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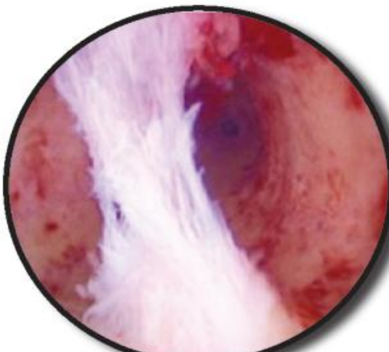

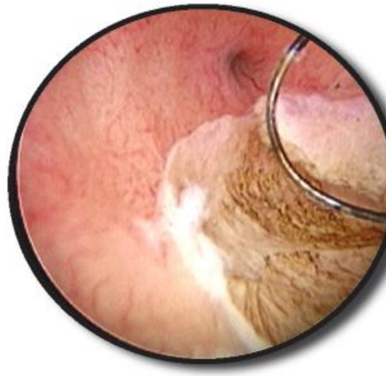
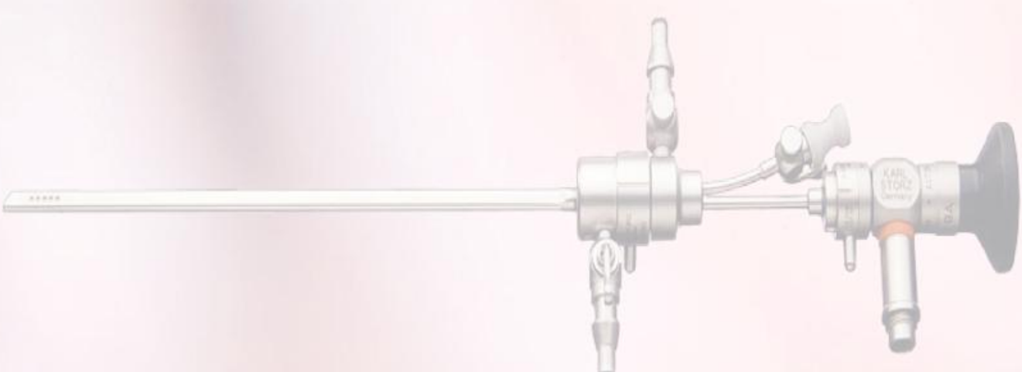

Nandita Palshetkar
Rishma Dhillon Pai
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Textbook of
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Dedicated to

My mother
Mrs Pushpalata Patil
Whose guidance was always quiet and assured;
Who stood by me and put faith in everything I did; and
Who gave me the best thing in life—life itself

and

Dr Hrishikesh D Pai
Who has been my inspiration for continuing to improve my knowledge
My motivation to move my career forward; and
for being an excellent teacher and outstanding mentor in my life

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Preface

Hysteroscopy in gynecological practice today, is one of the foremost approaches used to treat a multitude of gynecologic conditions. For the practicing gynecologist, keeping up with new publications is always a challenge, as is applying the theory in a clinical context.

Combining a strong clinical emphasis with practical tips, the *Textbook of Hysteroscopy* is an invaluable companion for both novice and experienced surgeons.

Since there have been a number of important advances in hysteroscopy both in technique and equipment, this text aims to update the readers on the changes in this field added with practice of the experts and is relevant, complete, and easy-to-understand. All procedures are described in detail and fully illustrated with color photographs and line drawings.

Written by practicing gynecologists and subject experts, the book provides clear understanding of techniques, outlines potential complications, and highlights circumstances for which procedures are contraindicated.

The book having even for a quick reference will be extremely valuable for practicing gynecologists in the management of patients.

