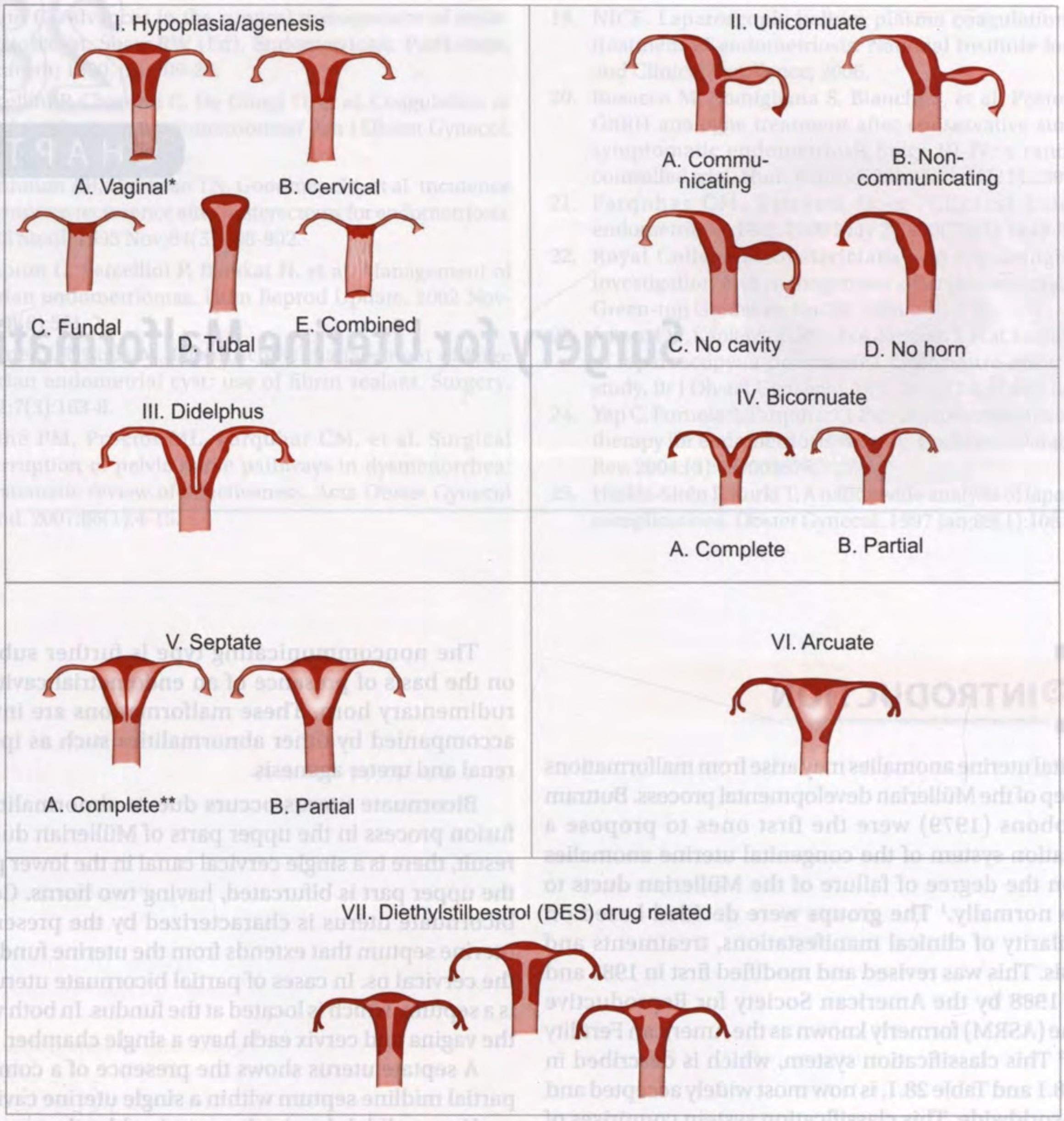


Fig. 28.1: Classification of the uterine anomalies by the American Society for Reproductive Medicine (1998)
*Uterus may be normal or take a variety of abnormal forms
**May have two distinct cervices
Source: Adapted from Reference 2

spontaneous abortions, may be related to the fact whether the bicornuate uterus is partial or complete.[3]

Septate uterus is the most common structural abnormality of all Müllerian duct defects.[4] It results from incomplete resorption of the median septum after complete fusion of the Müllerian ducts has occurred. The septum, located in the midline fundal region, is composed of poorly vascularized fibromuscular tissue. The septum could be of two types: partial and complete. The complete septum extends from the fundal area to the internal os and divides the endometrial cavity into two components. This anomaly is often associated with a longitudinal vaginal septum. The partial septum does not extend to the os and, therefore, may permit partial communication between the endometrial cavities. If there is presence of two separate cervices, this entity should be distinguished from the didelphys uterus because management of both the pathologies would be different. A complete septum would be removed hysteroscopically while no surgical intervention would be recommended for the uterine didelphys. Although septate uterus is not responsible for substantially compromising the patient's infertility, it is likely to be associated with the poorest reproductive outcomes amongst all the Müllerian duct anomalies.[5]

Table 28.1: American Society for Reproductive Medicine classification of congenital uterine anomalies

Classification	Clinical Finding	Description
I	Segmental or complete Müllerian agenesis or hypoplasia	♦ Vaginal ♦ Cervical ♦ Fundal ♦ Tubal ♦ Combined
II	Unicornuate uterus with or without a rudimentary horn	♦ With a communicating rudimentary horn ♦ With a noncommunicating rudimentary horn ♦ With a rudimentary horn and no cavity ♦ With an absent rudimentary horn
III	Didelphys uterus	Characterized by complete or partial duplication of the vagina, cervix and uterus
IV	Complete or partial bicornuate uterus	♦ Complete ♦ Partial
V	Complete or partial septate uterus	♦ Complete ♦ Partial
VI	Arcuate uterus	A small septate indentation is present at the fundus
VII	Diethylstilbestrol (DES) related abnormalities	Presence of a T-shaped uterine cavity with or without dilated horns

Vaginal agenesis is a defect, characterized by an absence or hypoplasia of the uterus, proximal vagina and, in some cases, the fallopian tubes.[6] This anomaly has been recently termed as Müllerian aplasia by the American Congress of Obstetricians and Gynecologists Committee Opinion. Müllerian aplasia is thought to occur in approximately 1 in every 5,000 newborn females. Müllerian aplasia can be partial or complete, of which the partial abnormality is more rarely encountered and is characterized by the presence of a normal uterus and a small vaginal pouch distal to the cervix. Complete Müllerian aplasia (also known as the MRKH syndrome) is the most commonly encountered variant and is characterized by congenital absence of the vagina and the uterus in 90–95% of cases.[7,8] The fallopian tubes are normal, and the ovaries have normal endocrine and oocyte function. Müllerian aplasia can either occur as an isolated finding or along with the presence of other associated anomalies like urologic abnormalities (15–40%), and skeletal anomalies, such as congenital fusion or absence of vertebra (12–50%). Some authorities have reported that mutations in either the anti-Müllerian hormone (AMH) or the Müllerian inhibitory substance (MIS) gene or its receptor gene are responsible for this disorder. The most common manifestation of Müllerian aplasia is primary amenorrhea.

INDICATIONS

The most common indications for repair of congenital uterine anomalies are as follows:
- Pelvic pain
- Repetitive pregnancy loss
- Dysmenorrhea in women with septate uteri may be considered an indication for hysteroscopic metroplasty if medical therapy is not effective.

INDICATIONS FOR VAGINOPLASTY

Indications for vaginoplasty are as follows:
- Complete absence of uterus and vagina (MRKH syndrome)
- Incomplete absence of uterus and vagina (with a transverse vaginal septum or a partially atretic vagina with an intact uterus)
- Testicular feminization syndrome or androgen insensitivity syndrome in cases where the vagina is incompletely developed
- Congenital adrenal hyperplasia where an ineffective suppression of Müllerian ducts results in the formation of ambiguous genitalia associated with small rudimentary uterus or a partially developed vagina
- Male to female sexual or gender reassignment surgery
- Patients whose vagina must be removed
- Patients with severe stenosis following irradiation therapy.

INDICATIONS FOR METROPLASTY

Metroplasty in cases of bicornuate and septate uterus is recommended only for those women who have experienced more than three recurrent spontaneous abortions, mid-trimester losses or premature births, and in whom no other etiologic factor for pregnancy wastage has been identified.

PREOPERATIVE PREPARATION

MÜLLERIAN APLASIA (VAGINAL AGENESIS)

Both surgical and nonsurgical methods of treatment have been used. The nonsurgical approach relies on the use of graduated dilators with progressively increasing size that help create a neovagina. Two methods of nonsurgical treatment are practiced: (1) active dilatation (Frank's method) and (2) passive dilatation (Ingram's method).[9] In Frank's method, the woman is asked to apply manual pressure to the fourchette with a dilator, twice a day for 15–20 minutes. In this method, dilators are placed against the fourchette and firm pressure is applied for up to 15 minutes twice a day or more often. Size of the dilators is gradually increased till a full length of vagina can be achieved. This method may take several months or a few years before a functional vagina is formed. Various nonsurgical methods, such as the use of intermittent pressure on the perineum, have shown the success rate of approximately 80%.

The Ingram's method, on the other hand, is based on passive dilatation where the woman is advised to wear a small mold and sit astride a special tool designed like a bicycle seat. Reasonable results have been reported with this method. However, surgery still remains the most effective method of treatment for Müllerian aplasia.

Choosing the Time for Surgery

Choosing the proper time regarding when to perform a vaginoplasty is of vital importance. Surgical treatment should be considered only when the patients are at least 17–20 years old and are emotionally and intellectually mature to be able to manage their vaginal mold. The patient should be mature enough to participate in the decision-making process. An alternative is to perform the procedure a few months prior to the patient's marriage in order to initiate regular sexual activity for the maintenance of the patency of the newly created vaginal cavity.

Patient Counseling and Motivation

Providing proper psychological support and counseling to the patient is an essential component of the preoperative evaluation. Many patients may be suffering from amenorrhea, as a result of which they may be facing many issues related to self-image and self-esteem. Additionally, these women are also likely to face problems such as inability to have sexual intercourse and infertility. These women need to be counseled that they can lead a near normal life. Undergoing the procedure of vaginoplasty would enable them to have sexual intercourse. Although they would be unable to conceive naturally, other reproductive options are available, which would enable them to have their biological offsprings. Since the ovaries are normal, oocyte harvesting can be conducted so that these women can have children with a surrogate woman.

Preoperative Investigations

Imaging modalities: The most commonly used imaging modality for confirmation of diagnosis is ultrasound examination. Ultrasonographic findings help in supporting the clinical findings by revealing the absence of uterus and fallopian tubes in the presence of normal ovaries. It also helps in differentiating between hematocolpos, hematometra, endometrial and other ovarian cysts and pelvic kidney. It also helps in scanning for other renal abnormalities. Magnetic resonance imaging (MRI) is another extremely useful but costly investigation. It helps in showing the absence of the vagina and uterus, thereby confirming the diagnosis of vaginal agenesis or hypoplasia. This imaging modality can also give picture of a rudimentary uterus and any coexisting renal abnormalities.

Hormone profile: The hormonal profile in these cases is similar to that of a normal female, having age-appropriate levels of luteinizing hormone (LH), follicle-stimulating hormone (FSH), estradiol and testosterone. The hormone profile helps in distinguishing the MRKH syndrome from androgen insensitivity syndromes, where the serum levels of testosterone is elevated. Other routine preoperative investigations, which must be performed in these cases include intravenous pyelography (IVP) and renal sonography to exclude urinary tract anomalies. Associated skeletal defects (vertebral abnormalities) can be detected by reviewing images from IVP radiographic studies.

METROPLASTY FOR BICORNUATE UTERUS

Preoperative Investigation Modalities

The most important step prior to surgery is to establish the correct diagnosis and to differentiate between the bicornuate and the septate uterus. It is important to differentiate between the two because the treatment strategies and reproductive outcomes of the two entities are markedly different. In fact, bicornuate uterus usually does not require surgery and is associated with minimal reproductive problems. The septate uterus, on the other hand, is associated with a high rate of reproductive failure. Moreover, the surgical correction of the septate uterus can be performed via a hysteroscope, which is a relatively easy surgery in comparison to abdominal metroplasy (Strassmann's metroplasty), which needs to be performed for the unification of bicornuate uteri.

The diagnostic modalities, which are commonly used to establish a definitive diagnosis, include hysterosalpingogram (HSG), hysteroscopy and laparoscopy. Ultrasonography and MRI are also useful investigations. Transvaginal ultrasonography is another useful investigation, which helps in diagnosing septate uterus. HSG helps in delineating a double-chambered uterus, assessment of the length and thickness of the septum and evaluation of tubal patency. However, the major limitation of HSG and hysteroscopy is that neither HSG nor hysteroscopy helps in distinguishing a septate uterus from a bicornuate one.[10,11] Both HSG and hysteroscopy cannot reliably distinguish bicornuate from septate uteri because both these entities show similar appearance of the uterine cavity, i.e. presence of a double uterus.

Laparoscopy is an investigation, which helps in reliably distinguishing between these entities by determining the fundal contour. The major difference between these two entities is the external anatomic appearance of the uterine fundus. The bicornuate uterus externally shows the presence of two horns, whereas the appearance of external fundus of the septate uterus is normal. Three-dimensional ultrasound also helps in showing the external appearance of uterus, thereby helping to differentiate between a bicornuate and a septate uterus.[12,13] MRI is another investigation, which helps in providing excellent tissue characterization and is reliably able to differentiate between a septate and a bicornuate uterus.

METROPLASTY FOR SEPTATE UTERUS

Surgery is recommended in case of septate uterus when this condition is thought to be responsible for producing poor reproductive performance. Traditionally, metroplasty for septate uterus was performed by abdominal route, using either Jone's or Tompkins procedure.[14] Nowadays, septum resection is usually performed through hysteroscopic route. The main advantage of hysteroscopic metroplasty is that it is a minimally invasive procedure. While cesarean section is mandatory after abdominal metroplasty, it is recommended only for obstetric indications after hysteroscopic metroplasty. Both these procedures would now be described. The preoperative preparation comprises of the following steps:

- *Deciding the time for surgery:* The ideal time for performing the surgery is when the endometrium is at its thinnest. This is likely to prevent excessive blood loss at the time of surgery. Some researchers recommend preoperative use of pharmacologic agents, such as progestins, danazol or gonadotropin-releasing hormone agonists, to reduce the thickness of the endometrium. This is also likely to help in visualizing the endometrium. Another group of researchers recommend scheduling the surgery during the early follicular phase of the menstrual cycle, when the endometrial thickness is already minimized.
- *Preoperative investigations:* The preoperative investigations described previously with Strassmann's metroplasty for bicornuate uterus need to be performed in order to establish an accurate diagnosis. Although urinary tract anomalies are not commonly associated with septate uterus, renal ultrasonography and/or IVP should be performed to help detect the presence of any concomitant anomalies.

SURGICAL STEPS

VAGINOPLASTY

Vaginoplasty is a major surgical procedure, which comprises of surgical creation of the neovagina. The strategy for vaginoplasty is to develop a space between the bladder and the rectum. In some approaches, a mold or form is placed in the newly created neovaginal space to ensure patency while healing occurs. One of the most commonly used vaginoplasty procedure is McIndoe's vaginoplasty. The principles of vaginoplasty are listed in Table 28.2.[15]

Table 28.2: The principles of vaginoplasty

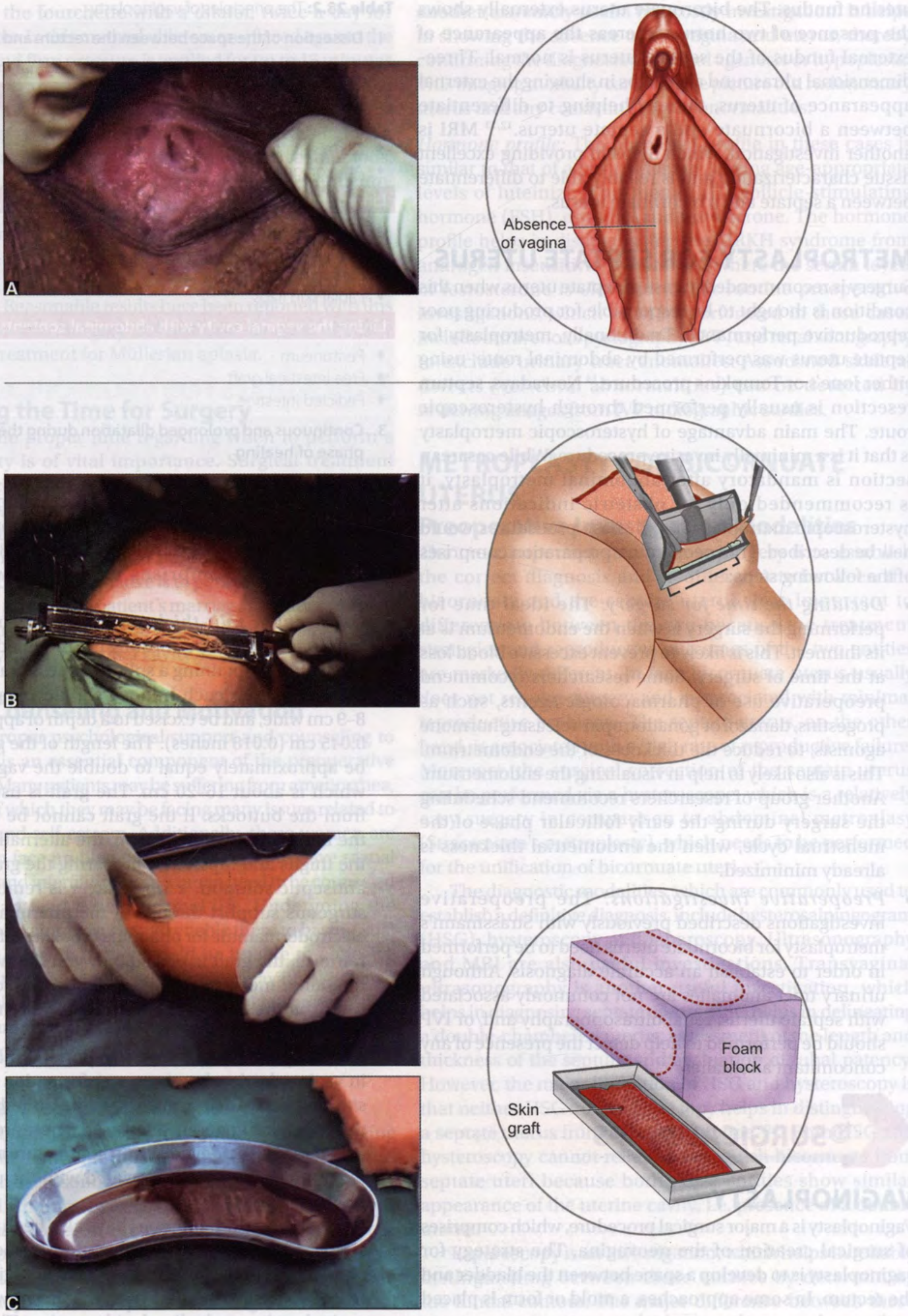
1. Dissection of the space between the rectum and the bladder
2. Use of split thickness skin graft and a vaginal mold
Lining the vaginal cavity with grafts:
• Split thickness skin grafts • Dermis grafts • Amnion grafts
Lining the vaginal cavity with flaps:
• Musculocutaneous flaps • Fasciocutaneous flaps • Subcutaneous pedicled skin flaps • Labial skin flaps
Lining the vaginal cavity with abdominal contents:
• Peritoneum • Free intestinal graft • Pedicled intestine
3. Continuous and prolonged dilatation during the contractile phase of healing

This surgery comprises of the following steps (Figs 28.2A to L):

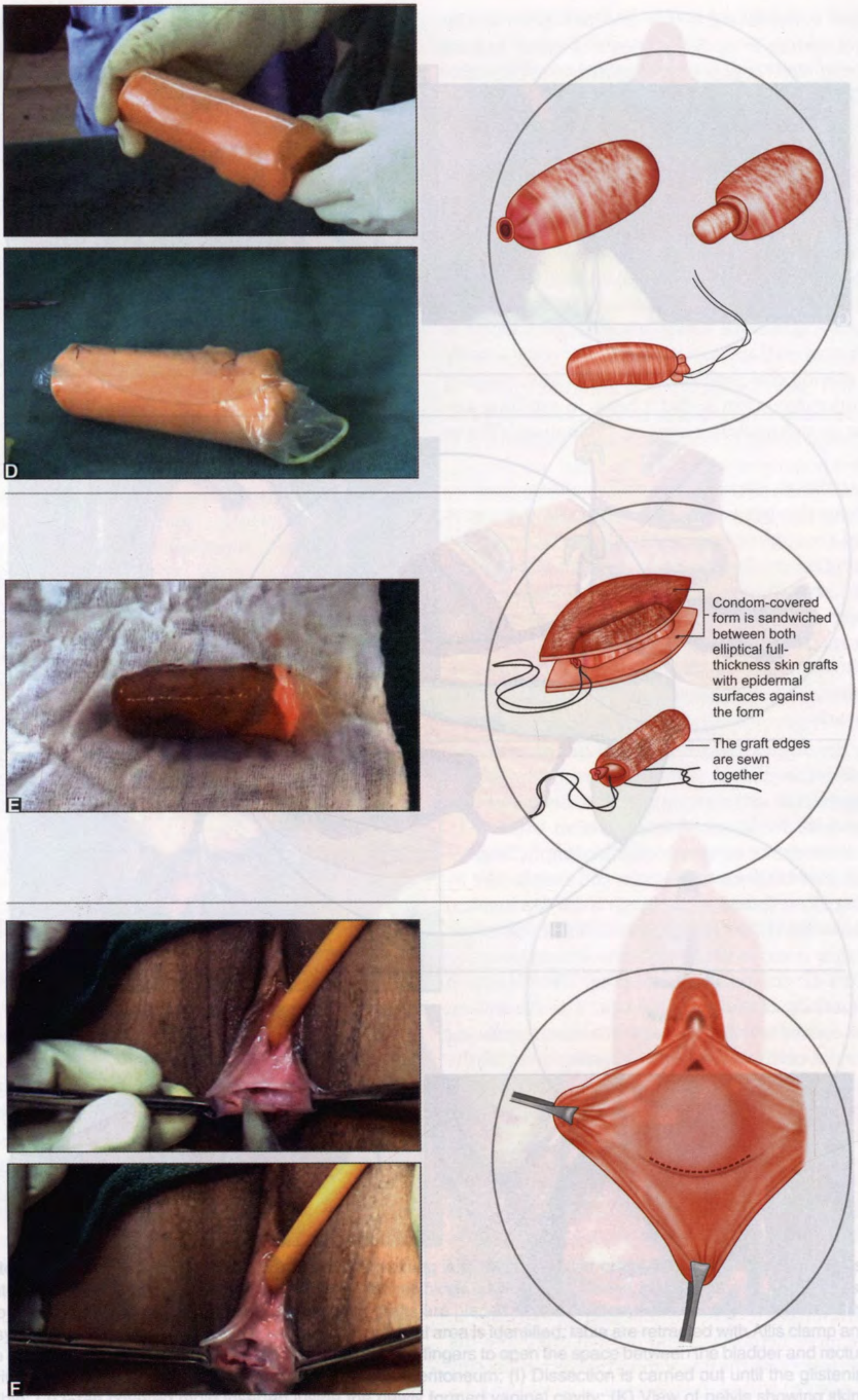
- *Obtaining a split-thickness graft*: One of the most important steps in performing the modified McIndoe's procedure is obtaining a split-thickness graft. The graft harvested from each buttock should measure about 8–9 cm wide, and be excised to a depth of approximately 0.045 cm (0.018 inches). The length of the graft should be approximately equal to double the vaginal depth, which is about 16–20 cm. The graft is usually taken from the buttocks. If the graft cannot be taken from the buttocks for some reason, the alternative sites are the thighs and hips. After preparing the graft site with antiseptic solution, a single layer is removed. Many surgeons support the use of the pneumatic Padgett electrodermatome for obtaining the skin graft. Following retrieval, the graft is placed between the two layers of the saline-moistened gauze and reserved for later use. After the dressing of the donor sites, the next step is performed.

  Skin graft remains the most popular material used in vaginoplasties; however, scar formation at the graft site has been a major concern. In the United States, full-thickness skin grafts are often used. These are associated with reduced incidence of graft contracture and stenosis in comparison to that associated with the use of split-thickness grafts.

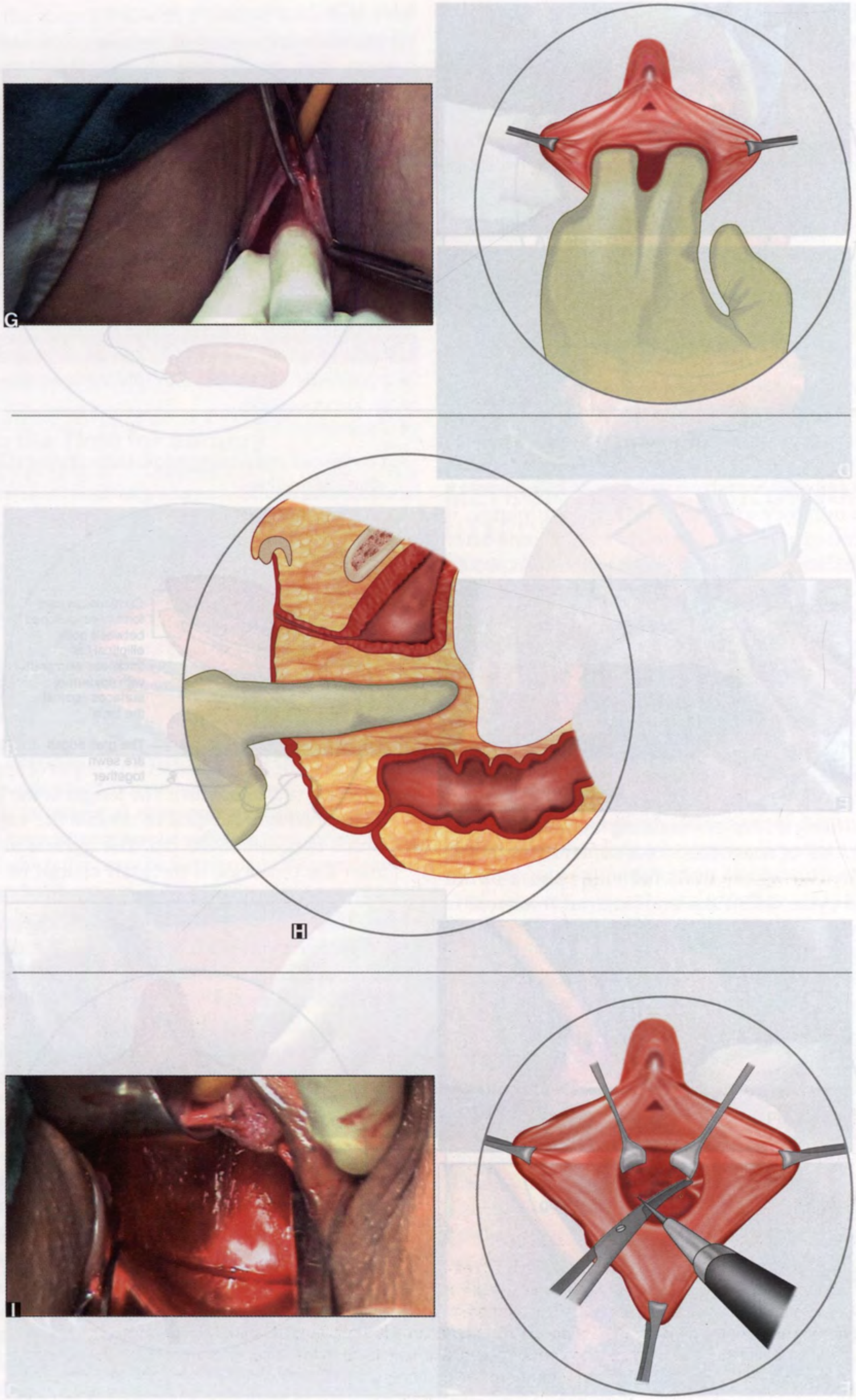
  A variety of other tissues have also been used as the source of graft. Human amnion, not stripped from the chorion, has been used as a graft for vaginoplasties. In these cases, instead of skin, the newly formed vaginal cavity can be lined with amnion. The amniotic



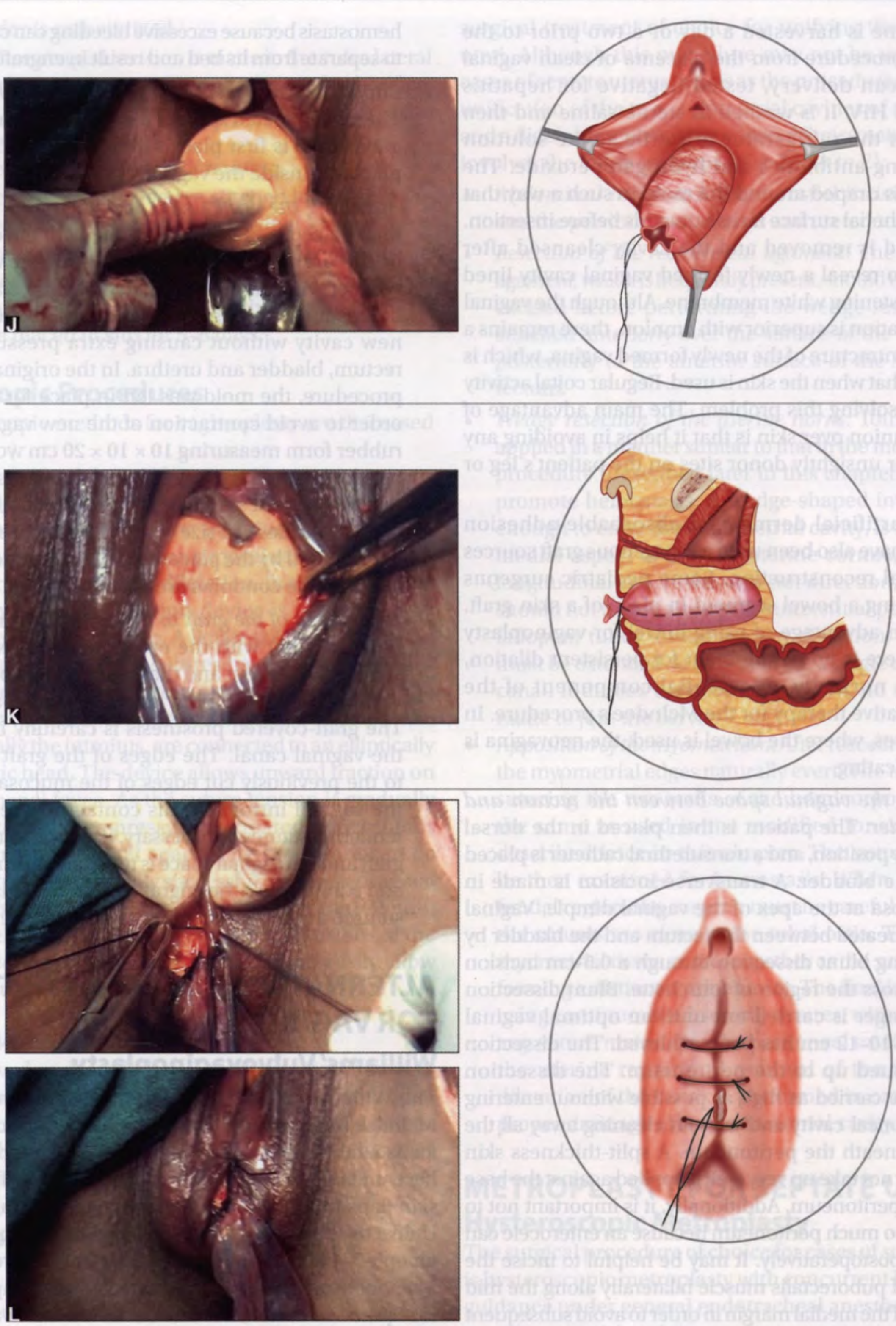
Figs 28.2A to C



Figs 28.2D to F



Figs 28.2G to I



Figs 28.2A to L: (A) Congenital absence of vagina; (B) Obtaining split thickness skin grafts from the buttock region using a Padgett electrodermatome; (C) Cutting out a vaginal form from a rubber block, skin graft is placed in a sterile pan filled with saline solution; (D) Vaginal forms are covered with a condom; (E) The skin grafts are placed over a condom covered vaginal form and the margins are sutured with synthetic absorbable sutures; (F) Dimple on the introital area is identified, labia are retracted with Allis clamp and a transverse incision made in the epithelium; (G) Blunt dissection performed with fingers to open the space between the bladder and rectum; (H) Sagittal section showing the dissection being carried out 2 cm from the peritoneum; (I) Dissection is carried out until the glistening peritoneum becomes visible; (J) Graft covered mold inserted inside the newly formed vaginal cavity; (K) View of pelvis showing skin covered form inserted in the newly created vaginal cavity; (L) Labia are sutured in the midline to hold the vaginal form in space

membrane is harvested a day or a two prior to the vaginal procedure from the placenta of clean vaginal or cesarean delivery, tested negative for hepatitis B, C and HIV. It is washed in sterile saline and then stored in the refrigerator in sterile saline solution containing antibiotics and hydrogen peroxide. The amnion is draped around the mold in such a way that its mesothelial surface faces outwards before insertion. The mold is removed and the cavity cleansed after 1 week to reveal a newly formed vaginal cavity lined with a glistening white membrane. Although the vaginal epithelization is superior with amnion, there remains a risk of contracture of the newly formed vagina, which is same as that when the skin is used. Regular coital activity helps in solving this problem. The main advantage of using amnion over skin is that it helps in avoiding any painful or unsightly donor sites on the patient's leg or buttocks.

The artificial dermis and absorbable adhesion barriers have also been used as exogenous graft sources in vaginal reconstruction. Some pediatric surgeons prefer using a bowel segment in place of a skin graft. The main advantage of using bowel for vaginoplasty is that there is no requirement for persistent dilation, which is normally an essential component of the postoperative therapy for the McIndoe's procedure. In these cases, where the bowel is used, the neovagina is self-lubricating.

- *Creating the vaginal space between the rectum and the bladder*: The patient is then placed in the dorsal lithotomy position, and a transurethral catheter is placed inside the bladder. A transverse incision is made in the mucosa at the apex of the vaginal dimple. Vaginal space is created between the rectum and the bladder by performing blunt dissection through a 0.5-cm incision made across the region of fourchette. Blunt dissection with a finger is carried out until an optimal vaginal length of 10–12 cm has been achieved. The dissection is continued up to the peritoneum. The dissection should be carried as high as possible without entering the peritoneal cavity and without cleaning away all the tissue beneath the peritoneum. A split-thickness skin graft may not take up very well if applied against the base of a thin peritoneum. Additionally, it is important not to expose too much peritoneum because an enterocele can develop postoperatively. It may be helpful to incise the margin of puborectalis muscle bilaterally along the mid portion of the medial margin in order to avoid subsequent narrowing of the vagina at the level of the urogenital diaphragm. This helps in enlarging the vaginal space. It is also important to achieve adequate hemostasis. In order to achieve hemostasis and prevent entry into the rectum, pressure with the finger must be exerted laterally and posteriorly. This is particularly important because the pressure application by the gauze is insufficient to achieve hemostasis because excessive bleeding can cause the graft to separate from its bed and result in engraftment failure.
- *Lining the newly created vaginal space with graft tissue*: The newly created space is then lined by graft tissue. The graft tissue is first placed over a suitable mold before placing it inside the vagina.
- *Attaching the graft tissue over the mold*: The graft is then placed over a suitable mold with the deep surface of the graft facing outwards so that it would be in contact with the newly created vaginal wall. It should be of sufficient length and width to fit snugly into the new cavity without causing extra pressure onto the rectum, bladder and urethra. In the original McIndoe's procedure, the mold was left in place for 3 months in order to avoid contraction of the new vagina. A foam-rubber form measuring 10 × 10 × 20 cm works well as a mold. The mold is sterilized, and the size is customized to fit the patient's vagina. The prosthetic material is cut to twice the desired size of the vagina, folded in half and compressed by the placement of two condoms over the surface. The condoms are tied at the open end.
- *Attachment of the graft to the mold*: The graft is placed over the stent with the epidermis approximating the surface of the stent and the dermis facing out. This graft is sutured over the form using 5-0 absorbable sutures. The graft-covered prosthesis is carefully inserted into the vaginal canal. The edges of the graft are sutured to the previously cut edges of the mucosal margins of the vaginal introitus. This contact is often adequate, rendering sutures unnecessary. If the contact between the graft and the vaginal space is too tight, serum may collect and compromise the engraftment. The labia minora are sutured around the stent using nonreactive sutures.

ALTERNATIVE SURGICAL STRATEGIES FOR VAGINOPLASTY

Williams' Vulvovaginoplasty

The Williams' vulvovaginoplasty is an alternative to the McIndoe's procedure.[16] This procedure is particularly useful for patients with previously failed vaginoplasty or patients who have undergone radical pelvic surgery. It uses full-thickness skin flaps from the labia majora to create a vaginal pouch. Unlike the McIndoe's procedure, vaginal dilation is required for only 3–4 weeks. Another advantage of this procedure over McIndoe's vaginoplasty is that it is technically simpler. No mold is required in these cases and hence the new vagina has no tendency to contract even though it is neither dilated nor used for natural coitus for sometime after the surgery. However, the vagina created by this approach is not anatomically similar to a normal vagina or the neovagina created by the McIndoe's procedure. Instead, the axis of the vaginal pouch is directly posterior and horizontal to the perineum. The procedure comprises of the next described steps:

- The bladder is catheterized.
- A horse-shoe shaped incision is made in the vulva lateral to the midline, passing superior to the urethral orifice. The base of the incision passes across the region of the fourchette in a gentle curve.
- Edges are freed by gentle undercutting.
- Internal edges of each side are stitched together in the midline with the knots inside the vaginal lumen.
- Finally, the internal skin margins are approximated with interrupted sutures. It should be possible to insert two fingers into the pouch up to a depth of 3 cm. Catheter should be placed in situ for 5-6 days.

Laparoscopic Procedures

Two laparoscopic methods for vaginoplasty are discussed next.

Vecchietti Operation

The Vecchietti operation was first introduced in 1965. This procedure can be considered as a surgical version of Frank's method of graduated vaginal dilatation. In this procedure, a specifically designed traction device is placed on the outer surface of the abdomen. A laparoscopy is performed and the device to which the sutures have been attached is inserted inside and allowed to course its way through the abdominal cavity. The sutures at their point of termination, which is usually the introitus, are connected to an elliptically shaped plastic bead. The device allows upward traction on the retrohymenal fovea. As the suture tension is gradually increased, continuous pressure is created which helps in lengthening the vaginal space. The procedure can be considered to be anatomically successful when a neovaginal space approximately 6 cm long has been created. Within approximately 6 months of surgery, the dimensions of the newly created vagina must be such that it can easily allow the introduction of two fingers.

Peritoneal Mobilization

In 1969, Davydov described a laparotomy procedure in which peritoneum from the uterorectal space is advanced so as to create a neovaginal canal. Laparoscopic modifications were later developed in order to mobilize the bladder peritoneum.

METROPLASTY FOR BICORNUATE UTERUS

Bicornuate uterus rarely requires surgical reconstruction. Surgery in the form of metroplasty in cases of bicornuate uterus is recommended only for those women who have experienced more than three recurrent spontaneous abortions, midtrimester loss or premature births, and in whom no other etiologic factor for recurrent miscarriages has been identified.[17-23] Although a number of metroplasty procedures are available, the Strassmann procedure is the surgical treatment of choice for unifying the bicornuate uteri. Although this procedure may not be very useful in cases of septate uterus, it acts as the procedure of choice for unification of the two endometrial cavities of a bicornuate and a didelphic uterus. The modified Strassmann procedure involves the following steps (Figs 28.3A to E):

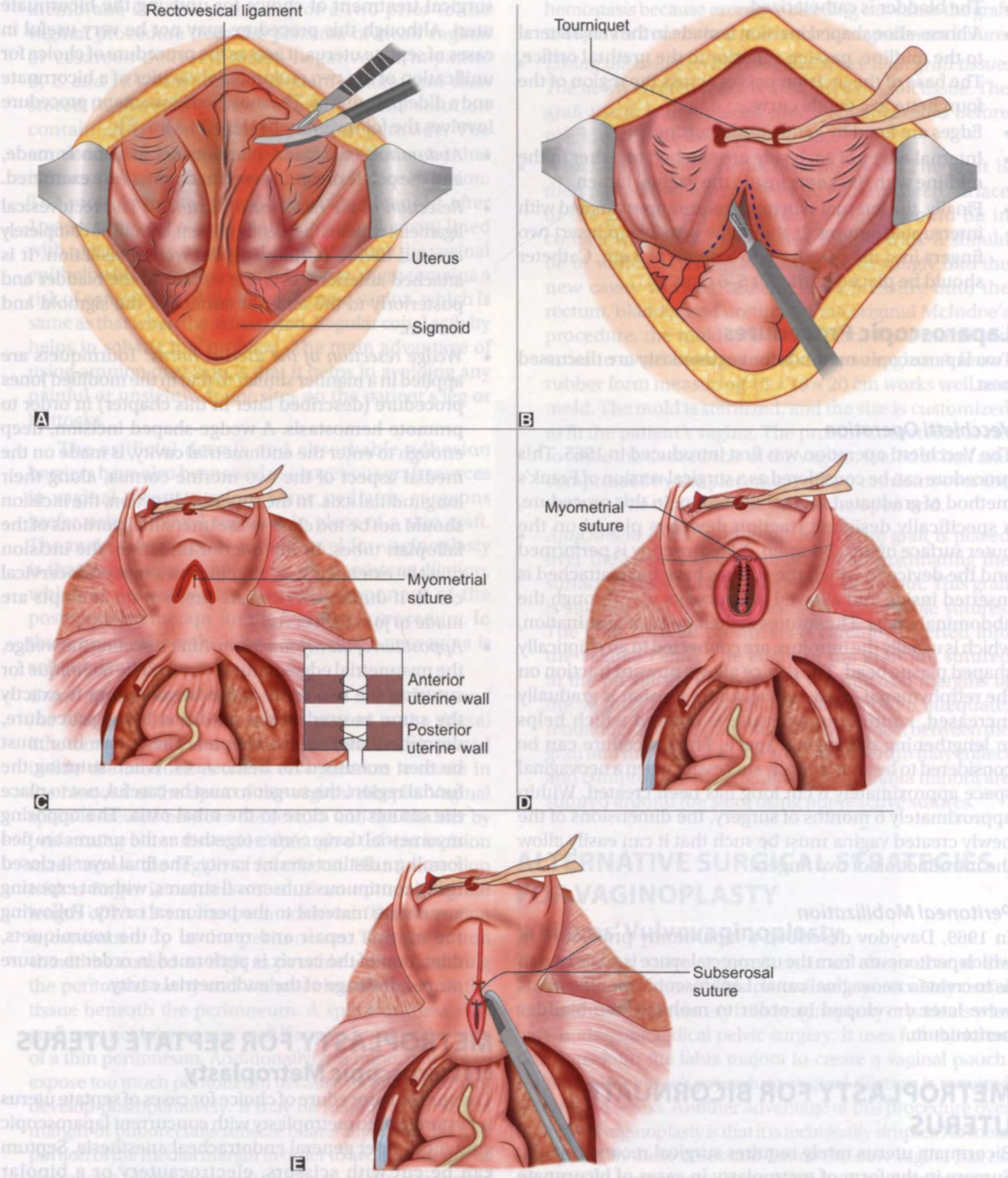
- *Abdominal incision*: A Pfannenstiel incision is made, and the pelvic organs, vessels and ureters are examined.
- *Resection of the rectovesical ligament*: The rectovesical ligament, which is frequently present, should be completely excised before performing the wedge resection. It is attached anteriorly over the surface of the bladder and posteriorly to the anterior surface of the sigmoid and rectum.
- *Wedge resection of the uterine horns*: Tourniquets are applied in a manner similar to that in the modified Jones procedure (described later in this chapter) in order to promote hemostasis. A wedge-shaped incision, deep enough to enter the endometrial cavity, is made on the medial aspect of the two uterine cornua, along their longitudinal axis. In the superior direction, the incision should not be too close to the interstitial portions of the fallopian tubes. In the inferior direction, the incision must be extended so as to achieve a single endocervical canal. If duplex cervices are present, no attempts are made to join the cervix.
- *Apposition of the myometrium*: After resecting the wedge, the myometrial edges naturally evert. The technique for suturing the two walls of the hemicorpora is exactly the same as used in the modified Jones procedure, described later in this chapter. The suture line must be then examined for hemostasis. When suturing the fundal region, the surgeon must be careful, not to place the sutures too close to the tubal ostia. The opposing myometrial tissue comes together as the sutures are tied forming a distinct uterine cavity. The final layer is closed using continuous subserosal sutures, without exposing any suture material to the peritoneal cavity. Following the uterine repair and removal of the tourniquets, dilatation of the cervix is performed in order to ensure proper drainage of the endometrial cavity.