Nandita Palshetkar
Rishma Dhillon Pai
Hrishikesh D Pai

Contents

CHAPTER 1

Surgical Anatomy of Uterus

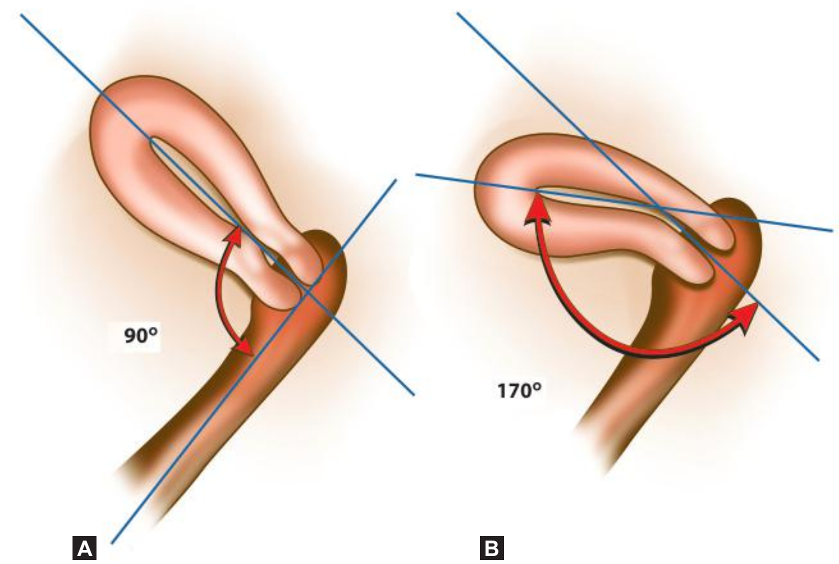
Vineet V Mishra

UTERUS

The *uterus* is hollow, muscular organ situated in the pelvis between the bladder in front and the rectum behind.

Position

Its normal position is one of anteversion and anteflexion. The uterus usually inclines to the right (dextrorotation) so that the cervix is directed to the left (levorotation) (Figs 1.1A and B) and comes in close relation with the left ureter.[1,2]



Figs 1.1A and B: (A) Anteverted position of the uterus; (B) Anteverted and anteflexed position of the uterus

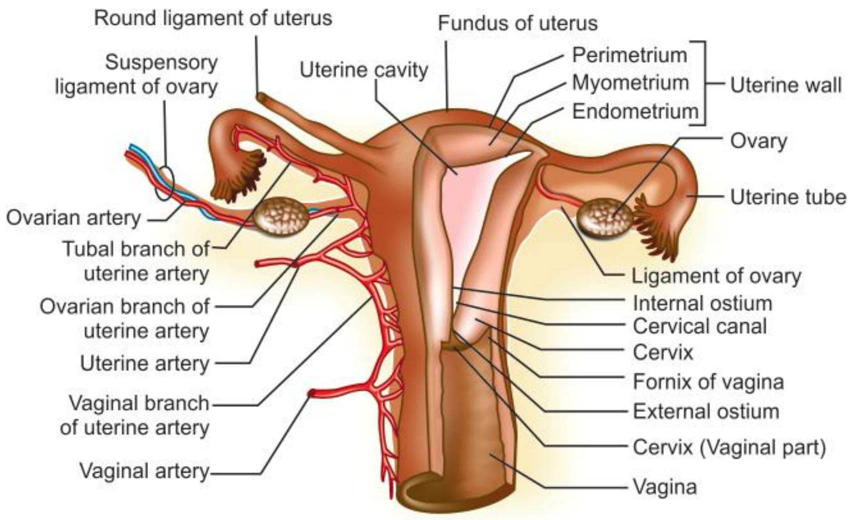


Fig. 1.2: Structure of uterus

Measurements and Parts

The uterus (Fig. 1.2) measures about 8 cm long, 5 cm wide at fundus and its walls are about 1.25 cm thick. Its weight varies from 50 to 80 gm. It has the following parts:[3-5]

- Body or corpus
- Isthmus
- Cervix.