METROPLASTY FOR SEPTATE UTERUS

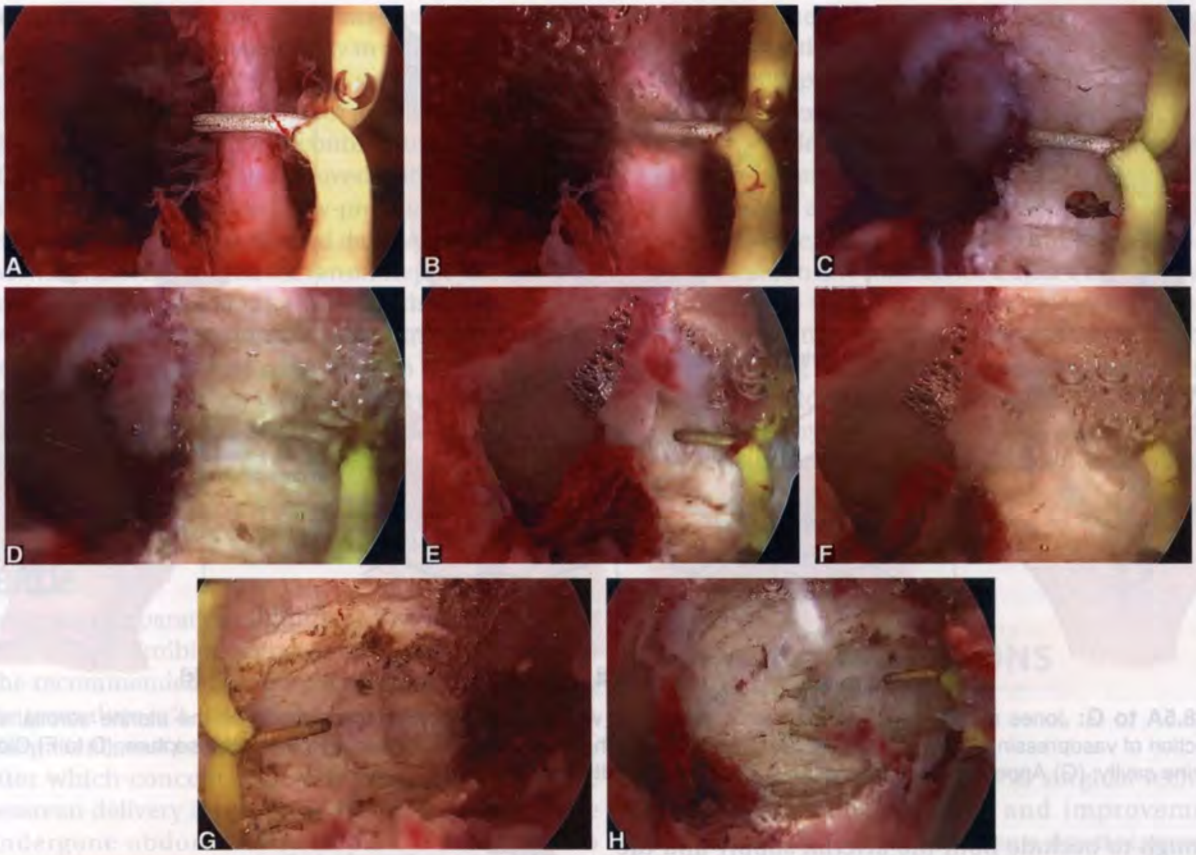
Hysteroscopic Metroplasty

The surgical procedure of choice for cases of septate uterus is hysteroscopic metroplasty with concurrent laparoscopic guidance under general endotracheal anesthesia. Septum can be cut with scissors, electrocautery or a bipolar vaporizer (Versapoint). Concomitant laparoscopy at the time of hysteroscopic resection helps in reducing the risk of uterine perforation at the time of septal incision. The procedure comprises of the following steps (Figs 28.4A to H):

- The uterus is first distended using dextran 70 or Hyskon via a resectoscope, which is inserted inside the cervix.



Figs 28.3A to E: (A) If a rectovesical ligament is present, it should be removed; (B) Incision made on the medial side of each hemicorpora. The incision should be deep enough so as to enter the uterine cavity; (C and D) Approximating the myometrium using the interrupted vertical figure-of-eight polyglycolic acid sutures; (E) Serosa is stitched using continuous polyglycolic acid subserosal sutures



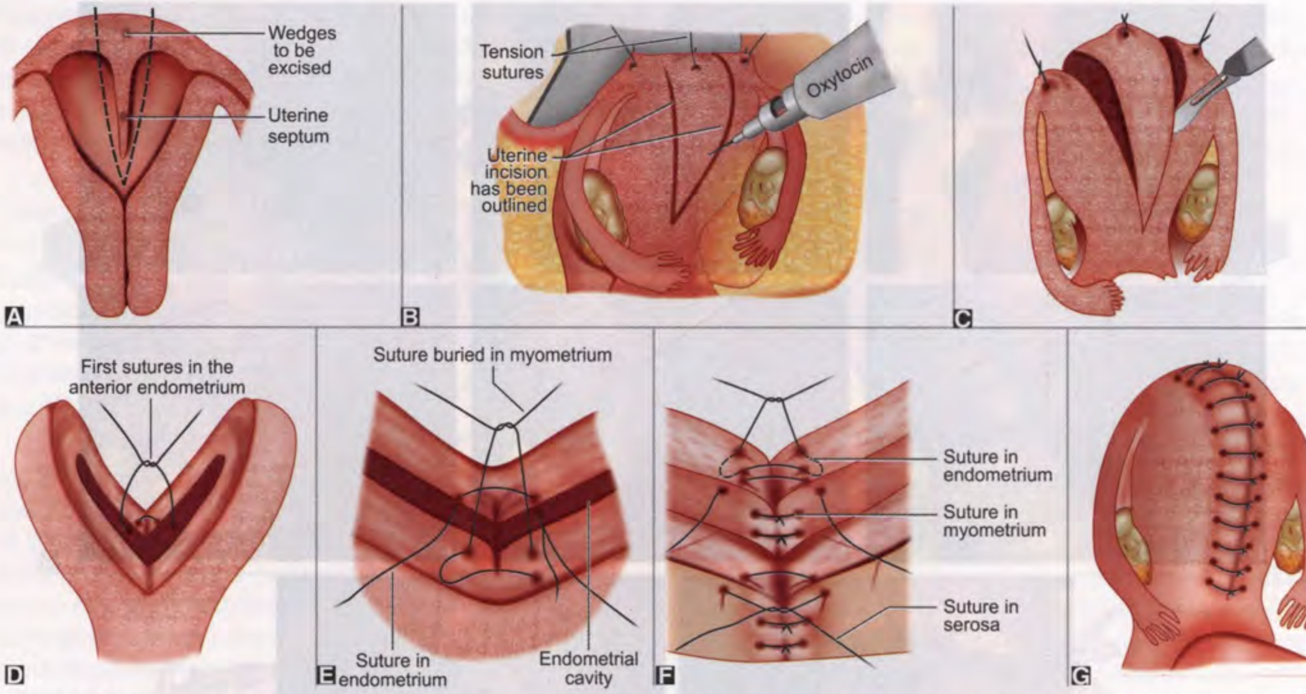
Figs 28.4A to H: Hysteroscopic resection of the uterine septum: (A) Hysteroscopic appearance of the uterine septum; (B to G) The resectoscope loop transecting the uterine septum; (H) Resection of the uterine septum is almost complete

- Using microscissors, electrosurgery or a laser, the surgeon can perform operative hysteroscopic metroplasty. When electrosurgical resectoscope is used for cutting the uterine septum, the septum is incised electrosurgically by advancing the cutting loupe and using the trigger mechanism of the resectoscope. When microscissors are used, flexible microscissors are passed through the operating channel of the hysteroscope.
- The inferior aspect of the septum is identified, and the septum is progressively dissected until a cavity with a normal-appearing contour is attained.
- When the septum is 3 cm or less at the fundus, the incision can be carried in the upward direction from the most inferior aspect of the septum and aimed laterally as the superior most aspect of the uterus is approached. When the septum is greater than 3 cm at the fundus, the incision is started at the most inferior portion of the septum. The scissors are directed superiorly along one lateral margin of the septum until that margin is incised up to 0.5 cm from the junction of the septum and normal myometrium. The opposite lateral margin is similarly incised.
- This process is repeated until the original V-shaped septum has been reconfigured into a short, broad notch between the tubal ostia. The notch is incised by starting near the tubal ostia and progressing to the opposite ostia.
- Dissection of the septum is done until the hysteroscope can be moved freely from one tubal ostium to the other without obstruction, and the tubal ostia can be visualized simultaneously.
- Laparoscopic visualization is done simultaneously in order to limit the risks of uterine perforation. After switching off the light of the laparoscope, the surgeon observes the serosal surface of the uterus for the presence of tissue blanching or localized light emanating from the hysteroscope. Occurrence of either of these signs must be taken as an indication that the hysteroscope has come close to the uterine surface.
- If arterial bleeding occurs, selective coagulation can be performed with a 7F ball-tipped electrode.

Modified Jones Metroplasty

This surgery comprises of the following steps (Figs 28.5A to G):

- *Abdominal incision*: The abdomen is opened through a transverse incision.
- *Controlling the bleeding*: Two methods to control the bleeding can be used during the procedure. In the first, a tourniquet is applied at the junction of the lower uterine segment and the cervix. A tourniquet is placed around the lower uterine segment and tied anterior to the uterus. All the tourniquets must be tied tightly



Figs 28.5A to G: Jones metroplasty: (A) Diagram outlining the wedge shape incision to be made on the uterine serosal surface; (B) Injection of vasopressin to ensure hemostasis; (C) Excision of the uterine wedge containing most of the septum; (D to F) Closure of the uterine cavity; (G) Appearance of the uterine surface following the closure

enough to occlude both the arterial supply and the venous drainage from the uterus. The second method of hemostasis involves the use of vasopressin diluted in saline into the anterior and posterior walls of the uterus. The uterine septum is surgically excised in the form of a wedge.

- *Uterine incision*: The incision should begin at the fundus of the uterus. The incision at the top of the fundus is usually within 1 cm or less of the insertion of the fallopian tubes.
- After the uterine wedge has been removed, the uterus is closed in three layers with interrupted stitches. The innermost layer of stitches includes about one-third of the thickness of myometrium and must also include the endometrium. If a double cervix is present, the surgeon must not try to unify the cervix because this may result in the development of an incompetent os.

Tompkins Procedure

In Tompkins procedure, the uterine corpus and the septum is divided with the help of a single median incision. The incision is carried inferiorly, until the endometrial cavity is reached. Each lateral septal half is then incised to within 1 cm of the tubes. No septal tissue is removed. The myometrial tissue is then reapproximated. The procedure is believed to be simpler than the Jone's procedure mainly because nearly all myometrial tissue is conserved by this procedure. It is supposed to provide better results in comparison to the Jone's metroplasty.

POSTOPERATIVE CARE

VAGINOPLASTY

Meticulous postoperative care is required, irrespective of the technique and comprises of the following steps:

- The patient is prescribed antibiotics and a low-residue diet.
- She is gradually allowed to ambulate within 24 hours after surgery in order to prevent the risk of thromboembolism. However, she must be advised bed rest in upright and flat positions for at least 1 week postoperatively.
- The suprapubic catheter can be removed when it appears that the patient would be able to void properly.
- One week after surgery, the labial sutures are removed, and the mold is carefully removed with the patient under mild sedation. The newly created vaginal cavity is inspected for healing and progress of epithelization. The patient is demonstrated how to reinsert the mold so that she can continue to dilate the neovaginal cavity all by herself following discharge. The patient is instructed to continue dilatation of the neovagina, 4–6 times a day for a time period of approximately 45 minutes per day. Initially, the dilatation may appear burdensome, aching and tender. However, over a period of time, the dilatation becomes relatively easier and less painful.
- The patient can be advised to attempt vaginal sexual intercourse as early as 6–8 weeks. She should be advised

to practice regular sexual intercourse because the newly created vagina has the tendency to undergo shrinkage in the absence of either regular sexual intercourse or alternative artificial dilatation of neovagina.

- The mold should be worn continuously for a period of 6 weeks and must be removed only at the time of urination and defecation. Low-pressure douches with warm water must be performed daily. At the same time, the mold must be cleaned with an antiseptic solution (e.g. povidone-iodine solution), covered with a fresh condom and then reintroduced into the neovagina. After 6 weeks, the rubber mold can be replaced with a silicone form, which is inserted nightly for the next 12 months. In most of the cases, the vagina becomes functional 6–10 weeks after surgery.

METROPLASTY FOR BICORNUATE UTERUS

Postoperative preparation comprises of the following steps:

- Prophylactic antibiotics are continued postoperatively.
- The recommended duration of hospital stay following the procedure is 2–3 days.
- The patient must use barrier contraception for 3 months, after which conception can be attempted. Elective cesarean delivery is recommended in those who have undergone abdominal metroplasty. Patients who have undergone metroplasty through hysteroscope or resectoscope can deliver vaginally.

METROPLASTY FOR SEPTATE UTERUS

Postoperative care in patients who have undergone metroplasty for septate uterus comprises of the following steps:

- Most patients can be discharged after few hours following the procedure.
- *Postoperative placement of an intrauterine device*: There is no evidence supporting the role of placing an intrauterine contraceptive device (IUCD) postoperatively. Postoperative placement of an intrauterine device for a month is controversial. While some researchers feel that use of IUCD may help to prevent the development of intrauterine adhesions, most experts still believe that this procedure is unnecessary and may provoke local inflammation with subsequent synechiae formation.
- *Antibiotics*: Most experts do not recommend routine prescription of antibiotics following the procedure. Despite the lack of any strong evidence, antibiotics are commonly administered before the procedure and up to 5 days after the surgery in order to limit the risks of infection.
- *Hormonal therapy*: Hormonal therapy is usually prescribed postoperatively to promote rapid epithelialization of the uterine endometrium. Conjugated estrogens in the dosage of 1.25 mg/day for 25 days and progesterone in the dosage of 10 mg/day on days 21–25 are frequently prescribed after surgery to promote the process of epithelialization.
- *Control of excessive postoperative bleeding*: In case of excessive bleeding postoperatively, a Foley's catheter can be placed inside the uterine cavity to achieve tamponade and is usually removed within 4–6 hours.
- *Follow-up examination*: A postoperative follow-up examination is recommended after 1 month of surgery. During this visit, either hysteroscopy or HSG can be performed to assess the status of the uterine cavity. After undertaking abdominal metroplasty, the patient must be advised to delay conception for atleast 4–6 months. Even after hysteroscopic septum resection, a delay of 2 months is advisable before attempting pregnancy. During this period, complete resorption of the septum occurs. Vaginal delivery can be sometimes undertaken in these cases.

COMPLICATIONS

VAGINOPLASTY

Nowadays, due to refinements in surgical techniques, greater surgical experience, and improvements in postoperative care, there has been a drastic improvement in the surgical outcomes of vaginoplasty and a reduction in the rate of complications. Patient satisfaction rates vary between 80% and 100%. Some commonly encountered problems include postoperative infection, hemorrhage and graft failure. Contracture of the graft and the development of excessive granulation tissue sometimes occur. Vaginal stenosis is the most significant complication of vaginoplasty. Nondilatation over a long period of time can result in shrinkage of vagina both in terms of diameter and length. Failure of primary surgery can result in infection and formation of fibrotic vaginal bands. Serious complications, which can sometimes occur, include postoperative fistula formation and rarely enterocele. There have also been cases reporting the occurrence of primary malignancy in the neovagina. Due to this, yearly Pap smears are recommended as part of long-term follow-up care.

METROPLASTY

Complications include those found in any other gynecologic surgery such as bleeding, infection, and injury to the bowel and bladder.

Uterine perforation may sometimes occur with hysteroscopic metroplasty. However, simultaneous laparoscopy along with hysteroscopy reduces the risk of perforation and can help in providing early identification of the perforation in case this complication actually occurs. Recently, ultrasound is being used for precise preoperative measurement of the septum, which can easily be distinguished from the myometrium. This enables continual monitoring of the operation, so that an extremely precise decision can be made about when to stop resecting the septum so that the myometrium is not affected. Preoperative treatment with danazol or luteinizing hormone-releasing hormone (LHRH) antagonists helps in reducing bleeding at the time of resection.

The cervical injuries are likely to result during the procedure of instrumentation. Postoperative hemorrhage has also been reported. Uterine rupture during subsequent pregnancies may occur and present as a potentially serious complication. Residual septa and synechiae have also been reported to occur following septal resection.

DISCUSSION

A high prevalence of congenital uterine anomalies has been observed in women with the history of recurrent miscarriages. Such women should be thoroughly investigated for the presence of congenital uterine anomalies. Various investigations, which can be performed to establish the initial diagnosis, include hysterosalpingography and two-dimensional ultrasound examination. The diagnosis can be confirmed with the help of investigations such as combined hysteroscopy and laparoscopy, three-dimensional ultrasound examination, MRI examination, etc.

Transabdominal metroplasty can substantially improve the reproductive performance of women with bicornuate uterus who had recurrent spontaneous abortions or premature deliveries before surgery. Although the correction of congenital uterine anomalies has been observed to improve reproductive outcome among women with recurrent miscarriage, the role of correction of these anomalies in women with infertility presently remains unclear.

Hysteroscopic metroplasty with concurrent laparoscopy is the treatment of choice for symptomatic septate uterus. This approach is a safe and effective method of achieving normal or near-normal uterine architecture. Moreover, the hysteroscopic approach is superior and safer to the transabdominal approach; is associated with considerably reduced rate of mortality and morbidity; is associated with a reduced risk of postoperative adhesion formation; is cost-effective; can be performed as an outpatient procedure; is associated with a rapid postoperative recovery and it allows for vaginal delivery, thereby obviating the requirement for cesarean delivery during subsequent pregnancies.

CONCLUSION

Müllerian anomalies are a morphologically diverse group of developmental disorders that involve the internal female reproductive tract. It is important for the gynecologist to establish an accurate diagnosis in order to plan adequate treatment and management strategies. The surgical approach for correction of various Müllerian duct anomalies needs to be individualized; taking into account various factors such as patient's age, desire for future fertility, desire to have healthy sexual relationships and achievement of successful reproductive outcomes. Strassmann's metroplasty, a procedure used for the unification of a bicornuate uterus, must only be considered in selective cases with bicornuate uterus, who experience recurrent pregnancy loss or preterm delivery. In patients with Müllerian agenesis, vaginal dilatation must be the first line of treatment for the creation of a neovagina. The McIndoe's vaginoplasty can also be considered as a safe and effective procedure for the surgical creation of a neovagina in cases where simple vaginal dilatation fails to be successful. This is a highly successful procedure, which is associated with high rate of patient satisfaction. Although patients would be unable to conceive naturally, except through the use of surrogates, they are at least able to have normal sexual relations. Hysteroscopic metroplasty can be considered as a successful, minimally invasive technique for the removal of a uterine septum. Resection of the uterine septum helps in improving pregnancy success rates in patients with previous history of recurrent pregnancy loss.

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CHAPTER 29

Surgery for Cancers

INTRODUCTION

A wide variety of gynecologic cancers can affect a woman's reproductive system: the uterus, vagina, ovaries, fallopian tubes and vulva. Gynecologic cancers have a potential to invade nearby tissues and organs or metastasize through the lymphatic system or the bloodstream to distant parts of the body. Though the general gynecological surgeons may be able to treat the patients with cancer, the actual expertise for care for such patients rests with gynecologic-oncologists. Gynecologic-oncologists are directly involved in all aspects of their patient's care, including surgery, chemotherapy, radiation therapy and supportive services. The woman's treatment options are determined on the basis of the specific cancer type and its stage. Women with early stage gynecologic cancer are often treated with hysterectomy. In this chapter, the surgical management of cancers, which have been covered, includes cervical cancer, endometrial cancer, ovarian cancer and vulvar cancer.

Endometrial cancer develops from the lining of the uterus, also known as the endometrium. It is the most common gynecologic cancer and the fourth most common cancer among women. Approximately 1 in every 50 women is likely to get affected with the endometrial cancer. The most common symptom associated with endometrial cancer is abnormal uterine bleeding.[1] Endometrial cancer usually affects women after menopause, commonly in the age group of 50–65 years. The most important risk factor for endometrial cancer is hyperestrogenism.

Cervical cancer develops from the cervix. Cervical cancer usually results from infection with the human papillomavirus (HPV) transmitted at the time of sexual intercourse. This cancer may result in abnormal bleeding, such as irregular vaginal bleeding, postcoital bleeding, bleeding in between periods, etc. Papanicolaou (Pap) test is a screening test, which helps in detecting cervical abnormalities at an early stage. Regular testing with Pap smears and HPV vaccination can help prevent cervical cancer. This cancer usually affects women aged 35–55 years, but it can also affect women as young as 20 years of age. Some risk factors for cervical cancer are young age at the time of first sexual intercourse, having multiple sexual partners, history of smoking cigarettes and having disorders of immune system (e.g. AIDS).

Ovarian cancer usually does not cause symptoms, until it is large or is in an advanced stage. This type of cancer develops most often in women aged 50–70 years. In the United States, it is the second most common gynecologic cancer. However, cancer of the ovaries has the worst prognosis in comparison to any other type of gynecologic cancer. As a result, it is the fifth most common cause of cancer deaths in women. Some of the risk factors for ovarian cancer include old age, nulliparity, having the first child late in life, early menarche, late menopause and family history of cancer of the uterus, breast or large intestine. There are many types of ovarian cancer. Nearly 80% of the cancers are epithelial cell cancers, which begin from the surface epithelium of the ovaries. Other types of ovarian cancers include the germ cell tumors or the stromal cell tumors. The ovarian cancer is one of the most aggressive types of cancers, which can spread directly to the surrounding tissues and through the lymphatic system to other parts of the pelvis and abdomen. It can also spread through the bloodstream to the distant body organs, mainly the liver and lungs.

Many women with ovarian cancer may not have any symptoms, until the cancer is in an advanced stage.

Moreover, if the symptoms do appear, they may be vague such as lower abdomen discomfort, indigestion, bloating, loss of appetite, backache, etc. Ovarian cancer rarely causes vaginal bleeding.

Vulvar cancer affects the vulva, an area of external female genitalia. In the United States, cancer of the vulva is the fourth most common gynecologic cancer, accounting for 3-4% of these cancers.[2] The most common histological subtype of vulvar cancer is squamous cell cancer. Vulvar cancer usually occurs after menopause. The average age at diagnosis is 70 years. The main risk factor for developing vulvar cancer is the presence of precancerous/dysplastic changes, lichen sclerosus, etc. in the vulvar tissues. Microinvasive carcinoma of vulva can be described as lesions less than or equal to 2 cm with less than 1 mm of stromal invasion. When the degree of stromal invasion is greater than 1 mm, there is a high probability of lymph node metastasis. In 50% of cases, presentation is in the form of a lump or a mass along with a long standing history of pruritus, which may be related to vulvar dystrophy. In 60% of the cases, the lesion is in labia majora; 20% of the cases in labia minora; 12% cases in the clitoris and 6% cases in the perineum. The vulvar cancer can spread by direct extension to the adjacent structures, such as vagina, urethra and anus, by lymphatic route to adjacent lymph nodes and via hematogenous route to distant organs such as lungs, liver and bone. Lymphatic metastasis occurs early in the disease and most commonly occurs to the inguinal group of lymph nodes. From here, the spread can occur to the femoral group of lymph nodes. Depending on the extent and type of the cancer, vulvectomy is performed. Lymphadenectomy may be also done depending upon the involvement of lymph nodes. For early stage cancers, such treatment is usually all that is required. However, for more advanced cancers, radiation therapy, along with cisplatin is usually required. After the removal of the cancerous tissues, surgical reconstruction of the vulva and vagina may be performed.

OVERVIEW OF SURGERY

In case of early stage endometrial, cervical or ovarian cancer, hysterectomy is the main treatment option. Hysterectomy is the second most common surgical procedure for women in the United States. The type of hysterectomy to be performed usually depends on the type and the extent of the cancerous growth and the previous medical history of the patient. Traditional hysterectomy for gynecologic cancers is performed using an open abdominal surgery, requiring a long vertical incision, extending from the pubic bone to just above the umbilicus. Hysterectomy can be performed by either vaginal or abdominal route, details of which have been described in Chapter 24 (Hysterectomy). For gynecological cancers, the uterus is usually removed through an incision in the lower abdomen. Due to advances in the technology, nowadays, hysterectomy is also performed using laparoscopic or robotic routes.

Radical Hysterectomy

The entire uterus plus the surrounding tissues, ligaments and lymph nodes are removed in cases of cervical cancer. Both fallopian tubes and ovaries are usually also removed in women older than 45 years. [Several types of radical hysterectomies can be employed for cervical cancer, which have been summarized in Table 29.1. The type of hysterectomy to be performed usually depends on the cervical cancer type and its stage.]

AIMS OF SURGERY

The surgical treatment for gynecological cancer usually aims at the surgical removal of the tumor. In case of cervical or endometrial cancer, it involves the removal of the uterus and cervix, and in case of ovarian cancer, hysterectomy along with bilateral salpingo-oophorectomy is also performed. Surgery may be followed by radiation therapy or chemotherapy. When a gynecologic cancer is very advanced and a cure is not possible, radiation therapy or chemotherapy may still be recommended to reduce the size of the cancer or its metastases and to relieve pain and other symptoms.

INDICATIONS

Some indications for surgery in cases of gynecological cancers are as follows:

Table 29.1: Classification of radical hysterectomy (as adopted by the Gynecological Cancer Group of the European Organization for Research and Treatment of Cancer)

Classification	Description
Type I radical hysterectomy (Simple/extrafascial hysterectomy)	Removal of the uterus and cervix, but not the parametria or more than the upper vaginal margin
Modified radical or type II radical hysterectomy	Removal of the entire uterus, both adnexa, medial half of cardinal and uterosacral ligaments, upper 2–3 cm cuff of the vagina and pelvic lymphadenectomy
Type III radical hysterectomy (originally described by Meig in 1944)	Removal of the entire uterus, both adnexa, most of the cardinal and uterosacral ligaments, upper one-third of the vagina and pelvic lymphadenectomy
Type IV radical hysterectomy (Extended radical hysterectomy)	Periureteral tissues, superior vesicle artery and as much as three-fourths of the vagina and paravaginal tissue are excised (in addition to structures removed in type III radical hysterectomy)
Type V radical hysterectomy (Partial exenteration)	In addition to the structures removed in type IV hysterectomy, portion of distal ureter and bladder are also removed

- *Cervical cancer*: Stage I and some cases of stage IIA cervical cancer.
- *Endometrial cancer*: Stage I and stage II endometrial cancers. Surgery for stage II endometrial cancers is followed by appropriate pelvic or extended field external and intravaginal irradiation.
- *Ovarian cancer*: Surgical treatment in the form of total abdominal hysterectomy (TAH) and a bilateral salpingo-oophorectomy and surgical staging is performed for stage I ovarian cancers. Additional chemotherapy or radiotherapy may be required for stage IA and IB (grade 2 and 3) and stage IC ovarian cancers. Debulking surgery or cytoreductive surgery may be done for stage II, III and IV ovarian cancers.
- *Vulvar cancer*: Surgery is performed in these patients as follows:
  - *T1 tumors*: The surgery of these lesions comprises of radical, local excision. Groin dissection in the form of inguinofemoral lymphadenopathy may or may not be required depending on the degree of stromal invasion.
  - *Management of T2 and early T3 tumors and N 0–1 nodes*: Surgical management of these patients comprises of radical vulvectomy with bilateral inguinofemoral lymphadenectomy with or without pelvic lymph node dissection.
  - *T3 and T4 tumors*: Pelvic exenteration in combination with radical vulvectomy and bilateral groin dissection may be required.

PREOPERATIVE PREPARATION

Pelvic examinations and Pap tests, if performed on a regular basis can help in the early detection of certain gynecologic cancers, especially cervical cancers. Regular pelvic examinations can also help detect early cancers of the vagina and vulva. A biopsy is usually performed to confirm or rule out the diagnosis of various types of cancers.

ENDOMETRIAL CANCER

In case of endometrial cancer (Figs 29.1A and B), an endometrial biopsy may be required to confirm the diagnosis. An ultrasound (typically a transvaginal ultrasound scan) and a hysteroscopic examination may be performed to further confirm the diagnosis. In case the diagnosis of endometrial cancer has been confirmed, the following investigations are performed to evaluate the spread of cancer:

- Blood tests (hematocrit)
- Kidney and liver function tests
- Chest X-ray
- Computed tomography (CT)
- Magnetic resonance imaging (MRI).

CERVICAL CANCER

Pap smear is able to accurately detect cervical cancers in up to 90% of the cases in the early stages, even before the symptoms have developed. In case an abnormality is detected on Pap smear, a colposcopic examination and biopsy may be performed to further confirm the diagnosis. Different types of biopsies, which can be performed are punch biopsy, endocervical curettage, cone biopsy, etc. Once the cervical cancer has been diagnosed, its exact size and stage are determined (Fig. 29.2). Staging begins with a physical examination of the pelvis. Various investigations, which help in the staging include cystoscopy, a chest X-ray, sigmoidoscopy, CT, MRI, barium enema, bone and liver scans and positron emission tomography.[3]

OVARIAN CANCER

For establishing the diagnosis of ovarian cancer (Fig. 29.3), the investigations which are most commonly performed include ultrasonography, CT and MRI. Biopsy of the tumor tissue and examination of the ascitic fluid may also be performed. In addition, blood tests to measure levels of ovarian cancer markers such as cancer antigen 125 (CA 125) may also be performed.

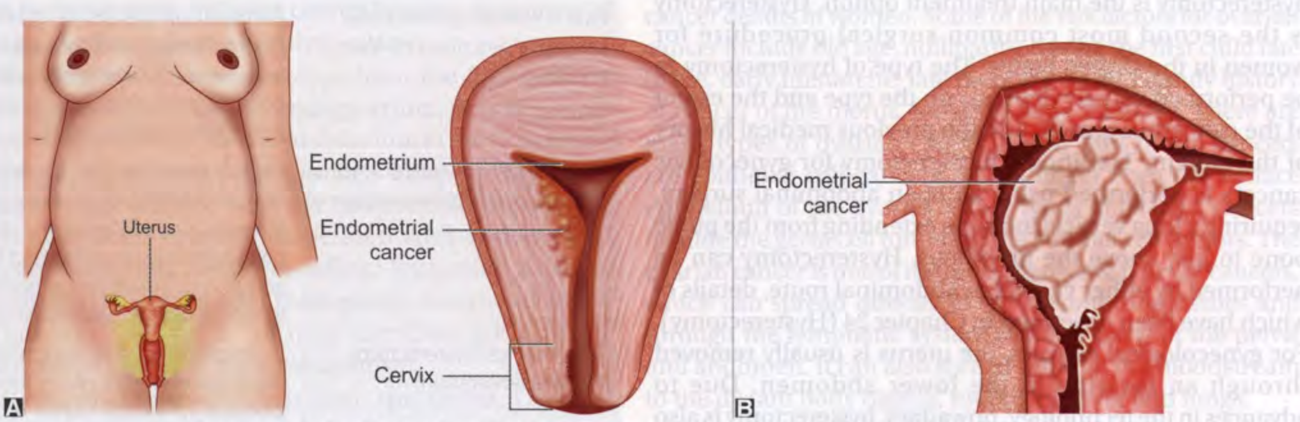


Fig. 29.1A and B: Endometrial cancer. (A) Ulcerative lesion; (B) Exophytic growth

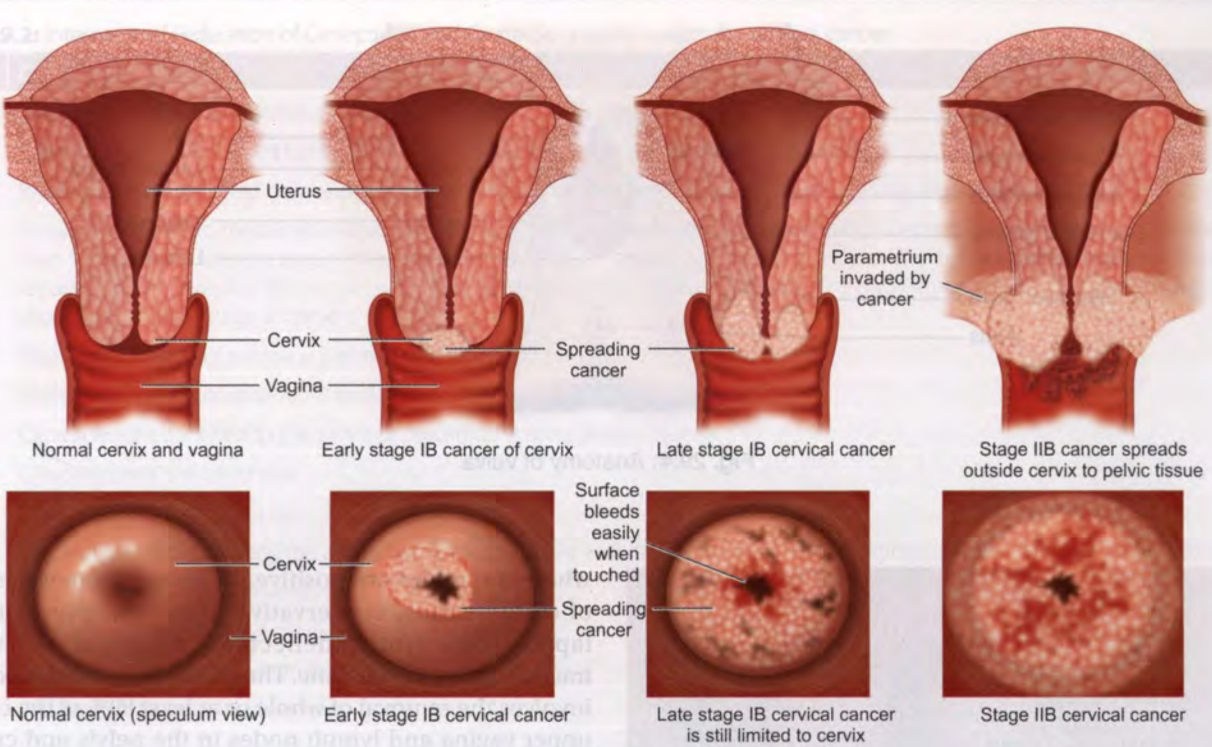


Fig. 29.2: Stages of cervical cancer

VULVAR CANCER

Vulva refers to the region of female external genitalia and includes various anatomical structures such as labia majora, mons pubis, labia minora, clitoris, vestibule, the urethral meatus and the vaginal introitus (Fig. 29.4). The Bartholin's complexes (vestibular glands and ducts) can also be considered as the component of vulva and, therefore, malignancies arising in these structures are grouped with vulvar cancers. Diagnosis of vulvar cancer (Fig. 29.5) is done by carrying out biopsy of the abnormal skin over the vulva. A complete pelvic examination must be performed. Pap smear is obtained from the cervix. Colposcopic examination of the cervix, vulva and vagina must be performed due to common association with other squamous epithelial cell neoplasms of the lower genital tract. Wedge biopsy of the lesions is commonly performed. In case the lesion is less than or equal to 1 cm in diameter, an excisional biopsy may be performed.

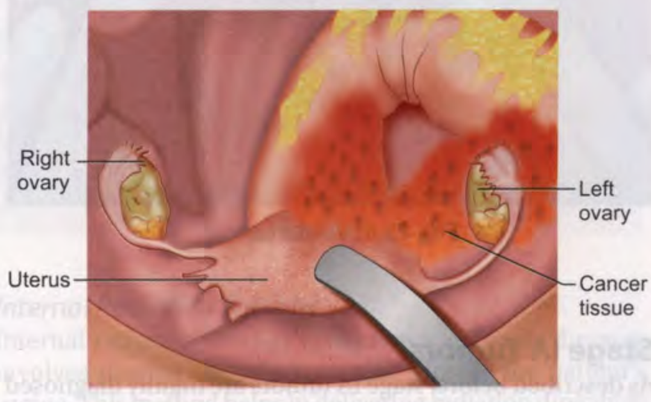


Fig. 29.3: Ovarian cancer

SURGICAL STEPS

As previously described, the treatment of various gynecological cancers is based on the stage of the disease.

SURGICAL TREATMENT FOR CERVICAL CANCER

Staging system for cervical cancer as devised by the International Federation of Gynecology and Obstetrics (FIGO) is described in Table 29.2 and Figure 29.6, while the TNM staging of cervical cancer is described in Table 29.3. The treatment of cervical cancer varies with the stage of the disease. For early invasive cancer, surgery is the treatment of choice. In more advanced cases, radiation combined with chemotherapy is the current standard of care. In patients with disseminated disease, chemotherapy or radiation provides symptom palliation.[4] Palliative radiotherapy is often useful for controlling bleeding, pelvic pain and urinary or partial large bowel obstruction, resulting from pelvic disease. Depending on the staging and grading of the cervical cancer, various treatment options are summarized in Table 29.4 and are described next in details.

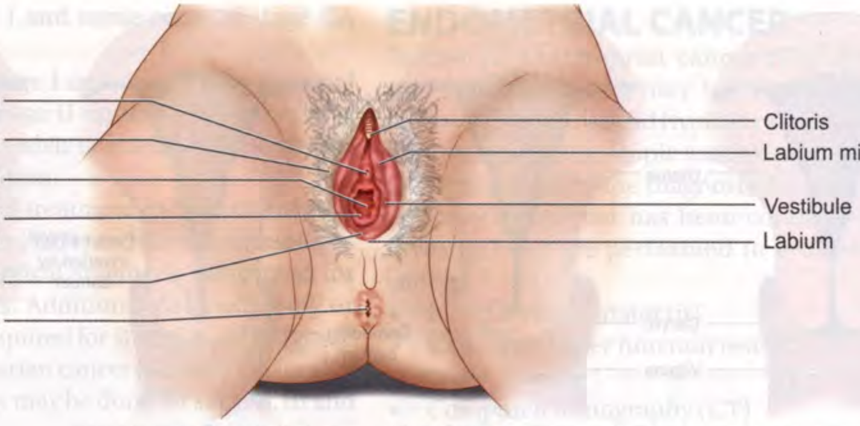


Fig. 29.4: Anatomy of vulva

Fig. 29.5: Vulvar cancer

Stage IA Tumors

As described before, stage IA tumors are mainly diagnosed by microscopic examination. The risk of nodal metastasis in the early invasive tumors (stage IA1) is quite low, only about 0.5%; therefore, the prognosis in these cases is quite good. Five years survival rate exceeds 95% with appropriate treatment. The recommended therapy for stage IA1 tumors is simple hysterectomy with or without pelvic lymph node dissection. Conization with clear margins may be considered adequate in young patients with stage IA disease, who want to conserve their uterus. However, these patients require close follow-up, including cytology, colposcopy and endocervical curettage. Lymph node dissection is not required, if the depth of invasion is less than 3 mm and no lymphovascular invasion is noted on microscopic examination. Patients with lymphatic or the vascular channel infiltration require treatment as in stage IB. Extended hysterectomy and lymph node sampling may be recommended in cases with stage IA2 disease. Postoperative radiotherapy may be administered in cases where the nodes are positive. In young women desirous of child bearing, conservative treatment comprising of laparoscopic lymphadenectomy, followed by vaginal trachelectomy can be done. The procedure of trachelectomy involves the removal of whole or at least 80% of the cervix, upper vagina and lymph nodes in the pelvis and cutting the Mackenrodt's ligament on either side. A radical trachelectomy can be performed abdominally or vaginally. Although, complications associated with the procedure are uncommon, women who are able to conceive after surgery are likely to develop preterm labor or late miscarriages.

Stage IB and IIA Tumors

The treatment options for stage IB and IIA are surgical treatment or radiotherapy or both combined surgery and radiotherapy. Radiotherapy can be either in the form of external beam and intracavitary radiotherapy. Both the treatment options—surgery and radiotherapy produce similar results with a five-year survival rate of 80–90%. Surgery includes a radical hysterectomy (Wertheim's hysterectomy or Schauta's vaginal hysterectomy known as Mitra operation in India). Wertheim's hysterectomy involves removal of the entire uterus, both adnexa, medial one-third of parametrium, uterosacral ligaments, upper 2–3 cm cuff of the vagina and dissection of pelvic lymph nodes. Oophorectomy is usually not necessary in premenopausal women. Recently, it has been shown that patients with parametrial involvement, positive pelvic nodes or positive surgical margins may benefit from a postoperative combination of cisplatin containing chemotherapy and pelvic irradiation.

Schauta's operation is an extended vaginal hysterectomy, consisting of removal of the entire uterus, adnexa, most of the vagina and medial portion of the parametrium. This may be preceded by laparoscopic pelvic lymphadenectomy or followed later by extraperitoneal (Taussig's) lymphadenectomy. Alternatively, postoperative pelvic radiotherapy may also be given.

Table 29.2: International Federation of Gynecology and Obstetrics staging system for cervical cancer

Stage	Characteristics
0	Carcinoma in situ, intraepithelial neoplasia
I	Carcinoma strictly confined to the cervix (extension to the corpus would be disregarded)
IA	Invasive cancer identified only microscopically. All gross lesions, even with superficial invasion, are stage IB cancers
	Invasion is limited to measured invasion of stroma ≤ 5 mm in depth and ≤ 7 mm in width. Depth of invasion must not be greater than 5 mm taken from the base of the epithelium of vaginal tissue, squamous or glandular. The depth of invasion must always be reported in mm, even for those cases with "early minimal stromal invasion" (~ 1 mm). The involvement of lymphatic/vascular spaces should not change stage allotment
IA1	Measured invasion of stroma ≤ 3 mm in depth and ≤ 7 mm in width
IA2	Measured invasion of stroma > 3 mm and ≤ 5 mm in depth and ≤ 7mm in width
IB	Clinical lesions confined to the cervix or preclinical lesions greater than IA
IB1	Clinical lesions ≤ 4 cm in size
IB2	Clinical lesions > 4 cm in size
II	Carcinoma extends beyond the cervix, but not to the pelvic wall; carcinoma involves the vagina but not as far as the lower one-third
IIA	No obvious parametrial involvement
IIA1	Clinically visible lesion ≤ 4 cm in greatest dimension
IIA2	Clinically visible lesion > 4 cm in greatest dimension
IIB	Obvious parametrial involvement
III	Carcinoma has extended to the pelvic wall; on rectal examination no cancer-free space is found between the tumor and the pelvic wall; the tumor involves lower one-third of the vagina; all cases with a hydronephrosis or nonfunctioning kidney should be included, unless they are known to be related to another cause
IIIA	No extension to the pelvic wall, but involvement of the lower one-third of the vagina
IIIB	Extension to the pelvic wall and/or hydronephrosis or nonfunctioning kidney, or both
IV	Carcinoma has extended beyond the true pelvis or has involved (biopsy proven) the mucosa of the bladder or rectum. A bullous edema as such does not permit the case to be allotted as stage IV
IVA	Spread to the adjacent organs
IVB	Spread to distant organs

Source: Adapted from Reference 11

Stage IIB, III and IV Tumors

In stage IIB, III and IV cancer, as the tumor invades local organs, radiation therapy has become the mainstay of treatment. However, in some cases combination chemotherapy and radiotherapy is employed. Patients with distant metastases (Stage IVB) also require chemotherapy with or without radiotherapy to control systemic disease. Recently, the combination of cisplatin and topotecan is being preferred rather than use of single-agent cisplatin. Adult dose of cisplatin is 50–100 mg/m² IV q 3 weeks. Cisplatin can result in side effects, such as hypersensitivity, renal failure, peripheral neuropathy and bone marrow suppression. Adult dose of topotecan is 1.5 mg/m²/d IV for 5 d q 4 weeks. In advanced cases of cervical cancer, the most extreme surgery called pelvic exenteration in which all of the organs of the pelvis, including the bladder and rectum are removed may be employed.

Radiation Therapy

Radiation may be used to treat cancer that has spread beyond the pelvis or cancer that has returned. Radiation therapy can be either external or internal.

Internal Radiation Therapy

Internal radiation therapy also known as brachytherapy, involves placing the selectron tubes inside the patient's vagina. This method helps in delivering radiation directly to the cervix and the surrounding areas. The radioactive balls in the selectron tube can be withdrawn into the machine when other people come into the patient's room. This helps in keeping the dose of radioactivity to visitors and nurses as low as possible.

External Radiation Therapy

External radiation therapy involves administration of radiation beams from a large machine onto the body, where the cancer is located. External radiotherapy is normally administered on an outpatient basis. The treatment is usually given from Monday to Friday with a rest at the weekend.

Chemotherapy

The most commonly employed chemotherapy regimens use cisplatin, 5-fluorouracil, carboplatin, ifosfamide, paclitaxel, cyclophosphamide, etc. Chemotherapy is sometimes used in the form of neoadjuvant chemotherapy.

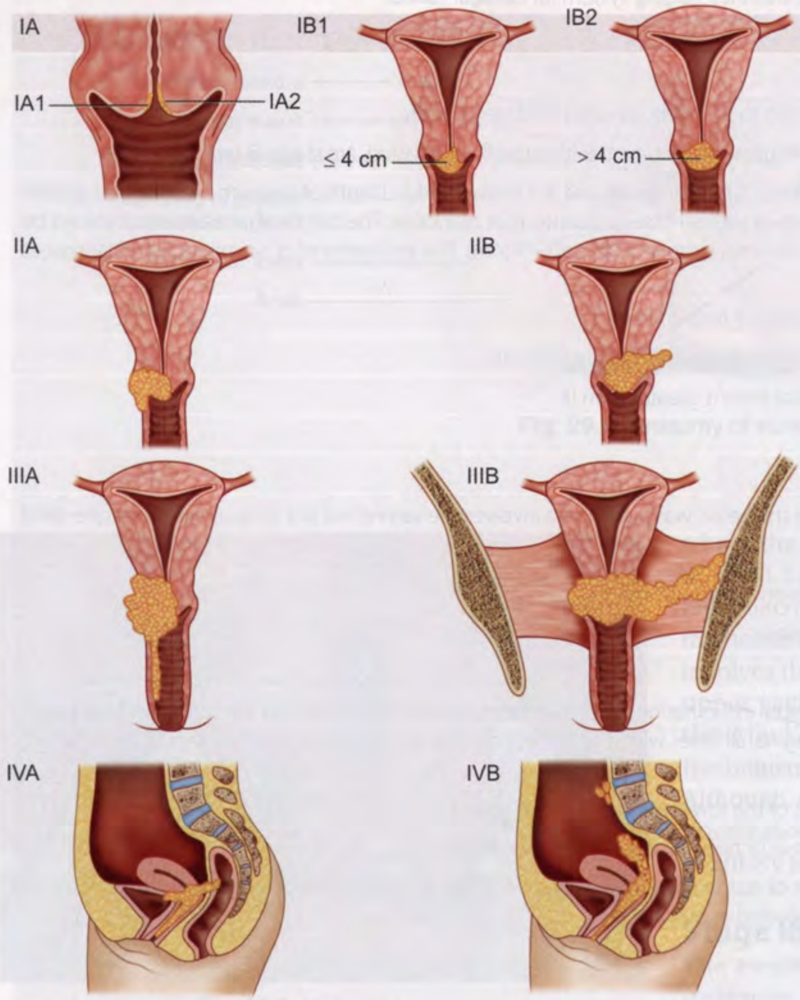


Fig. 29.6: Staging of cervical cancer as devised by the International Federation of Gynecology and Obstetrics

This method involves use of chemotherapy before surgery or radiotherapy to shrink the cancer and to make these treatments more effective.

Pelvic Exenteration

If the cancer recurs in the pelvis after radiation therapy, the gynecologist may need to resort to surgery for removing all the pelvic organs. This procedure cures up to 50% of women. This is a major operation that involves removing all of the structures in the pelvic area including the uterus, cervix, vagina, ovaries, bladder and the rectum. This operation may involve creating two stomas: (1) a colostomy and (2) a urostomy. The operation also involves reconstructing a new vagina.

SURGICAL TREATMENT FOR ENDOMETRIAL CANCER

Cancer Staging

The detailed staging of endometrial cancer is described in Table 29.5 and Figure 29.7.[5]

For patients with stage I and IIA, the treatment of choice is an extrafascial total abdominal hysterectomy and bilateral salpingo-oophorectomy, with lymph node sampling. Removal of a vaginal cuff is usually not required in these cases. The removed tumor specimen is examined for tumor size, depth of myometrial invasion and extension into the cervix. Sampling of the pelvic lymph nodes may be done in selective cases.[6]

Indications for pelvic lymph node sampling are enlisted in Table 29.6. In these conditions, lymph node sampling must be done even if the lymph nodes are clinically negative. Laparoscopically assisted vaginal hysterectomy with bilateral salpingo-oophorectomy and laparoscopic retroperitoneal lymph node sampling is being tried at certain centers in place of the conventional abdominal surgery. Surgery alone may serve as an appropriate treatment option for patients with stage IA (G1 and G2) tumors, in whom there is no evidence of invasion of the lymphovascular space, cervix or isthmus; peritoneal cytology is negative, and there is no evidence of metastasis.

Table 29.3: TNM cervical cancer staging

TNM Stage	FIGO Stage	Stage Description
TX	-	Primary tumor cannot be assessed
T0	-	No evidence of primary tumor
Tis	0	Carcinoma in situ
T1	I	Cervical carcinoma confined to uterus (extension to corpus should be disregarded)
T1a	IA	Invasive carcinoma diagnosed only by microscopy All macroscopically visible lesions—even with superficial invasion—are T1b/IB. Stromal invasion with a maximal depth of 5 mm measured from the base of the epithelium and a horizontal spread of 7 mm or less. Vascular space involvement, venous or lymphatic, does not affect classification
T1a1	IA1	Measured stromal invasion 3 mm or less in depth and 7 mm or less in lateral spread
T1a2	IA2	Measured stromal invasion more than 3 mm but not more than 5 mm with a horizontal spread 7 mm or less
T1b	IB	Clinically visible lesion confined to the cervix or microscopic lesion greater than IA2
T1b1	IB1	Clinically visible lesion 4 cm or less in greatest dimension
	IB2	Clinically visible lesion more than 4 cm
T2	II	Cervical carcinoma invades beyond uterus but not to pelvic wall or to the lower third of vagina
T2a	IIA	Tumor without parametrial invasion
T2b	IIB	Tumor with parametrial invasion
T3	III	Tumor extends to the pelvic wall and/or involves the lower third of the vagina and/or causes hydronephrosis or nonfunctioning kidney
T3a	IIIA	Tumor involves lower third of vagina; no extension to pelvic wall
T3b	IIIB	Tumor extends to pelvic wall and/or causes hydronephrosis or nonfunctioning kidney
-	IV	Cervical carcinoma has extended beyond the true pelvis or has involved (biopsy proven) the bladder mucosa or rectal mucosa. Bullous edema does not qualify as a criteria for stage IV disease
T4	IVA	Spread to adjacent organs (bladder, rectum, or both)
M1	IVB	Distant metastasis
Lymph nodes*		
NX	-	Regional lymph nodes cannot be assessed
N0	-	No regional lymph nodes metastasis
N1	-	Regional lymph nodes metastasis

*Regional lymph nodes (N), include paracervical, parametrial, hypogastric (obturator), common, internal and external iliac, presacral and sacral group of lymph nodes

Table 29.4: Summary of treatment of invasive cervical carcinoma

Cervical Cancer Stage	Therapeutic Option
Stage 0	Loop electrosurgical excision procedure (LEEP), laser therapy, conization and cryotherapy
Stage IA1	Conization or type I hysterectomy
Stage IA2	Radical trachelectomy or radical type II hysterectomy with pelvic lymphadenectomy
Stage IB1 (invasion > 5 mm, < 2 cm)	Radical trachelectomy or radical type III hysterectomy with pelvic lymphadenectomy Radical type III hysterectomy with pelvic lymphadenectomy
Stage IB2	Radical type III hysterectomy with pelvic and para-aortic lymphadenectomy or primary chemoradiation
Stage IIA1 and IIA2	Radical type III hysterectomy with pelvic and para-aortic lymphadenectomy or primary chemoradiation
Stage IIB, IIIA and IIIB	Primary chemoradiation
Stage IVA	Primary chemoradiation or primary exenteration
Stage IVB	Primary chemotherapy with or without radiotherapy

Table 29.5: Staging of endometrial cancer

Stage	Characteristics
Stage I*	Tumor confined to the corpus uteri
Stage IA*	No or less than half myometrial invasion
Stage IB*	Invasion equal to or more than half of the myometrium
Stage II*	Tumor invades cervical stroma, but does not extend beyond the uterus†
Stage III*	Local and/or regional spread of the tumor
Stage IIIA*	Tumor invades the serosa of corpus uteri and/or adnexa§
Stage IIIB*	Vaginal and/or parametrial involvement§
Stage IIIC*	Metastasis to pelvic and/or para-aortic lymph nodes§
Stage IIIC1*	Positive pelvic nodes
Stage IIIC2*	Positive para-aortic nodes with or without positive pelvic lymph nodes
Stage IV*	Tumor invades bladder and/or bowel mucosa and/or distant metastasis
Stage IVA*	Tumor invasion of the bladder and/or bowel mucosa
Stage IVB*	Distant metastasis including intra-abdominal metastasis and/or inguinal lymph nodes

Source: Adapted from Reference 11
*Either G1, G2 or G3
†Endocervical glandular involvement only should be considered as stage I and no longer as stage II
§Positive cytology has to be reported separately without changing the stage

In all the other patients, some form of adjuvant radiotherapy is indicated. Indications for postoperative vaginal irradiation are enumerated in Table 29.7. This method helps in bringing about a significant reduction in the incidence of vaginal vault recurrence. However, radical hysterectomy has no place in the management of early stage endometrial cancer.

For stage II tumors, radical hysterectomy with bilateral salpingo-oophorectomy and pelvic lymphadenectomy is the most commonly used treatment modality. However, some gynecologists prefer to use the same standard surgical approach, as described for stage I disease, followed by appropriate pelvic or extended field external and intravaginal irradiation. Both the methods are associated with similar cure rates.

For stage III growths, the goal of surgery is TAH and bilateral salpingo-oophorectomy with selective lymphadenectomy, biopsies of suspicious areas, omental biopsy and debulking of tumor followed by radiotherapy. Stage IV cancers are usually non-operatable. Treatment has to be individualized in those with stage IV tumors. Usually, a combination of surgery, radiotherapy, hormone therapy or chemotherapy is required. Chemotherapy with doxorubicin in the dosage of 60 mg/m^2 and other drugs including cisplatin and paclitaxel is also being tried. Medroxyprogesterone acetate administered in the dosage of 1 g weekly, acts as an adjuvant to chemotherapy.

Patients with stage IBG3 and stage IIA (G1 and G2) tumors are given either pelvic irradiation or vaginal cuff irradiation. For those with tumors in stage IC (all grades), stage IIA (G3) and stage IIB (all grades), stage IIIA (all grades) or those with lymphovascular space invasion, external pelvic irradiation of 50 Gy is recommended in addition to vaginal irradiation. This may also be suitable for selected IVA patients. Various indications for radiotherapy are listed in Table 29.7.

Patients with documented para-aortic and common iliac lymph node involvement are additionally given extended field irradiation in the dosage of 45 Gy. Patients with stage IV disease with intraperitoneal spread may require whole abdominal irradiation along with systemic chemotherapy. The treatment of endometrial cancer has been summarized in Table 29.8.

SURGICAL TREATMENT FOR MALIGNANT OVARIAN NEOPLASMS

The FIGO system is used for cancer staging, based on the findings of exploratory laparotomy.[7] The initial spread of ovarian cancer is via transcoelomic implantation and in later stages via lymphatics (Figs 29.8A and B). This system of surgical staging is described below and is summarized in Table 29.10 and Figures 29.9A to D.

Stage I

Cancer growth is limited to the ovaries. This stage is divided into three subgroups:

- *Stage IA:* The growth is limited to one ovary. There is no ascites containing malignant cells, no tumor is present on the external surface and capsule is intact.
- *Stage IB*: The growth is limited to both the ovaries. There is no ascites containing malignant cells, no tumor is present on the external surface and capsule is intact.
- *Stage IC*: The cancer is either at stage IA or IB, but with tumor on the surface of one or both the ovaries or with capsule ruptured or with ascites present, containing malignant cells or with positive peritoneal washings.

Stage II

Growth involves one or both ovaries with pelvic extension. There are three subgroups:

- *Stage IIA*: The cancer has spread to the uterus and/or fallopian tubes.
- *Stage IIB*: There is extension to other pelvic tissues, such as the rectum or bladder.
- *Stage IIC*: The cancer is either at stage IIA or IIB, with tumor on the surface of one or both ovaries, or with capsule ruptured, or with ascites present containing malignant cells or with positive peritoneal washings.

Stage III

Tumor involves one or both the ovaries, with peritoneal implants outside the pelvis and/or positive retroperitoneal

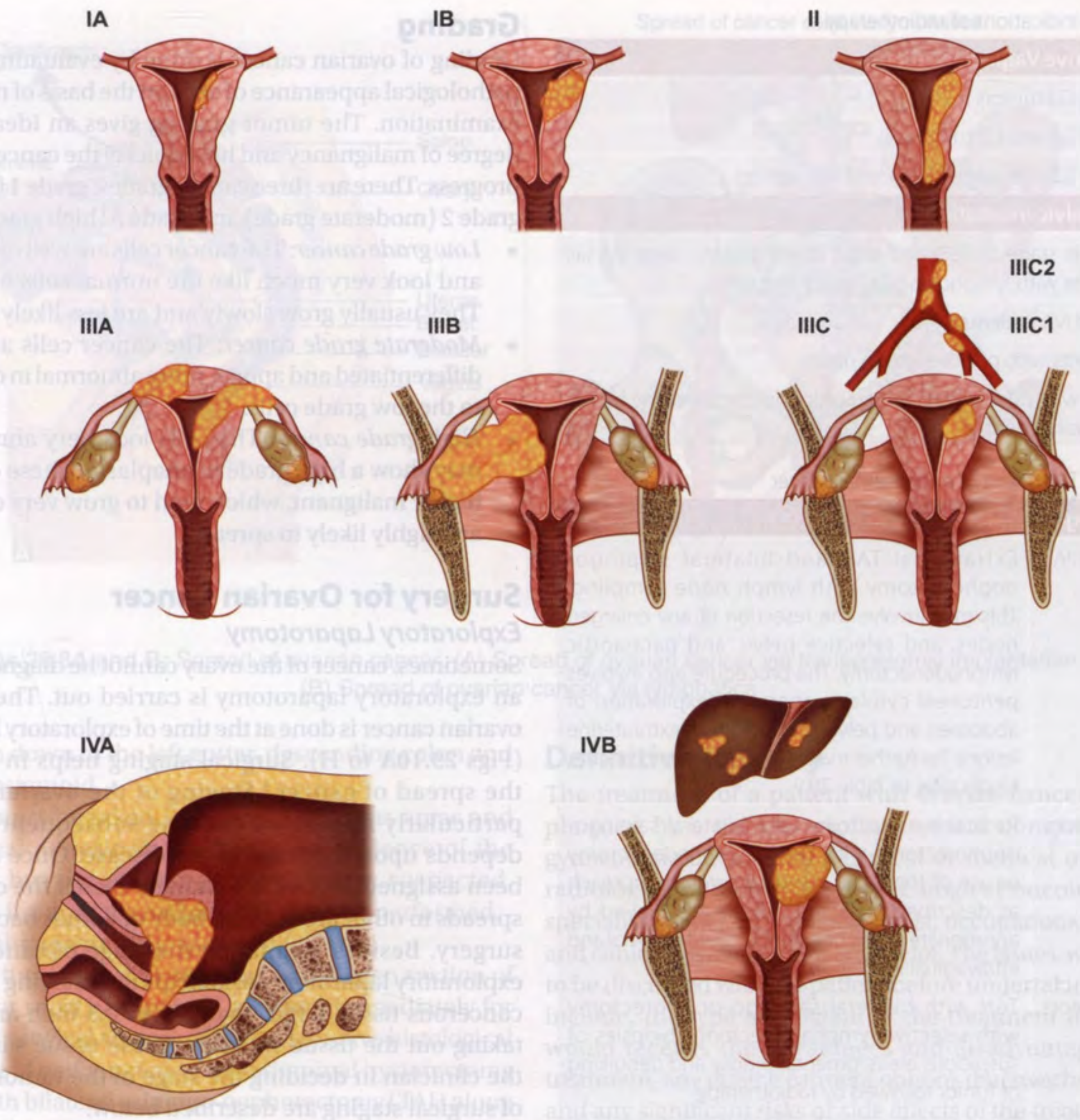


Fig. 29.7: Different stages of endometrial cancer

Table 29.6: Indications for pelvic lymph node sampling

♦ The tumor histology is known to be clear cell type, serous, squamous or poorly differentiated grade III endometrioid type
♦ Cut section shows that the myometrium has been invaded to more than half of its thickness
♦ The tumor has extended to the cervix or isthmus
♦ Size of the tumor is greater than 2 cm
♦ There is evidence of extrauterine disease

or inguinal nodes. Superficial liver metastasis equals stage III. Tumor is limited to the true pelvis, but with histologically proven extension to small bowel or omentum.

- *Stage IIIA*: Tumor is grossly limited to true pelvis with negative nodes, but with histologically confirmed seeding of abdominal/peritoneal surfaces.
- *Stage IIIB*: Tumor of one or both ovaries with histologically confirmed implants of abdominal peritoneal surfaces, none exceeding 2 cm in diameter. Nodes are negative.
- *Stage IIIC*: Abdominal implants greater than 2 cm in diameter and/or positive retroperitoneal or inguinal lymph nodes.

Stage IV

There is growth involving one or both ovaries with distant metastasis. If pleural effusion is present, there must be positive cytological test results to allot a case to stage IV. Parenchymal liver metastasis equals stage IV. The above mentioned categories are based on the findings of clinical examination and/or surgical exploration. If the cancer comes back after initial treatment, this is known as recurrent cancer.

Table 29.7: Indications of radiotherapy

Postoperative Vaginal Irradiation
♦ Stage IA G3 tumors
♦ Stage IB G1 and G2 tumors
♦ Stage IB G3 and stage IIA (G1 and G2) tumors
External Pelvic Irradiation
♦ Tumors in stage IIA (G3) and stage IIB (all grades), stage IIIA (all grades) or with lymphovascular space invasion
♦ Selected IVA patients
♦ All patients with positive lymph nodes
♦ Patients with documented para-aortic and common iliac lymph node involvement

Table 29.8: Treatment of endometrial cancer

Cancer Stage	Treatment
Stage I and IIA	Extrafascial TAH and bilateral salpingo-oophorectomy with lymph node sampling. This may involve the resection of any enlarged nodes, and selective pelvic and para-aortic lymphadenectomy. The procedure also involves peritoneal cytology, thorough exploration of abdomen and pelvis and biopsy of extrauterine lesions. For further management in these patients, kindly refer to Table 29.9
Stage II tumors	Radical hysterectomy with bilateral salpingo-oophorectomy with pelvic lymphadenectomy or use of the same standard surgical approach as described for stage I disease, followed by appropriate pelvic or extended field external and intravaginal irradiation
Stage III tumors	TAH with bilateral salpingo-oophorectomy with selective lymphadenectomy, biopsies of suspicious areas, omental biopsy and debulking of tumor followed by radiotherapy
Stage IV tumors	Palliative chemotherapy, radiotherapy and progestogens

Abbreviation: TAH, Total abdominal hysterectomy

Table 29.9: Further management in patients with stage I and II endometrial cancer following initial treatment

Histopathological Findings	Management Option
♦ Grade 1, 2 ♦ No or minimal myometrial invasion	Observation
♦ G2, superficial myometrial invasion ♦ G3, no myometrial invasion	Vaginal irradiation
♦ Deep myometrial invasion ♦ Cervical spread ♦ Positive lymph nodes	Pelvic radiotherapy and vaginal boost (extended field of positive para-aortic nodes)
♦ Adnexal spread ♦ Intraperitoneal disease ♦ Completely resected tumor	Whole abdominal radiation or chemotherapy
♦ Positive peritoneal cytology	Observation or progestins

Grading

Grading of ovarian cancer is done by evaluating the histopathological appearance of cells on the basis of microscopic examination. The tumor grading gives an idea about the degree of malignancy and how quickly the cancer is likely to progress. There are three cancer grades: grade 1 (low grade); grade 2 (moderate grade) and grade 3 (high grade).

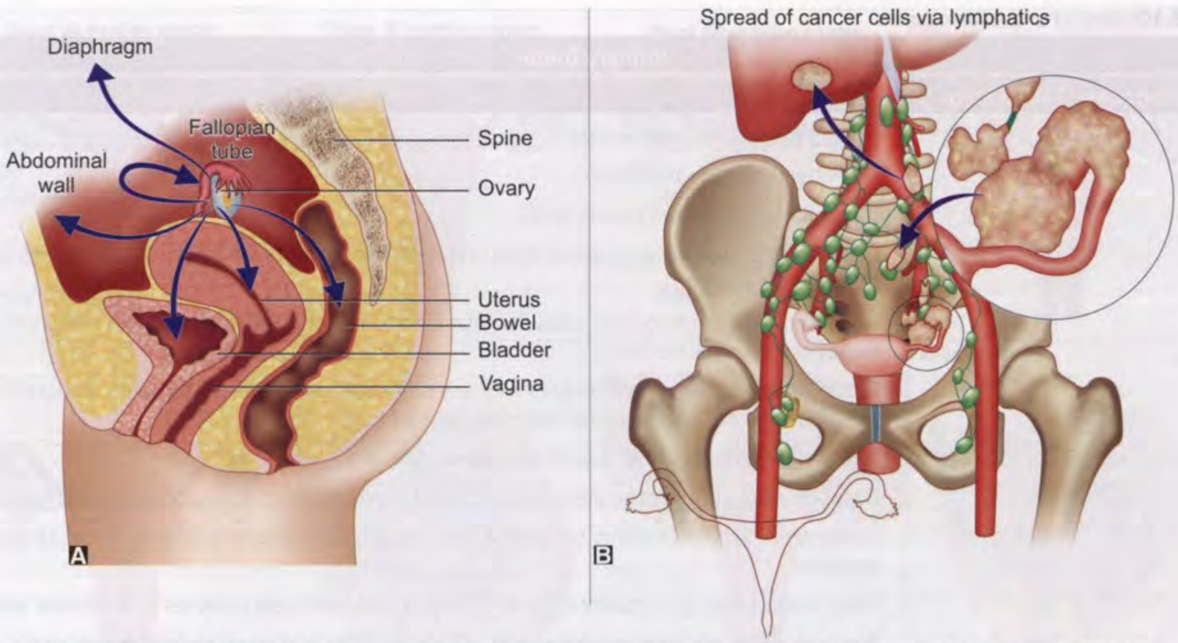
- *Low grade cancer*: The cancer cells are well differentiated and look very much like the normal cells of the ovary. They usually grow slowly and are less likely to spread.
- *Moderate grade cancer*: The cancer cells are less well differentiated and appear more abnormal in comparison to the low grade cells.
- *High grade cancer*: The cells look very abnormal and may show a high grade of anaplasia. These cancers are highly malignant, which tend to grow very quickly and are highly likely to spread.

Surgery for Ovarian Cancer

Exploratory Laparotomy

Sometimes, cancer of the ovary cannot be diagnosed before an exploratory laparotomy is carried out. The staging of ovarian cancer is done at the time of exploratory laparotomy (Figs 29.10A to H). Surgical staging helps in estimating the spread of cancer.[8] Staging of the ovarian cancer is particularly important because subsequent treatment depends upon the stage of the disease. Once a stage has been assigned, it does not change, even if the cancer later spreads to other areas of the body or comes back following surgery. Besides estimating the stage of cancer spread, exploratory laparotomy also helps in removing most of the cancerous tissue larger than about 0.5 inch and helps in taking out the tissue samples. These tissue samples help the clinician in deciding the stage of the tumor. The steps of surgical staging are described below:

- A midline or a paramedian abdominal incision is given in order to allow adequate access to the upper abdominal cavity, especially in cases where there is a possibility of malignancy.
- At the time of surgery, the ovarian tumor must be removed intact and a frozen histological section should be obtained.
- Any intra-abdominal free fluid or that present in the pouch of Douglas must be submitted for the cytological analysis.
- If no free fluid is present, peritoneal washings should be performed by instilling and recovering 50–100 mL of saline from the pelvic cul-de-sac, each paracolic gutter and beneath each hemidiaphragm.
- A systematic exploration of all intra-abdominal surfaces and viscera must be performed. The gynecologist must proceed in a clockwise fashion from the cecum, moving cephalad along the paracolic gutter and the ascending colon to the right kidney, the liver and gall bladder, the right hemidiaphragm, transverse colon



Figs 29.8A and B: Spread of ovarian cancer. (A) Spread of ovarian cancer via transcoelomic implantation; (B) Spread of ovarian cancer via lymphatics

and then down to the left gutter, descending colon and the rectosigmoid.

- Biopsy must be taken from any suspicious areas and peritoneal adhesions. If there is no evidence of the disease, but the disease is nevertheless suspected, multiple intraperitoneal biopsies must be performed.
- The diaphragm must be sampled.
- Ovarian tumor must be resected out. Frozen section of the tumor must be obtained and sent immediately for histopathological analysis. In case of positive histological evidence of malignancy, total abdominal hysterectomy along with bilateral salpingo-oophorectomy (TAH along with BSO) must be performed.
- Infracolic omentectomy, which involves resection of omentum from the transverse colon, needs to be performed.
- Exploration of retroperitoneal spaces to evaluate the pelvic and para-aortic lymph nodes also needs to be done.

Screening for Ovarian Cancer

Presently, research studies are being carried out to assess, whether ovarian cancers can be detected at an early stage so that they can be treated more effectively. Some of the tests, which are being considered in various research trials, include estimation of CA125 levels or performing a transvaginal ultrasound.[9] The aim of these research trials is to evaluate, if either of these tests might help in the diagnosis of women with early stage ovarian cancer. Since presently it is not known, whether these screening tests could help in detection of ovarian cancers at an earlier stage, currently there exists no national screening program for ovarian cancer.

Definitive Therapy

The treatment of a patient with ovarian cancer must be planned by a multidisciplinary team comprising of a gynecologic oncologist, a clinical or medical oncologist, radiologist, pathologist, a gynecological oncology nurse specialist, dietician, physiotherapist, occupational therapist and clinical psychologist or counselor. The issues, which need to be discussed with the patient before undertaking therapy include, the type and extent of the treatment the patient would receive, the advantages and disadvantages of the treatment, any other treatment options that may be available and any significant risks or side effects of the treatment.

Stage IA (Grade 1 Disease)

Primary treatment for stage I epithelial ovarian cancer is surgical, i.e. a total abdominal hysterectomy and a bilateral salpingo-oophorectomy and surgical staging. The uterus and contralateral ovary can be preserved in women with stage IA, grade 1 disease, who desire to preserve their fertility. However, such women must be periodically monitored with routine pelvic examinations and determination of serum CA 125 levels.

Stage IA and IB (Grade 2 and 3) and Stage IC

Treatment options in this case include additional chemotherapy or radiotherapy besides surgery as described above. Chemotherapy is the more commonly used option and comprises of either single-agent or multi-agent chemotherapy. The most commonly used single-agent chemotherapy is melphalan, which is administered orally on a "pulse" basis for 5 consecutive days, every 28 days.[10] Radiotherapy could be administered either in the form of

Table 29.10: Staging of ovarian cancers

Primary Tumor		
TNM Categories	**FIGO Stage**	**Stage**
TX		Primary tumor cannot be assessed
T0		No evidence of primary tumor
T1	I	Tumor limited to ovaries (one or both)
T1a	IA	Tumor limited to one ovary; capsule intact, no tumor on ovarian surface. No malignant cells in ascites or peritoneal washings
T1b	IB	Tumor limited to both ovaries; capsules intact, no tumor on ovarian surface. No malignant cells in ascites or peritoneal washings
T1c	IC	Tumor limited to one or both ovaries with any of the following: capsule ruptured, tumor on ovarian surface, malignant cells in ascites or peritoneal washings
T2	II	Tumor involves one or both ovaries with pelvic extension
T2a	IIA	Extension and/or implants on uterus and/or tube(s). No malignant cells in ascites or peritoneal washings
T2b	IIB	Extension to and/or implants on other pelvic tissues. No malignant cells in ascites or peritoneal washings
T2c	IIC	Pelvic extension and/or implants (T2a or T2b) with malignant cells in ascites or peritoneal washings
T3	III	Tumor involves one or both ovaries with microscopically confirmed peritoneal metastasis outside the pelvis. There may be positive retroperitoneal or inguinal lymph nodes. Superficial liver metastasis equals stage III disease. Though tumor is limited to the true pelvis, histologically proven malignant extension to small bowel or omentum may be there
T3a	IIIA	Microscopic peritoneal metastasis beyond pelvis (no macroscopic tumor); nodes are negative
T3b	IIIB	Tumor of one or both the ovaries with macroscopic peritoneal metastasis beyond pelvis, which is 2 cm or less in the greatest dimension; nodes are negative
T3c	IIIC	Peritoneal metastasis beyond pelvis more than 2 cm in greatest dimension and/or regional lymph node metastasis
T4	IV	Growth involving one or both the ovaries with distant metastasis. If pleural effusion is present, there must be a positive cytological test result to allot a case to stage IV; parenchymal liver metastasis also equals stage IV
Regional Lymph Nodes (N)		
TNM Categories	**FIGO Stages**	
NX		Regional lymph nodes cannot be assessed
N0		No regional lymph node metastasis
N1	IIIC	Regional lymph node metastasis
Distant Metastasis (M)		
TNM Categories	**FIGO Stages**	
M0		No distant metastasis
M1	IV	Distant metastasis (excludes peritoneal metastasis)

Abbreviations: TNM, tumor, node and metastasis; FIGO, International Federation of Gynecology and Obstetrics

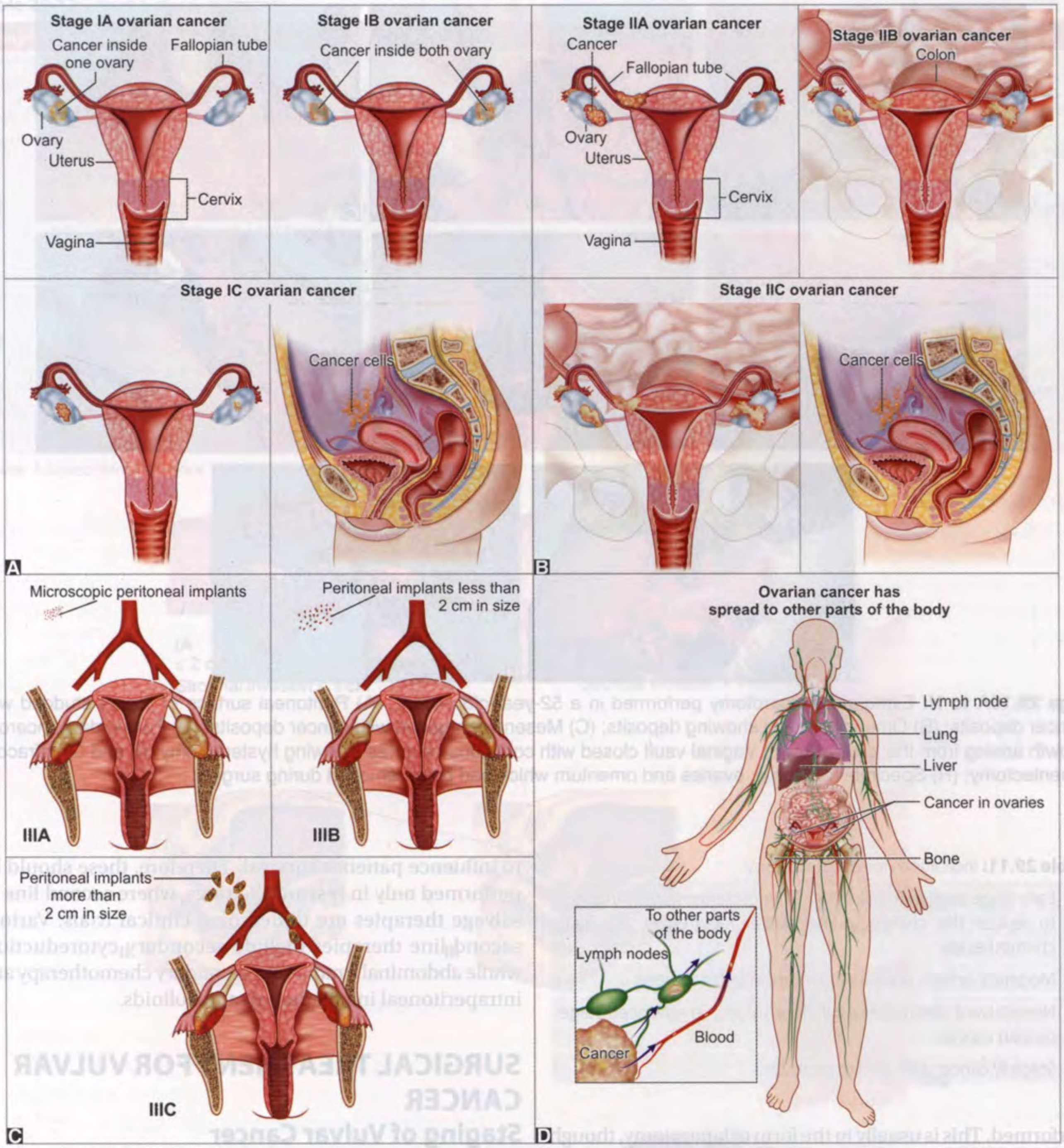
intraperitoneal radiocolloids (P32) or whole abdominal radiation.

According to the current treatment recommendations, the treatment must be in the form of either cisplatin or carboplatin or combination therapy of either of these drugs with paclitaxel for 3–4 cycles. Short course of melphalan (4–6 cycles) may be preferable in the older women.

Stage II, III and IV

Debulking surgery or cytoreductive surgery is performed in these cases. This involves an initial exploratory procedure with the removal of as much disease as possible (both tumor and the associated metastatic disease). Cytoreductive surgery includes abdominal hysterectomy and bilateral salpingo-oophorectomy, complete omentectomy and resection of metastatic lesions from the peritoneal surface. The surgeon also takes the biopsies or removes some of the lymph nodes in the abdomen and pelvis. They may also have to remove the omentum, the appendix and part of the peritoneum.

This operation can be complicated and should ideally be done by a specialist gynecologic oncologist. The goal



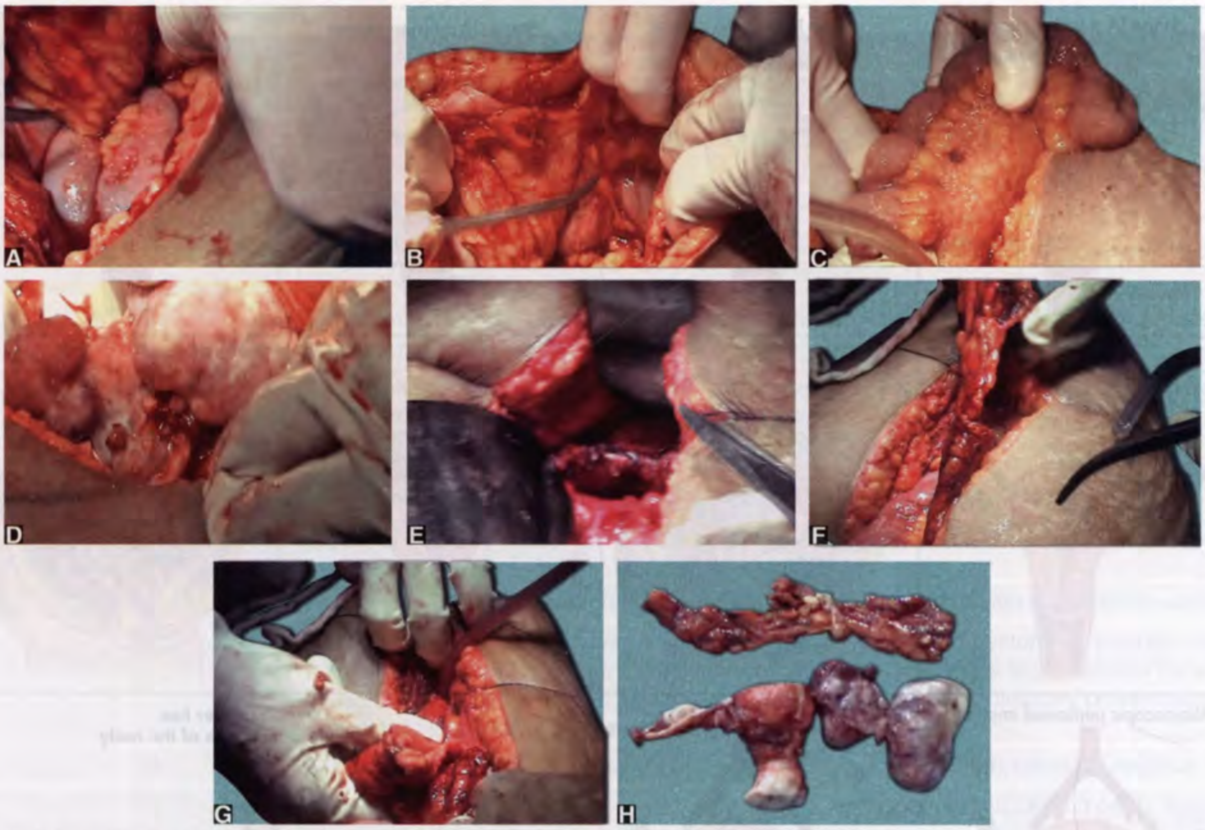
Figs 29.9A to D: Staging of ovarian cancer. (A) Stage I of ovarian cancer; (B) Stage II; (C) Stage III; (D) Stage IV

of cytoreductive surgery is resection of the primary tumor and all the metastatic disease. If this is not possible, the goal must be to reduce the tumor burden by resection of the tumor to an "optimal status". The study by the Gynecologic Oncology Group (2004) has defined optimum debulking, as residual tumor diameter of less than or equal to 1 cm.

Many patients are given a few cycles of chemotherapy (intraperitoneal or systemic) following the surgery. Various indications for chemotherapy are listed in Table 29.11. For some patients with completely resected disease, whole abdominal radiation therapy may be used. For patients with no clinical evidence of disease and negative tumor markers at the completion of chemotherapy, a reassessment laparotomy or "second-look" surgery may be performed.

Second-Look Laparoscopy

Many patients who undergo cytoreductive surgery and chemotherapy may have no evidence of disease at the completion of the treatment. In order to detect the presence of subclinical disease, a second-look surgery is often



Figs 29.10A to H: Exploratory laparotomy performed in a 52-year-old patient. (A) Peritoneal surface of uterus studded with cancer deposits; (B) Omental surface showing deposits; (C) Mesentery studded with cancer deposits; (D) Polypoidal cancerous growth arising from the left ovary; (E) Vaginal vault closed with continuous sutures following hysterectomy; (F and G) Infracolic omentectomy; (H) Specimen of uterus, ovaries and omentum which had been removed during surgery

Table 29.11: Indications for chemotherapy

• Early stage ovarian (stage IB or IC) cancer (after surgery in order to reduce the chance of the cancer recurrence): Adjuvant chemotherapy
• Moderate or high grade ovarian cancer (after surgery)
• Neoadjuvant chemotherapy before surgery in advanced stage ovarian cancer
• Stage IV cancer with distant metastasis

performed. This is usually in the form of laparotomy, though laparoscopy is sometimes performed. The technique of second-look laparotomy is essentially identical to that for the staging laparotomy. Multiple cytological specimens and biopsies of the peritoneal surface must be performed, particularly in any areas of previously documented tumor. Additionally, any adhesions or surface irregularities must also be sampled. Biopsy specimen must be taken from the pelvic side walls, cul-de-sac, bladder, the paracolic gutters, residual omentum and the diaphragm. A pelvic and para-aortic lymph node dissection should be performed for those patients, whose nodal tissues have not been previously removed. Second-look laparotomies have not been shown to influence patient's survival. Therefore, these should be performed only in research settings, where second line or salvage therapies are undergoing clinical trials. Various second line therapies include secondary cytoreduction, whole abdominal irradiation, secondary chemotherapy and intraperitoneal instillation of radiocolloids.

SURGICAL TREATMENT FOR VULVAR CANCER

Staging of Vulvar Cancer

FIGO staging of vulvar cancers is described in Table 29.12 and Figure 29.11. Staging involves resection of the primary tumor(s) and inguinofemoral lymphadenectomy. Surgical staging consists of excision of the primary lesion and inguinofemoral lymph node evaluation.

SURGICAL TREATMENT OF VULVAR CANCER

Surgical procedures for the treatment of vulvar cancer include wide local excision, simple partial vulvectomy, radical partial vulvectomy, en block radical vulvectomy and

Table 29.12: Staging of vulvar cancer[11]

Stage	Characteristics
I	Tumor confined to the vulva IA: Tumor ≤ 2 cm in size, confined to the vulva or perineum and with stromal invasion ≤ 1.0 mm and no nodal metastasis IB: Lesions > 2 cm in size with stromal invasion > 1.0 mm confined to the vulva or perineum with negative nodes
II	Tumor of any size with extension to the adjacent perineal structures (one-third lower urethra, one-third lower vagina, anus) with negative nodes
III	Tumor of any size with extension to the adjacent perineal structures (one-third lower urethra, one-third lower vagina, anus) with positive inguinofemoral lymph nodes IIIA: Either with 1 lymph node metastasis ≥ 5mm or 1–2 lymph node metastasis(es) (< 5 mm) IIIB: With 2 or more lymph node metastasis (≥ 5mm) or 3 or more lymph node metastasis (< 5mm) IIIC: Having positive nodes with extracapsular spread
IV	Tumor invades other regional (two-thirds upper urethra, two-thirds upper vagina) or distant structures IVA: Tumor invades any of the following: Upper urethral and/or vaginal mucosa, bladder mucosa, rectal mucosa or the tumor is fixed to the pelvic bone or there are fixed or ulcerated inguinofemoral lymph nodes IVB: Any distant metastasis including pelvic lymphadenopathy

Source: Adapted from Reference 11

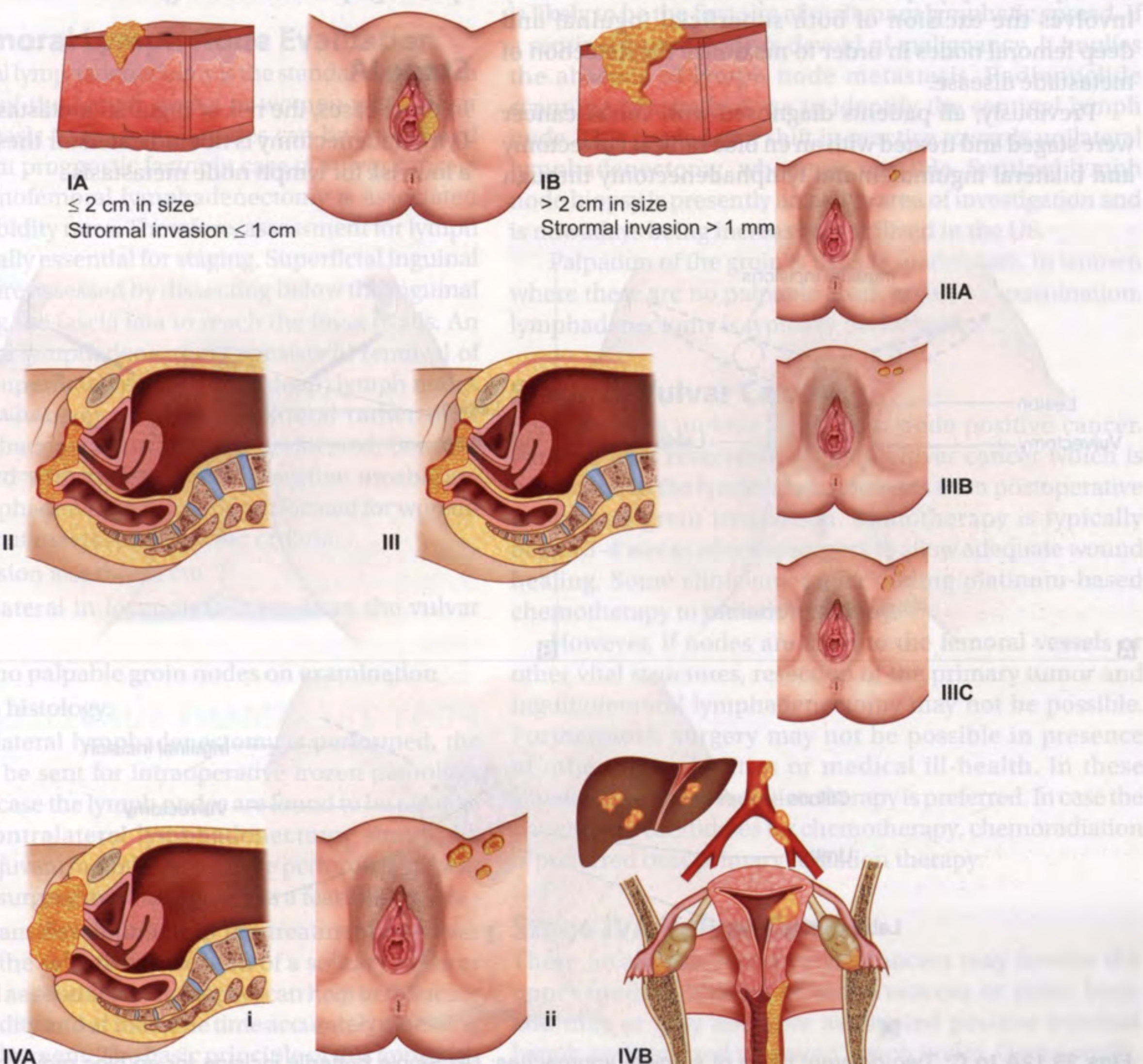


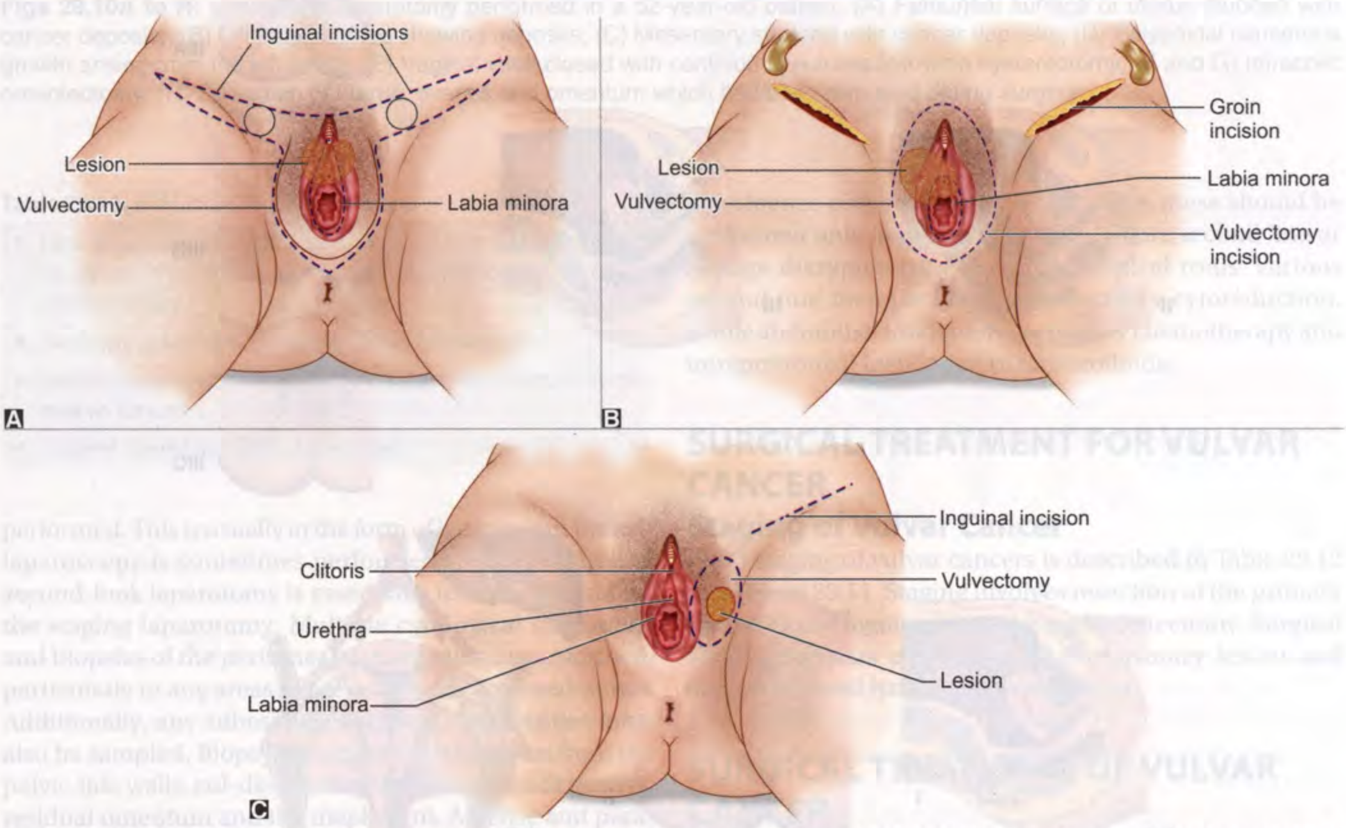
Fig. 29.11: Staging of vulvar cancer

radical complete vulvectomy (Figs 29.12A to C).[12-18] Of the various surgical procedures used, the en block dissection, which was commonly used previously, has now largely been abandoned. In current practice, radical local excision is preferred over radical vulvectomy. This approach conserves vulvar anatomy and encourages wound healing. Wide local excision is used for microinvasive tumors of the vulva. In case of wide local excision, 1-2 cm surgical margins are obtained around the lesion. With radical partial vulvectomy, tumor-containing portions of vulva are completely removed. Skin margins of 1-2 cm are usually obtained and the excision extends deep till the perineal membrane. In radical complete vulvectomy, 1-2 cm margins are obtained around a large vulvar tumor and the dissection is completed down till the perineal membrane. Vulvar defects created as a result of surgery can be closed with the help of skin grafts, advancement flaps or rotational flaps. The procedure of radical partial or radical complete vulvectomy is often accompanied by lymphadenectomy. This dissection usually involves the excision of both superficial inguinal and deep femoral nodes in order to maximize the detection of metastatic disease.