Body or Corpus

The body is further divided into fundus—the part which lies above the openings of the uterine tubes. The body proper is triangular and lies between the openings of the tubes and the isthmus. The superolateral angles of body of the uterus project outwards from the junction of fundus and body and are called the cornua of the uterus. The uterine tube, round ligament and ovarian ligament are attached to it.[1,3]

Isthmus

Isthmus is a constricted part measuring about 0.5 cm situated between the body and the cervix. It is limited above by the anatomical internal os and below by the histological internal os.[2,6]

Cervix

Cervix is cylindrical in shape and measures about 2.5 cm.[2,3,6] It extends from the isthmus and ends at the external os which opens into the vagina after perforating its anterior wall. The part lying above the vagina is called supravaginal and that which lies within the vagina is called the vaginal part.

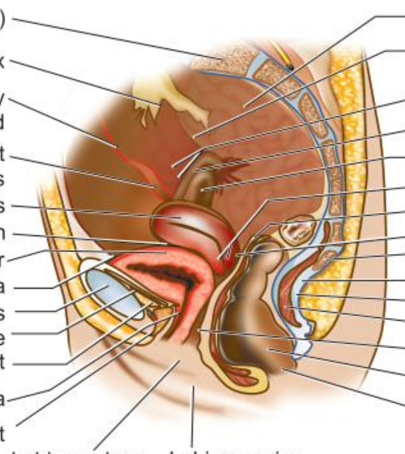


Fig. 1.3: Anteroposterior structure of uterus

Cavity

The uterine cavity is triangular on coronal section with the base above and the apex below. Its measures about 3.5 cm. The cervical canal is fusiform and measures about 2.5 cm. Thus,the normal length of the uterine cavity is usually 6.5 to 7 cm.[2,3]

Relations (Fig. 1.3)

Anteriorly: Above the internal os, the body forms the posterior wall of the uterovesical pouch.[1,2,7] Below the internal os, it is separated from the base of bladder by loose areolar tissue.

Posteriorly: It is covered with peritoneum and forms the anterior wall of pouch of Douglas containing coils of intestine.[6,8,9]

Laterally: The double fold of peritoneum of the broad ligament are attached between which the uterine artery ascends up. Attachment of Mackenrodt's ligament extends from the internal os down to the supravaginal cervix and lateral vaginal wall. About 1.5 cm away at the level of internal os, the uterine artery crosses the ureter. The uterine artery crosses from above and in front of the ureter, soon the ureter enters the ureteric tunnel.[4,6,8]

Structures

Body

The wall consists of three layers from outside inwards (Fig. 1.2):

Perimetrium: It is the serous coat which covers the entire organ except on lateral borders. The peritoneum is intimately adherent to the underlying muscles .[1,7]

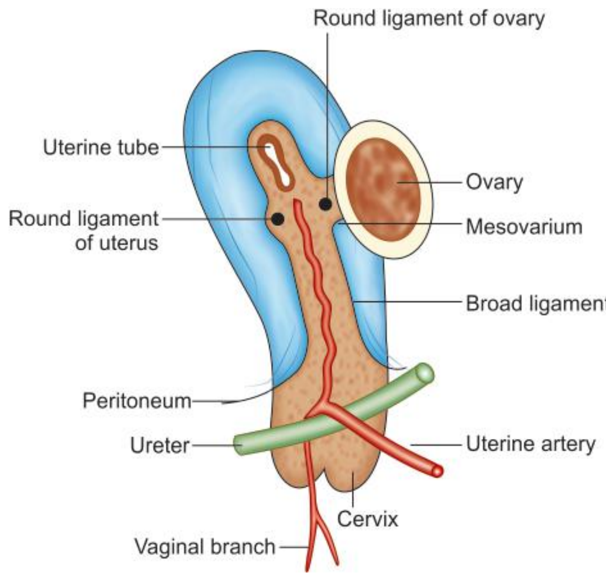


Fig. 1.4: Uterus on lateral view. Note the structures that lie within the broad ligament[3]