Previously, all patients diagnosed with vulvar cancer were staged and treated with an en bloc radical vulvectomy and bilateral inguinofemoral lymphadenectomy through a butterfly incision. This procedure has nowadays, largely become obsolete because it is associated with high rates of morbidity, such as poor wound healing, lymphedema, adverse effects on body image and sexual dysfunction. Both the techniques of radical partial vulvectomy and radical complete vulvectomy, which are commonly used nowadays, employ two or three separate incisions. The first incision is made to perform a radical local excision (a radical partial vulvectomy, radical hemivulvectomy, or modified radical vulvectomy) and involves resection of the primary tumor with 1 cm clinical margins laterally and a dissection down to the perineal membrane (deep fascia of the urogenital diaphragm). The excision can be unilateral in most cases. The other (and separate) incisions are for the inguinofemoral lymphadenectomy, which may be unilateral or bilateral depending on the primary vulvar tumor. This approach helps in keeping the intervening skin bridge intact, which aids in conserving vulvar anatomy and speeding up wound healing.

Stage IA

In these cases, the risk of inguinal metastasis is negligible. Lymphadenectomy is not indicated for these patients with a low risk for lymph node metastasis.



Figs 29.12A to C: Two different types of surgical approaches: (A) Single butterfly incision for en bloc radical vulvectomy and groin dissection; (B) Three separate skin incisions for radical complete vulvectomy and groin dissection; (C) Two separate skin incisions for radical partial vulvectomy with ipsilateral inguinofemoral lymphadenectomy

Stage IB to Stage II

These patients require radical resection of the primary tumor and assessment of the inguinofemoral lymph nodes. A more conservative approach at the time of surgery is favored. Stage IB lesions can be managed with radical partial vulvectomy.

An inguinofemoral lymphadenectomy (which may be either unilateral or bilateral depending on the location of the valvular lesions) may be required.

Most ipsilateral vulvar lesions defined as lesions located 1-2 cm of the midline can be managed with an ipsilateral inguinofemoral lymphadenectomy. Midline lesions located within 1-2 cm of the midline require bilateral inguinofemoral lymphadenectomy.[19] Lesions greater than 2 cm or those having extension to the lower perineal structures are best managed with a radical partial excision. This includes anterior hemivulvectomy with distal urethrectomy and bilateral inguinofemoral lymphadenectomy.

Inguinofemoral Lymph Node Evaluation

Inguinofemoral lymphadenectomy is the standard approach to evaluation of the lymph nodes in women with vulvar cancer. Metastasis to the lymph nodes can be considered as an important prognostic factor in case of vulvar cancers because inguinofemoral lymphadenectomy is associated with high morbidity rates. Therefore, assessment for lymph node is especially essential for staging. Superficial inguinal lymph nodes are assessed by dissecting below the inguinal ligament along the fascia lata to reach the fossa ovalis. An inguinofemoral lymphadenectomy consists of removal of the inguinal (superficial) and femoral (deep) lymph nodes (Fig. 29.13). Wherever possible, unilateral rather than bilateral lymphadenectomy must be performed, because it is associated with reduced postoperative morbidity. Unilateral lymphadenectomy can be performed for women with disease that meets the following criteria:

- Primary lesion less than 2 cm
- Lesion is lateral in location (> 2 cm from the vulvar midline)
- There are no palpable groin nodes on examination
- Squamous histology.

When unilateral lymphadenectomy is performed, the nodes should be sent for intraoperative frozen pathology evaluation. In case the lymph nodes are found to be positive for cancer, contralateral lymphadenectomy should be performed. Adjuvant radiotherapy can be performed in cases where further surgery may not appear as a feasible option.

An important development in the treatment of vulvar cancer is that the selective dissection of a solitary node or nodes (termed as sentinel node biopsy) can help in reducing surgical morbidity and at the same time accurately assessing the nodal involvement. The basic principle of this approach is that the first lymph node to receive lymphatic drainage from the tumor site is sentinel lymph node.[20] Therefore, this

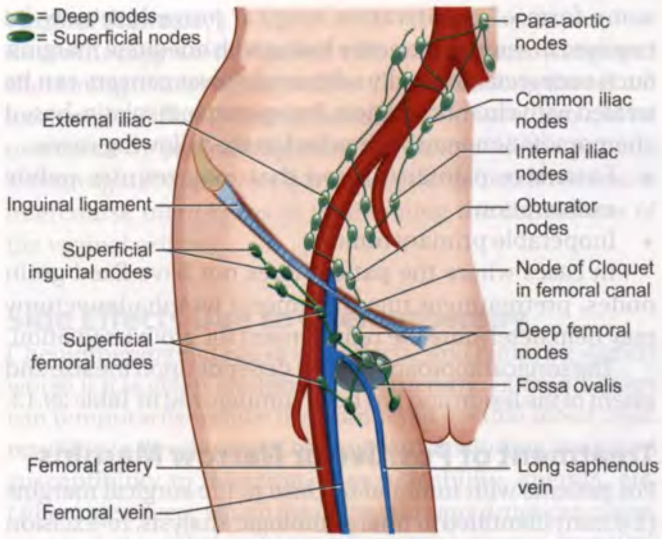


Fig. 29.13: Inguinofemoral lymph nodes

is likely to be the first site of malignant lymphatic spread. If a sentinel lymph node is devoid of malignancy, it implies the absence of lymph node metastasis. Radionuclide scanning is usually done to identify the sentinel lymph node. This has led to a shift in practice towards unilateral lymphadenectomy, whenever possible. Sentinel lymph node biopsy is presently an active area of investigation and is nowadays being increasingly utilized in the US.

Palpation of the groin is usually inadequate. In women where there are no palpable groin nodes on examination, lymphadenectomy is typically performed.

Stage III Vulvar Cancer

Such patients include those with node positive cancer. Patients with resectable primary vulvar cancer which is metastatic to the lymph nodes benefits from postoperative pelvic and groin irradiation. Radiotherapy is typically begun 3-4 weeks after the surgery to allow adequate wound healing. Some clinicians prefer adding platinum-based chemotherapy to radiation therapy.

However, if nodes are fixed to the femoral vessels or other vital structures, resection of the primary tumor and inguinofemoral lymphadenectomy may not be possible. Furthermore, surgery may not be possible in presence of other comorbidities or medical ill-health. In these situations, primary radiation therapy is preferred. In case the patients are candidates for chemotherapy, chemoradiation is preferred over primary radiation therapy.

Stage IVA Vulvar Cancer

These locally advanced vulvar cancers may involve the upper urethra, bladder or rectal mucosa or pubic bone and may or may not have associated positive inguinal lymph node or fixed ulcerated lymph nodes. Occasionally, such patients can be treated with radical primary surgery. However, more often due to size and location of the tumor, some form of exenterative surgical procedure may be required to remove the entire lesion with adequate margins. Such unresectable locally advanced vulvar cancers can be treated with chemoradiation. Preoperative cisplatin-based chemoradiation may be required in the following cases:

- Extensive primary lesion that may require pelvic exenteration
- Inoperable primary tumors.

In cases where the patient does not have fixed groin nodes, pretreatment inguinofemoral lymphadenectomy may help determine the requirement for groin irradiation.

The surgical approach chosen depends upon the size and extent of the lesion and has been summarized in Table 29.13.

Treatment of Positive or Narrow Margins

For patients with tumor at or close to the surgical margins (≤ 8 mm) identified at final pathologic analysis, re-excision must be performed. For those patients who do not want to undergo repeat surgery, radiation therapy may serve as a reasonable alternative.

Involved Groin Nodes on Examination

Patients presenting with suspicious or bulky groin nodes, who are candidates for surgery can be considered for nodal debulking followed by chemoradiation.

Table 29.13: Summary of treatment for vulvar cancer

Tumor Stage	Extent of Spread	Treatment
T1 lesions	No extension to adjacent perineal structures, i.e. lower/distal one-third urethra, lower/distal one-third vagina, anus	Radical local excision
T2 lesions	Extension to adjacent perineal structures	Modified radical vulvectomy (e.g. modified radical hemivulvectomy, modified radical anterior vulvectomy, modified radical posterior vulvectomy)
T3 lesions	Extension to any of the following: upper/proximal two-thirds of urethra, upper/proximal two-thirds vagina, bladder mucosa, rectal mucosa, or fixed to pelvic bone	Most of these patients are treated with chemoradiation followed by a selective procedure that is individualized to the patient on the basis of size and location of the residual tumor. In selected patients where chemoradiation is unsuccessful, exenteration with colostomy or urethral diversion appears to be a feasible option

Radiation Therapy

Patients who are not candidates for any form of surgical excision (e.g. due to medical frailty or comorbidities) should receive primary radiation therapy (total dose of radiation should be between 60 Gy and 70 Gy).

Adjuvant Radiation Therapy

Adjuvant radiation therapy is performed in the following high-risk cases:

- Tumor size > 4 cm
- Evidence of lymphovascular invasion
- Close or positive surgical margins
- Pathologic involvement of lymph nodes.

Primary Chemoradiation

For patients who are candidates for chemotherapy, some experts prefer to administer chemoradiation in patients with vulvar cancer who have tumors that might not be technically resectable without being at significant risk for postoperative morbidity. The bilateral inguinofemoral lymph nodes may be included within the treatment target volume for these patients. Patients who are not candidates for surgery and are deemed not to be candidates for chemotherapy should receive primary radiation therapy. Appropriate candidates for chemoradiation include patients with:

- Anorectal, urethral or bladder involvement (in an effort to avoid colostomy and urostomy)
- Disease that is fixed to the bone
- Gross inguinal or femoral node involvement (regardless of whether a debulking lymphadenectomy was previously performed).

Use of chemoradiation is associated with higher survival benefits in comparison to the use of radiotherapy alone. Use of single-agent cisplatin with radiotherapy is usually preferred. Concurrent use of fluorouracil (5-FU) alone or in combination with cisplatin or mitomycin-C is also being used.

POST-TREATMENT SURVEILLANCE

The optimal surveillance strategy has not been established. However, some commonly used recommendations are as follows:

- Serial review of symptoms and physical examination of the vulva, skin bridge and inguinal nodes.
- For early stage disease, this should be done every 6 months for the first 2 years and then annually.
- For advanced stage disease, this should be done every 3 months for the first 2 years, then every 6 months for years 3 through 5, and then annually.
- Cervical cytology (or vaginal cytology, if the cervix has been removed) annually.

For patients with locally advanced vulvar cancer who undergo surgery and have evidence of high-risk features (i.e. two or more microscopically positive groin lymph nodes, one or more macroscopically involved lymph nodes, or any evidence of extracapsular spread), some experts recommend the use of adjuvant radiation therapy. However, other experts prefer to treat these patients with chemoradiation.

COMPLICATIONS

Therapeutic modalities like surgery, radiotherapy and chemotherapy can result in numerous complications. Some of these complications are described below.[3]

Side Effects Due to Radiotherapy

During the acute phase of pelvic radiation, the surrounding normal tissues, such as the intestines, the bladder and the perineum skin are often affected. As a result, radiotherapy to the pelvic area can cause side effects, such as tiredness, diarrhea, dysuria, etc. These side effects can vary in severity depending on the strength of the radiotherapy dose and the length of treatment. Some of these complications are described next:

Cystourethritis

Inflammation of bladder and urethra can result in complications, like dysuria, increased urinary frequency and nocturia. Antispasmodics medicines are often helpful in providing symptomatic relief. Urine should be examined for possible infection. If urinary tract infection is diagnosed, therapy should be instituted without delay.

Gastrointestinal Effects

Gastrointestinal side effects due to radiotherapy include diarrhea, abdominal cramping, rectal discomfort, bleeding, etc. Diarrhea can be either controlled by loperamide (Imodium) or diphenoxylate (Lomotil). Small, steroid containing enemas are prescribed to alleviate symptoms resulting from proctitis.

Sore Skin

Radiotherapy can result in erythema and desquamation of skin.

Tiredness

Radiotherapy can result in extreme tiredness. Therefore, the patient must be advised to take as much rest as possible.

Bowel Complaints

In a small number of cases, the bowel may be permanently affected by the radiotherapy, resulting in continued diarrhea. The blood vessels in the bowel can become more fragile after radiotherapy treatment, resulting in hematochezia.

Vaginal Stenosis

Radiotherapy to the pelvis can cause narrowing and shortening of the vaginal orifice, thereby making the sexual intercourse difficult or uncomfortable. This problem can be overcome by prescribing estrogen creams to the patient. Using vaginal dilators or having regular penetrative sexual intercourse often helps in maintaining the suppleness of the vaginal orifice.

Side Effects Due to Chemotherapy

Chemotherapy can cause side effects, which may be slightly worse if it is given alongside radiotherapy. Chemotherapy can temporarily reduce the number of normal blood cells, resulting in development of symptoms including increased susceptibility to infection, easy fatigability, anemia, etc. Other side effects, which the chemotherapy drugs can cause, may include oral ulcerations (stomatitis), nausea, vomiting and alopecia. Nausea and vomiting can be well controlled with effective antiemetic drugs. Regular use of mouthwashes is important in treating the mouth ulcerations.

Complications from Surgery

Complications related to hysterectomy are described in Chapter 24 (Hysterectomy). Some other complications are enumerated next:

Premature Menopause

Removal of ovaries in young patients can result in symptoms related to premature menopause.

Urinary Dysfunction

The most frequent complication of radical hysterectomy is urinary dysfunction, as a result of partial denervation of the detrusor muscle.

Other Complications

Other complications resulting from surgery may include shortened vagina, ureterovaginal and rectovaginal fistulas, hemorrhage, infection, bowel obstruction, stricture and fibrosis of the intestine or rectosigmoid colon and bladder, formation of seromas in the femoral triangle, deep vein thrombosis, pulmonary embolism, myocardial infarction, etc.

Complications Related to Radical Vulvectomy and Bilateral Inguinal Lymphadenectomy

Some specific complications related to such surgery are:

- In case of groin dissection, the most important cause of immediate postoperative morbidity is wound infection, necrosis and breakdown. This can be considerably reduced by adopting a separate incision approach.
- *Wound breakdown*: This occurs due to the skin loss at the margins of the groin incision. This complication

can be reduced by removing lesser amounts of skin and reducing the undermining of the skin flaps. Suction drainage also helps in reducing the morbidity.

- *Lymphedema of the lower extremities*: This may occur in patients who have undergone dissection of inguinal and deep pelvic group of lymph nodes.
- *Late complications*: Late complications can occur in the form of chronic leg edema, recurrent lymphangitis or cellulitis of the leg. Introital stenosis in the long run can result in dyspareunia.

DISCUSSION

A new minimally invasive surgical procedure for gynecologic cancer patients, which has nowadays been commonly employed, is robotic surgery using da Vinci® hysterectomy. Traditionally, hysterectomy is associated with numerous complications such as a lengthy recovery period and increased risk of bleeding and infection. The da Vinci® surgical system can offer numerous benefits over traditional open surgery. Some of these include: shorter duration of hospital stay, reduced pain, faster recovery, reduced amount of blood loss, requirement for fewer transfusions and reduced risk of infection, risk of scar formation and an overall improved quality of life. For further details related to robotic surgery, kindly refer to Chapter 33. The types of robotic surgeries, which can be performed, are the da Vinci® hysterectomy with lymph node dissection for endometrial cancer and early stage cervical cancer. However, robotic surgery is yet not used for the treatment of ovarian cancer. It is even now, almost invariably treated using traditional surgical approach.

CONCLUSION

Surgical removal of the tumor serves as the treatment of choice for many gynecological cancers. However, the conventional surgery comprising of hysterectomy and pelvic lymphadenectomy is associated with considerable morbidity and mortality. With the advancements in the surgical techniques and introduction of robotic surgery, it has now become a commonly performed procedure in women with endometrial cancer and cervical cancer, who have been recommended for surgery.

For some gynecologic oncological procedures such as radical hysterectomies, robot-assisted surgery may serve as the most effective, least invasive treatment option and is associated with numerous benefits over the traditional laparotomy approach.

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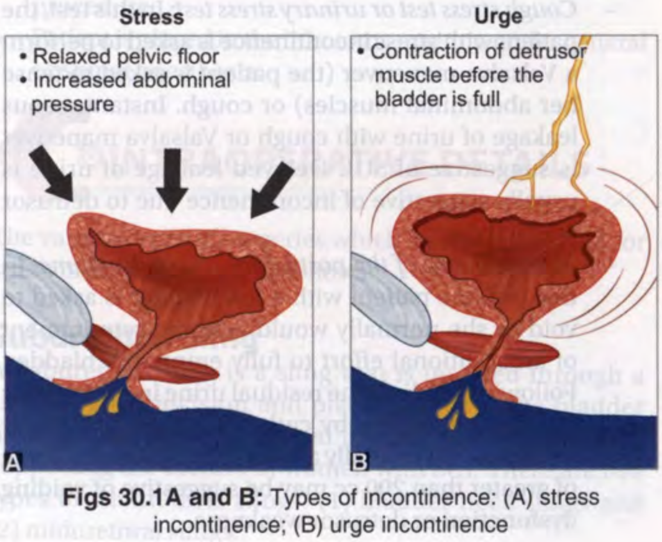
30 CHAPTER

Surgery for Urinary Incontinence

INTRODUCTION

Urinary incontinence can be defined as an involuntary loss of urine, which is a social or hygienic problem and can be demonstrated with objective means. There are two main types of urinary incontinence (Figs 30.1A and B): (1) stress incontinence and (2) urge incontinence. Stress urinary incontinence (SUI) is the most common form of urinary incontinence.[1] Urodynamic diagnosis of stress incontinence is termed as genuine stress incontinence. Urinary incontinence usually has a multifactorial etiology and includes the following:

- Structural and functional disorders involving the bladder, urethra, ureters and surrounding connective tissues



Figs 30.1A and B: Types of incontinence: (A) stress incontinence; (B) urge incontinence

- Disorders of the spinal cord or central nervous system (CNS) (stroke, multiple sclerosis and Parkinson disease)
- Some cases of urinary incontinence may be pharmacologically induced (e.g. sedatives, anticholinergic drugs, antispasmodics, alpha-adrenergic agonists, alpha-blockers, calcium channel blockers, etc.).
- Stress incontinence can occur due to two separate etiologies: (1) anatomic hypermobility of the urethra and (2) intrinsic sphincter deficiency/weakness.[2]
- Damage to the nerves, muscle and connective tissue of the pelvic floor is important in the genesis of stress incontinence. Weakening of pelvic connective tissues due to repeated childbirths (especially vaginal deliveries with episiotomy) appears to be an important mechanism.
- Genitourinary atrophy due to hypoestrogenism (especially in relation to menopause).
- Urge incontinence is usually caused due to uninhibited contractions of the detrusor muscle.

Clinical Presentation

The patient with urinary incontinence can present as follows:

- Involuntary loss of urine (either triggered by stress or associated with urgency). This may present as a social and/or hygienic problem. The complaints may be minor and situational or severe, constant and debilitating.
- There may be concomitant symptoms of fecal incontinence or pelvic organ prolapse.
- *General physical examination*: The examination is tailored based on each specific case history. The following parameters must be recorded for each patient: height; weight; blood pressure and pulse. The grading

system for urinary incontinence as devised by Stamey (1970) is described in Table 30.1.

Stress Urinary Incontinence

Stress urinary incontinence can be defined as involuntary leakage of urine during conditions resulting in an increase in intraabdominal pressure (exertion, sneezing, coughing or exercise) which causes the intravesical pressure to rise higher than what the urethral closure mechanisms can withstand (in the absence of detrusor contractions).

Urge Incontinence

Urge urinary incontinence can be defined as involuntary leakage of urine accompanied by or immediately preceded by urgency. The corresponding urodynamic term is detrusor overactivity, which is evident in form of involuntary detrusor contractions at the time of filling cystometry. Urge incontinence is caused by uninhibited contractions of the detrusor muscle.

OVERVIEW OF SURGERY

Surgery for Stress Incontinence

Surgery forms the mainstay of treatment for cases of stress incontinence. The vaginal surgery for stress incontinence involves the following:[3-8]

- Suburethral slings (Bladder neck slings and midurethral sling)
- Retropubic bladder neck colposuspension (especially Burch colposuspension)
- Injection of urethral bulking agents.

The advent of synthetic tapes especially that of the tension-free vaginal tapes (TVTs) has further revolutionized the surgery for stress incontinence.[9-13] Several newer modifications of these tapes are available nowadays, such as the transobturator tapes (TOTs) and crossover tapes. The advantage, which the sling surgery has over the previously used surgeries (especially Burch procedure) is the potential of sling surgery to treat intrinsic sphincter deficiency (ISD) in addition to the urethral hypermobility. Since some element of ISD seems to be mandatory for a leak, it is nearly always present in cases of stress incontinence and is commonly the cause for long-term recurrence. As a result, nowadays, most surgeons favor sling surgery over Burch colposuspension.

Table 30.1: Grading system for urinary incontinence

Grade	Definition
0	Continent
1	Loss of urine with sudden increase in abdominal pressure, but not in bed at night
2	Incontinence worsens with lesser degree of physical stress
3	Incontinence with walking, standing erect from sitting position or sitting up in bed
4	Total incontinence occurs and urine is lost without relation to physical activity or position

Surgery for Urge Incontinence

Surgical therapy should be considered only in severe and refractory cases of urge incontinence and include bladder augmentation procedures; denervation procedures; urinary diversion; sacral neuromodulation, etc.

AIMS OF SURGERY

Various procedures for stress incontinence share the common goal of stabilizing the bladder neck and proximal urethra.

INDICATIONS FOR SURGERY

Indications for sling surgery are as follows:

- Various forms of stress incontinence, especially those with ISD
- Stress incontinence with concomitant pelvic organ prolapse
- Failed procedures such as needle suspension or Burch colposuspension
- Women with a urethral diverticulectomy or urethral loss such as after a urethra-vaginal fistula repair (an autologous sling is preferred over synthetic sling in these cases).

PREOPERATIVE PREPARATION

Preoperative evaluation involves taking the complete history from the patient and performing a complete general physical examination, focusing on the following parameters:

- The type of incontinence: whether the symptoms are suggestive of stress incontinence, urge incontinence or mixed (both the types)
- Performance of tests for confirmation of stress incontinence.
  - *Cough stress test or urinary stress test*: In this test, the patient with stress incontinence is asked to perform a Valsalva maneuver (the patient is asked to tense her abdominal muscles) or cough. Instantaneous leakage of urine with cough or Valsalva maneuver is suggestive of SUI. Delayed leakage of urine is usually suggestive of incontinence due to detrusor overactivity.
  - *Measurement of the postvoidal residual volume:* In this test, the patient with a full bladder is asked to void as she normally would, without requirement of an additional effort to fully empty the bladder. Following voiding, the residual urine in the bladder is measured either by catheterization or bladder sonography. Generally a postvoidal residual volume of greater than 200 cc may be suggestive of voiding dysfunction or detrusor weakness.

- The patient must be asked to maintain a complete voiding diary.
- The clinician must assess the pelvic anatomy including strength of the muscles of pelvic floor.
- The surgeon also needs to determine if there is any associated voiding dysfunction suggestive of intrinsic sphincter deficiency. This might have an impact on the surgical management plan to be followed as well as the future prognosis because the patients with ISD do not have as good a long-term outcome with any procedure in comparison to those patients having predominant hypermobility. A patient with an underactive detrusor may be associated with the likelihood of voiding difficulty following surgical treatment of incontinence.
- The surgeon must also determine if there is any associated pelvic floor dysfunction such as cystocele, enterocele, rectocele, anal sphincter incompetence or vault prolapse. In case any such dysfunction is present, it must be taken care of at the time of surgery.
- Performance of urodynamic studies may provide important diagnostic and prognostic information and must be performed prior to any invasive therapy. Urodynamic evaluation is not necessary for many women with uncomplicated SUI. Urodynamic testing may prove to be useful in cases where the symptoms are not consistent with physical examination findings or in women having mixed/complicated incontinence situations.
- Estrogen replacement therapy prior to surgery may enhance urethral, bladder and vaginal tissue integrity.
- Treatment of various underlying medical disorders such as asthma, chronic obstructive pulmonary disease (COPD), diabetes, chronic constipation, etc. must be undertaken prior to surgery.
- Good nutrition helps to maximize tissue integrity and to support good healing.
- *Patient counseling*: This must comprise of thorough discussion of risks, benefits, anticipated success rates and potential common complications related to the procedure.
- Patient is placed in the lithotomy position under general or spinal anesthesia.

INTRAOPERATIVE DETAILS

The various types of surgeries which can be performed for stress incontinence are as follows:

Suburethral Sling

A suburethral sling is a sling that is inserted through a small vaginal incision and placed either at the bladder neck, midurethra or proximal urethra for the purpose of supporting the urethra in women with SUI. There are two types of suburethral slings: (1) bladder neck slings and (2) midurethral slings.

1. *Bladder neck sling*: Also known as a proximal urethral sling, this sling is placed at the level of the proximal urethra and bladder neck. This procedure is usually performed using both a vaginal and abdominal incision. These slings can be made of either biologic materials (including the patient's own tissue) or synthetic mesh. The bladder neck slings are also referred to as pubovaginal slings when the arms of the sling material are affixed to the anterior rectus fascia rather than the pubic bone or Cooper's ligament. Pubovaginal slings involve the use of autologous fascia, which can be harvested from the patient's rectus sheath or alternatively from the patient's thigh (fascia lata).
2. *Midurethral sling*: This is a suburethral sling that is inserted via a small vaginal incision and placed at the level of the midurethra in a tension-free manner. This surgery involves the interplay of three structures: (1) pubourethral ligaments, (2) suburethral vaginal tissues and (3) the pubococcygeus muscle. Though there can be several variations of these procedures, all involve placement of a synthetic mesh. Based on the route of placement, i.e. whether a retropubic or a transobturator approach is used, these procedures can be classified as follows:
   - Retropubic method: Tension-free vaginal tape
   - Transobturator approach: Transobturator tape

Retropubic Approach

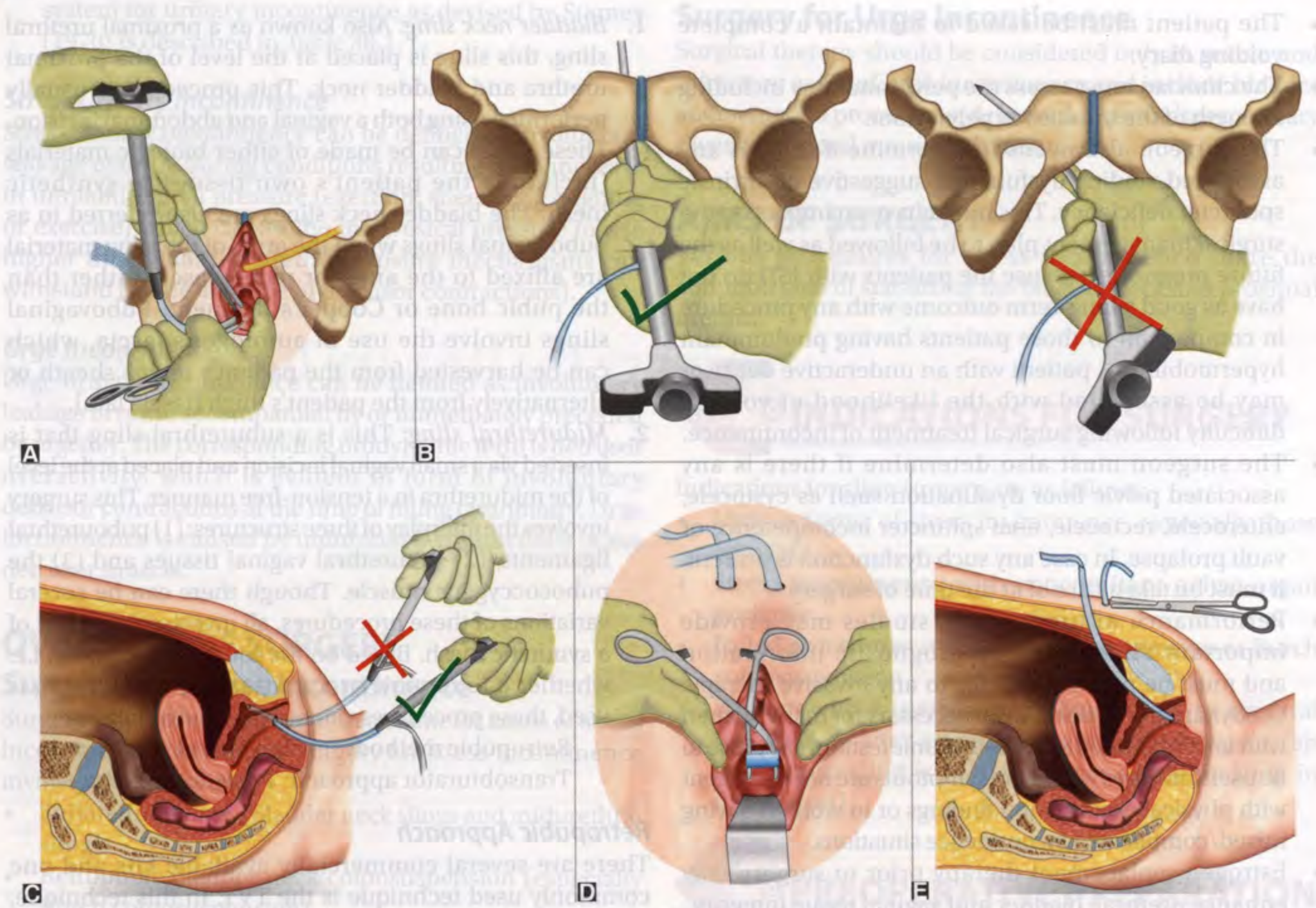
There are several commercially available kits and one commonly used technique is the TVT. In this technique, one trocar is placed through a vaginal suburethral incision lateral to the urethra and brought out suprapubically through a skin incision (Figs 30.2A to E). The TVT devices are associated with a 71% cure rate at 11.5 years.[14]

Transobturator Approach

This approach was introduced to reduce the risks related to injury to the lower urinary tract and vascular structures, which can be associated with traversing the retropubic space. Various kits for this approach are available, each containing a needle and a mesh design sling material made up of polypropylene. In this surgery, the sling material is directed bilaterally through the obturator foramen underneath the midurethra (Figs 30.3A to D). The point of entry overlies the proximal tendon of adductor longus muscle. Based on the method of needle placement, the transobturator procedures can be of two types:

1. An "in-to-out" approach: Needle placement begins inside the vagina and is directed outwards.
2. An "out-to-in" approach: Needle placement begins outside the vagina and is directed inwards.

   Initially, when the transobturator sling procedure was introduced, an "out-to-in" approach was used. However, this approach was associated with several complications such as injury to the bladder, urethra, etc. The "in-to-out" approach was then introduced with the aim of reducing injury to the lower urinary tract.



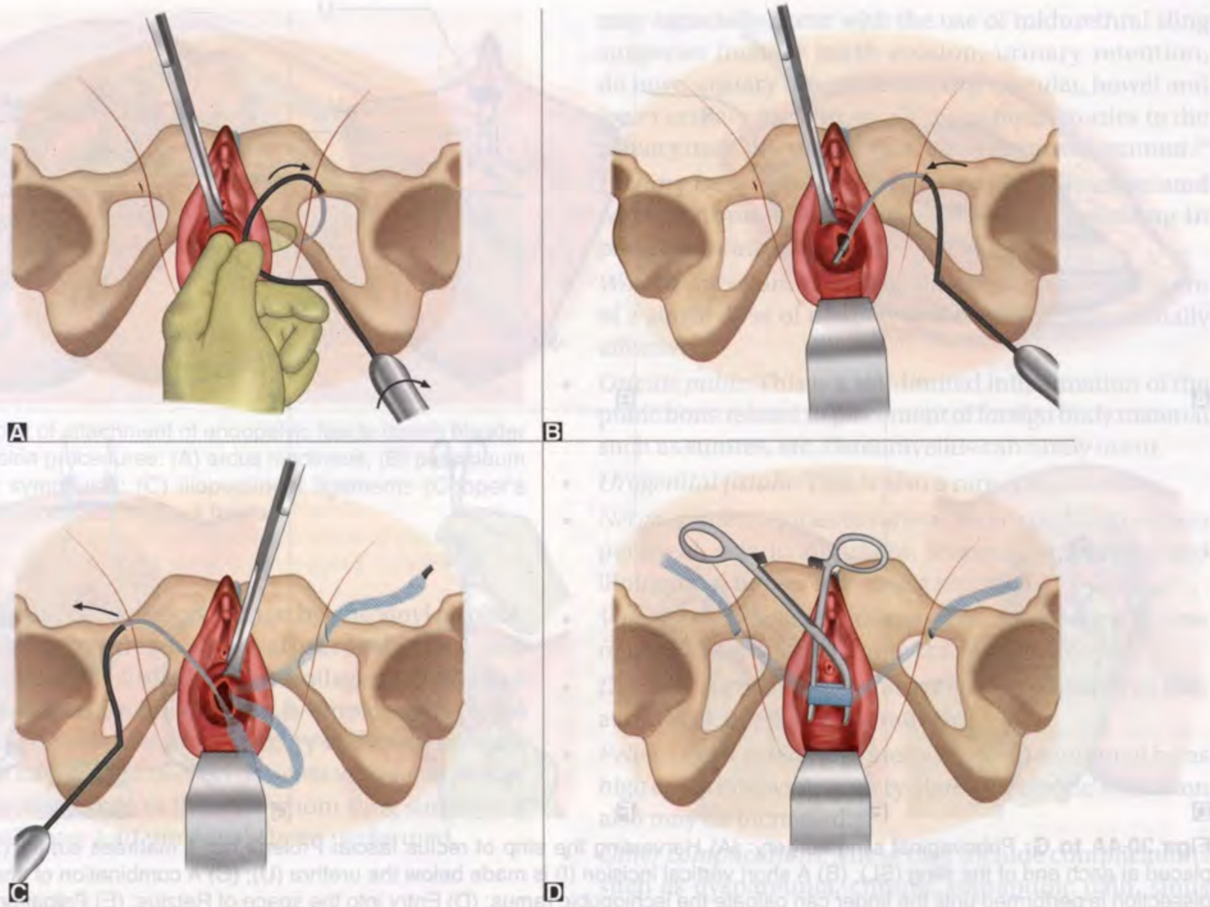
Figs 30.2A to E: Tension-free vaginal tape surgery: (A) Placing the needle through the submucosal tunnel; (B) Correct and incorrect positioning of the transducer; (C) Correct and incorrect positioning of hand and the transducer; (D) Setting mesh tension; (E) Bringing the tape out through the suprapubic abdominal incision and trimming the tape

However, in this approach, the needle travels to the obturator neurovascular bundle. Though each method has theoretical advantages, the possibility of injury cannot be completely excluded. Nevertheless, the transobturator approach serves as an effective day-surgery technique with potentially lower rate of bladder injury. However, some retrospective studies have shown that it may show limited effectiveness in patients having urodynamic criteria for intrinsic sphincter deficiency.[8,9]

Pubovaginal Sling Surgery

This surgery comprises of the following steps (Figs 30.4A to G):

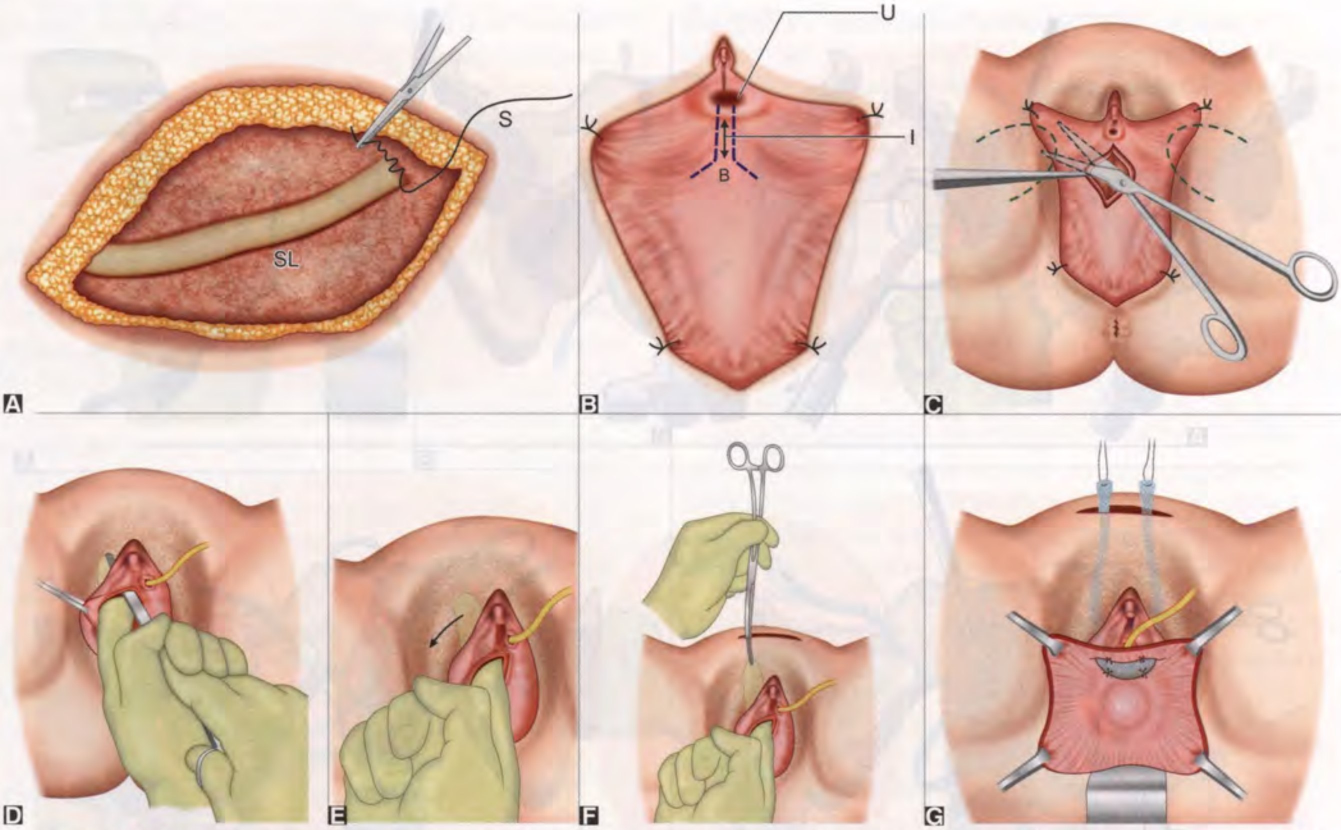
- *Harvesting the strip of rectus fascia:* In this surgery, firstly a strip of rectus fascia is harvested by making a 3-inch long transverse incision just above the pubis below the pubic hairline down to the surface of the rectus fascia. The rectus fascia is dissected free of subcutaneous tissue from the above and freed from the muscles below to fashion out a rectus fascia sling, which is about 12–16 cm long and 2 cm in width. Once the entire dissection is complete, the fascial strip is excised and placed in a basin of saline. A helical stitch is placed using a 0 gauge delayed-absorbable polypropylene sutures at each end of the fascial strip. The abdominal wound is packed temporarily and the vaginal surgery is begun.
- *Identification of bladder neck:* A Foley catheter is inserted into the bladder. The bladder neck can be identified by inserting a Foley catheter inside the urethra. Applying gentle traction on the Foley catheter and palpation of the balloon would help in delineation of bladder neck.
- *Vaginal dissection to reach the pubic bone:* A vertical incision or a gently curved horizontal incision (about 5–6 cm long) is made about 2 cm below the urethral meatus on the anterior vaginal wall superficial to the pubocervical fascia (Fig. 30.4B). The edges of the incision are held using Allis forceps, and a combination of sharp and blunt dissection is used to lift the vaginal epithelium off the underlying fibromuscular layer. The plane corresponding to the undersurface of the anterior vaginal wall is identified by noting the characteristic shiny white appearance. Blunt dissection is then performed to create a space up to the pubic bone by entering the space of Retzius. The dissection is carried out using the dissecting scissors, pointing laterally until



Figs 30.3A to D: Tension-free obturator tape: (A) Introduction of the needle; (B) Passage of the needle; (C) Placing the tape; (D) Setting mesh tension

the pubic bone is reached. A combination of sharp and blunt dissection is performed until the finger can palpate the ischiopubic ramus. During this part of the dissection, the surgeon must try to stay as far lateral as possible to avoid injury to the urethra, bladder, and ureters.

- *Placing the urethral sling*: Using the surgeon's right hand, a long dressing or packing forceps or needle ligature carrier is used from the abdominal side to perforate the rectus sheath caudal to the prior harvest incision. Simultaneously, the surgeon's left index finger is placed in the vagina to bluntly retract the bladder neck medially. The forceps is placed against the back of pubic bone and advanced towards the vagina. Concurrently, the surgeon guides the instrument using his fingers within the space of Retzius. The suture at one end of the harvested rectus fascial strip is grasped with the penetrating forceps and threaded up through the abdominal incision on the side of urethra. A similar procedure is repeated on the other side with the other end of the sling. As a result, the fascial sling lies positioned beneath the bladder neck. The sling is fixed beneath the bladder neck using 3–4 delayed absorbable sutures. Two small stab wounds are made in the rectus fascia just above the pubis and the sling is brought through them on either side.
- *Placing the sling in a tension-free manner*: Sutures attached to the sling are then tied together above the rectus sheath. While tying the knot, a space of two- or three-finger breadth is left between the knot and the fascia to prevent future complications such as bladder neck obstruction and urinary retention. Once the knot has been secured, there should be no upward angulation of the urethra or bladder. The sling is placed in a tension-free manner, just like the TVT. One should be able to place a heavy pair of scissors between the sling and the urethra to ensure that the sling is not under tension.
- *Closure of the vaginal incision*: Cystoscopy is performed to ensure that the urinary tract is safe and there has been no bladder perforation or obstruction of urethra. The vagina is then closed using 2-0 chromic catgut sutures in a running fashion. Some surgeons may prefer to close the vagina before the sling has been tied since adequate access may become difficult once the sling is tied and the bladder neck has moved up to a higher and a less accessible location. A Foley catheter is left in place.



Figs 30.4A to G: Pubovaginal sling surgery: (A) Harvesting the strip of rectus fascia: Prolene no. 1 mattress suture (S) should be placed at each end of the sling (SL); (B) A short vertical incision (I) is made below the urethra (U); (C) A combination of sharp and blunt dissection is performed until the finger can palpate the ischiopubic ramus; (D) Entry into the space of Retzius; (E) Palpation of the pubic bone; (F) Placement of the strip of fascia; (G) Suturing the fascial sling in place

- *Closure of the abdominal incision:* At the end of surgery, the abdominal incision is closed using interrupted silk sutures.

Minimally Invasive Slings

Modification of TVT and TOT procedures is observed with minimally invasive slings, sometimes also known as the microslings or minislings. In this technique a small incision is made in the vagina, through which an 8-cm long strip of polypropylene synthetic mesh is placed across and beneath the midurethra. Since the mesh is not threaded through the retropubic space, it helps in avoiding potential vascular injury.