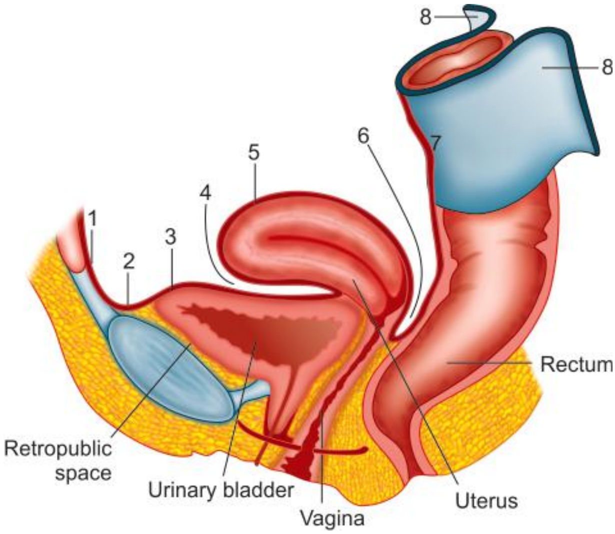
Myometrium: It consists of thick bundles of smooth muscle fibers held by connective tissues and are arranged in various directions. During pregnancy, three distinct layers can be identified—outer longitudinal, middle interlacing and the inner circular.[2,7]

Endometrium: The mucous lining of the cavity is called endometrium. As there is no submucous layer, the endometrium is directly apposed to the muscle coat.[1] It consists of lamina propria and surface epithelium. The surface epithelium is a single layer of ciliated columnar epithelium. The lamina propria contains stromal cells, endometrial glands, vessels and nerves. The glands are simple tubular and lined by mucus secreting nonciliated columnar epithelium which penetrate the stroma.[1,2] The endometrium is changed to decidua during pregnancy.

Cervix

The cervix is composed mainly of fibrous connective tissue. The smooth muscle fibers average 10 to 15 percent.[1,6] Only posterior surface has peritoneal covering. Mucous coat lining the endocervix is simple columnar and lining gland is nonciliated secretory columnar cells. The vaginal part of the cervix is lined by stratified squamous epithelium. The squamocolumnar junction is situated at the external os.

Peritoneum in relation to the uterus (Figs 1.4 and 1.5):[1-3,5,6] Anteriorly the peritoneum covering the superior surface of the bladder reflects over the anterior surface of the uterus at the level of the internal os. The pouch, so formed, is called uterovesical pouch. The peritoneum is firmly attached



Female
Peritoneum passes:
- From the anterior wall (1)
- Superior to the pubic bone (2)
- On the superior surface of the urinary bladder (3)
- From the bladder to the uterus, forming the vesicouterine pouch (4)
- On the fundus and body of the uterus, posterior fornix and all of the vagina (5)
- Between the rectum and uterus, forming the rectouterine pouch (6)
- On the anterior and lateral sides of the rectum (7)
- Posteriorly to become the sigmoid mesocolon (8)

Fig. 1.5: Uterus on medial view

to the anterior and posterior walls of the uterus and upper one-third of the posterior vaginal wall where from it is reflected over the rectum. The pouch, so formed, is called pouch of Douglas.

Laterally the peritoneum of the anterior and posterior walls of the uterus is continuous forming the broad ligament. It extends to the lateral pelvic walls where the layers reflect to cover the anterior and posterior aspect of the pelvic cavity. On its superior free border, lies the fallopian tube and on the posterior layer, the ovary is attached by mesovarium (Fig. 1.6). The lateral one-fourth of the free border is called infundibulopelvic ligament.

Blood Supply

Arterial Supply

The blood supply is from the uterine artery one on each side. The artery arises directly from the anterior division of the internal iliac or in common with superior vesical artery. The other sources are ovarian and vaginal arteries to which the uterine arteries anastomose.[1,6]

Veins

The venous channels correspond to the arterial course and drain into internal iliac veins.