Retropubic Bladder Neck Colposuspension

All these procedures are performed through lower abdominal incision and involve the attachment of periurethral and perivesical endopelvic fascia (vaginal wall adjacent to midurethra and bladder neck) to some other supporting structure in the anterior pelvis (Table 30.2 and Fig. 30.5). These procedures are also referred to as retropubic urethropexy. Nowadays, some of these procedures are performed through laparoscopic and robotic surgery. These procedures had been long considered as the gold standard for the surgical treatment of stress incontinence, with 1-year continence rates varying between 85% and 90%.[15]

Table 30.2: Various supporting structures in different types of retropubic procedures

Name of surgical procedure	Supporting structure in the anterior pelvis
Paravaginal procedure	Arcus tendineus
Modified Marshall-Marchetti-Krantz procedure	Back of pubic symphysis
Burch colposuspension	Iliopectineal ligament (Cooper's ligament)
Turner-Warwick vaginal obturator shelf procedure	Fascia over obturator internus

Some complications commonly associated with retropubic urethropexy include detrusor overactivity, urinary retention and in case of Marshall-Marchetti-Krantz procedure, osteitis pubis.

Injection of Urethral Bulking Agents

Periurethral injections are performed under local anesthesia and involve administration of various types of materials around the periurethral tissues to facilitate their coaptation under conditions of increased intra-abdominal pressure. Various bulking agents have been used including

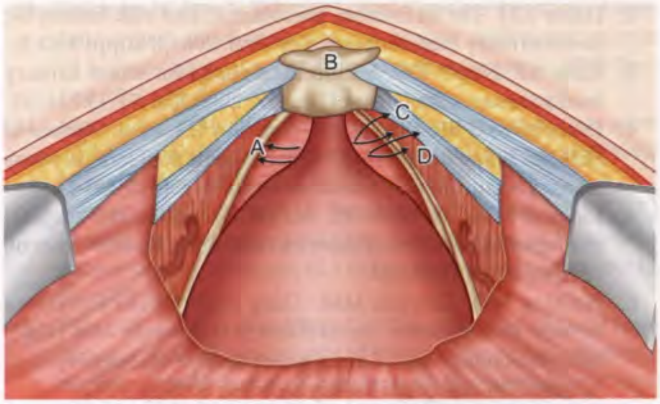


Fig. 30.5: Point of attachment of endopelvic fascia during bladder neck suspension procedures: (A) arcus tendineus; (B) periosteum of the pubic symphysis; (C) iliopectineal ligaments (Cooper's ligaments); (D) obturator internus fascia

collagen; carbon-coated zirconium; ethylene vinyl alcohol; polydimethylsiloxane; polytetrafluoroethylene and glutaraldehyde cross-linked bovine collagen (Contigen). Use of periurethral bulking agents is employed in those cases who are unable to tolerate surgery or those who want to avoid it. It can also be used in patients with recurrent or refractory incontinence or those in whom sling surgery for stress incontinence had previously been performed.

POSTOPERATIVE CARE

- Voiding trials are begun as soon as the patient is comfortable, usually on the 1st or 2nd postoperative day.
- Bladder drainage is an essential aspect of postoperative care. Most patients are able to void spontaneously in 3–7 days.
- Measures must be taken to control chronic cough and to avoid or treat constipation.
- The patient should avoid lifting anything heavier than 10 pounds for 12 weeks.
- The patient must be instructed to avoid smoking and other activities that may repetitively stress the pelvic floor, resulting in long-term failure of the procedure.

COMPLICATIONS

- *Hemorrhage*: Bleeding is usually from the perivesical venous plexus. Hemorrhage can occur in nearly 2% cases undergoing retropubic procedures.
- *Urinary tract and visceral injury*: Bladder injuries can commonly occur with the laparoscopic approach. Injury to the ureter can occur due to kinking or angulation during the retropubic procedures. Injury to the bowel can also sometimes occur. Various complications, which may especially occur with the use of midurethral sling surgeries include mesh erosion, urinary retention, de novo urinary incontinence and vascular, bowel and lower urinary tract injury. Of the various injuries to the urinary tract, bladder perforation is the most common.[16]
- *Urinary tract infection*: These are especially associated with postoperative voiding difficulties resulting in prolonged catheterization.
- *Wound infection*: Prophylactic antibiotics in the form of a single dose of a broad-spectrum agent are usually effective.
- *Osteitis pubis*: This is a self-limited inflammation of the pubic bone related to placement of foreign body material such as sutures, etc. Osteomyelitis can rarely occur.
- *Urogenital fistula*: This is also a rare complication.
- *Nerve injuries*: Injuries to various nerves such as common peroneal, sciatic, obturator, femoral, saphenous and ilioinguinal nerves have been reported.
- *Voiding dysfunction*: This may manifest in form of slow or poor urinary stream or in the inability to void.
- *Detrusor overactivity*: De novo detrusor overactivity may at times develop postoperatively.
- *Pelvic organ prolapse*: Enterocele formation may be as high as 8% following surgery. Rate of rectocele formation also may be increased.
- *Other complications*: These may include complications such as dyspareunia, chronic suprapubic pain, sinus tract formation, etc.

DISCUSSION

Nowadays, midurethral sling procedures are commonly used. Midurethral slings are as effective as other surgical treatments for SUI, but with a shorter operative duration and a lower risk of certain postoperative complications.[11,17] Midurethral slings are associated with considerably reduced morbidity and voiding dysfunction in comparison to the bladder neck slings. Therefore, bladder neck slings are used only in those women where the midurethral slings are contraindicated or are unsuccessful. Moreover, midurethral slings are associated with several advantages such as high short-term cure rate and better quality of life.[18-24] Of the two approaches (retropubic and transobturator approach) commonly used in cases of midurethal sling surgeries, both the approaches appear to offer comparable results.[25-30] Despite these favorable comparisons, abundant long-term data regarding the efficacy of transobturator approach are lacking. Pubovaginal rectus fascia slings have excellent long-term results with more than 80% of the patients remaining continent beyond 5 years of surgery.[31]

Some surgical procedure which were commonly used previously, but are rarely used nowadays for treatment of incontinence include anterior colporrhaphy with Kelly's plication,[32] transabdominal paravaginal repair, transvaginal needle suspension procedures,[33] etc. Transvaginal urethropexies/needle suspension procedures/Pereyra-Raz's/Stamey's procedure involves passage of sutures between the vagina and anterior abdominal wall using an especially designed long needle carrier, which is inserted through the vaginal incision made at the level of bladder neck. The other end of the suture passes through a small abdominal incision, which is made transversely just above the pubic bone and is carried down to the rectus fascia. These surgeries therefore relied on the strength and integrity of the periurethral tissue and the abdominal wall.

Before undertaking any surgery, the following factors need to be considered by the surgeon:[34]

- *Intrinsic sphincter deficiency versus hypermobility*: If hypermobility predominates, both pubovaginal sling and Burch colposuspension are equally effective. However, if ISD predominates, a pubovaginal sling is more effective.
- *Findings of the urodynamic studies*: If the urodynamic findings are suggestive of underactive detrusor, the surgeon must take extra caution in order to avoid urethral obstruction during the procedure. It might also require the surgeon to counsel the patient regarding a possible postoperative clean intermittent catheterization.
- *Patient's lifestyle*: A sling surgery may be better suited to a young and very active patient, whereas an old patient, with an underlying medical condition, unfit for surgery may benefit from the use of minimal therapy, such as a collagen injection.

CONCLUSION

When urinary incontinence markedly disrupts the woman's life and the symptoms of stress incontinence do not respond to conservative management and/or pharmacological therapy, surgical treatment may be the only option. Most options for urinary incontinence surgery treat stress incontinence. A sling is a piece of human or animal tissue or a synthetic tape, which the surgeon places in order to support the bladder neck and urethra. Nowadays midurethral sling surgeries, those using the retropubic or the transobturator approaches are commonly used. Both these approaches are designed to reduce or eliminate stress incontinence in women.

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31
CHAPTER

Diagnostic and Operative Hysteroscopy

INTRODUCTION

Hysteroscopy is a minimally invasive procedure, involving the direct inspection of the cervical canal and endometrial cavity through a rigid, flexible or a contact hysteroscope (Figs 31.1A to C). The procedure allows for the diagnosis of intrauterine pathology and serves as a method for surgical intervention (operative hysteroscopy). Hysteroscopy has the benefit of allowing direct visualization of the uterus, thereby avoiding or reducing iatrogenic trauma to delicate reproductive tissues. Not only does hysteroscopy allows direct observation of the intrauterine/endometrial pathology (presence of submucous fibroids, endometrial cancer, etc.), but also it acts as a way of sampling the endometrium under direct visualization.[1]

OVERVIEW OF SURGERY

Both diagnostic and operative hysteroscopy have now become a standard part of routine gynecological practice. Besides diagnosing certain uterine pathologies and aiding in the biopsy, hysteroscopy has now also become the method of choice for treatment of intrauterine pathology.

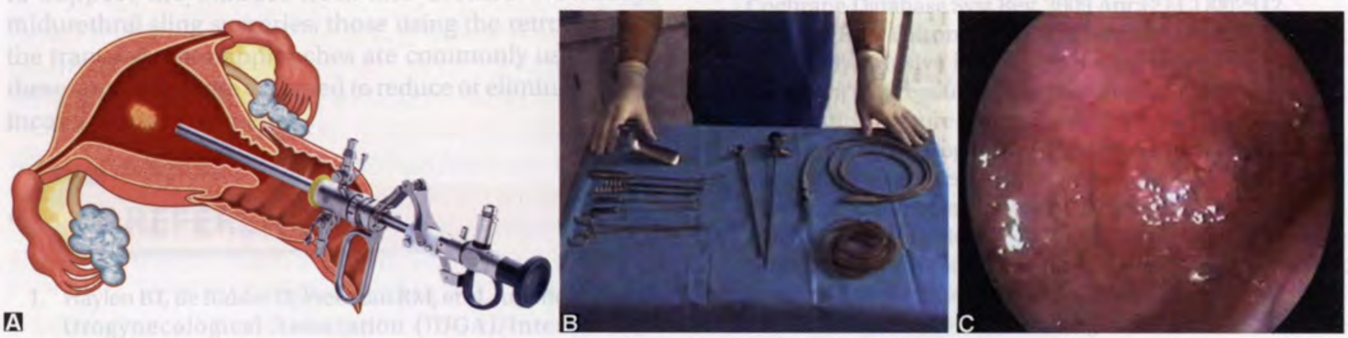
SURGICAL EQUIPMENT

Hysteroscope

The hysteroscopic system comprises of a rigid telescope that is used together with an outer sheath for instillation of the distension media.

Telescope

Telescopes of different diameters (2–4 mm) and a variety of viewing capabilities are available (0°, 12°, 30°, 70°). The most popular hysteroscope is a 4 mm, 30° telescope with a 5.5 mm outer sheath for diagnostic as well as operative hysteroscopy. A sharp and clear image can be obtained with the help of a 4 mm telescope (Fig. 31.2). This is also associated with the smallest outside diameter. The most desirable optics provide a large field that subtends an angle of approximately 105°. The telescopes are available with a 0°



Figs 31.1A to C: (A) Diagrammatic view of a hysteroscope inside the uterine cavity; (B) Instruments used at the time of diagnostic hysteroscopy; (C) Appearance of normal uterine endometrium on hysteroscopic examination

Fig. 31.2: Telescope
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Fig. 31.3: Continuous-flow examination sheath
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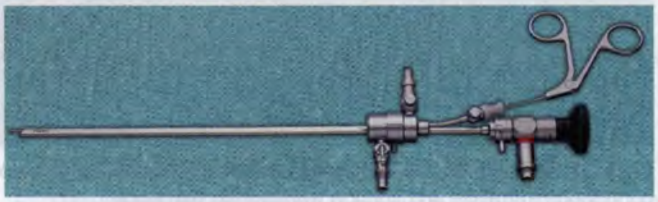

Fig. 31.4: Operative hysteroscope with instruments through the operative channel
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straight-on or a 30° fore-oblique view.[2] The major advantage of the 0° lens is that it allows the operator to see the operative devices as a relatively distant panorama, whereas this view is lost when 30° lens is used. The telescope has three parts: (1) the eyepiece, (2) the barrel and (3) the objective lens. Light generators act as a source of light for the hysteroscope. Three types of light generators are available: (1) tungsten, (2) metal halide and (3) xenon.

Diagnostic and Operative Sheath

The diagnostic sheath helps in the delivery of the distension media inside the uterine cavity. The diagnostic sheath, commonly used is 5 mm and allows 1 mm clearance space between its inner wall and the telescope, through which the distending medium is delivered. A 6.5 mm double channel continuous-flow sheath is available and is useful when the uterine cavity is bleeding (Fig. 31.3). The same telescope can be used with operative hysteroscopy sheath and resectoscope.

The diameter of the operative sheath is usually greater than that of the diagnostic sheath and ranges from 7 mm to 10 mm (Fig. 31.4). The operative sheath has space for instillation of the distension medium, for the 4 mm telescope and for the insertion of operating devices. The resectoscope is a specialized electrosurgical endoscope comprising of an inner and outer sheath. In the inner sheath, there is a common channel for the telescope, medium and electrode (Figs 31.5A and B). There is a trigger device which pushes the electrode out beyond the sheath and pulls it back within the sheath. The operating tool comprises of two basic electrodes: (1) a 4 mm ball and (2) a 5 mm cutting loop.

The internal lumen of the sheath must be of adequate size to allow the passage of telescope and operative instruments, e.g. scissors, biopsy forceps, catheters and coagulation electrodes. The external sheath diameter ranges from 3.7 mm to 7 mm to allow the passage of telescope, operative instruments and liquid distension medium. Resectoscope has been used by urologists to perform operative procedures such as excision of submucous myomas, polypectomy, division of uterine septa and endometrial ablation or resection. The main characteristics of the widely used Karl Storz resectoscope are described in Table 31.1.

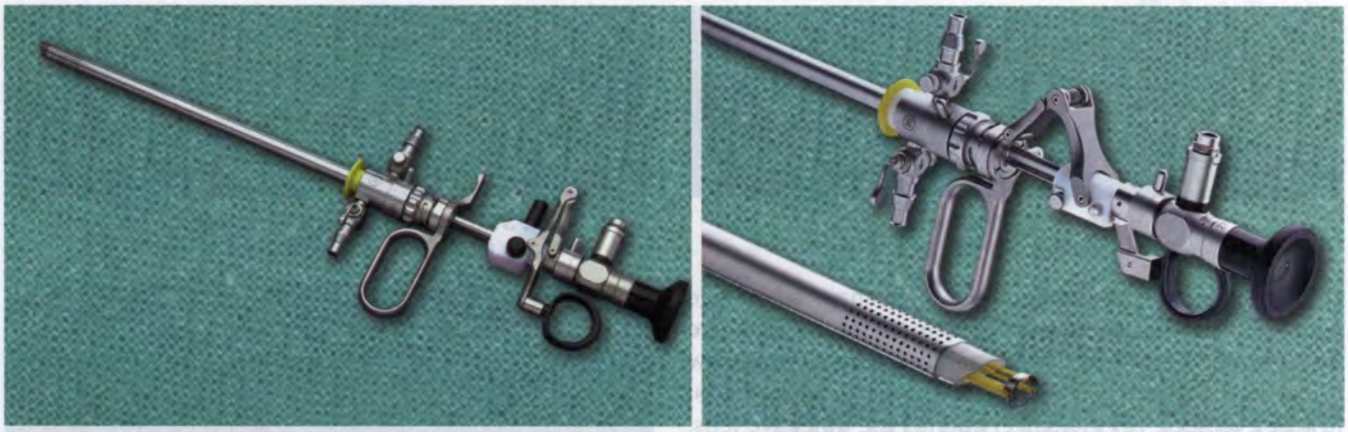
A diagnostic sheath is required to deliver the distending medium into the uterine cavity. The telescope fits into the sheath and is secured by means of a water-tight seal that locks into place. The hysteroscope must be inserted under direct vision, and the axis of the cervical and uterine canal must be carefully followed until the uterine corpus has been reached. This way, chances of uterine perforation can be minimized. Improper coupling between the telescope and sheath is likely to result in leakage of the medium at that interface. Operative sheaths have a larger diameter varying between 7 mm and 10 mm (average 8 mm).

Distension Medium

Various types of distension media are used at the time of hysteroscopic surgery. Distension media used at the time of hysteroscopy can be either gaseous or liquid.[3] Water is usually not used as a distension medium due to its hypoosmolar nature. Also, once it is absorbed, it can cause hemolysis.

Gaseous Distension Medium

The most commonly used gaseous medium for diagnostic hysteroscopy is CO_2. It is inexpensive, does not produce any mess, is readily available and helps in providing a clear view. However, in the presence of blood or mucus, it can produce a distorted view. CO_2 is rapidly absorbed by the blood and speedily cleared by the lungs. If proper flow rate and pressure is maintained, the incidence of intoxication or embolism due to CO_2 can be considerably reduced. However CO_2 can sometimes leak around the hysteroscope, making diagnosis very difficult. Mild contamination of the lens by the mucus or blood can result in the formation of troublesome bubbles with the use of CO_2. This may result in the obscuration of the picture quality. With the use of CO_2 as the distension medium, the pressure should be maintained in the range of 100–120 mm Hg, with a flow rate of 30–60 mL/min. This corresponds to the final intrauterine working pressure of 40–80 mm Hg. With office hysteroscopy, it is best to use fluid distension media rather than CO_2 gas distension media for the visualization of the uterine cavity.



Figs 31.5A and B: (A) Resectoscope (Karl Storz); (B) Resectoscope sheath including connecting tube for inflow and outflow for continuous irrigation and suction with bipolar electrode

Table 31.1: Main characteristics of the widely used Karl Storz resectoscope

Diameter	Telescope	Electrosurgical system
26 Fr	0°, 12°, 30°	Monopolar

One requires the use of a dedicated gas hysteroflator which helps in maintaining the intra-abdominal pressure and adjustment of CO_2 insufflation flow rate (Fig. 31.6). Laparoscopic insufflators having high flow rates must not be used. Inadvertent use of these laparoscopic insufflators can lead to CO_2 embolism and even death.

Fig. 31.6: Carbon dioxide insufflator

Liquid Media

Fluid distension media can be used for both diagnostic and operative purposes. This involves the use of either high viscosity, high molecular weight media, such as Hyskon, or the low viscosity, low molecular weight media such as saline or glycine.

High Viscosity Media

High molecular weight dextran: It has been used in the past as the distension media for hysteroscopy. The main disadvantage of this medium is that it is viscous, messy and inconsistent and has the potential to immobilize the moving parts of the hysteroscope if not properly cleaned. There is a risk of causing complications, such as pulmonary edema, disseminated intravascular coagulation (DIC) or anaphylaxis, if its amount exceeds 500 mL. This medium is rarely used in the present day practice.

Low Viscosity Media

Low viscosity media can be of two types: (1) Nonionic and (2) ionic. Nonionic media include glycine, mannitol or sorbitol, while ionic media include fluids such as normal saline and ringer lactate. These are used for both diagnostic as well as therapeutic purposes.

Glycine: It is a simple amino acid which is used as a distension medium after mixing it with water to form a 1.5% solution. It is cheap, readily available and provides a fair degree of visibility. It allows the use of both monopolar and bipolar current. Since it is miscible with blood, it requires continuous-flow irrigation. Being a nonelectrolyte solution, it can be used with monopolar electrosurgical equipment. Being a hypoosmolar and hypotonic solution, it can intravasate into the vascular tree resulting in side effects such as hyponatremia, hypervolemia, pulmonary edema, cerebral edema, heart failure and death. Water intoxication and fluid overload especially occurs if the fluid (800–1,000 mL) intravasates into the patient. Therefore, it is important to accurately measure the input/output of the distension media. As soon as the amount of intravasation exceeds 1,000 mL, the procedure must be stopped.

Saline and ringer lactate: These are isoosmolar and isotonic physiological media. Until very recently, these media were being used only at the time of diagnostic hysteroscopic procedures not involving the use of monopolar electrosurgical equipment. This is so because the presence of electrolytes in these solutions was supposed to interfere with the use of electrosurgical systems.

However, now with the advent of bipolar intrauterine surgery, the use of electrolyte-free solutions can be avoided at the time of surgery. This has encouraged the use of solutions such as normal saline for hysteroscopic surgery.

Electrolyte-Free Distension Media (Sorbitol-Mannitol Solution)

Sorbitol is commonly used as a distension media for operative hysteroscopy. It is a hypoosmolar solution, absorption of which poses a risk for development of cerebral edema. Absorption of the hypoosmolar solution by the brain causes the brain to pump out the cations. This cation pumping mechanism in the brain may be deficient in women under the effect of hormone, progesterone. Therefore the women are at a higher risk of development of cerebral edema.

Distension Machines

The various types of distension machines which can be used include:

- Gravity
- Pressure cuff
- Hysteromat (Fig. 31.7)
- Total input-output system

The hysteromat can be considered as the ideal system of all because it helps in maintaining intrauterine pressure of approximately 70 mm Hg.

Fig. 31.7: Hysteromat of Hamou helps in providing a constant flow of low viscosity fluid, which helps in maintaining sufficient pressure to keep the uterine walls distended

Hysteroscopic Operating Equipment

Various types of hysteroscopic scissors and grasping forceps are shown in Figures 31.8A and B and 31.9A to C, respectively. There are various types of unipolar cutting thermal loops and electrodes with different shapes and sizes (Figs 31.10A to E), which can be used with resectoscope sheaths.

INDICATIONS

Hysteroscopy is useful in numerous diagnostic as well as operative procedures.

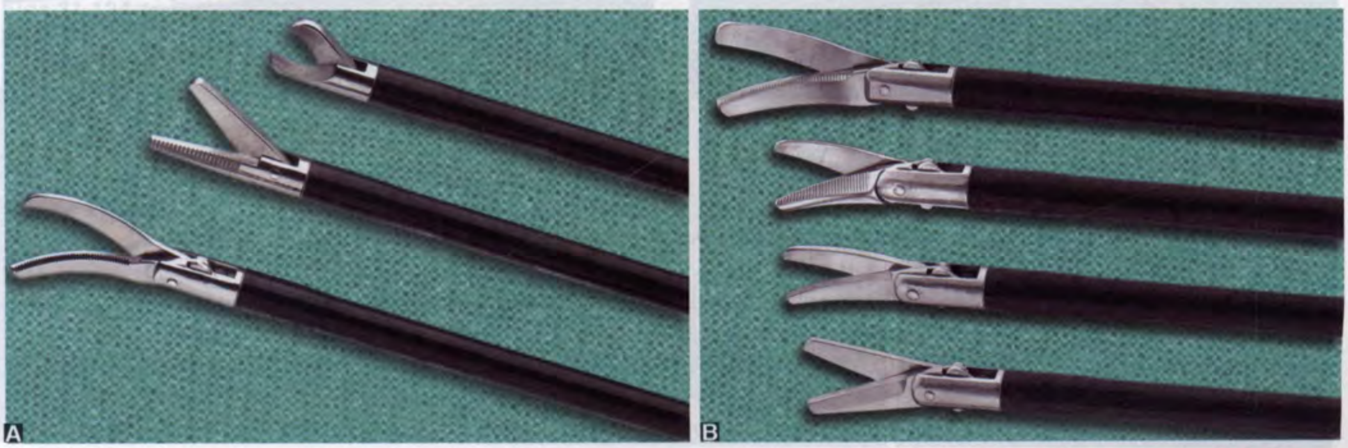
DIAGNOSTIC INDICATIONS

- Diagnosis of causes of infertility [abnormalities on hysterosalpingography such as filling defects, intrauterine synechiae (Fig. 31.11), adhesions, Asherman's syndrome, etc.].[4]
- Diagnosis of cases of recurrent miscarriage
- Diagnosis of causes of abnormal bleeding such as menorrhagia, irregular bleeding, abnormal uterine bleeding (AUB), postmenopausal bleeding, etc.[5] This could be related to causes such as presence of endometrial polyps (Figs 31.12A to E), submucosal fibroids (Figs 31.13A to C), endometrial hyperplasia (Fig. 31.14), endometrial carcinoma (Figs 31.15A and B), etc.
- Diagnosis of congenital uterine abnormalities [e.g. septate uterus (Fig. 31.16),[6,7] T-shaped uterus, etc.].
- Diagnosis of lost or misplaced intrauterine devices (Fig. 31.17).[8]

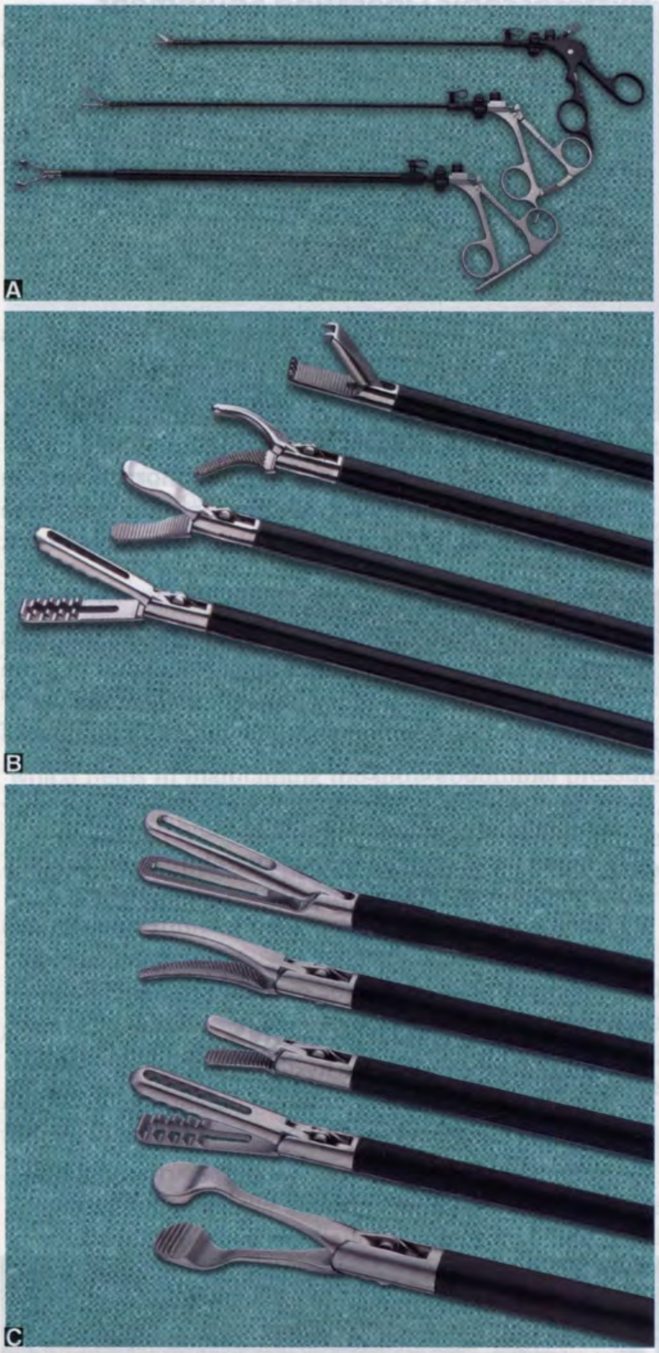
OPERATIVE INDICATIONS

The indications of operative hysteroscopy are as follows:[9]

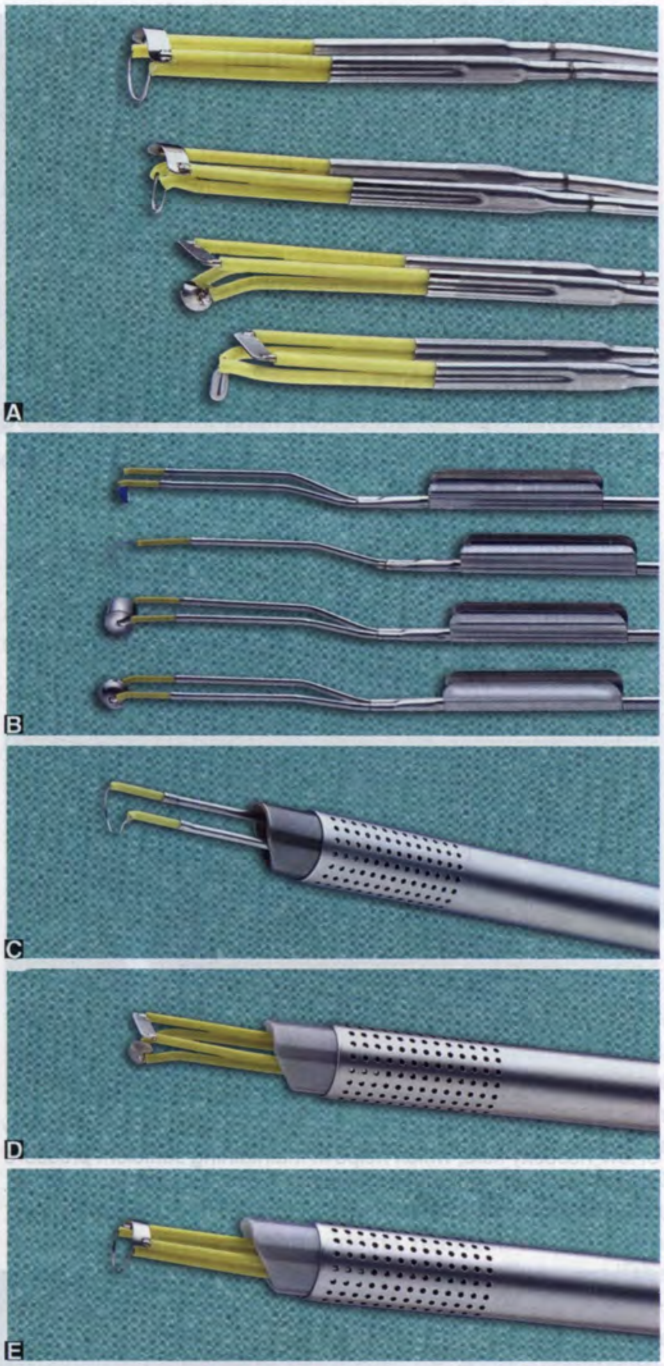
- Treatment of AUB [endometrial ablation (Figs 31.18A to F), transcervical resection of endometrium (TCRE; Figs 31.19A to C)].
- *Polypectomy:* Removal of endometrial polyps.



Figs 31.8A and B: Various types of scissors



Figs 31.9A to C: Various types of grasping forceps



Figs 31.10A to E: Unipolar cutting loops and electrodes (for use with resectoscope sheaths)

- *Adhesiolysis:* Hysteroscopic resection of adhesions is achieved either using microscissors or thermal energy modalities. This method is also used in case of presence of intrauterine adhesions (e.g. Asherman's syndrome).
- Myomectomy for submucosal fibroids (refer to Chapter 20 for details)
- *Treatment of congenital uterine malformations or Müllerian abnormalities:* Metroplasty for incision of uterine septum (refer to Chapter 28 for details).
- Removal of misplaced/embedded intrauterine contraceptive device (IUCD)
- Sterilization (use of electrocoagulation or tubal plugs to block the cornual ends of the tubes).
- Targeted endometrial biopsy in suspected cases of tuberculosis, endometrial cancer (Figs 31.20A and B).
- *Hysteroscopy allows access to the uterotubal junction for entry into the fallopian tube:* This is useful for tubal occlusion procedures for sterilization and for falloposcopy.

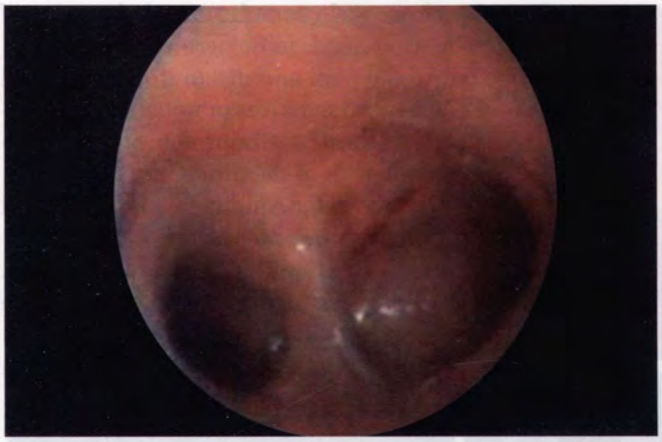
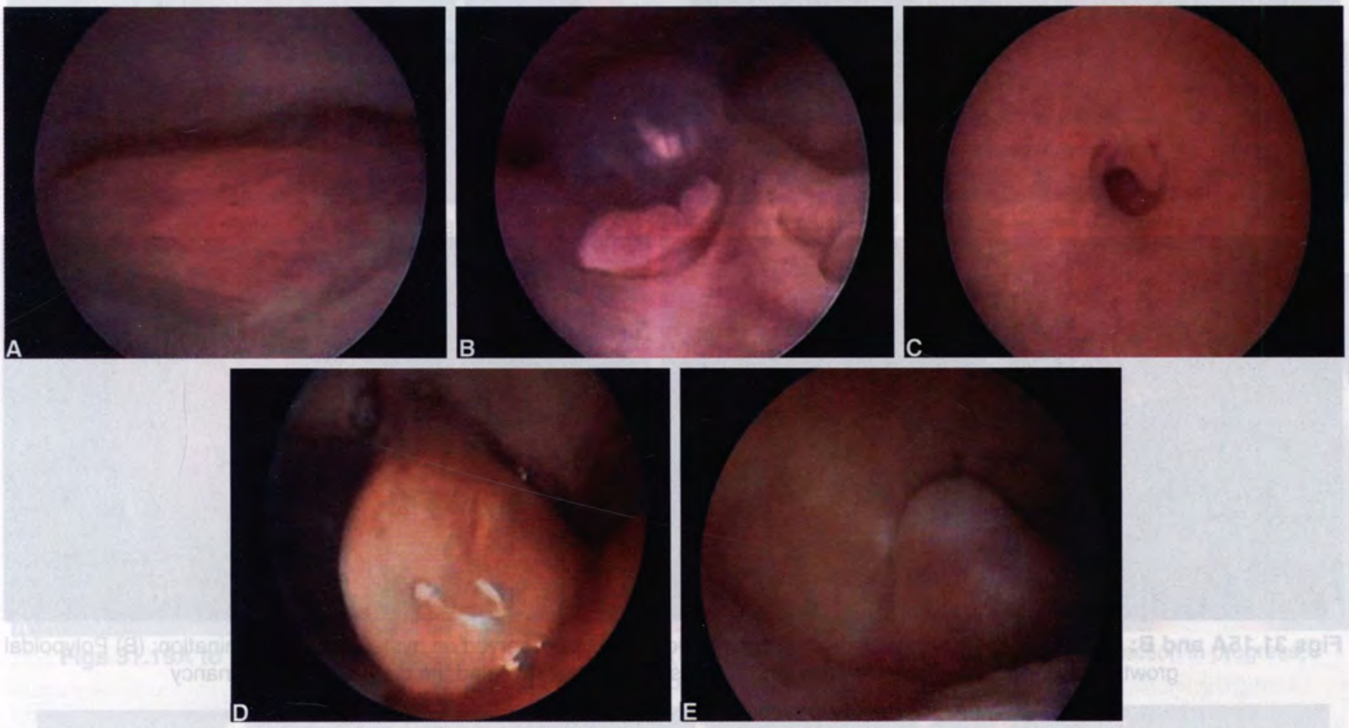


Fig. 31.11: Intrauterine synechiae

- *Management of cornual and interstitial tubal blockage:* Tubal cannulation can be useful in cases of cornual or interstitial blocks. For details related to hysteroscopic tubal cannulation, kindly refer to Chapter 25.

PREOPERATIVE PREPARATION

- Hysteroscopy has been done in the hospital, surgical centers and the office.
- Hysteroscopy is best done in the immediate post-menstrual phase when the endometrium is relatively thin which facilitates intracavitary viewing.
- Paracervical block using 1% lidocaine is usually sufficient for diagnostic hysteroscopy procedures.



Figs 31.12A to E: Various polyps as observed on hysteroscopic examination: (A) A large cervical polyp; (B) Cervical mucosal polyp; (C) Cornual polyp; (D) Endometrial polyp; (E) Endometrial polyp in another patient

Figs 31.13A to C: Submucous fibroids as observed on hysteroscopic examination: (A) Submucosal fibroid in the fundal region; (B) Pedunculated submucosal fibroid; (C) Numerous submucous fibroids on the uterine wall

Operative hysteroscopic interventions are usually performed under general endotracheal anesthesia.
- Informed consent must be taken from the patient.
- Prior to diagnostic/operative hysteroscopy, a detailed patient history, physical examination and discussion regarding the choice of procedure and the type of anesthesia to be used needs to be performed.
- In order to reduce the pain and discomfort associated with the procedure, mild sedatives or nonsteroidal anti-inflammatory drugs (NSAIDs) (ibuprofen, 600–800 mg) can be administered prior to the procedure.
- Patients with high risk cardiac conditions may be offered an antibiotic prophylaxis prior to the procedure.
- For the procedure, the patient is placed in a standard lithotomy position with legs apart in order to maximize the vaginal access.
- The perineum and vagina are gently swabbed with povidone-iodine or another suitable antiseptic solution.

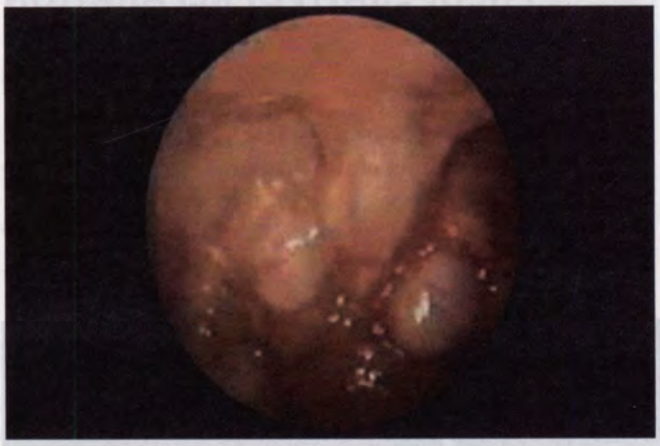
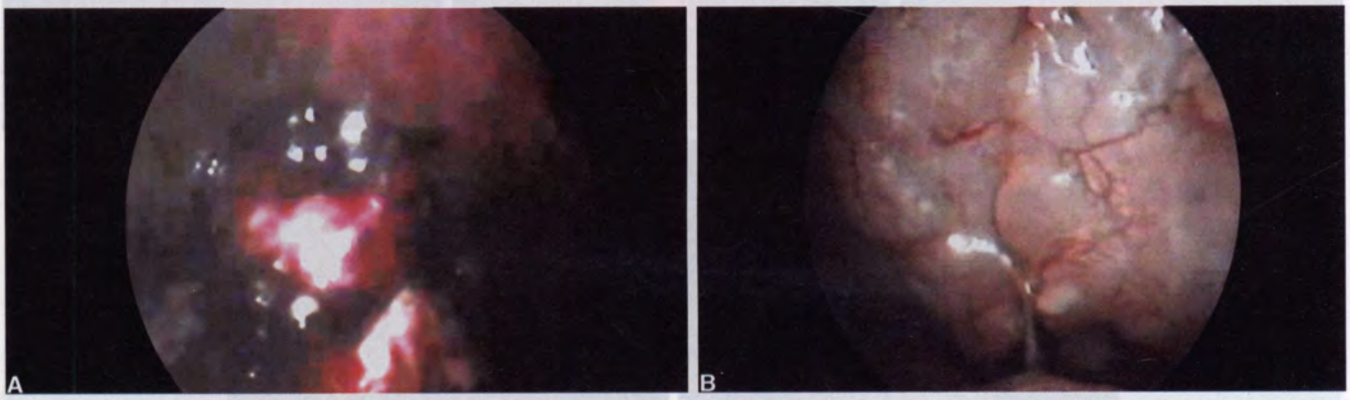


Fig. 31.14: Polypoidal endometrial hyperplasia

SURGICAL STEPS

DIAGNOSTIC HYSTEROSCOPY

The steps of diagnostic hysteroscopy are as follows:[10,11]
- The posterior vaginal wall is retracted using Sims' speculum.



Figs 31.15A and B: Endometrial cancer: (A) Necrotic hemorrhagic growth as observed on hysteroscopic examination; (B) Polypoidal growth showing abnormal proliferation of blood vessels. Biopsy revealed the diagnosis of malignancy

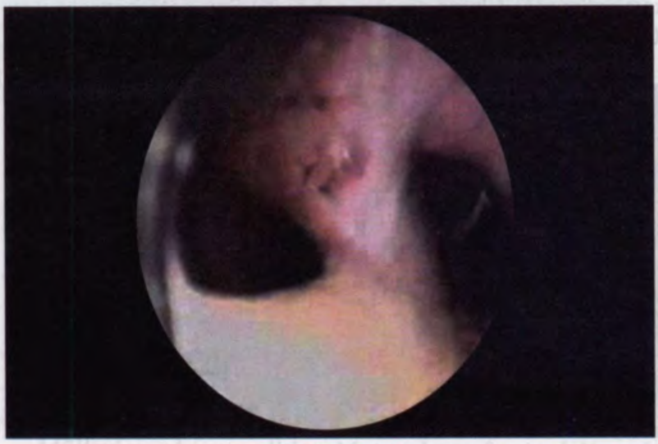


Fig. 31.16: Uterine septum as observed on hysteroscopic examination

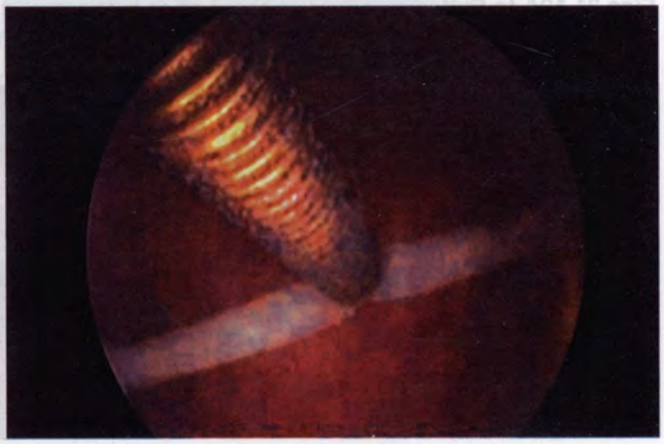
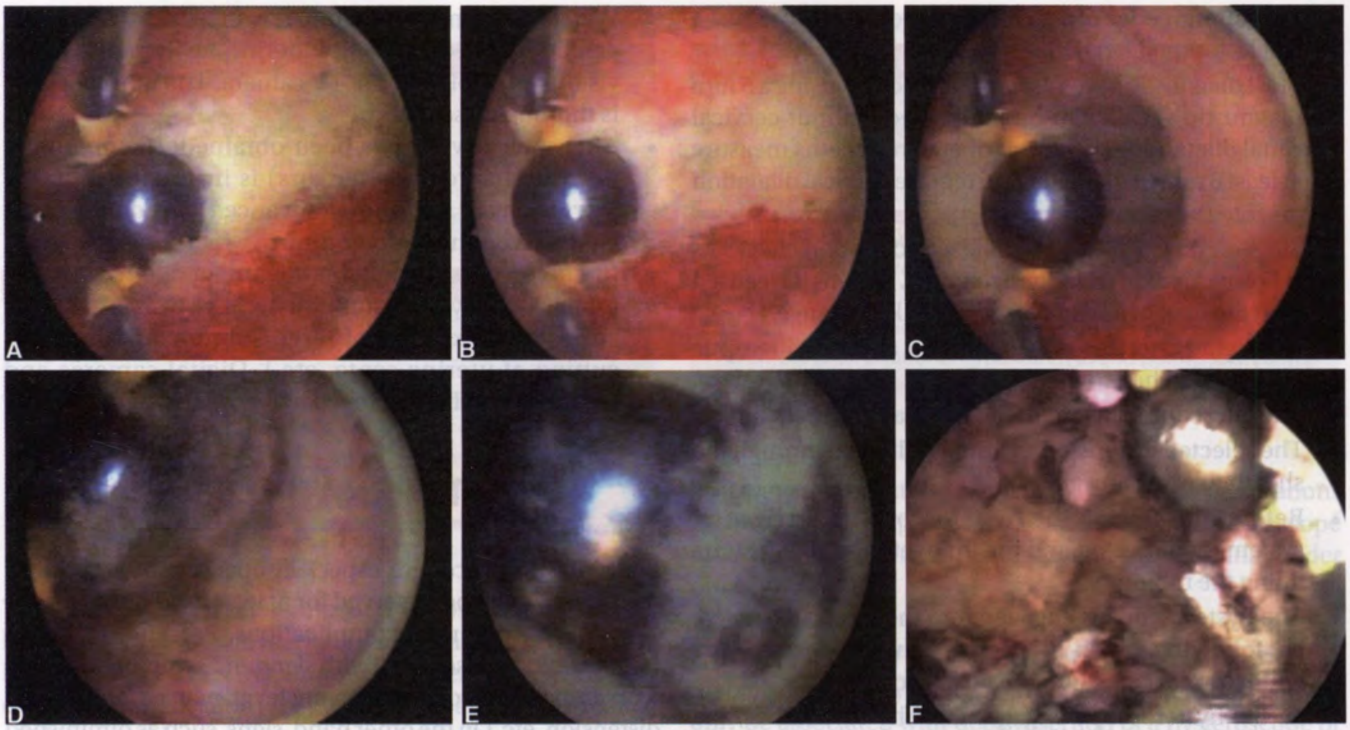
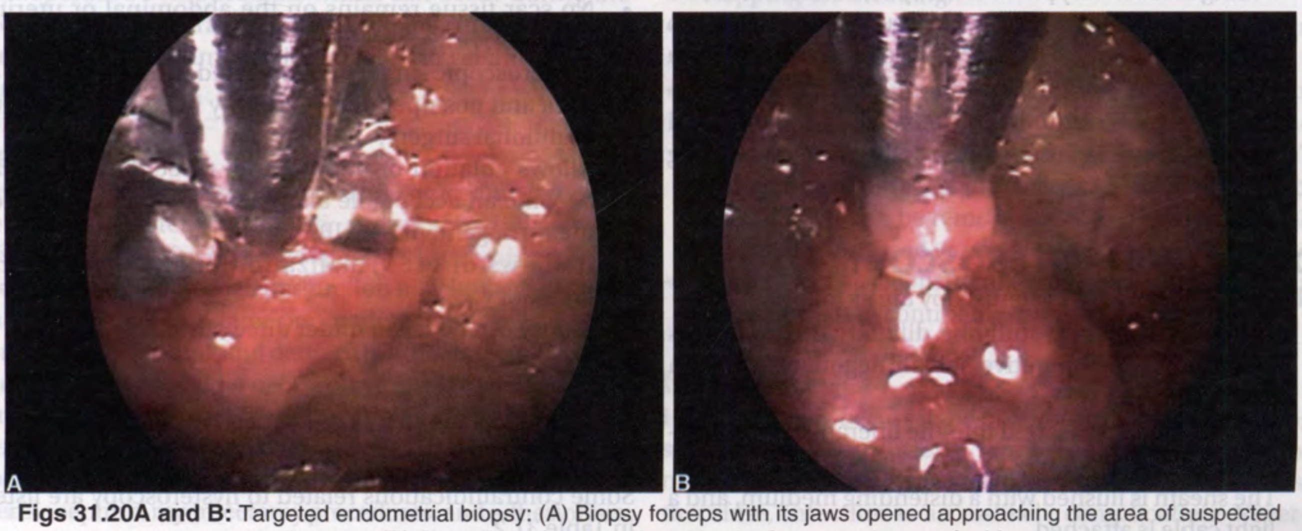


Fig. 31.17: Intrauterine contraceptive device in the endometrial cavity as observed on hysteroscopic examination



Figs 31.18A to F: Roller ball ablation of endometrium: (A and B) Roller ball ablation of the fundal region; (C) Roller ball ablation of the cornual region; (D and E) Progression of the ablation process; (F) Process of ablation is complete

Figs 31.19A to C: Transcervical resection of endometrium: (A) Beginning of resection; (B) Process of resection in progress; (C) Resection is complete



Figs 31.20A and B: Targeted endometrial biopsy: (A) Biopsy forceps with its jaws opened approaching the area of suspected malignancy; (B) A small bit of tissue gripped by the forceps to be sent for biopsy

- The anterior edge of cervix is grasped with the help of a single-toothed tenaculum.
- Most diagnostic hysteroscopic procedures using a 5 mm diagnostic sheath can be performed without cervical canal dilatation. The newer operative sheaths measure at least 8 mm in diameter and require cervical dilatation prior to the insertion.
- Surgeon then selects a suitable telescope and checks its eyepiece for proper clarity. If required, the lens is cleansed with the help of a saline or water-soaked sponge.
- The light generator is switched on and the fiberoptic cable is attached to the telescope.
- The telescope is inserted into the diagnostic sheath.
- The selected distension medium is flushed through the sheath to expel any air.
- Before introducing the hysteroscope, the irrigation system is connected and the fluid let in so that it starts filling the tubing.
- The hysteroscope is engaged into the external cervical os, following which it is gently advanced inside the endocervical canal into the uterine cavity.
- As the hysteroscope engages into the external os, the flow of distension medium must be started.
- The hysteroscope is gently moved forwards, keeping the endocervical canal at 6 O'clock position eccentrically. This position is especially required to keep the telescope in center when a 30° telescope is used.
- The endocervical canal typically shows longitudinal folds, papillae and clefts. The internal os appears as a narrow constriction at the top of endocervical canal. The uterine isthmus appears as a cylindrical extension above the os. The uterine corpus appears as a capacious cavity above the isthmus. The tubal ostia are visible at the upper end of the fundal cornua. The uterine endometrium appears smooth and pink-white in color during the proliferative phase.
- During the secretory phase of the cycle, the endometrium appears lush and velvety and protrudes irregularly into the uterine cavity. The secretory endometrium has a magenta hue.
- There should be no air bubbles when using liquid distension media; air bubbles can be sucked out using VersaPoint.

OPERATIVE HYSTEROSCOPY

The steps of operative hysteroscopy are as follows:[12-14]

- The cervix must carefully be dilated with a Hegar's dilator until the operative sheath negotiates through the cervix.
- The telescope is inserted into the operative or resectoscope sheath.
- The sheath is flushed with a distending medium, and a light cable is attached.
- With the distension medium flowing, the hysteroscope can be inserted inside the uterine cavity under direct vision or coupled to the TV camera. The uterine cavity is thoroughly scanned.
- After a clear view has been obtained, the operating device (electrode or scissors) is inserted inside the uterine cavity and slowly advanced in order to make contact with the endometrium.
- In some cases, it may be advantageous to perform a laparoscopy simultaneously (e.g. lysis of uterine adhesions, excision of large submucous myomas, cutting of uterine septa, etc.). Digital cameras and recorders can be employed to record the surgery.

POSTOPERATIVE CARE

Following the procedure, especially operative hysteroscopy, the patient must be observed for at least 6–12 hours for the signs of any potential complications. Presence of bowel injury could be associated with signs and symptoms such as worsening of postoperative pain, fever, nausea, abdominal distension, etc. On the other hand, signs, such as diminished urinary output, fever and abdominal distension, could be suggestive of bladder or urethral trauma and/or injection. Tachycardia and/or hypotension could be suggestive of continuing third-space hemorrhage.

ADVANTAGES

Hysteroscopy is associated with the following advantages:

- Minimally invasive procedure: hysteroscopy is a least invasive form of surgery which uses endocervical canal to gain entry into the uterine cavity.
- It is associated with shortened hospital stay and reduced recovery time.
- No scar tissue remains on the abdominal or uterine walls.
- Hysteroscopic surgery is associated with a lower rate of intra and postoperative morbidity in comparison with traditional surgery.
- Allows ablation or endometrial resection which has become an acceptable alternative to hysterectomy for the management of AUB.
- It allows direct visualization of any intrauterine pathology.
- Biopsy can be taken under direct vision.

DISADVANTAGES

Some contraindications related to hysteroscopy are listed in Table 31.2.

Table 31.2: Contraindications for diagnostic hysteroscopy

Absolute contraindications
• Intrauterine pregnancy • Known cervical or uterine infection (recent or active PID, acute cervicovaginal infections, etc.) • Cancer of cervix • Profuse/active uterine bleeding (which might obscure the operative field)
Relative contraindications
• Cervical stenosis • Endometrial cancer

Abbreviation: PID, pelvic inflammatory disease

Table 31.3: Complications of hysteroscopy

Instrument related complications
• Cervical trauma • Uterine perforation • Bleeding • Infection
Complications related to the use of distension media
• CO_2: Hypercarbia resulting in arrhythmias and shoulder pain • *Glycine (1.5%):* Dilutional hyponatremia and pulmonary edema • *Dextran:* Anaphylactic shock, ascites • *Dextrose (5%):* Dilutional hyponatremia and pulmonary edema • *Sorbitol:* Cerebral edema

COMPLICATIONS

The overall complication rate for diagnostic and operative hysteroscopy is 2% with serious complications occurring in less than 1% of cases.[15] Operator's experience and exclusion of any contraindication for hysteroscopy before performance of the procedure are two important prerequisites for preventing the occurrence of complications.[16] Various complications related to hysteroscopy are summarized in Table 31.3.[17-19] Previously, there had been concerns that hysteroscopy performed as a routine office procedure in case of AUB might cause the undiagnosed endometrial cancer to spread transtubally.[19] However, there is absence of any strong evidence to prove this point. Now, hysteroscopy has nearly replaced blind dilation and curettage as the procedure of choice for the diagnosis of intrauterine pathology.

INTRAOPERATIVE COMPLICATIONS

Traumatic Injury

Intraoperative complications which can occur during the procedure include traumatic injury to the cervix and rarely uterus as well. At times, injury to the bowel and bladder can also occur.

Perforation

A possible problem associated with the procedure is uterine perforation which commonly occurs when either the hysteroscope itself or one of its operative instruments breach the uterine wall.[20] A small perforation may be symptomless and heal on its own. A large perforation, however, can cause considerable bleeding and damage to other organs. Damage to organs such as bladder or bowel can result in spilling of the intestinal contents inside the peritoneal cavity, producing peritonitis and sepsis, which may even prove to be fatal. The operative hysteroscopic procedures, such as resection of the uterine septum, myomectomy procedures, and adhesiolysis, are associated with a high risk of uterine perforation. The best way to prevent the occurrence of uterine perforations is simultaneous laparoscopy. Moreover, the hysteroscope must be inserted inside the cervix and uterine canal under direct vision.

Poor Visibility of the Operative Field

Inability to properly visualize the operative field may commonly be associated with deep insertion of a hysteroscope or overdilatation of cervix. Overdilatation of cervix may result in excessive leakage of the distending medium, thereby resulting in an inability to maintain distension within the uterine cavity. Moreover, the presence of blood and debris may cloud the operative field.

Intraoperative and Postoperative Bleeding

A common complication associated with the procedure is the occurrence of bleeding during and after the procedure. The bleeding occurring during the procedure can be controlled in the following ways:

- Aspiration of the blood.
- Increasing the pressure of the distending medium so that it compresses the wall of the uterus, thereby stopping the bleeding.
- Electrocoagulation of a bleeding vessel with an electrode.
- Insertion of an intrauterine balloon inflated to about 5–10 mL. In case of continuous bleeding, uterine tamponade can be performed by inserting a Foley's catheter inside the uterine cavity and inflating its bulb. The catheter can be removed after 4–5 hours, once the bleeding has ceased to occur.
- Injection of vasoconstrictor drug, such as vasopressin can also help to control bleeding.

Infection

Infection rarely occurs if the procedure is performed using strict aseptic precautions. Moreover, the uterine endometrium is usually resistant to various microorganisms; therefore, infection is an unlikely complication. Nevertheless, hysteroscopy must be avoided in the presence of gross cervical infections, sexually transmitted diseases, uterine infection or salpingitis. Prophylactic antibiotics need to be administered only in high risk cases such as patient with the history of rheumatic carditis, congenital heart disease, prolapsed mitral valves, etc.

Gas Embolism

Gas embolism is a rare, but devastating complication of hysteroscopy. It can result in clinical signs and symptoms such as reduction in end-tidal CO_2, hypoxia, tachycardia, hypotension followed by bradycardia and cardiovascular collapse.

Electrical and Laser Injuries

Uterine perforation caused by either laser fiber or electrode is likely to be more serious than the injury caused by mechanical devices, such as scissors, because thermal injury is likely to inflict greater damage to the surrounding tissues. Moreover, the injury due to thermal damage may not manifest itself until 2–3 days after surgery. Therefore, in these cases, laparoscopy or laparotomy must be done to determine the exact extent of injury.

Complications Caused by the Distension Media

The use of insufflation media can result in serious and even fatal complications due to embolism or fluid overload with electrolyte imbalances. Furthermore, use of CO_2 as a distension medium can result in the formation of gas emboli.[21-24]

Fluid Absorption

Fluid overload can occur with the use of distension media such as normal saline.

This can be corrected by the use of diuretics, oxygen and central venous pressure (CVP) monitoring. An important precaution which helps in preventing fluid overload is to restrict intrauterine pressure from increasing above 100 mm Hg at the time of procedure. Fluid overload with media, such as glycine, can present with symptoms such as nausea, vertigo, hyponatremia, confusion, disorientation, etc. With excessive fluid overload, sometimes the blood ammonium levels may rise resulting in encephalopathy. As previously mentioned, fluid overload with sorbitol can result in development of cerebral edema.

Endometrial Cancer

Since clusters of viable endometrial tissues can persist in women who have undergone TCRE; it has been hypothesized that there is a risk of development of endometrial cancer from the remnant tissues in future. Such patients must be followed up with transvaginal sonography (TVS) to detect abnormal changes in the residual endometrium. Abnormal bleeding in these patients must be duly investigated to rule out the risk of endometrial cancer.

Hematometra

Hematometra may occur due to the development of intrauterine adhesions in the area of active endometrium, which continues to undergo active cyclical bleeding. Patients may present with cyclical pain and the condition may be diagnosed on TVS. Drainage may be performed by a repeat hysteroscopy.

Uterine Rupture

Uterine rupture during pregnancy has been reported in cases where women have become pregnant following endoscopic procedures such as myoma or septum resection.

Operator Inexperience

The most likely complications with hysteroscopy commonly occur in the presence of operator inexperience. If the surgeon is properly acquainted with hysteroscopic techniques, the rate of complications would be much less.

DISCUSSION

Hysteroscopy has become an important component of the gynecological surgeon's armamentarium.[25,26] One of the commonly performed procedures is hysteroscopic myomectomy, which has currently become the standard minimally invasive surgical procedure for treating patients with submucous fibroids (refer to Chapter 20: Surgery for Uterine Leiomyomas), especially those presenting with AUB and reproductive issues. While hysteroscopic myomectomy has been shown to be safe and effective in the control of menstrual disorders, its effects on infertility remain unclear.[27] Although argon, krypton and neodymium-doped yttrium aluminium garnet (Nd:YAG) lasers have all been successfully used, only the latter has found widespread application in hysteroscopic surgery. Two techniques "touch" and "non-touch" may be used in hysteroscopic Nd:YAG laser surgery.[28] In the "touch technique", the laser fiber is in contact with the surface to be treated, whereas in the latter it is separated from it by a few millimeters. Both techniques are utilized for hysteroscopic myomectomy. The most commonly used hysteroscopic technique for myomectomy is slicing. This procedure comprises of repeated and progressive passages of the cutting loop. Excision usually begins from the top of the fibroid, progressing in a uniform way towards the base. In case of a pedunculated fibroid, the base of the pedicle might be cut by resectoscopic loop.[29-31]

CONCLUSION

Hysteroscopic-guided surgery has now become an important tool for the gynecological surgeon. Hysteroscope can be used both for the diagnostic and therapeutic purposes. It is a form of minimally invasive surgery which helps in avoiding giving a scar on the patient's abdomen and sometimes also helps in preventing removal of the uterus. With the help of hysteroscope, the surgeon gains entry into the endometrial cavity via the cervix. Since the procedure does not require opening up of the patient's abdomen or peritoneal cavity, it is associated with minimal postoperative morbidity and mortality in comparison to that associated with laparotomy. During the past 2 decades due to major advances in the field of science and technology, hysteroscopic myomectomy has acquired a great importance amongst the various gynecologic surgical techniques.

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32

CHAPTER

Diagnostic and Operative Laparoscopy

INTRODUCTION

Laparoscopy is a type of endoscopy, which helps in visualization of the peritoneal cavity. The earliest description for the use of endoscopy for visualizing the interior of the body organs can be attributed to Philipp Bozzini who attempted to visualize the interior of the urethra in 1805.[1] However, it was only in the past 3 decades that the potential applications of laparoscopy in the field of operative laparoscopy have been recognized. During the last 35 years, gynecologic laparoscopy has evolved from a limited surgical procedure used only for diagnosis and tubal ligations to a major surgical tool used for the treatment of a large number of gynecological indications.[2] Today, laparoscopy has become one of the most common surgical procedures performed by gynecologists. Some of the areas where laparoscopic surgery has become the treatment of choice include ectopic pregnancy, treatment of endometriosis, or a benign ovarian cyst. Compared with laparotomy, laparoscopy is a form of minimal invasive surgery which is associated with a low complication rate, reduced pain, better cosmetic result, reduced rate of adhesion formation, shorter recovery time and reduced duration of hospital stay.[3]

OVERVIEW

Laparoscopy is a hybrid surgical approach that shares characteristics of both minor and major surgery. To patients, laparoscopic procedures often seem to be minor surgery because of the small incisions, reduced hospital stay, reduced amount of postoperative pain and other complications, and shortened convalescence period.

However, at its core, laparoscopy remains an intra-abdominal procedure. Therefore, it can be associated with various intraoperative and postoperative complications of laparotomy, such as infection and injury to adjacent intra-abdominal structures.[4] Since laparoscopy requires a small incision, the postoperative pain and morbidity is significantly less in comparison to that associated with laparotomy. Besides this, laparoscopic procedures are associated with unique risks and complications related to methods used for creating pneumoperitoneum and the placement of abdominal wall ports.

SURGICAL EQUIPMENTS

The first step in any laparoscopic surgery comprises of the placement of Veress needle and a primary trocar. Placement of both Veress needle and primary trocar can be particularly dangerous because this is the time when uncontrolled axial penetrating forces may be applied blindly to the sharp instruments.

Veress Needle

Veress needle is used for creating a pneumoperitoneum, which can be considered as the first step of most laparoscopic surgeries. This helps in separating the internal organs and tissues from the abdominal wall so that the trocar can be inserted safely without causing any injury to the surrounding structures. The Veress needle is available in three sizes depending upon its length: (1) 80 mm, (2) 100 mm and (3) 120 mm. It has an inner blunt tip, which springs out when the needle enters the peritoneal cavity (Fig. 32.1).

The most commonly used gas for insufflation is CO_2. It is a noncombustible gas, which is rapidly absorbed by the blood where it gets converted to carbonic acid after combination

Fig. 32.1: Veress needle
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with water. A CO_2 gas insufflator must provide continuous flow rate of gas in order to maintain the intra-abdominal pressure (IAP) between 10 mm Hg and 15 mm Hg. A high IAP facilitates the introduction of the trocar as well as helps in increasing the distance between the trocar and the retroperitoneal vessels. The insufflator display must always remain within the surgeon's vision because it helps in providing important information regarding the patient's IAP, flow rate and total volume of CO_2 which has been insufflated.

Laparoscopic Access Equipment (Trocars)

There are two types of laparoscopic access equipment: first generation equipment (with a central trocar and an encasing outer sheath or cannula) and the second generation equipment (based on visual access method):

First Generation Laparoscopic Access Instruments

First generation laparoscopic access instruments consist of two parts: a removable central trocar and an encasing outer cannula (Figs 32.2 and 32.3). Once this access instrument is placed inside the body's cavity, the central trocar is removed in order to place the laparoscope and other operating instruments. The proximal end of the primary trocar is designed to accommodate the palm of surgeon's dominant hand. The distal end of the trocar could have a pointed, sharp, conical or beveled pyramidal cutting blade tip. Conical trocars have pointed nonbladed sharp tips with no cutting edges. These types of trocars require considerably more penetrating force because the various tissue layers are not resected, rather parted radially in order to accommodate the outer diameter of the cannula. Disposable trocars are also available which have the advantage of being safe, transparent, stable, and both surgeon and patient friendly (Fig. 32.4).[5]

The sharp edges of the trocars may sometimes cause damage to the small blood vessels and other organs. With the blunt trocar tips, the chances of injury are relatively low because the blood vessels are pushed aside at the time of insertion and are thereby protected to a large degree. Optical access trocars, which help in visualizing the layers of abdominal wall during placement are also available. A spring mechanism same as that in the Veress needle is present on most disposable trocars, which help in increasing their safety.

The actual trocar is a stylet, which is introduced through the cannula. The cannula allows the insertion of laparoscopic instruments inside the abdominal cavity. The most commonly used trocars vary between the sizes of 5–10 mm. Trocars usually have two types of valves to prevent the escape of gas. These include the flap valve and trumpet valve. The trumpet valves protect the telescope from contamination by the tissue and blood particles at the time of insertion. These valves have to be pressed at the time of insertion. However, the main disadvantage associated with their use is that they are likely to grip the instruments, thereby preventing their smooth movement. Hence the flap valve trocars are generally preferred.

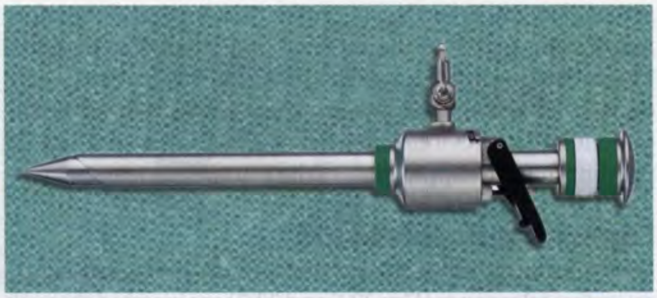

Fig. 32.2: Primary trocar and cannula
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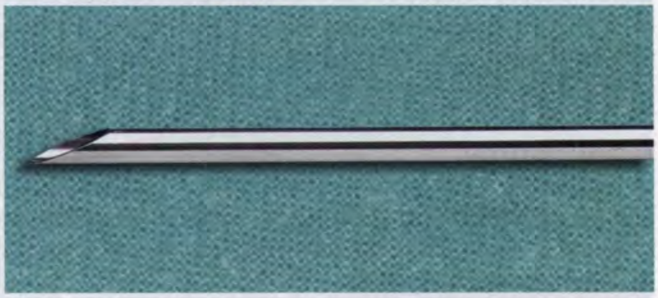

Fig. 32.3: Cannula tip shown separately without the trocar
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Fig. 32.4: Disposable trocar

Second Generation Laparoscopic Access Instruments

Second generation laparoscopic access instruments with visual access method are also sometimes used. These include the optical access trocars, which help in visualizing the layers of abdominal wall during placement. The EndoTIP, a sheath with screw threading (Fig. 32.5) is a new second generation instrument, which allows safe peritoneal entry under direct vision. In this method, the sheath which has screw thread tip is inserted with the telescope inside so that as the sheath is screwed in, the tissue layers can be visualized and therefore inadvertent injury to the internal organs may be avoided. This technique may especially prove to be safe in cases where dense adhesions are expected, especially in cases where the patient had a previous laparotomy. The screwed EndoTIP prevents it from slipping out of the intraperitoneal space.

Laparoscopic Telescope

Following the removal of the primary trocar, the laparoscopic/operative telescopes (Figs 32.6 and 32.7) are inserted through the cannula in order to visualize the abdominal cavity. Laparoscopic telescopes are available in various sizes (2–10 mm) and various visualization capabilities (optical axis varying from 0° to 45°) (Fig. 32.8A). Figure 32.8B shows the proximal end of the laparoscopic telescope.

Light Source

Good quality light source enables proper visualization of tissues. High intensity light sources are based on the use of xenon or halogen. The beam of light is transmitted through the fiber-optic cables.

Cameras

The cameras consist of two components: the camera head with its cables and the camera control unit. The image is received through the camera lens, which is attached to the laparoscope. It is then converted into an electronic image, which is transmitted to the camera control units through the camera cables. The image is finally sent to the monitor where it is converted into a digital image and displayed.

Ancillary Instruments

Various other ancillary instruments, which are used to facilitate laparoscopic surgery, include the following (Figs 32.9 to 32.11):

Blunt Probe

This is one of the simplest instruments and is used for stabilizing or manipulating the organs, especially the uterus. Some of these manipulators also facilitate the instillation of an inert colored solution (such as sterile saline with indigo carmine dye) into the uterine cavity to determine the patency of the fallopian tubes (Figs 32.12A and B).

Electromechanical Morcellator

Many laparoscopic surgeries involve the removal of large sections of tissues such as in uterine myomectomy or removal of large ovarian masses. This can be achieved with help of electromechanical morcellator (Fig. 32.13). The morcellator comprises of a motor driven cutting tube, which can be inserted directly into the abdomen without using an additional trocar cannula. A cylindrical block of tissue can be cut out and removed.

Graspers

Graspers with different sizes and designs (claw forceps, Allis type forceps, spoon forceps, atraumatic forceps, etc.) are important for any laparoscopic procedure. These instruments are essential for holding and grasping various pelvic structures while performing laparoscopic surgery.

Fig. 32.5: EndoTIP reusable visual access cannula

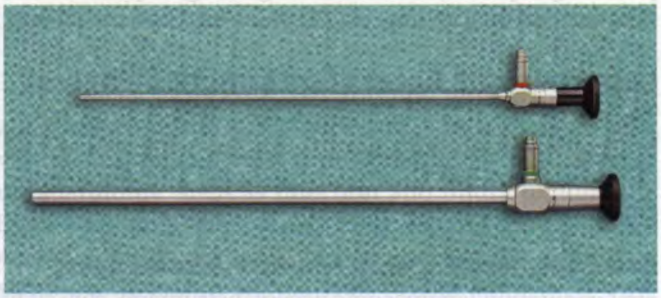


Fig. 32.6: Laparoscopic telescope

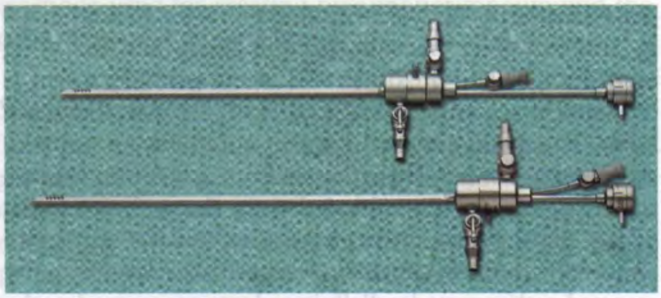
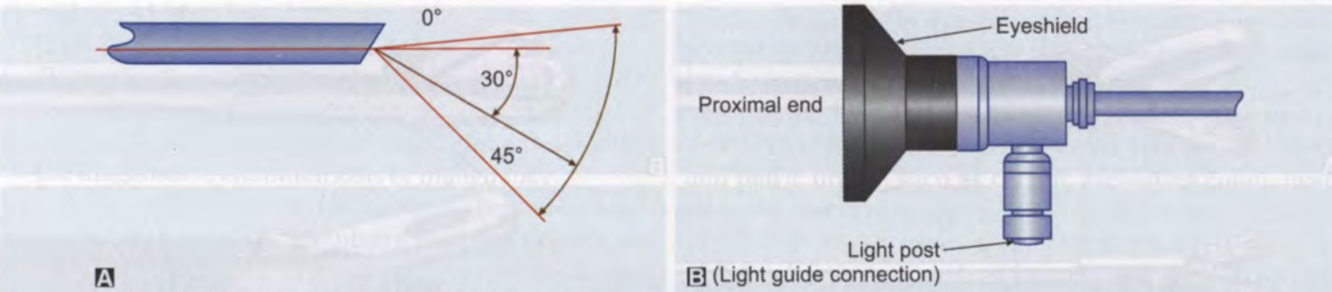


Fig. 32.7: Operative telescope

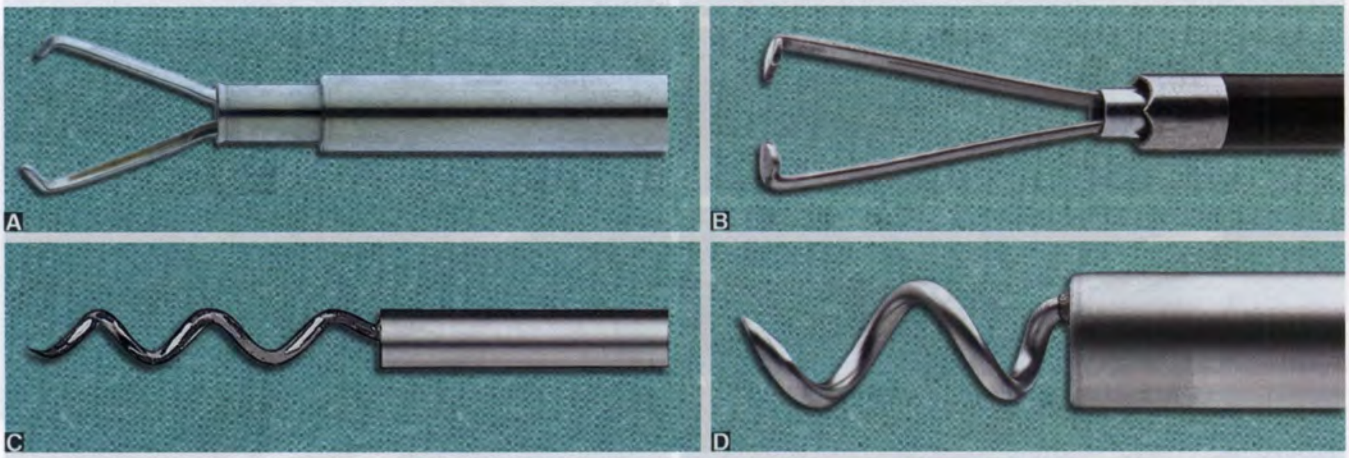
Scissors

Scissors are essential for dissection and cutting of various structures, adhesions, etc. They can be either straight or curved types.

Hemostasis and cutting can be safely achieved using simple instrumentation, provided that the surgeon has a sound understanding of both pelvic anatomy and of the techniques or energy modalities and their impact on the



Figs 32.8A and B: (A) Varying optical axis of laparoscopic telescope; (B) Proximal end of laparoscopic telescope



Figs 32.9A to D: Grasping and holding equipments
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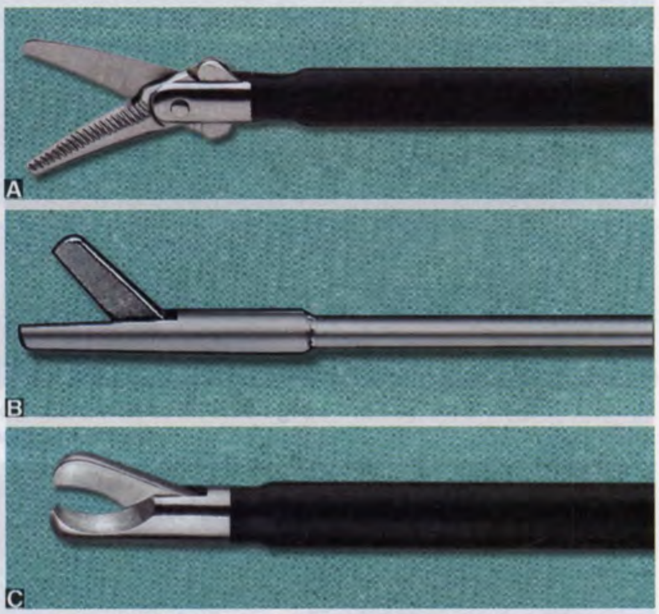
tissues. There can be two types of electrosurgical units: unipolar and bipolar electrocoagulation units.

Laparoscopic Suturing Techniques

There are two types of laparoscopic suturing techniques: intracorporeal suturing (Figs 32.14A to F) and extracorporeal suturing (Figs 32.15A to C). Both the techniques are safe and reliable and can be performed in different clinical situations.

Intracorporeal knot tying and suturing technique: In this technique, after passing the sutures through the tissues, using laparoscopic equipment and utilizing classic microsurgical principles, surgeon's knots are tied inside the abdominal cavity. This technique can be used for approximating tissues, reconstructing organs or ligating the blood vessels.

Extracorporeal knot tying and suturing technique: In this technique, after passing the suture through the tissues, both ends are brought back out of the peritoneal cavity. Extracorporeal knots are formed outside of the body and pushed into the peritoneal cavity through the cannula sleeve using a knot pusher.



Figs 32.10A to C: Straight and curved blade scissors
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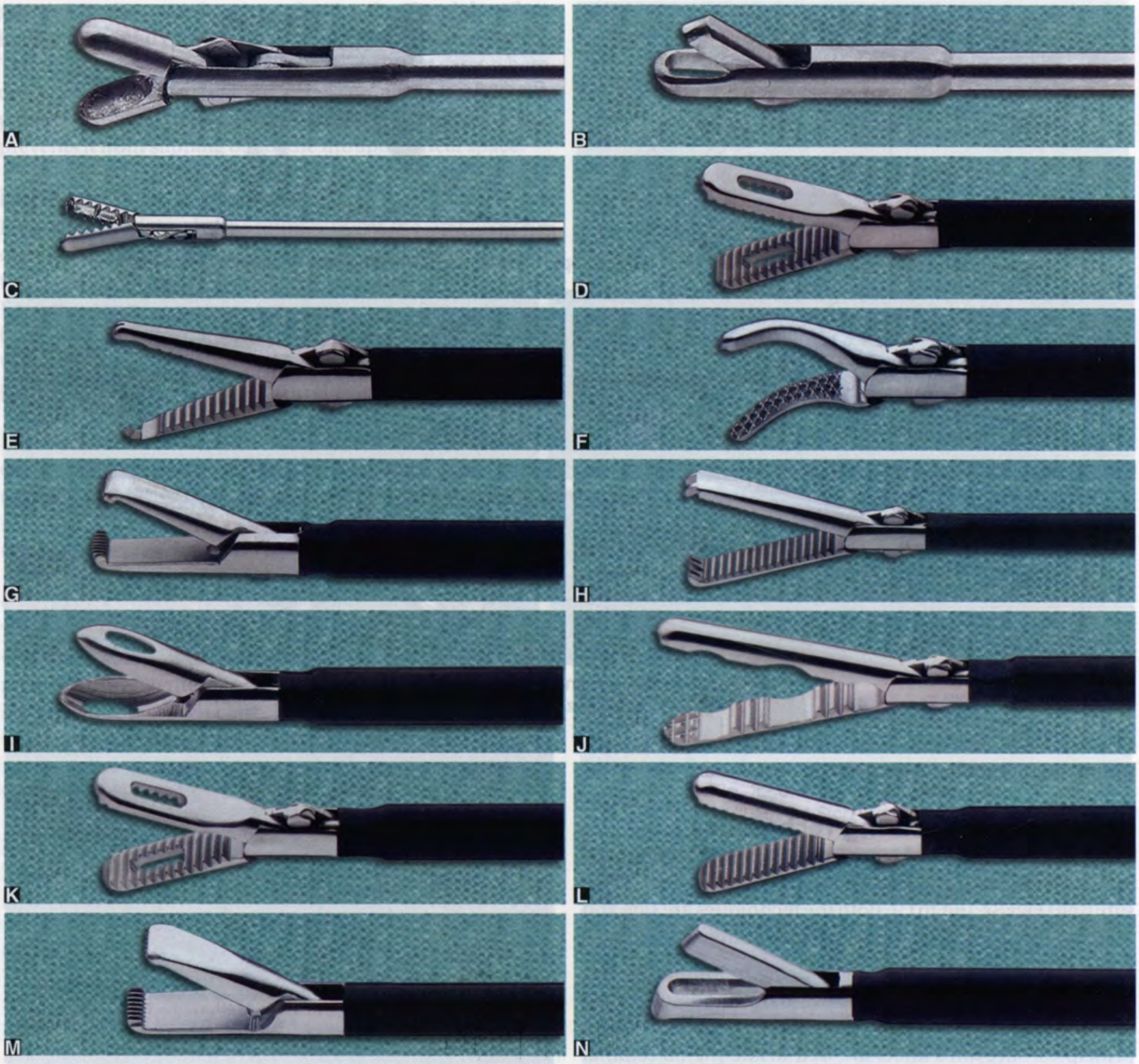
INDICATIONS

DIAGNOSTIC LAPAROSCOPY

Diagnostic laparoscopy helps in the direct visualization of the abdominal and pelvic organs and helps in establishment of definitive diagnosis in cases where the diagnosis could not be made on the basis of findings of clinical and radiological investigations. Figure 32.16 shows normal laparoscopic view of pelvis. The most common indications for diagnostic laparoscopy are as follows:

- Assessment of the pelvis in cases of acute or chronic pelvic pain, adnexal masses,[6] ectopic pregnancy,



Figs 32.11A to N: Various types of laparoscopic bipolar forceps
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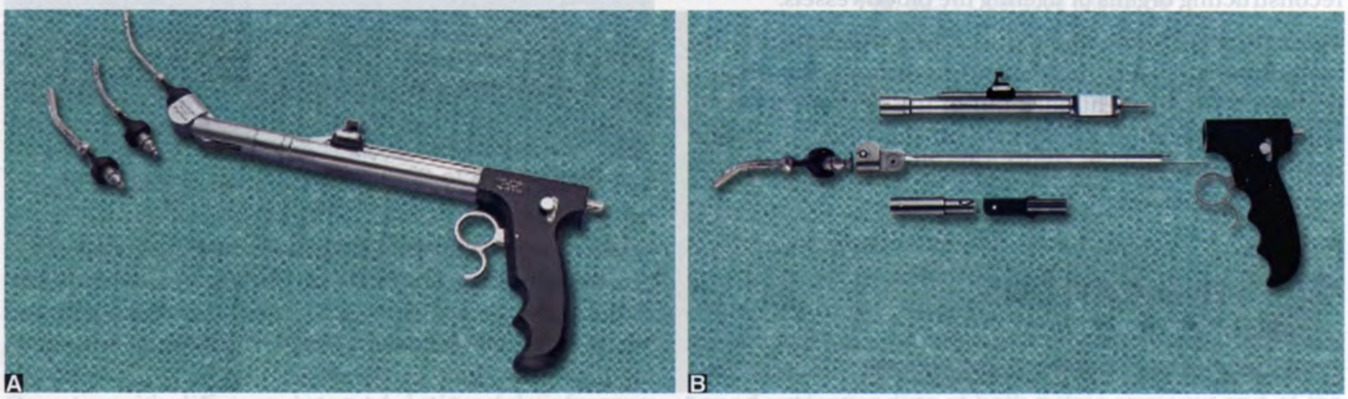

Figs 32.12A and B: Uterine manipulator
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endometriosis, adnexal torsion or other pelvic pathology (Figs 32.17A to I).

- Determination of tubal patency through transcervical dye instillation (chromopertubation) (Figs 32.18A to C).[7]
- A biopsy specimen can be obtained, if required to aid in the diagnosis of endometriosis or malignancy.

At the time of diagnostic laparoscopy, the patient must be placed in a 20° Trendelenburg position in order to displace the bowel and omentum so as to obtain a clear view of the abdominal and pelvic organs. After insertion of the laparoscope, the surgeon must perform a panoramic view of the abdomen to ensure that no inadvertent damage has been caused by the needle or trocar. The inspection of the abdominal and pelvic cavity must be performed in a clockwise manner so as to visualize all the abdominal and pelvic organs such as cecum, ascending colon, liver, stomach, transverse colon and descending colon. Presence of any adhesions must also be noted. After visualization of the pelvic organs such as uterus, both the ovaries and cul-de-sac, patency of both the tubes is checked through chromopertubation by injecting methylene blue inside the tubes via a uterine cannula. The tubes can be considered as patent if the dye passes out of the fimbrial ends.

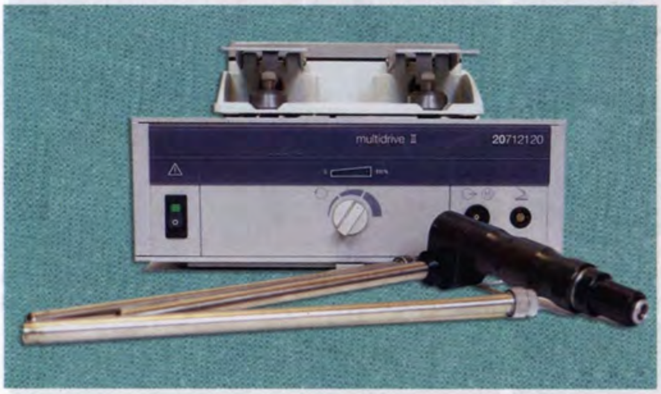


Fig. 32.13: Electromechanical morcellator

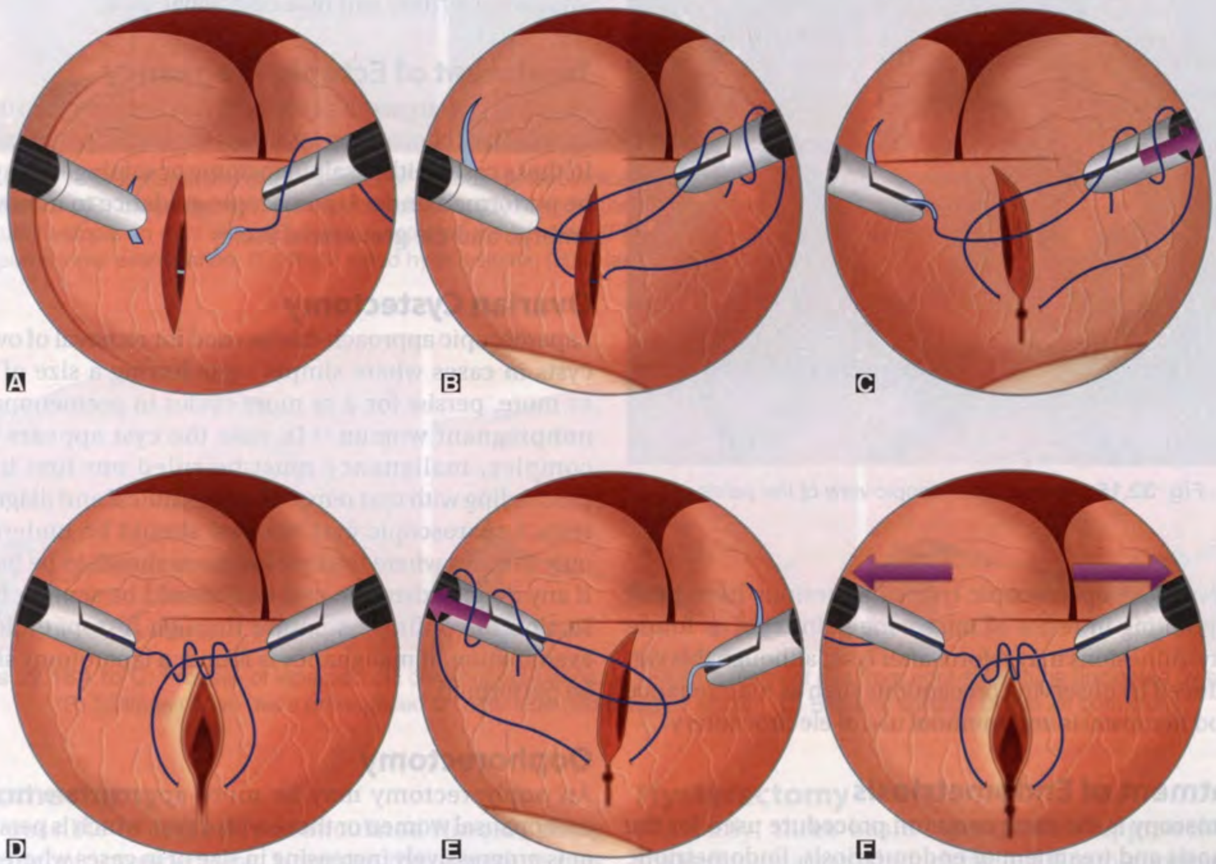
THERAPEUTIC LAPAROSCOPY

Tubal Sterilization

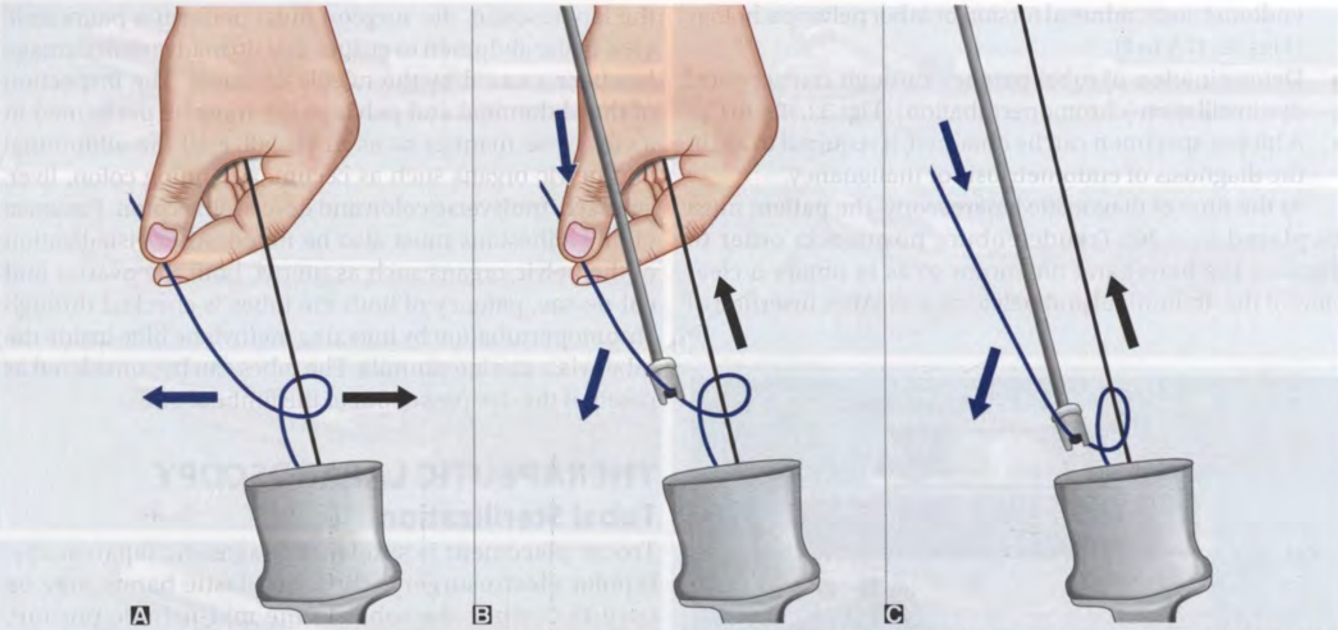
Trocar placement is similar to diagnostic laparoscopy. Bipolar electrosurgery, clips, or silastic bands may be used to occlude the tubes at the mid-isthmic portion, approximately 2–3 cm from the cornua.[8]

Lysis of Adhesion

Adhesions may be present as a result of pelvic inflammatory disease, endometriosis, or previous surgery. Adhesions may be lysed by blunt or sharp dissection.[9] Unfortunately



Figs 32.14A to F: The technique of intracorporeal knot tying and suturing



Figs 32.15A to C: The technique of extracorporeal knot tying and suturing: (A) The ends of the suture are brought back out of the peritoneal cavity; (B) Extracorporeal knots are formed outside of the body; (C) A hollow plastic rod is used to push down the extracorporeal knot into the peritoneal cavity

Fig. 32.16: Normal laparoscopic view of the pelvis

the results of laparoscopic lysis of adhesions have been disappointing in terms of improving pain relief or future fertility. Adhesions may reform after lysis, although this can be reduced by observing precautions such as maintenance of good hemostasis and minimal use of electrocautery.