Lymphatics

Body

From the fundus and upper part of the body of the uterus, the lymphatics drain into preaortic and lateral aortic groups of glands. The cornu drains to

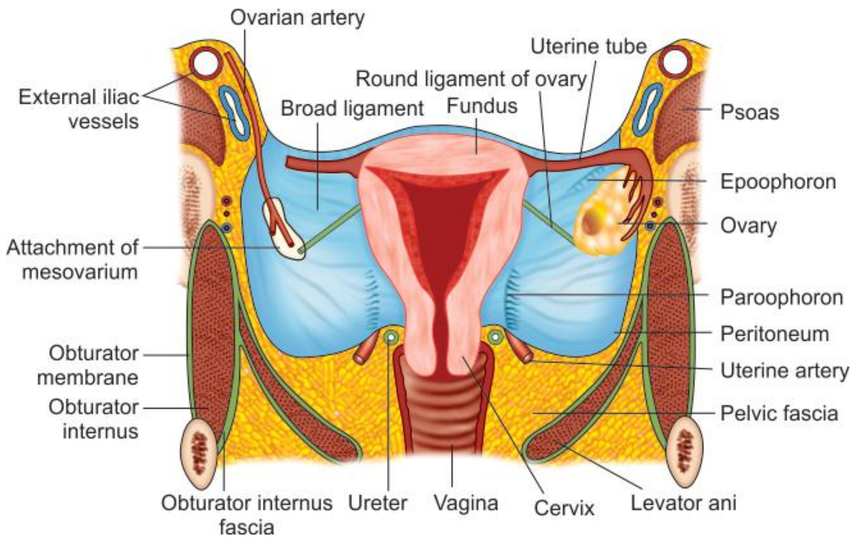


Fig. 1.6: Coronal section of the pelvis showing the uterus, broad ligaments, and right ovary on posterior view. The left ovary and part of the left uterine tube have been removed for clarity[3,5]

superficial inguinal glands along the round ligament.[1,6] Lower part of the body drains into external iliac groups.

Cervix

On each side, the lymphatics drain into external iliac, obturator lymph nodes directly or through paracervical lymph nodes, internal iliac groups and sacral groups.[1,2]

Nerves

The nerve supply of the uterus is derived principally from the sympathetic system and partly from the parasympathetic system. Sympathetic components are from T5 and T6 (motor) and T10 to L1 spinal segments (sensory). The somatic distribution of uterine pain is that area of the abdomen supplied by T10 to L3. The parasympathetic system is represented on either side by the pelvic nerve which consists of both motor and sensory fibers from S2, S3, S4 and ends in the ganglia of Frankenhauser.[1,2,7]

SURGICAL APPLIED ANATOMY OF UTERUS

Hysteroscopy

Direct visual inspection of the cervical canal and uterine cavity through a rigid, flexible, or contact hysteroscope (Figs 1.7 and 1.8).[6,10]

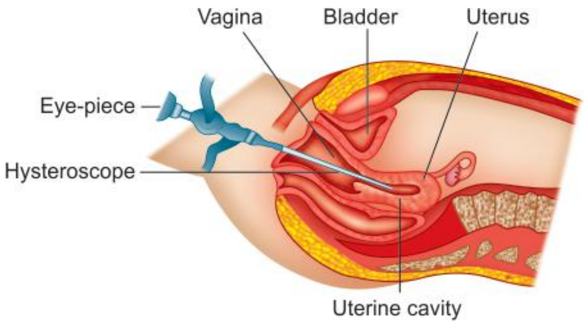


Fig. 1.7: Hysteroscope introduced into the endometrial cavity

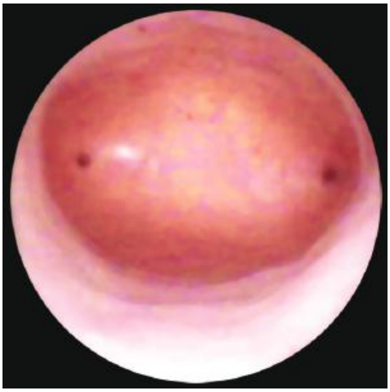


Fig. 1.8: Normal hysteroscopic view of uterine cavity

Clinical Indications for Hysteroscopy (Figs 1.9 to 1.17)[10-12]