Treatment of Endometriosis

Laparoscopy is the most common procedure used for the diagnosis and treatment of endometriosis. Endometriotic lesions may be resected or ablated using any of the power instruments under laparoscopic visualization.[10] There is good evidence to show that this technique helps in improving fertility and reducing pelvic pain.

Treatment of Ectopic Pregnancy

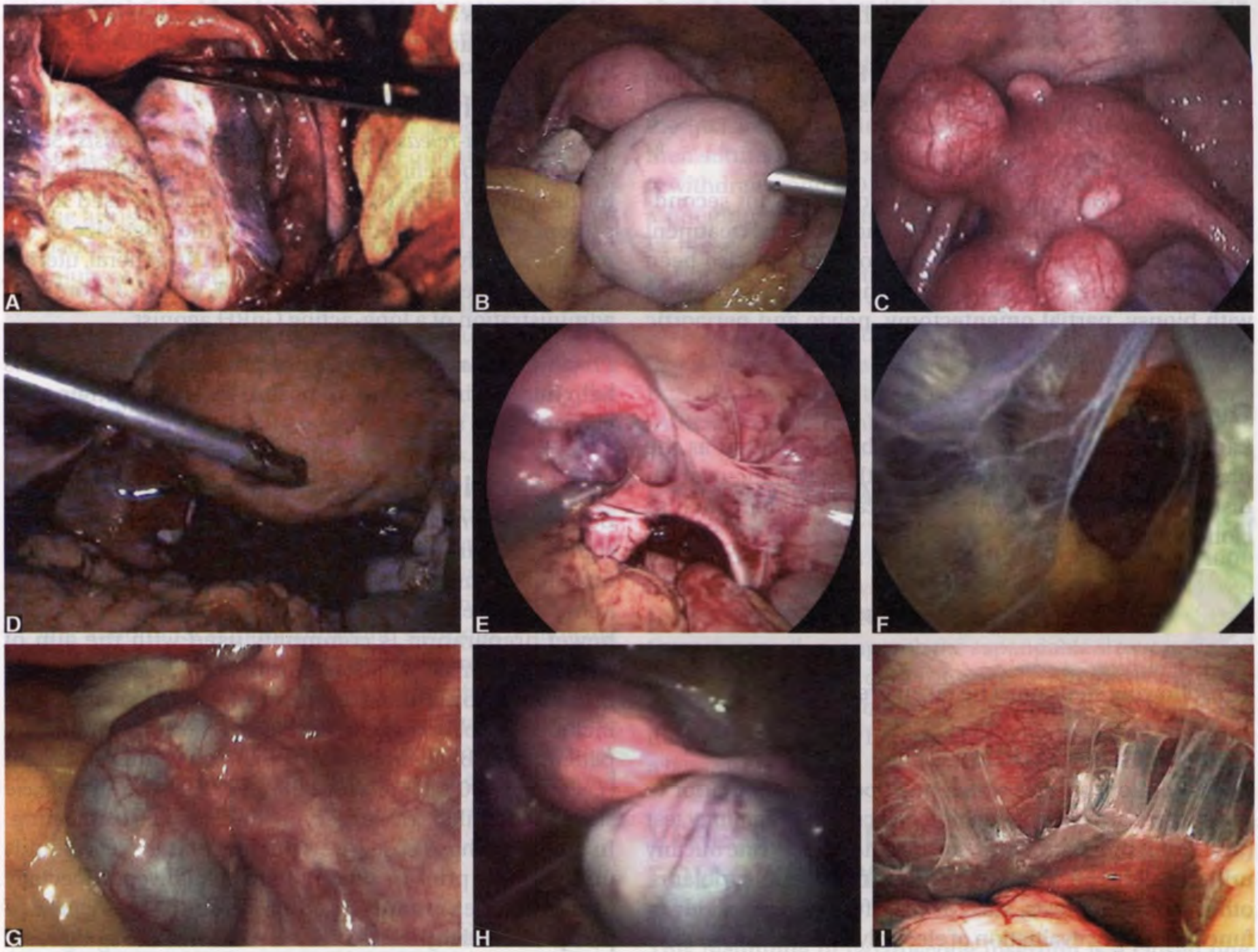
Presently, laparoscopic approach has become the surgical approach of choice for most cases of ectopic pregnancies.[11] In these cases, either salpingostomy or salpingectomy may be performed under laparoscopic guidance to remove the embryo and the gestational sac.[12]

Ovarian Cystectomy

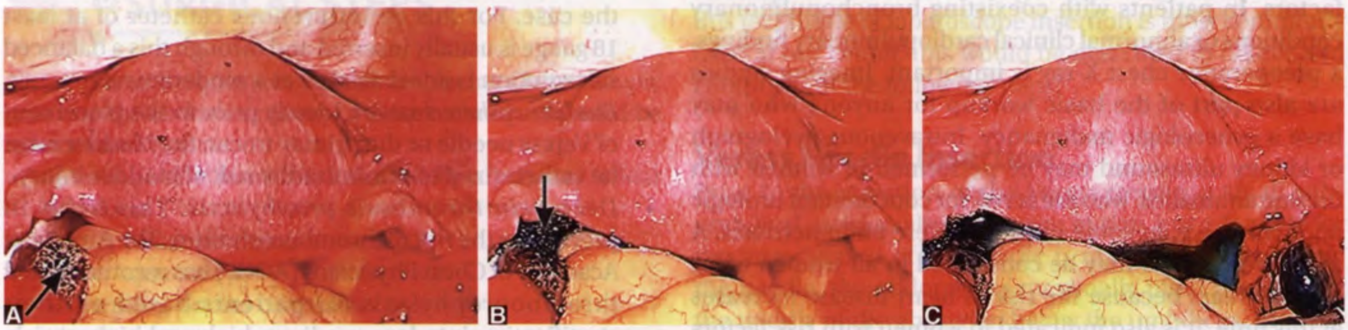
Laparoscopic approach can be used for removal of ovarian cysts in cases where simple cysts having a size of 6 cm or more, persist for 2 or more cycles in premenopausal, nonpregnant woman.[13] In case the cyst appears to be complex, malignancy must be ruled out first before proceeding with cyst removal using clinical and diagnostic tests. Laparoscopic cyst removal should be undertaken only in cases where the cyst has been shown to be benign. If any doubt exists, the cyst wall should be sent for frozen section to confirm its nature through histopathological examination. If malignancy is found, a laparotomy should be performed.

Oophorectomy

An oophorectomy may be more appropriate in postmenopausal women or those with a cyst, which is persistent or is progressively increasing in size or in cases where there is a higher risk of malignancy.



Figs 32.17A to I: Laparoscopic diagnosis of various gynecological pathologies: (A) Polycystic ovaries as observed on laparoscopic examination; (B) Large dermoid cyst on the left side; (C) Multiple uterine subserosal fibroids; (D) Collection of blood in the pelvic cavity with tubal ectopic on right side; (E) Tubal ectopic on the left side; (F) Adhesions between the omentum and pelvic organs as visualized on laparoscopic examination; (G) Right sided hydrosalpinx; (H) A large endometrioma on the right side; (I) Fitz-Hugh-Curtis syndrome



Figs 32.18A to C: Process of laparoscopic chromopertubation: (A) Slight spillage of dye from right-sided tube (indicated by arrow); (B) Spillage of dye more pronounced on right side (indicated by arrow); (C) Bilateral spillage of dye on both sides

Myomectomy

It is possible to remove pedunculated fibroids using laparoscopic myomectomy. However, the procedure may not be feasible for intramural or submucosal fibroids.

Hysterectomy

Presently, three basic laparoscopic approaches for hysterectomy are used which include laparoscopic-assisted vaginal hysterectomy (LAVH), laparoscopic hysterectomy

(LH), and laparoscopic supracervical hysterectomy (LSH).[14] Controversy exists over the risks, benefits, and most appropriate indications of each.[15,16] For details regarding LAVH, kindly refer to Chapter 24 (Hysterectomy).

Oncologic Procedures

Laparoscopy has long been used in oncology for second-look procedures following surgical and chemical treatment of malignancy. More recently, laparoscopy has also been used for staging, including obtaining peritoneal washes with biopsy, partial omentectomy, pelvic and periaortic lymphadenectomy etc.[17]

Ovarian Drilling

Laparoscopic ovarian drilling can be considered as the procedure of choice in patients with polycystic ovarian diseases who are resistant to medical treatment such as clomiphene citrate.

PREOPERATIVE PREPARATION

The following steps must be taken preoperatively:

Investigative Studies

The laboratory studies which must be performed prior to the surgery are complete blood cell count; pregnancy test (to rule out pregnancy)[18] and urine analysis (to rule out any urinary infection). In patients with known health problems, other laboratory tests, such as liver function tests/kidney function tests or evaluation of electrolyte levels, may also be indicated. An alternative to performing routine pregnancy tests prior to surgery is to schedule all elective surgeries during the follicular phase (i.e. within 2 weeks of the last menstrual period). Imaging tests such as a preoperative chest radiograph is not indicated for patients with no risk factors. In patients with coexisting bronchopulmonary conditions or abnormal clinical cardiopulmonary findings, a preoperative chest X-ray is important. Imaging studies are also part of the basic workup for anyone who may have a gynecologic malignancy. Intravenous pyelograph or kidney ultrasound may be performed in women with uterine anomalies, who are at risk for concomitant urologic anomalies, e.g. in some cases of severe endometriosis. A preoperative ECG may be considered in all women older than 50 years because the risk of heart disease increases at this time. It is also indicated in women with risk factors (e.g. diabetes mellitus, hypertension, thromboembolic diseases, stroke, etc.) which put them at an increased risk of cardiovascular disease.

Informed Consent

Informed consent must be taken from the patient after explaining the nature of the procedure, the risks, complications and alternatives. The patient should also be counseled regarding the likelihood of a possible laparotomy.

Preoperative Medications

Gonadotropin-releasing hormone (GnRH) agonists: Some women may benefit from the use of GnRH agonists prior to the surgery. These agents are commonly used in the presence of a large leiomyoma when the large size of the myoma is likely to make surgery difficult. In general, uterine volume can be decreased by up to 50% with 2-3 months of administration of a long-acting GnRH agonist.

Prophylactic antibiotics: Use of prophylactic antibiotics help in reducing the risk of postoperative infections after gynecological surgery.

Preoperative Gastrointestinal Preparation

Bowel preparation: In case the surgeon is planning significant surgical division of intestines or removal of intestinal adhesions and either endometriosis or pelvic adhesions are suspected of being present, preoperative bowel preparation is commonly used with the aim of reducing the risk of serious postoperative sequelae. The most commonly used method of bowel preparation includes use of oral agent such as magnesium citrate. The patient must be instructed to remain NPO after midnight (i.e. after 12:00 AM) to avoid the risk of aspiration in case she is scheduled for surgery in the early next morning. In patients whose cases are scheduled later, clear liquids until 6 hours prior to surgery may be allowed, especially in the summer months in order to reduce the degree of preoperative dehydration.

Other Preoperative Considerations

- *Intravenous access*: In case the surgeon is suspecting a major blood loss during laparoscopy, establishment of intravenous access may be required prior to starting the case. For this an intravenous catheter of at least 18 gauge is usually inserted and through this a balanced salt solution is administered at a moderate rate.
- *Bladder catheterization*: Ideally prior to the placement of Veress needle or the primay trocar, the bladder must be catheterized to minimize the risk of bladder injury.
- *Deep vein thrombosis prophylaxis*: This helps in preventing the risk of thromboembolism. The American Academy of Chest Physicians (ACCP) has recommended thromboprophylaxis for patients based on their stratification into low, medium, high and highest risk. For details regarding the ACCP guidelines, refer to Chapter 3 (Anesthesia and Preoperative Care).
- *Patient positioning*: Gynecologic laparoscopy procedures are usually performed with the patient in the low dorsal lithotomy position with the buttocks extended over the end of the table. This allows the surgeon to obtain adequate vaginal access for uterine

manipulation. Most laparoscopists now use pneumatic boot stirrups specially designed for laparoscopy. In case of prolonged procedures, the legs should be given a compression bandage in order to reduce the incidence of thromboembolism. The patient is positioned in a semi-lithotomy position with sequential stockings and arm pads, pressure point pads and abduction of the arms to her sides. Modern stirrups are sufficiently padded and have gel inserts which help in minimizing injury at the time of surgery.

- Once the primary trocar is placed, the patient is usually placed in no more than 25° Trendelenburg position to help keep the bowel out of the pelvis. Both the patient's arms should be either abducted or tucked in by the patient's side. This allows restriction of movement at the time of manipulation of instruments.
- *Skin preparation*: Shaving of abdominal and pubic hair is not routinely advocated. In case, the hair extends to the intended site of ancillary trocar placement, clipping the pubic hair above the symphysis may be required. The site of surgery is prepared by cleaning and draping the abdominal skin by antiseptic solutions. Following this, specially designed fenestrated laparoscopy drapes are placed over the site of surgery. After changing gloves in order to avoid contamination, vaginal dilators are then inserted inside the uterine cavity for the purpose of uterine manipulation. The vagina is then draped separately to keep the abdominal field separate from the lower vaginal field.

Anesthesia

Though general anesthesia with endotracheal intubation is most commonly used for laparoscopy, other anesthetic techniques including regional blocks, and local infiltration can also be used.

SURGICAL STEPS

Numerous techniques are available for placing a laparoscopic port into the abdomen. Some of these techniques would be enumerated next:

- Veress needle insertion followed by a primary trocar insertion
- Direct trocar insertion
- Open laparoscopy
- Expanding-access cannulas.

OPEN LAPAROSCOPY

In the open technique (Hasson's technique), the peritoneal cavity is entered through a minilaparotomy incision, which may be transverse or vertical in the subumbilical region after incising the anterior rectus fascia. The primary trocar can also be introduced through the Palmer's point which is about two-finger breadths below the left costal margin in the midclavicular line. After making a small incision about 1 cm wide at any of the previously mentioned locations, a blunt-tipped trocar with sleeve is placed vertically through the incision. Following the insertion of the cannula, it is then sutured to the peritoneum and fascia. The obturator is withdrawn and CO_2 attached to the cannula to establish a pneumoperitoneum. The laparoscope is then inserted. In these cases, intra-abdominal CO_2 insufflation is not performed prior to the insertion of the trocar. Also, the chance of injury to various intra-abdominal structures is reduced because the Veress needle and trocar are not inserted blindly. The technique of open laparoscopy was initially developed to reduce the risk of complications associated with the blind insertion of Veress needle.

EXPANDING-ACCESS CANNULAS

This is a relatively new technique for placement of laparoscopic trocars. In this technique, after insufflation of peritoneal cavity with CO_2, the Veress needle is removed and reinserted after it is placed into an expandable sleeve. Once the needle along with the expandable sleeve is placed inside the peritoneal cavity, the needle is removed, with the sleeve left in place. Following this, the sleeve is dilated to a diameter of about 5–10 mm. This helps in accommodating a laparoscopic lens.

VERESS NEEDLE INSERTION FOLLOWED BY A PRIMARY TROCAR INSERTION

This technique of laparoscope insertion is a closed one, where the peritoneal cavity is initially distended with CO_2 and the trocar is blindly introduced inside the peritoneal cavity. The primary cannula with the stylet is usually inserted through the umbilical port and then laparoscopic telescope is introduced through the primary cannula. Since this technique of laparoscope insertion is most commonly used at our center, this would be described in details and comprises of the following steps:

Veress Needle Insertion

Prior to the insertion of the Veress needle, a small sub-umbilical incision about 3–4 mm in size, just adequate for the introduction of the needle is made. Before inserting the needle, the abdomen is maximally lifted by grasping the middle of the abdomen below the umbilicus. In order to avoid injury to the surrounding structures, the needle should be held by the shaft in form of a dart. It should be directed towards the center of pelvic cavity at an angle of 45° to the horizontal. In a very thin patient, the vital structures are much closer to the abdominal wall, with sometimes the distance between the skin and large retroperitoneal vessels being as little as 4 cm. In such cases, it is important to insert the needle at an angle of 45° rather than adopting a more vertical approach. On the other hand, in obese patients [body mass index (BMI) of 30 kg/m^2 or more], a more vertical approach, approximately 70–80° is required because of the increased thickness of the abdominal wall. Without using the vertical insertion, the needle or trocar would not be long enough to penetrate the layers and enter the peritoneal cavity. At the time of insertion of Veress needle, two distinct pops are usually felt. First one occurs when the needle punctures through the anterior rectus fascia and the second occurs when the needle passes through the posterior fascia and peritoneum. Once the second pop is felt, the insertion of the needle is stopped. Some common sites of Veress needle placement are as follows:

- Intraumbilical placement
- Palmer's point: Left subcostal margin in the midclavicular line.
- McBurney's point
- Transvaginal approach: Insertion of the needle is performed through the posterior cul-de-sac. This technique may prove useful in patients in whom previous attempts at needle insertion were unsuccessful.

Since some of the most dangerous complications at the time of laparoscopic surgery can occur at the time of insertion of Veress needle and the sharp primary trocar, the operator must observe utmost precaution at the time of insertion of either Veress needle or the primary trocar. The entry of the needle into the peritoneal cavity and its proper placement can be ascertained with the help of following signs:

- *Sound of air*: As the needle enters the peritoneal cavity, there would be a hissing sound of air being sucked inside.
- *Palmer's test*: A 20-mL syringe is half-filled with saline and is attached to the hub of Veress needle. The plunger is first drawn back. Aspiration of blood or bowel contents implies that the needle is in a major splanchnic structure such as bowel or blood vessel. If no blood or bowel contents are aspirated back, then 10 mL of saline contained inside the syringe can be flushed back inside the peritoneal cavity. This can occur easily without resistance if the needle is positioned properly inside the peritoneal cavity. As the saline enters the peritoneal cavity, it cannot be aspirated back. The last phase of this test comprises of withdrawing the plunger again. When the needle is positioned properly, no fluid would be sucked back into the syringe. However, if the needle tip is lying within the adhesions or in the abdominal wall, the saline is likely to have collected in form of a pool and can be drawn back.
- *Hanging drop test*: This test is done by placing a drop of saline at the open end of the Veress needle. The abdominal wall is then elevated, while observing if the saline drop disappears into the shaft or not. The drop of saline instilled into the needle will be sucked in if the needle is inside the peritoneal cavity. However, if the needle is extraperitoneal, the saline drop would remain there.
- *Measurement of intra-abdominal pressure with carbon dioxide insufflation*: The Veress needle may be attached to the insufflator with the valve in the off position, (with the gas off). The valve is then opened so that the gas starts distending the abdomen. If a negative pressure reading is observed on the insufflation instrument, it is indicative of correct needle placement. Only when the needle has been securely placed intraperitoneally and the pressure reading is less than 10 mm Hg, the insufflation rate is increased.
- *Loss of liver dullness*: The intraperitoneal placement of the needle can also be confirmed by visualizing uniform distension of the abdomen and obliteration of the liver dullness. If the needle has been correctly placed, following the insufflation of gas, four quadrant percussion in the hepatic area produces a tympanic note, with the loss of liver dullness. If the needle is extraperitoneal, distension would be confined to the hypogastrium and the pressure recorded would be high.

If results from one of the above-mentioned tests indicate malposition of the needle, it needs to be repositioned.

Carbon Dioxide Insufflation

After confirming the position of Veress needle, CO_2 insufflation can begin at the rate of 3 L/minute. The purpose of CO_2 insufflation is to raise the abdominal wall away from the underlying structures so that the surgeon can safely insert the sharp trocar into the gas-filled abdominal cavity without causing any harm to the underlying structures. The amount of gas to be insufflated is measured in the terms of IAP produced by the gas. In an average-built woman, 3 L of insufflated gas is likely to produce an IAP of 10 mm Hg. Trocar insertion usually requires a force of 4–5 kgm/s^2. When the IAP of approximately 22 mm Hg has been obtained, the force of 4–5 kgm/s^2 applied for trocar insertion indents the abdominal wall in such a way that there is still a gas barrier of at least 5 cm between the abdominal wall and the bowel.

Insertion of Primary Trocar and Cannula

After adequate amount of IAP has been created, trocar and cannula (most commonly 5 mm or 10 mm in diameter) are placed at an angle similar to that of the Veress needle, aiming at the hollow of the sacrum. Following this, the laparoscope is inserted. Once the primary trocar is in position, the IAP is reduced to 14 mm Hg. While introducing the primary cannula and trocar through the umbilical port, the patient should be made to lie in the supine horizontal position without Trendelenburg tilt. This is important because placing the patient in Trendelenburg tilt is likely to bring the aortic bifurcation more anteriorly and therefore it is more likely to get injured.

Placement of Secondary Trocars

Barring the diagnostic laparoscopies, secondary trocars are required for most operative gynecologic laparoscopy procedures. Additional ports are placed lateral to the inferior epigastric vessels on both the sides. After identifying the epigastric vessels by transillumination and intraperitoneal observation, secondary trocars are placed.

The trocars are placed either in the midline, 3 cm above the pubic symphysis, or approximately 8 cm lateral to the midline and 8 cm above the pubic symphysis to avoid injury to the epigastric (inferior and superficial) and the superficial circumflex iliac vessels.

Introduction of the Laparoscopic Telescope

The trocar is removed from its sleeve (cannula) and the laparoscopic telescope then inserted inside through the cannula. The flapper valve of the trocar allows the surgeon to insert the laparoscope and other instruments without the loss of gas. Prior to insertion, the telescope must be examined to ensure that lenses are clear and bright and may be cleaned if they appear dirty.

Performance of Laparoscopic Procedures

Depending on the indication of laparoscopic surgery, diagnostic or operative procedures are performed next.

POSTOPERATIVE CARE

Following the performance of a major gynecologic laparoscopic procedure, the bowel function may take several days to normalize. The pain may be worse on the day following the procedure, but generally improves after that. Also, the postoperative incision usually becomes healthy within the first week. Patients should be counseled about this course of events which usually occur postoperatively. The patients should be instructed to contact their physician if any variation from this course occurs or she experiences extensive pain or bleeding at any point.

In the absence of complications, in most of the cases, the patient is able to return to full activity within 72 hours after most gynecologic laparoscopic procedures. Recovery from LH can be expected within 2–3 weeks.

ADVANTAGES

Laparoscopic surgery is associated with several advantages over laparotomy such as:

- Reduced duration of hospital stay and earlier discharge from the hospital
- Reduced postoperative pain
- Reduced blood loss.

DISADVANTAGES

In gynecology, the most commonly suggested contraindication for laparoscopic surgery is hemodynamic instability resulting from a ruptured ectopic pregnancy. However, following appropriate fluid resuscitation, laparoscopy can be considered as a safe approach. Another traditional contraindication was pregnancy. In the last few years, several large series have documented the safety of using an open technique for laparoscopy during pregnancy. Several risk factors for laparoscopic surgery are as follows:

Patient Risk Factors

- Obesity
  - Obesity is a well-recognized factor that increases the risk of any abdominal surgery. Women with a BMI greater than 25 kg/m^2 are classified as overweight, and those with a BMI greater than 30 kg/m^2 are considered obese. In an average-sized woman of approximately 160 cm, these cut-off points correspond roughly to weights of 73 kg (160 lbs) and 91 kg (200 lbs), respectively.
  - In women who are overweight, and even more so in those who are obese, every aspect of laparoscopy becomes more difficult and potentially more risky. Placement of laparoscopic instruments becomes much more difficult and often requires special techniques. Bleeding from abdominal wall vessels may be more common because these vessels become difficult to locate. Many intra-abdominal procedures become increasingly difficult because of a restricted operative field secondary to retroperitoneal fat deposits in the pelvic sidewalls and increased bowel excursion into the operative field.
- Age
  - Another well-described surgical risk factor is age. Older patients are at an increased risk of having concomitant disease processes that affect their perioperative morbidity and mortality.
  - Probably the single most important consideration is age-associated increase in cardiovascular disease. Risk is increased even greater in women who have not taken replacement hormones after menopause. Intraoperative cardiac stress related to anesthesia and the surgery itself may result in sudden cardiac decompensation based on arrhythmia, ischemia or infarct.
  - Of special importance is the increased susceptibility of elderly persons to hypothermia because the vast majority of patients experience some degree of hypothermia during laparoscopy. In older patients, even mild degrees of hypothermia may increase the

risk of cardiac arrhythmias and prolong recovery time.
- Previous abdominal surgery
  - As far as laparoscopic complications are concerned, one of the most important risk factors is the history of previous abdominal surgery. The risk of adhesions of omentum and/or bowel to the anterior abdominal wall after previous abdominal surgery is greater than 20% of sharp instruments into the abdominal cavity, a reasonable assumption is that previous surgery would increase the risk of bowel injury.

COMPLICATIONS

Besides causing the long-established complications related to surgery such as infection and generalized bleeding, laparoscopic surgery can result in some unique complications related to the procedure itself. Some of these are as follows:[19]

Gas Embolism

Since carbon dioxide is used to create the pneumoperitoneum during laparoscopic procedures, gas embolization is an uncommon but very serious complication, which can occur. Embolization is usually caused by inadvertent placement of the Veress needle into a major vessel during attempts to insufflate the abdominal cavity with carbon dioxide.[20] To avoid this complication, the operator must verify intraperitoneal placement of the Veress needle prior to insufflation.[21]

Retroperitoneal Vessel Injury

Although laceration of a major abdominal blood vessel is one of the least common complications, it is one of most life-threatening complications in laparoscopy.[22] This may occur during insertion of the Veress needle or the primary trocar. Since the umbilicus usually lies over the bifurcation of the aorta at L4, the aorta and inferior vena cava are avoided if one inserts the Veress needle or trocar through the umbilicus toward the hollow of the pelvis. At times, there may be a variation in the level of aortic bifurcation. Patients who are thin are at an additional risk because the distance from the umbilicus to the retroperitoneal vessels may be as short as 2–3 cm.[23] When placing the Veress needle, the patient must be in the horizontal position (not Trendelenburg) and the angle of entry must vary depending on the patient's weight.[24]

Abdominal Wall Vessel Injury

Placement of numerous and large accessory trocars lateral to the rectus muscles at the time of laparoscopic surgery has increased the risk of abdominal wall vessel injury. Injury to the epigastric vessels (inferior and superficial) and the superficial circumflex iliac vessel may occur during the placement of secondary ports.[25] The superficial epigastric vessels originate from the femoral artery, while the inferior (deep) epigastric vessels originate from the external iliac arteries. These arteries are accompanied by corresponding veins in most cases. Damage to these vessels can cause significant blood loss, resulting in a hematoma formation or postoperative hemorrhage.

This risk can be reduced by using techniques such as direct laparoscopic visualization of the inferior epigastric vessels. Very often, the superficial abdominal wall vessels can be visualized by transilluminating the abdominal wall with the laparoscope.[26] The inferior epigastric artery cannot be transilluminated but may be seen intraperitoneally beneath the peritoneum.[27] Prior to insertion of the lateral trocars, the operator should make an effort to identify and avoid these vessels. Another way of avoiding such injuries is the insertion of trocars lateral to the edge of rectus muscle or at least 8 cm lateral to the midline. The use of conical trocars in contrast to the pyramidal tipped trocars can also help reduce the risk of injury to these vessels.

Intestinal Injury

Both the small and large intestines can be injured during laparoscopy, which can act as a life-threatening situation, if it remains unrecognized. Recently, disposable trocars have been introduced which have a safety shield to help reduce the occurrence of bowel injury with entry of the trocar into the peritoneal cavity. Moreover, there is a risk of thermal injury to the bowel, especially when using electrocautery, particularly monopolar electrosurgery.[28,29] This injury can cause peritonitis if remains unrecognized. This is a potential life-threatening situation, if not treated immediately.

Urologic Injuries

Injury to the bladder or ureters can occur during trocar placement or during the use of power instruments, stapling or suturing devices.[30] The greatest challenge is recognizing that the injury has occurred so that treatment can be performed in a timely manner.[31] One important step for avoiding injuries to the bladder is catheterizing the bladder before starting the laparoscopic surgery. Ureteral injuries can occur with any procedure involving instrumentation near the ureters.

Incisional Hernia

Incisional hernias were rare in those days when small sized ports were used. However, with the use of larger ports (> 5 mm), the incidence of incisional hernias has increased.

Nerve Injuries

Patient positioning during laparoscopic surgery is associated with a low risk of potentially serious nerve injury to either the lower or upper extremities (e.g. brachial plexus injury).[32] To minimize the risk of brachial plexus injuries during laparoscopy, the arms should be tucked at the side of the patient whenever possible. Arms extended on arm boards should be abducted less than 90°. On the other hand, lithotomy position for prolonged periods of time can result in injuries to nerves of the lower extremity, including the femoral, lateral femoral cutaneous, obturator, sciatic and common peroneal nerves. Entrapment of the peroneal nerve can occur when there is undue pressing of knees against some structure. In order to prevent any nerve-related injury, some important things which must be kept in mind while placing the patient in lithotomy position include maintaining hip flexion of 60–170° and knee flexion of 90–120°. Hip abduction should be maintained at no more than 90° and there should be minimal external rotation of the hip joint. Extrinsic pressure on the legs should be avoided.

Anesthetic Complications

Complications related to anesthetic medications can also occur.[33]

REDUCING LAPAROSCOPIC RELATED COMPLICATIONS

Steps to be taken to reduce the complications related to laparoscopic surgery are as follows:

- The patient should be lying flat at the time of surgery
- The bladder must be empty
- The abdomen must be palpated to rule out presence of any abdominal mass
- The primary incision should be either subumbilical or at the base of the umbilicus.

DISCUSSION

Laparoscopy continues to evolve as more sophisticated instrumentation is introduced, which allows a greater variety of procedures to be performed. In the past, many of the procedures, which would have been performed only through laparotomy can now be performed using laparoscopic techniques. The present evidence has yet not evaluated the risks and benefits of the some of the complicated procedures, which are performed nowadays using laparoscopy. Some of the simple procedures, such as tubal ligation, ectopic pregnancy removal, and simple lysis of adhesions, appear to be safely and efficiently performed laparoscopically. However, the use of laparoscopic approach in potential gynecologic malignancies still remains controversial. In cases of ovarian masses with low risk of malignancy, laparoscopy has become the approach of choice. Laparoscopy is used by some gynecologic oncologists for patients with known gynecologic malignancies to biopsy retroperitoneal lymph nodes and for second-look procedures to evaluate for residual tumors after chemotherapy. There is a requirement for randomized, double blinded well-designed studies to evaluate the risk, benefits, and effects on long-term prognosis with the laparoscopic approach for various gynecologic malignancies.

In fact even the field of laparoscopic surgery has evidenced modifications and developments in the past few years. Some of the most noticeable innovations, which have been introduced in the field of laparoscopy include: robotic surgery; natural orifice transluminal endoscopic surgery (NOTES) and single incision laparoscopic surgery (SILS).[34-38] All these three innovations have their own advantages and disadvantages compared to traditional laparoscopy. Of these three developing technologies, robotic surgery is presently having the largest impact on clinical care. A new minimally invasive surgical procedure for gynecologic cancer patients, which have nowadays been commonly employed is robotic surgery using da Vinci® hysterectomy. For details related to robotic surgery and other innovations of laparoscopic surgery, kindly refer to Chapter 33.

Natural orifice transluminal endoscopic surgery refers to using an endoscope to access the abdominal cavity through the body orifices such as the mouth, rectum, and vagina. This technique combines endoscopic and laparoscopic techniques to diagnose and treat intra-abdominal pathology.

Robotic Laparoscopic Surgery

The advent of robotic laparoscopic surgery appears to be changing the approach to many gynecological surgery cases. The robotic system allows surgeons to perform procedures that previously would have been performed via laparotomy using modified laparoscopic procedures.

The da Vinci® System is now being widely used for cardiovascular, urologic, and gynecologic surgeries. The only robotic system commercially available today is the da Vinci® Surgical System (Intuitive Surgical, Inc., Sunnyvale, California). In this surgery, robotic tools are attached to the traditional laparoscopic ports. The surgeon controls the instruments from a console located in the same room.

The robotic surgical system allows the surgeon to operate from a remote station using hand controls. This helps in providing increased dexterity and also helps in minimizing fatigue, tremors, or incidental hand movement.[39,40] This allows the surgeon to operate safely and effectively. Another advantage of this surgical system is that it allows direct correlation between hand and instrument movements. This is in contrast to traditional laparoscopy, where hand movements are translated into grasping or cutting movements in different flat planes. The use of robotic surgery has allowed the more widespread application of laparoscopy for complicated gynecologic procedures. For details regarding the use of robotic surgery, kindly refer to Chapter 33.

Single incision laparoscopic surgery refers to performing laparoscopy through a single incision. This approach is associated with numerous benefits such as reduced pain, improved cosmetics, and reduced risks associated with a secondary port placement.

Single incision laparoscopic surgery is associated with numerous disadvantages such as limited visibility, depth perception, maneuverability, reach, and the ability to create countertraction. Due to these disadvantages, the use of this approach in gynecological surgery is largely limited.

CONCLUSION

This minimally invasive procedure has become a preferred method of choice for diagnosis and treatment of several gynecological surgical conditions. Laparoscopic surgery is associated with numerous advantages such as reduced duration of hospital stay, reduced recovery time and reduced incidence of postoperative complications such as pain. Furthermore, the advent of robotic laparoscopic surgery appears to be changing the approach to many gynecological surgery cases. The robotic system allows surgeons to perform procedures that previously would have been performed via laparotomy using modified laparoscopic procedures.

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CHAPTER 33

Recent Advances in Gynecological Surgery

INTRODUCTION

Operative laparoscopy was introduced in the field of gynecology nearly 5 decades back. By early 1980s the laser and electric energy technology had been incorporated into laparoscopic surgery. As a result, operative laparoscopy extended to include complicated gynecologic procedures such as hysterectomy, adnexal surgery and uterine myomectomy. Presently, laparoscopic surgery has become an integral part of surgical treatment for various gynecologic diseases. Since the introduction of laparoscopic surgery in 1970s there have been several innovations in this field especially robotic surgery, laparo-endoscopic single-site surgery (LESS), natural orifice transluminal endoscopic surgery (NOTES), hand-assisted laparoscopic surgery (HALS), etc. In this chapter robotic surgery and single-incision laparoscopic surgery (SILS) would be primarily discussed. Recently da Vinci® surgery with Single-Site instruments has been approved for use for removing gallbladder, for hysterectomy and removal of ovary for benign conditions. There may be an increased risk of incision-site hernia with single-incision surgery, including Single-Site surgery with da Vinci®.

OVERVIEW OF SURGERY

da Vinci® Surgical System

The da Vinci® Surgical system is a robotic surgical system made by the American company, Intuitive Surgical. Approved by the Food and Drug Administration (FDA) in 2000, it has been designed to facilitate complex surgery using a minimally invasive approach, and is controlled by a surgeon operating from a console.

The system is commonly being used for performing various gynecologic surgical procedures. According to the manufacturer, the da Vinci® system is called "da Vinci" in part "because Leonardo da Vinci invented the first robot", according to Italian academician Mario Taddei.[1] da Vinci also used anatomical accuracy and three-dimensional (3D) details in his work.

Da Vinci® robots operate in hospitals worldwide, with an estimated 200,000 surgeries conducted in 2012, most commonly for hysterectomies and prostate removals. By January 2013, more than 2,000 units had been sold worldwide.[2] The "Si" version of the system costs on an average slightly under US $2 million, in addition to several hundred thousand dollars of annual maintenance fees.

FDA approval: Food and Drug Administration approved the da Vinci® Surgical system in 2000 for adult and pediatric use in urologic surgical procedures, general laparoscopic surgical procedures, gynecologic laparoscopic surgical procedures, general noncardiovascular thoracoscopic surgical procedures and thoracoscopically assisted cardiotomy procedures. The FDA also cleared the da Vinci® system to be employed with adjunctive mediastinotomy to perform coronary anastomosis during cardiac revascularization.[1,2]

Setup of the Operating Room

Figure 33.1 illustrates setup in an operating room utilizing the da Vinci® robotic equipment. The robotic surgeon operates from the remote master console and uses a combination of hand controls and foot pedals (Figs 33.2A to Q). The patient-side cart is positioned in between the patient's legs, and the robotic arms are attached to stainless steel robotic trocars through a process termed as docking. One of the foot pedals (being managed by the surgeon)

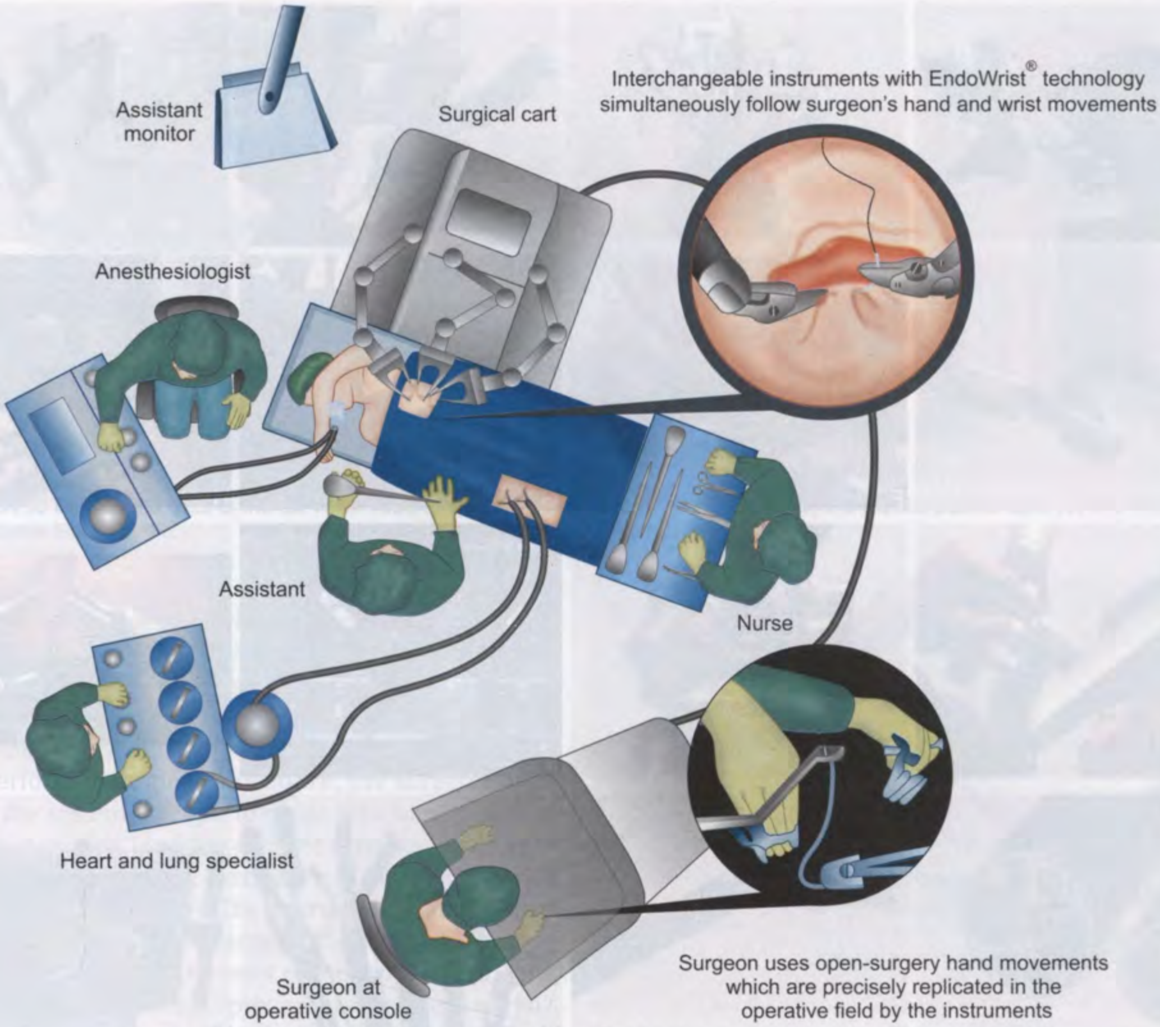


Fig. 33.1: Setup of the operating room (© 2015 Intuitive Surgical, Inc.)

controls the movement of camera; another one may control the focus; another pedal helps in providing a range of motions to the robotic equipment, whereas yet another one controls both monopolar and bipolar energy sources. The hand controls of the surgeon sitting on the side console help in the movements of the camera as well as the various robotic instruments. There are about three operative robotic arms. Despite all of these advancements, while performing robotic surgery, a bedside assistant is still required.

Laparo-Endoscopic Single-Site Surgery

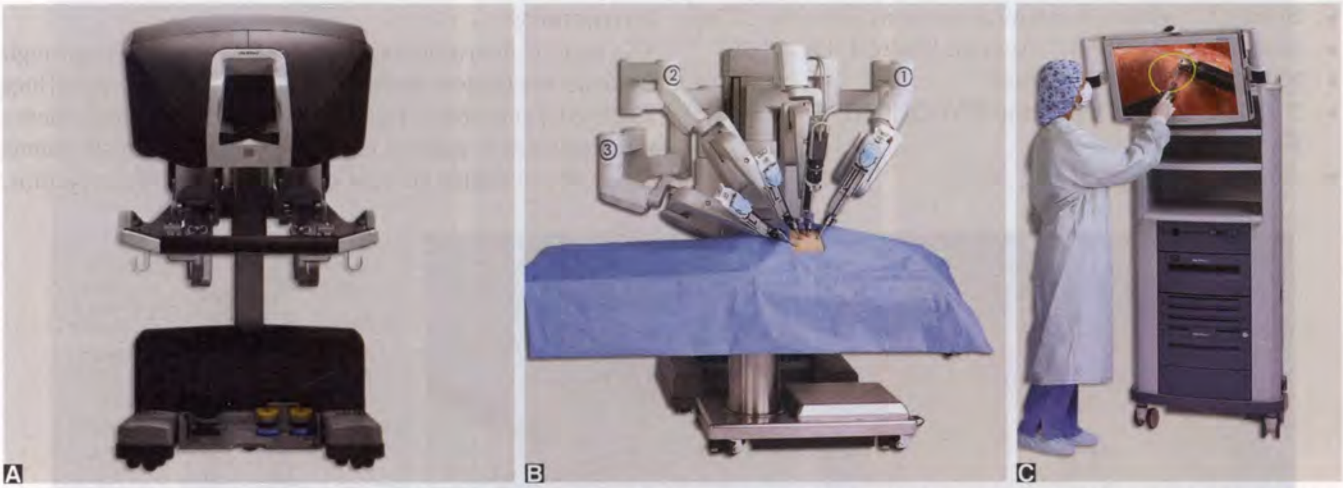
Laparo-endoscopic single-site surgery can be considered as the recent most innovation in the minimal invasive laparoscopic surgery. The single port laparoscopic approach had already been widely applied in gynecology. The principle idea of LESS involves placing all the laparoscopic working ports through the same incision. The first single incision tubal ligation in 1969 was performed by Wheeless.[3] Soon thereafter, total hysterectomy with bilateral salpingo-oophorectomy using single puncture technique was performed by Pelosi in 1991.[4] However, hysterectomy using LESS did not gain extensive usage due to many technical difficulties. Nevertheless, nowadays this technique is been widely employed for hysterectomy and various adnexal surgeries.

SURGICAL EQUIPMENT

da Vinci® Robotic System

The da Vinci® robotic system, which is the only FDA approved and commercially available robot in gynecology, consists of three main components: (1) a surgeon's console that is typically in the same room as the patient, (2) a vision cart and (3) a robotic side cart with four interactive robotic arms controlled from the console (Figs 33.3A to C). Three of the arms are for holding tools such as scalpels, scissors, bovies, or unipolar or bipolar electrocautery instruments. The fourth arm carries an endoscopic camera with two lenses that provides the surgeon with full stereoscopic vision from the console. The surgeon sits at the console

Figs 33.2A to Q: Robotic da Vinci® operating system. (A) da Vinci® robotic operating system along with the operating console where the surgeon sits; (B) Image of the robotic operating equipment cart from the front; (C) Magnified view showing the robotic operating equipments; (D) Camera arm; (E) Angled instrument arm; (F) Robotic operating equipment after being inserted into the patient's abdomen; (G) The operating console where the surgeon sits; (H) Cameras of the robotic system which help in providing magnified, 3-dimensional, high-definition view of the operating field; (I) Surgeon's hand controlling movement of robotic equipment; (J) Movement of surgeon's fingers controlling the movements of robotic equipment; (K) Operating surgeon's monitor screen for controlling the movement of various surgical instruments in the operative field; (L) Surgeon's fingers controlling the movements of the robotic equipment to stitch the abdominal incision; (M) A 12 mm and 8.5 mm endoscope; (N) EndoWrist® forceps; (O) Array of robotic equipment; (P) View of robotic surgery as visualized on the monitor of vision cart; (Q) An assistant surgeon changes the details of the monitor of the vision cart



Figs 33.3A to C: Components of the da Vinci® robotic system: (A) the surgeon's console; (B) the robotic/patient cart; (C) the vision cart © 2015 Intuitive Surgical, Inc.

and looks through two eye holes at the 3D images of the procedure, while maneuvering the arms with two foot pedals and two hand controllers. This system scales, filters and translates the surgeon's hand movements into more precise micromovements of the instruments, which operates through small incisions in the body (Fig. 33.4).