- Abormal premenopausal and postmenopausal uterine bleeding.
- Diagnosis and possible transcervical removal of submucous leiomyomas or endometrial polyps.
- Location and retrieval of lost intrauterine devices or other foreign bodies.
- Evaluation of infertile patients with abnormal hysterograms.
- Diagnosis and surgical treatment of intrauterine adhesions.
- Diagnosis and division of symptomatic uterine septa.
- Endometrial destruction by laser or electrosurgery in patients with dysfunctional uterine bleeding unresponsive to hormonal therapy.
- Tubal cannulation for fallopian tube cornual obstruction.
- Exploration of the endocervical canal and uterine cavity in patients with repetitive pregnancy losses.
- Tubal sterilization (Essure system).

Uterine Morphogenesis (Figs 1.18 to 1.20)[1,6,10]

In embryos of 10 weeks, the female duct system (Müllerian or paramesonephric) is evident. The cranial segments of both ducts persist as uterine

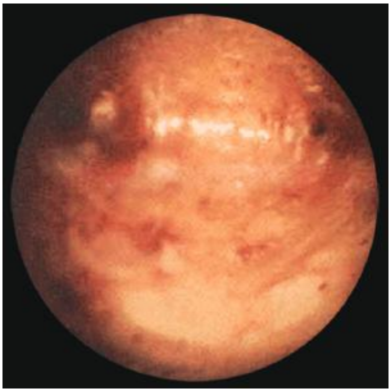


Fig. 1.9: Atrophic endometrium in a postmenopausal woman

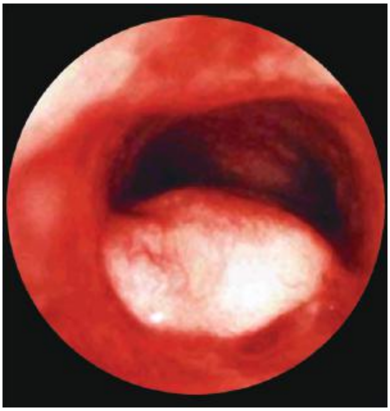


Fig. 1.10: Hysteroscopy showing the endometrial polyp

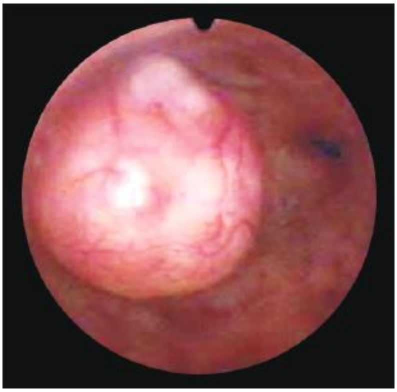


Fig. 1.11: Hysteroscopy showing submucous myoma

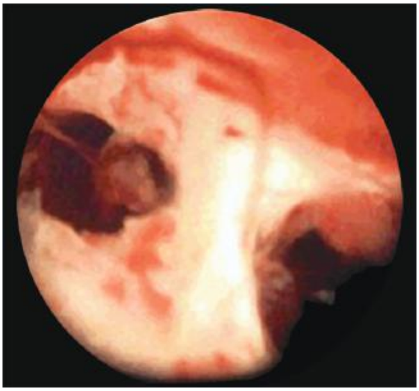


Fig. 1.12: Hysteroscopy showing curtain like adhesions connecting the anterior and posterior uterine walls