To perform a surgical procedure, the surgeon must first use the system's weight to judge how hard it should work. Then he/she uses the console's master controls to maneuver the patient-side cart's three or four robotic arms (depending on the model). The instrument's jointed wrist design exceeds the natural range of motion of the human hand. Motion scaling and tremor reduction due to the use of robotic arms further interpret and refine the surgeon's hand movements. The da Vinci® system always requires a human operator, and has multiple safety features built in to minimize opportunities for human error when compared with traditional approaches.

The da Vinci® system has been designed to improve upon conventional laparoscopy, in which the surgeon operates while standing, using hand-held, long-shafted instruments, which have no wrist. With conventional laparoscopy, the surgeon must look up and away from the instruments, to a nearby two-dimensional (2D) video monitor to see an image of the target anatomy. Also, in these cases, the surgeon must rely on his/her patient-side assistant to position the camera correctly. In contrast, the da Vinci® system's ergonomic design allows the surgeon to operate from a seated position at the console, with eyes positioned in line with the instruments. To move the instruments or to reposition the camera, the surgeon simply moves his/her hands.

Laparo-Endoscopic Single-Site Surgery

As previously described, LESS involves placing of all the laparoscopic working ports through the same incision. However, this may result in the collision of hands outside the abdomen and clashing of instruments within the abdomen. Nowadays, various devices have been introduced to overcome these technical challenges. These devices include laparoscopic ports designed in such a way that multiple instruments can be introduced through a single incision. Moreover, flexible/long endoscopes and articulating instruments of variable lengths have also been introduced. Additionally, the da Vinci® robotic platforms with articulating instruments can also be integrated into single port laparoscopic surgery (SPLS) for performing surgeries such as hysterectomy or salpingo-oophorectomy.[5]

Fig. 33.4: Comparison of hand movements with that of da Vinci® robot © 2015 Intuitive Surgical, Inc.

The Port Devices

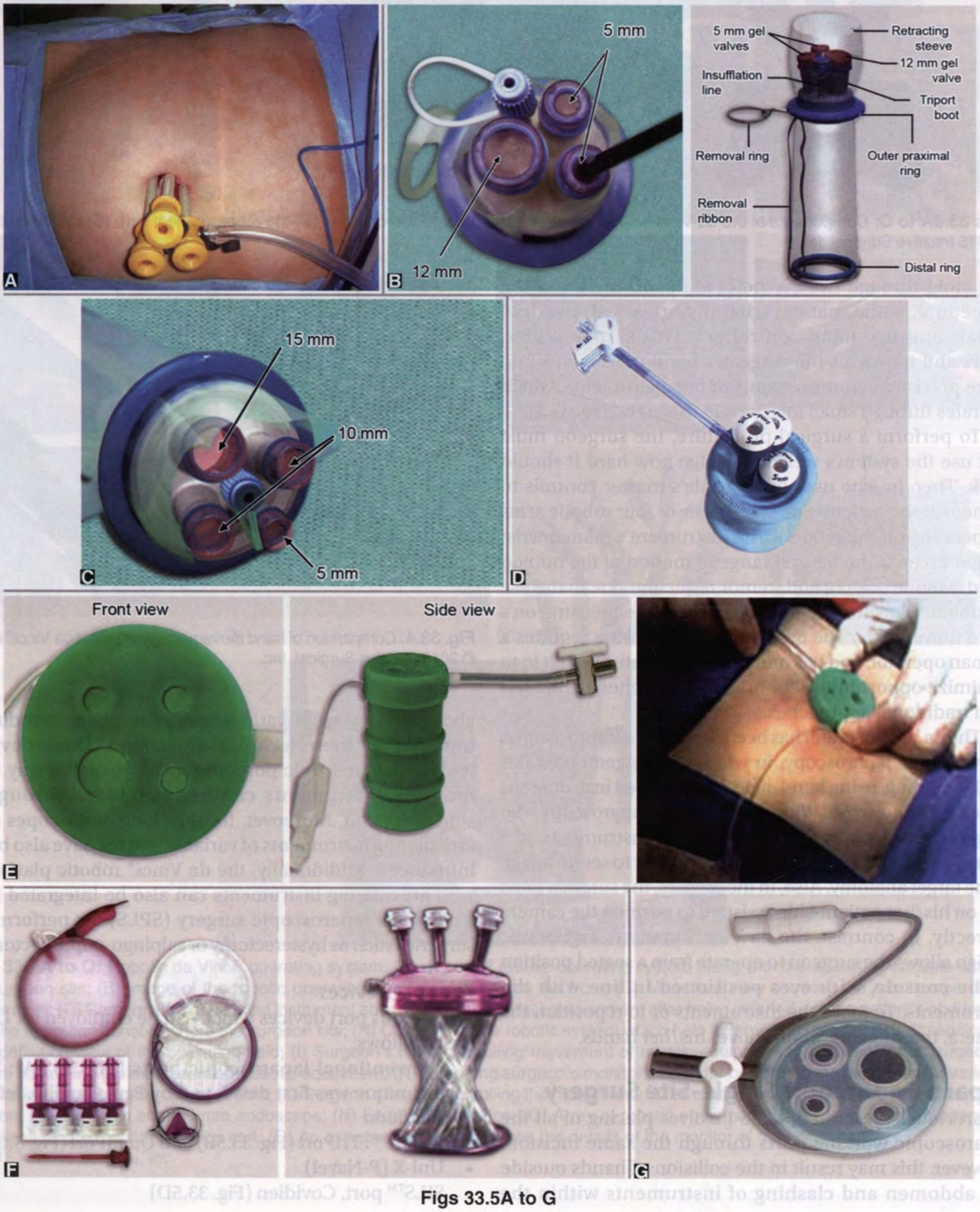
The various port devices which can be employed for LESS are as follows:

- Conventional laparoscopic ports (Fig. 33.5A): The technique was first developed by Paul Curcillo, Jeffrey Caddedu
- R-Port™: TriPort (Fig. 33.5B) and QuadPort (Fig. 33.5C)
- Uni-X (P-Navel)
- SILS™ port, Covidien (Fig. 33.5D)

- SITRACC®, single access trocar platform, Edlo (Fig. 33.5E)
- GelPoint and GelPort®, Applied Medical (Fig. 33.5F)
- SSLAS, Ethicon (Fig. 33.5G)
- X-CONE® (Fig. 33.5H) and ENDOCONE® (Fig. 33.5I), Karl Storz
- AirSeal®, SurgiQuest (Fig. 33.5J).

Instruments

The various instruments which could be inserted through these access devices include articulating instruments (Figs 33.6A to C) or prebent (Fig. 33.7). Straight instruments have a significant role to play in LESS. Articulating/bent instruments should be available in case of need in specific situations.



Figs 33.5A to G

Figs 33.5H to J

Figs 33.5A to J: Various port devices for single incision laparoscopic surgery. (A) Conventional laparoscopic ports; (B) TriPort; (C) QuadPort; (D) SILS™ port, Covidien; (E) SITRACC®, single access trocar platform, Edlo; (F) GelPoint and GelPort®, Applied Medical; (G) SSLAS, Ethicon; (H) X-CONE®, Karl Storz; (I) ENDOCONE®, Karl Storz; (J) AirSeal®, SurgiQuest

Familiarity with articulating instruments during standard laparoscopy increases its usefulness during LESS procedures.

Prebent Instruments: The prebent instruments offer the following advantages:

- Provides internal triangulation and external separation
- Has rigidity similar to straight instruments
- Lower cost (reusable).

The prebent instruments are associated with the following limitations:

- Long learning curve
- Requirement of a specialized access trocar for insertion.

Articulating Instruments: These instruments are associated with the following advantages:

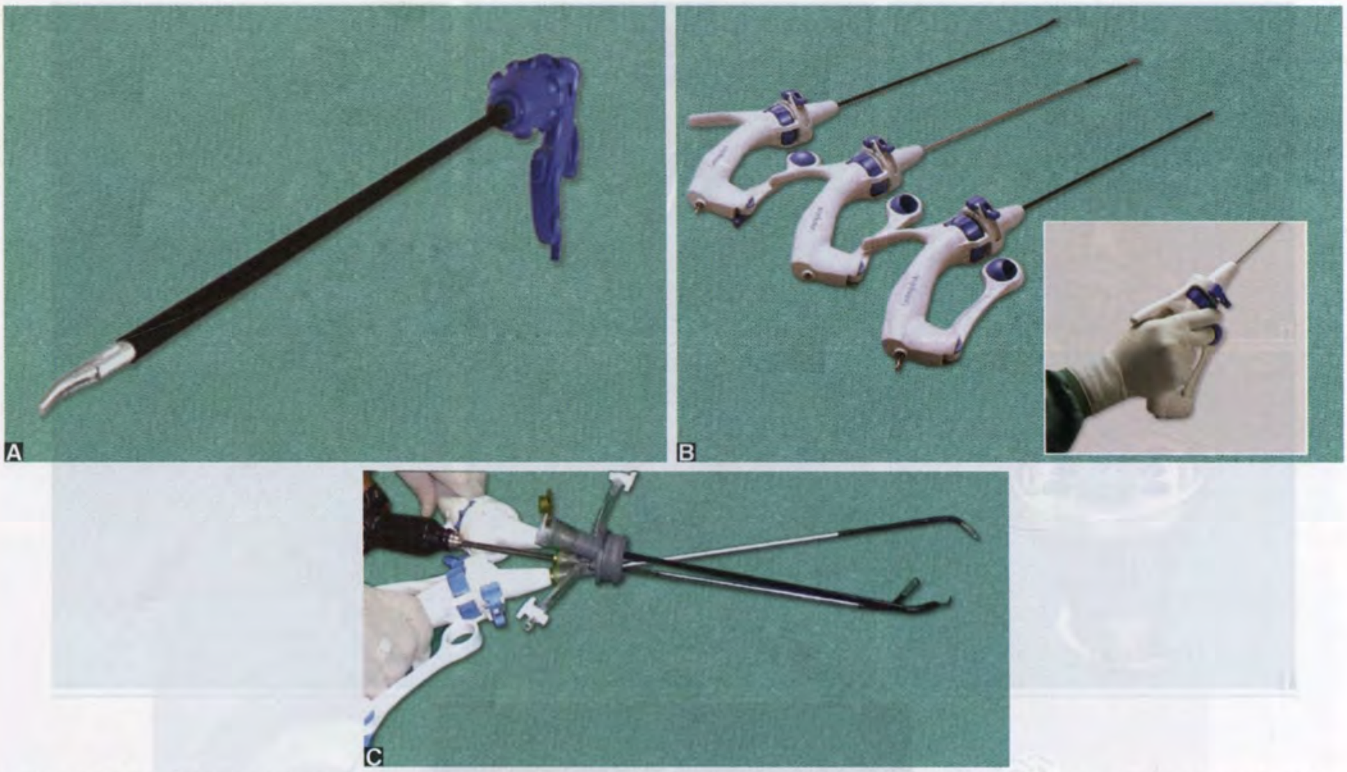
- Increased freedom of movement
- Better triangulation.

These instruments have following limitations:

- Longer learning curve
- Low strength for retraction
- External ergonomics
- High cost factor.

Various technical nuances associated with actively articulating instruments:

- If both the instruments are straight there is a need to cross the instrument
- If the right instrument is straight and left is articulating, dissection is easier with right, whereas the retraction is less robust on the left side
- If the right instrument is articulating and left is straight, retraction is more robust on the right side, whereas the dissection is difficult.



Figs 33.6A to C: Articulating instruments: (A) Real Hand, Novare®; (B) Cambridge Endo®; (C) Passing the articulating instruments through the port

Fig. 33.7: Prebent instrument

AIMS OF SURGERY

Robotic Surgery

By providing surgeons with superior visualization, enhanced dexterity, greater precision and ergonomic comfort, the da Vinci® Surgical system makes it possible for more surgeons to perform minimally invasive procedures involving complex dissection or reconstruction. For the patient, a da Vinci® procedure can offer all the potential benefits of a minimally invasive procedure, including less pain, less blood loss and less need for blood transfusions. Moreover, the da Vinci® system can enable a shorter hospital stay, a quicker recovery and faster return to normal daily activities.

INDICATIONS

ROBOTIC SURGERY

Indications for use of robotic surgery in gynecology are as follows:[6-8]

- Endometriosis: Endometriosis resection
- Uterine fibroids: Myomectomy, da Vinci hysterectomy
- Excessive menstrual bleeding/dysfunctional uterine bleeding: da Vinci hysterectomy
- Pelvic prolapse: da Vinci sacral colpopexy and/or hysterectomy
- Treatment of cancer (staging for endometrial and cervical cancers and hysterectomy for their early stages)
- Tubal reversal surgery
- Fistula repair.

SINGLE PORT LAPAROSCOPIC SURGERY

Some of the indications for SPLS are as follows:

- Hysterectomy
- Adnexal surgery for adnexal tumors
- Treatment of ectopic pregnancy using a single-site trocar salpingectomy.

PREOPERATIVE PREPARATION

Steps for preoperative preparation for both robotic surgery and LESS are same as those used in laparoscopic surgery. For details kindly refer to Chapter 32. The da Vinci® surgery is usually not performed in patients in whom non-robotic minimally invasive surgery (MIS) cannot be performed.

SURGICAL STEPS

In cases of robotic surgery, several small incisions are made along the abdomen and the surgical tools are inserted through these incisions (Fig. 33.8). The movement of each instrument and each surgical maneuver is controlled by the surgeon, who sits on a console slightly away from the site of surgery.

ROBOTIC SURGERY

Endometriotic Resection Using the Robotic System

There are four ways in which da Vinci® technology facilitates precise management of endometriosis lesions.

Adhesiolysis: Three-dimensional high-definition (HD) vision provides improved visualization of tissue planes, making it easy to restore normal anatomy while avoiding injury to ureters, vasculature and other structures. In addition, hot shear (monopolar curved scissors) offers two modes for meticulous freeing of adhesions throughout the pelvic cavity (Fig. 33.9).

Excision of ovarian endometrioma: Excellent visualization using the robotic system allows easy identification of the ovary/endometrioma wall, helping to avoid damage to the ovary and to preserve functionality. The PK® dissecting forceps and long-tip forceps can be used together to provide traction/retraction for effective removal of the endometrioma (Fig. 33.10).

Ureterolysis: EndoWrist® instruments facilitate careful ureterolysis, even when the ureters are hidden by scar tissue and nodular disease. Wristed instrumentation also enables precise resection of lesions that have deeply infiltrated structures such as bowel and ureters. Complete autonomy can be achieved, utilizing the third instrument arm to assist in tissue manipulation or retraction (Fig. 33.11).

Resection of rectovaginal nodules: Unparalleled visualization of the posterior cul-de-sac, combined with fully articulating instrumentation, enables the surgeon to identify and resect lesions and nodules throughout the pelvic cavity. The EndoWrist® instrumentation also facilitates easy and efficient access to intraperitoneal and retroperitoneal anatomy for excision of all nodules (Fig. 33.12).

Myomectomy Using the Robotic System

The steps of robotic myomectomy have been previously illustrated in Chapter 20. There are four ways in which da Vinci® technology facilitates a precise myomectomy:

1. *Hysterotomy*: The permanent cautery hook allows the surgeon to make a horizontal or vertical incision over the uterine surface, based upon the location of the pathology, while avoiding excessive divots or tunneling within the myometrium surrounding the myoma. The PK® dissecting forceps help retract the incised myometrium and provide improved coagulation with minimal thermal spread to facilitate deliberate perpendicular cuts down to the myoma capsule.
2. *Multilayered suture closure of defect—deep layers*: The suture cut needle driver securely holds CT-2 needles as they pass through the myometrial layers while providing integrated cutting following knot tying for improved operative efficiency. The EndoWrist® large needle driver allows for interrupted figure-of-eight or running sutures to be thrown and tied intracorporeally for a deep multilayer closure. The unsurpassed visualization of the camera allows for accurate placement of imbricated stitches in additional layers and superior ability to reconstruct the uterine defect.

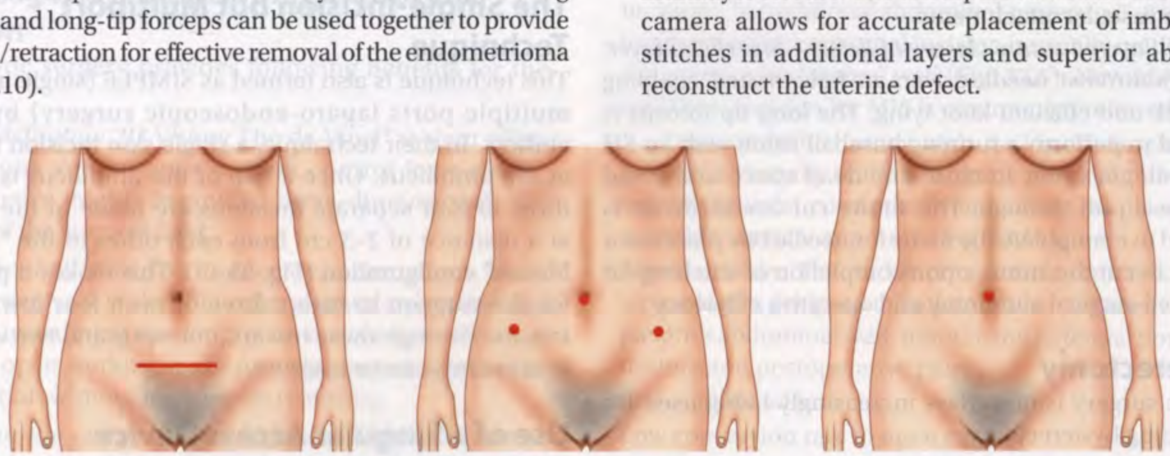


Fig. 33.8: Incision given in traditional open surgery compared to the minimal small incisions given in the robotic surgery and a single umbilical incision given in case of laparo-endoscopic single-site surgery and single incision robotic surgery

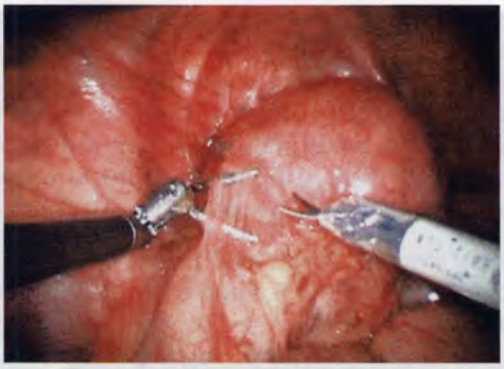


Fig. 33.9: Adhesiolysis

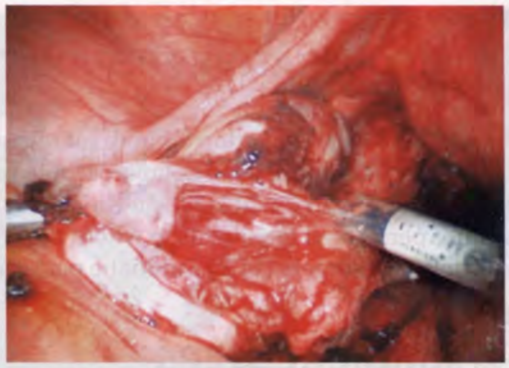


Fig. 33.10: Excision of ovarian endometrioma

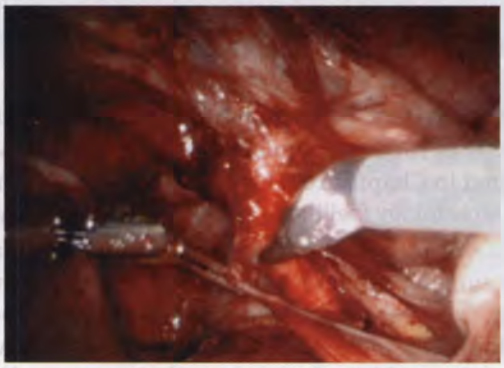


Fig. 33.11: Ureterolysis

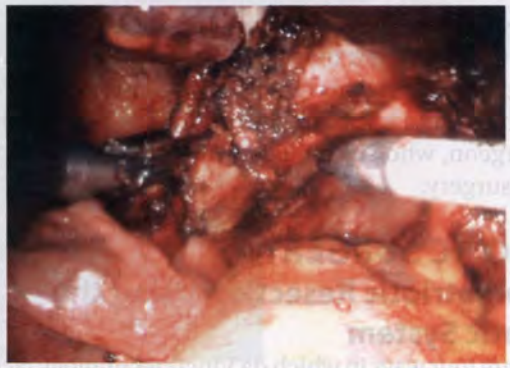


Fig. 33.12: Resection of rectovaginal nodules

3. *Enucleation*: Consistent, careful countertraction can be attained by utilizing the EndoWrist® tenaculum forceps while avoiding entrance into the endometrial cavity or premature avulsion of the myoma. The PK® dissecting forceps facilitate development of the correct dissection plane surrounding the myoma, while also providing more site-specific countertraction, facilitating a more precise dissection and enucleation of the fibroid. The hot shears is used to peel the myoma free of all attachments. Coagulation with the PK® dissecting forceps should be prudently used to preemptively deal with vascular attachments.
4. *Multilayered suture closure of defect—superficial layer*: All EndoWrist® needle drivers are fully wristed, enabling quick and efficient knot tying. The long-tip forceps is used to perform a running baseball stitch with an SH needle, in order to close any dead space and avoid serosal pull-through. The suture cut needle driver is used to manipulate the tissue for needle bite placement and to cut the suture upon completion of stitching for added surgical autonomy and operative efficiency.

Hysterectomy

Robotic surgery is nowadays increasingly being used for performing hysterectomy.

Treatment of Gynecological Cancers

The types of robotic surgeries, which can be performed for the management of cancer cases, are the da Vinci® hysterectomy with lymph node dissection for endometrial cancer and early stage cervical cancer. However, robotic surgery is yet not extensively used for the treatment of ovarian cancer. It is even now almost invariably treated using traditional surgical approach.

LAPARO-ENDOSCOPIC SINGLE-SITE SURGERY

The various techniques of LESS are as follows:

The Single-Incision but Multiport Technique

This technique is also termed as SIMPLE (single incision, multiple ports laparo-endoscopic surgery) by some authors. In their technique, a single skin incision is given at the umbilicus. Once a flap of the umbilicus is raised, three to four separate incisions are made in the sheath at a distance of 2–3 cm from each other in the "Mickey Mouse" configuration (Fig. 33.13). This makes it possible for the surgeon to insert three or even four low profile trocars. Through these trocars, one optic and two working instruments can be inserted.

Use of a Singular Access Device

This second technique involves the use of a singular access device which allows the insertion of three or four instruments through a single opening in the umbilicus into which the device is first inserted. The first of these devices to be available was

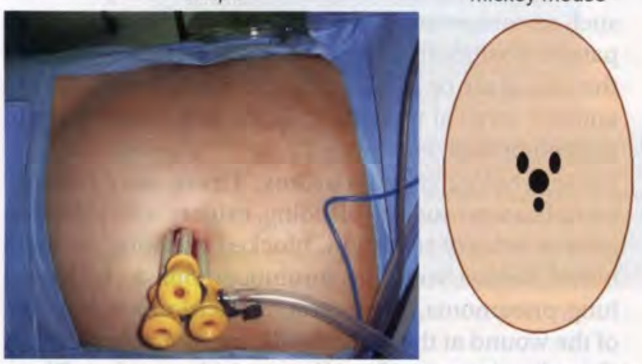


Fig. 33.13: Single incision technique having "Mickey Mouse" configuration

the R-Port™ (Advanced Surgical Concepts, Wicklow, United Kingdom). Presently many such devices are available (SILS™ port by Covidien, SSLAS by Ethicon, AirSeal® by SurgiQuest, Octoport™ by Daikin Surgical, Korea and X-CONE® by Karl Storz) (Figs 33.5A to J). These ports were inserted through an incision measuring anywhere between 17 mm and 50 mm depending on the port and the organ to be accessed/removed.

POSTOPERATIVE CARE

Steps to be taken postoperatively in both robotic surgery and LESS are same as those used in laparoscopic surgery. For details kindly refer to Chapter 32.

ADVANTAGES

ROBOTIC SURGERY

Advantages of Robotic Surgery for the Surgeon

The robotic surgery provides following benefits for the surgeon:

- *High-definition 3D Vision:* The da Vinci® system offers surgeons autonomous camera control for a stable, immersive, highly magnified three-dimensional, HD view of the surgical field.
- *Precise, collision-free movements*: Surgeon's hand movements are scaled, filtered and seamlessly translated to the instrument tips for precise instrument control. A large, open working space provides unrestricted range of motion without instrument crowding.
- *Ergonomic comfort*: The surgeon's console shows multiple ergonomic adjustments for increased comfort and reduced fatigue during surgical procedures.
- *Intuitive motion*: Advanced system software correlates the surgeon's hand movements to the instrument tips, restoring intuitive control to what would otherwise be cross-handed surgery.

Based on the above-mentioned features, the da Vinci® Surgical system has the potential to change surgical procedure in three basic ways:

1. *Make existing MIS operations easier*: Surgical procedures routinely performed today using MIS techniques will be performed more quickly and easily. Control of the camera and all three operative arms provide ultimate accuracy in maintaining surgical autonomy, accuracy and efficiency.
2. *Making difficult MIS operations routine*: Surgical procedures that today are performed only rarely using MIS techniques are expected to be performed routinely and with confidence using the da Vinci® Surgical system. Some procedures have been adapted for port-based techniques but are extremely difficult and are currently performed by a limited number of highly skilled surgeons.
3. *Making new surgical procedures possible*: A number of surgeries that could not be performed in a minimal invasive manner can be performed today using the robotic system.

Advantages of Robotic Surgery for the Patient

The da Vinci® Surgical system can offer numerous benefits over traditional open surgery. Some of these include: shorter duration of hospital stay, reduced pain, faster recovery, reduced amount of blood loss, requirement for fewer transfusions and reduced risk of infection, risk of scar formation and overall improved quality of life. Possible benefits of robotic surgery in comparison to open surgery include the following:

- *Minimal scarring*: Robotic surgery is a type of minimally invasive procedure, in which several small incisions (0.25–0.75 inch) are made along the abdomen, and the surgical equipments are inserted through these incisions. In traditional abdominal surgery, a 7–8 inches long vertical or horizontal incision is usually made over the anterior abdominal wall (Fig. 33.5). Nowadays, an umbilical incision for MIS is commonly preferred.

  Transumbilical entry with da Vinci® Single-Site enables a virtually scarless surgery, providing patients one of the most cosmetically appealing results of any available surgical approach (Fig. 33.14).
- *Minimal pain*: The da Vinci® system's remote center technology is designed to limit cannula movement at the patient's abdominal wall, minimizing potential port-site trauma and postoperative pain
- Reduced blood loss
- Low conversion rate to open surgery
- Low rate of complications
- Short duration of hospital stay
- Small incisions resulting in minimal scarring
- Reduced requirement for narcotic pain medicine.

Fig. 33.14: Improved cosmesis due to transumbilical entry with da Vinci® Single-Site incision

LAPARO-ENDOSCOPIC SINGLE-SITE SURGERY

Laparo-endoscopic single-site surgery provides the following advantages:

- Improved cosmesis
- Ease of tissue retrieval due to a large umbilical incision
- Improved patient acceptance
- Overall improved quality of life
- *Reduced postoperative complications associated with trocar insertion*: Complications such as epigastric vessel injury, visceral organ herniation, wound infection, and damage to the visceral organs are likely to be reduced in cases of SPLS due to no requirement for insertion of ancillary ports.
- *Reduced postoperative pain*: This is probably related to a single skin incision resulting in reduced penetration of skin, muscle and fascia.

COMPLICATIONS

ROBOTIC SURGERY

Though the overall rate of complications with robotic surgery is quite low, some possible risks of robotic surgery in comparison to open surgery include the following:

- Injury to tissues/organs (e.g. injury to the bladder, urinary tract, bowel, etc.)
- Bleeding (loss of large amount of blood may require transfusion)
- Infection and internal scarring, which can cause long-lasting dysfunction/pain.
- *Potential for equipment failure and/or human error*: da Vinci® robotic surgical system could malfunction or fail leading to serious injury or the need to switch to another type of procedure. Switching to another procedure type could also result in a longer procedure time, a longer time under anesthesia and increased rate of complications.
- Abscess formation
- *Risks related to MIS*: These may include complications such as temporary pain/nerve injury associated with patient positioning; temporary pain/discomfort from the use of air or gas in the procedure; conversion to another surgical technique, incisional hernia, pulmonary embolism, etc.
- *Postoperative complications*: These may include complications such as bleeding, urinary tract infection and/or urinary retention, blocked intestine or small bowel, nausea/vomiting, thromboembolism, collapsed lung, pneumonia, infection at the incision site, bursting of the wound at the incision site, incisional hernia, etc.
- *Complications specific to the surgical procedure*: There could be specific complications related to the procedure which is performed (e.g. hysterectomy, myomectomy, sacrocolpopexy, etc.).

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Some complications which can occur as a result of LESS are as follows:

- Formation of an incisional hernias
- Wound complications
- No reduction in postoperative pain in comparison to the conventional laparoscopic methods
- *Technical problems*: Despite the availability of novel devices for LESS, clashing of laparoscopic instruments and limited vision of in-line view still present as potential disadvantages of LESS. This may be associated with longer operative times, longer learning curves and difficulty in training the new surgeons.

DISCUSSION

ROBOTIC SURGERY

Innovations Used in Robotic Surgery

EndoWrist® One Vessel Sealer

The EndoWrist® one vessel sealer is a fully wristed instrument, enabling an optimized approach for sealing and cutting of vessels up to 7 mm in diameter and tissue bundles. Available exclusively for the da Vinci® Si system, the EndoWrist® one vessel sealer is a single use 8 mm instrument, providing a pristine sealing surface and cutting blade for effective performance in each procedure. The EndoWrist® Stapler 45 System, however, is still awaiting FDA approval.

Features of EndoWrist® one vessel sealer (Fig. 33.15): The features of an EndoWrist® one vessel sealer are as follows:

- *Uncompromised access and control*: Fully wristed articulation allows surgeons to approach anatomy at optimal angles for effective sealing performance with hallmark da Vinci® precision, dexterity and control.
- *Optimal flexibility and efficiency*: Independent seal/cut functions along with transection boundary indicator,

Fig. 33.15: Features of the EndoWrist® one vessel sealer

facilitates efficient seal with confident transection, plus affords surgeons flexibility to assess the seal prior to cut.

- *Exceptional seal quality*: The 16 mm length sealing surface and consistent computer-controlled closing pressures ensure excellent tissue sealing.
- *Remarkable versatility*: Dual-hinged, thermally isolated jaws with 40° opening angle and unique tip profile offer efficient dissection.
- *Unparalleled ease of use*: Real-time system self-checks and onscreen feedback keeps the surgeon informed.

EndoWrist® One Suction/Irrigator for da Vinci® Myomectomy: Potential Benefits (Table 33.1)

The EndoWrist one suction/irrigator (Fig. 33.16) offers surgeons precise control of a fully articulated suction/irrigation instrument during the various steps of myomectomy (Figs 33.17A and B). Use of this instrument also provides console surgeons with the following benefits:

- Greater surgeon autonomy
- Management of fluids for optimal visualization of the surgical field during enucleation

Table 33.1: Potential benefits of EndoWrist® one suction/irrigator

Procedure step	Uses of suction/irrigator
Enucleation	♦ Help visualize tissue layers
Closure of deep layers	♦ Keep surgical site clear of blood to maintain good visualization ♦ Achieve adequate hemostasis before moving to serosal layer closure
Closure of serosal layer	♦ Optimize visualization by controlling bleeding
Site clean up	♦ Clean anatomy with suction and irrigation after morcellation

- Access to difficult-to-reach anatomy, such as myomas in posterior locations
- Ability to maintain a clear surgical field, enabling surgeon to quickly identify bleeding vessels for managing hemostasis.

Fluorescence Imaging

Firefly™ fluorescence imaging for da Vinci® system allows for the identification of real-time anatomy using near-infrared guidance.

Fig. 33.16: EndoWrist® one suction/irrigator for da Vinci® myomectomy

Features

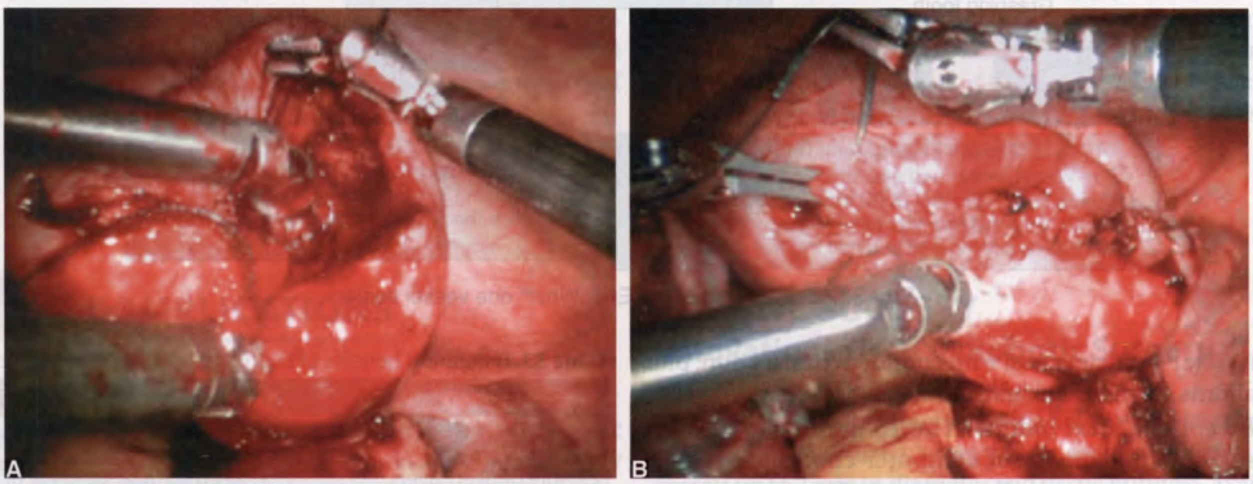
- Provides real-time near-infrared guidance through visualization of injectable fluorescence dye (Figs 33.18A and B)
- Interface allows efficient toggling between normal illumination and fluorescence imaging modes
- Incorporates illuminator utilized light emitting diode technology.

Potential Benefits

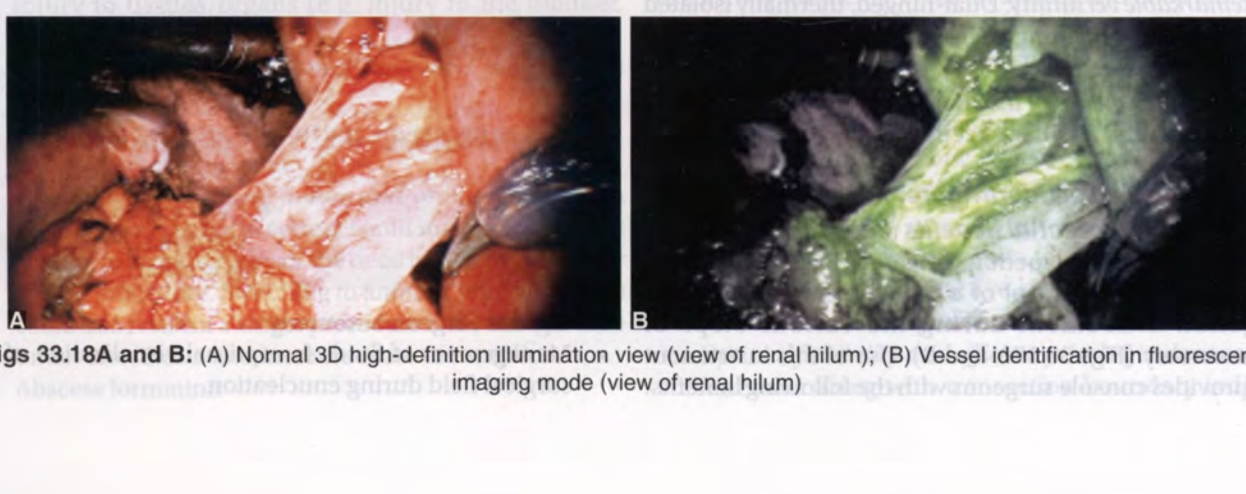
- Enables enhanced visualization capabilities for:
  - Vessel identification
  - Soft tissue perfusion
- Allows real-time identification of anatomy in fluorescence imaging mode from the surgeon console in three-dimensional, HD quality
- Minimizes downtime, operating expense associated with lamp replacement.

Criticism and Controversies

The term "robotic surgery" which is commonly used to refer to this technology can give the impression that da Vinci® system is used for performing the surgeries in an autonomous manner. In contrast, the current da Vinci® Surgical system does not function on its own because it has not been designed as an autonomous system. It lacks



Figs 33.17A and B: Using EndoWrist® one suction/irrigator at the time of da Vinci® myomectomy



Figs 33.18A and B: (A) Normal 3D high-definition illumination view (view of renal hilum); (B) Vessel identification in fluorescence imaging mode (view of renal hilum)

decision-making software and relies on a human operator for all its input. Moreover, all operative steps are performed through remote human-computer interaction. The current system has been deliberately constructed in a manner so as to effortlessly duplicate the movement of the surgeon's hands with the help of the tips of micro instruments. The instrument cannot make decisions without receiving the surgeon's direct input.

Critics of robotic surgery emphasize that the technique of robotic surgery is difficult for users to learn and that this technique is not likely to be more effective than traditional laparoscopic surgery. The available evidence presents with conflicting views related to the efficacy and various side-effects related to the use of robotic equipments while performing various surgeries. Presently, there is inadequate data related to the safety of this system and the likelihood of causing injuries to the patients due to electrical currents released from the various surgical tips used by the system. As of 2013, the FDA is enquiring problems related to the use of da Vinci® robot, including fatalities that have occurred during surgeries using this device. A number of lawsuits related to the injuries and problems caused by this system are also in progress.

The major disadvantage associated with the use of robotic system is the high cost involved in installing the da Vinci® robotic system. The total cost involved in installing a robotic platform in an institution ranges from $1,000,000 to $1,500,000 along with an additional 10% annual maintenance fee and expense for robotic equipment which can be used only 10 times.[9]

Other disadvantages associated with the use of robotic system include lack of tactile feedback of robotic arms, prerequisite of larger ports (> 8 mm) for robotic surgery in comparison to the conventional laparoscopic staging surgery. Placement of a large-sized port may be associated with aggravated postoperative pain, poor cosmetic results and development of trocar site hernia in the long run.

Also, da Vinci® system uses the software manufactured by the proprietor, which cannot be modified by surgeon. This, therefore, severely limits the surgeon's ability to change the operation system. Furthermore, the cost involved in the installation and establishment of this system is quite high and may be beyond the reach of many institutions. There have also been much criticism and debate related to the procedure for obtaining the FDA approval of this system and provision of adequate training before using this system.

Available Evidence

A retrospective study reviewing the previous 200 consecutive hysterectomy cases completed before and after implementation of a robotics program aimed at comparing gynecology practice and perioperative outcomes of patients undergoing total laparoscopic hysterectomy and robotic hysterectomy.[10] This study showed that there was a higher likelihood of exploratory laparotomy and intraoperative conversion to laparotomy in the patients undergoing total laparoscopic hysterectomy versus the patients undergoing robotic hysterectomy. Robotic hysterectomy was also found to be associated with reduced operative time, reduced blood loss, and shortened length of stay in comparison to a non-robotic approach. The use of robotic surgery may therefore facilitate minimally invasive treatment of patients while potentially reducing the rate of conversion to laparotomy. The study analyzing the results of 5 meta-analyses have confirmed that robot-assisted laparoscopic hysterectomy is associated with reduced harmful effects on length of hospital stay, postoperative complications (estimated blood loss, operative time, etc.) and patient stress.[11] The same results hold true in case of women with large uteri (weighing between 250 g and 3,020 g) undergoing hysterectomy.[12]

Robotic surgery is commonly being used in the staging and treatment of various gynecological cancers. Total robotic hysterectomy with staging appears to be a practical and desirable option over total abdominal hysterectomy as well as total laparoscopic hysterectomy in women with endometrial cancer.[13] Many researchers have demonstrated the feasibility of robotic radical hysterectomy in the management of cervical cancer.[14-21] Introduction of a robotic program for endometrial cancer surgery has been found to be associated with an increased proportion of patients benefitting from MIS.[22] It has also been found to be associated with improved short-term outcomes, and lower hospital costs. Many studies have also demonstrated that the surgical outcomes associated with robotic staging of endometrial cancer robot is comparable to conventional laparoscopic and laparotomy approach.[23,24] Robotic surgery has been found to be associated with reduced length of hospital stay, blood loss and perioperative complication rates and an increased number of resected lymph nodes in comparison to laparoscopic surgery or laparotomy. The most probable hindrance to the widespread acceptance of minimally invasive approach in gynecologic cancer is the technical difficulties of a conventional laparoscopic surgery. Further studies are necessary to determine long-term oncologic outcomes.

Retrospective analysis assessing the feasibility of treating pelvic pain in patients with suspected endometriosis using robot-assisted laparoscopic techniques in comparison with CO_2 laser laparoscopy has shown similar perioperative outcomes.[25] Further studies would be required to determine whether robotic surgery provides better visual acuity for visualization and excision of endometriosis. Further studies are also required to establish if the robotic approach would be able to bring about the long-term resolution of symptoms and an improvement in the fertility outcomes.

A retrospective cohort study conducted to compare symptomatic and anatomic outcomes 1 year after robotic versus abdominal sacrocolpopexy found similar anatomic and symptomatic outcomes with the two approaches after 1 year.[26] On the other hand, retrospective study by Hoyte et al. has shown that overall costs associated with robotic sacrocolpopexy are less in comparison with the abdominal approach but the surgeon may take slightly longer to perform the robotic procedure in comparison to the open procedure.[27]

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Presently, there is minimal/no literature available, examining the potential benefits of LESS in gynecology in comparison to the conventional laparoscopic approach. Therefore, there is requirement of multicentric randomized controlled trials in future for the evaluation of advantages of a single port approach in comparison to the conventional laparoscopy. Presently, all the available ports for LESS are associated with their own pros and cons. The surgeon must aim to have familiarity with more than one system and develop expertise with at least one. Some ports are better suited for certain indications than others.

CONCLUSION

In robotic surgery, several small incisions are made along the abdomen and the surgical tools are inserted through these incisions. The movement of each instrument and each surgical maneuver is controlled by the surgeon, who sits on a console slightly away from the site of surgery. The types of robotic surgeries, which can be performed in cases of cancer are the da Vinci® hysterectomy with lymph node dissection for endometrial cancer and early stage cervical cancer. Robotic surgery can also be used for the resection of endometriosis lesions, myomectomy, sacral colpopexy, tubal reversal surgery, etc. The da Vinci® surgery is associated with much lower mortality and morbidity in comparison to the conventional surgery. With the advancements in the surgical techniques and introduction of robotic surgery, it has now become a commonly performed procedure in women with endometrial cancer and cervical cancer, who have been recommended for surgery.

For some gynecologic oncological procedures such as radical hysterectomies, robot-assisted surgery may serve as the most effective, least invasive treatment option and is accompanied with several benefits over the traditional laparotomy approach. Though still much research is expected to occur in the field of robotic surgery, the available evidence has already proven the robotic surgery to be worthwhile. Though the learning curve for these systems may be a little long, there remains slight suspicion that this is the surgical technology of the future.

Laparo-endoscopic single-site surgery currently has a long way to go. In the armamentarium of minimal access surgery, at the present time, LESS stands between standard laparoscopy and NOTES. With more good quality evidence being available in future regarding the success and effectiveness of LESS in future, this surgery may occupy an important place in gynecological surgery.

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TIPS & TRICKS IN OPERATIVE OBSTETRICS & GYNECOLOGY

The book, *Tips and Tricks in Operative Obstetrics and Gynecology,* provides succinct details about various obstetrics and gynecological surgeries, which will be very useful to the postgraduates, intellectual undergraduates, fellow gynecologists in training, obstetric and gynecologic consultants and practitioners. Each chapter of this book has a unique style of presentation in form of a template containing different headings such as introduction, indications, preoperative preparation, surgical steps, postoperative care, complications, discussion, conclusion, etc. This would help the readers to focus on specific aspects of surgery. The book also contains a DVD, which provides numerous new interesting case studies. This would help in ensuring that the book chapters do not become too theoretical and a definite correlation with clinical practice is maintained.

In this second edition, the textual matter has been extensively reconstructed with several current developments which have taken place in obstetrics and gynecology since the publication of first edition (e.g. revised updated guidelines for screening of cervical cancer, 2012). This second edition encompasses new chapters on labor room procedures and various gynecological surgeries related to endometriosis and urinary incontinence. To further simplify the surgeries, the text has been illustrated with the help of newly added beautiful, self-explanatory, multicolor pictures, tables and flow charts. It also elaborates the recent advances in gynecological surgery (robotic surgery, laparoendoscopic single site surgery, etc.), fetal surgery and surgeries related to assisted reproductive techniques.

Richa Saxena was born and raised in New Delhi, India. After successfully completing her graduation in medicine from the prestigious Maulana Azad Medical College, New Delhi, India, she pursued her postgraduation from the Delhi University and subsequently did a clinical research project at the renowned All India Institute of Medical Sciences (AIIMS), New Delhi, India. To further enhance her knowledge in the field of obstetrics and gynecology, she went to the UK to pursue MRCOG (Member of Royal College of Obstetricians and Gynaecologists).

She has a profound passion for writing. Other than this book, she has authored nine medical books related to obstetrics and gynecology for both undergraduate and postgraduate medical students. Besides, she has authored several biographies and a fiction novel. Several articles pertaining to the health care for general public as well as the health care professionals have also been written by her. More details about the author and her works can be found at the author's website, www.drrichasaxena.com.

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