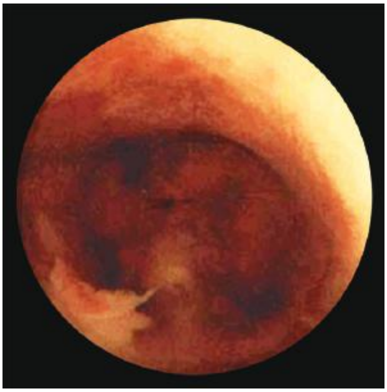


Fig. 1.13: Uterine cavity dissected free of adhesions

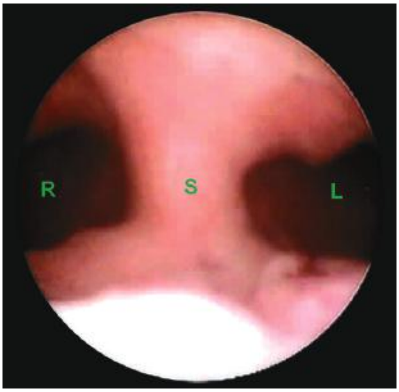


Fig. 1.14: Complete uterine septum as viewed from the internal os of the cervix

Fig. 1.15: Hysteroscopy guided division of the septum

Fig. 1.16: Hysteroscopic view of the endometrial ablation procedure

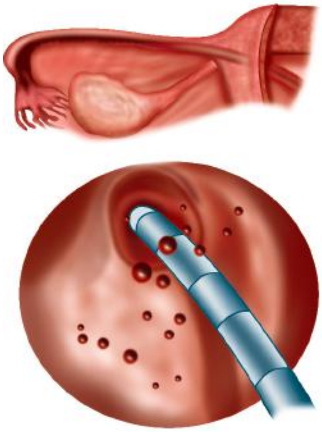


Fig. 1.17: An inner guidewire is inserted via direct hysteroscopic view into the tubal ostium and advanced. An outer cannula is then advanced over the guidewire. Methylene blue may be injected to demonstrate tubal patency to an assistant viewing from above via laparoscopy[6]

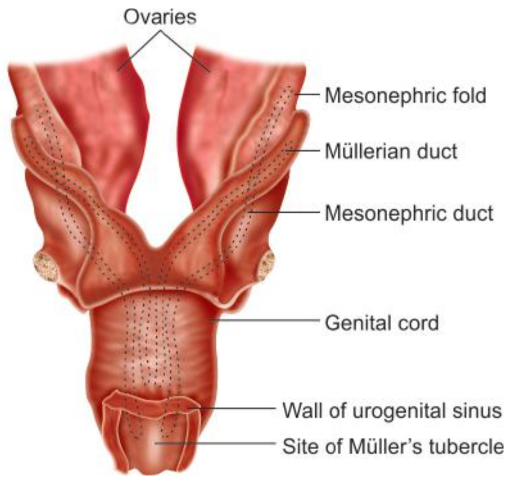


Fig. 1.18: Course of the Müllerian ducts and formation of the genital cord at 2 months[10]

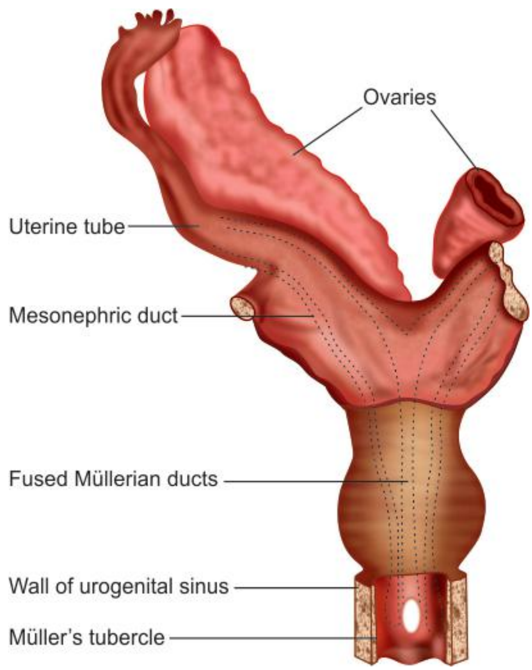


Fig. 1.19: Female genital tract at 10 weeks

tubes. Slanting middle segments of both ducts will soon merge and give rise to the fundus of the uterus. The caudal segments of the ducts, already fused, become the corpus cervix and much of the vagina. The caudal end of the now single tube presses against the urogenital subdivision of the cloaca, the joint membrane then representing the future hymen. The uterine epithelium buds off glands by the seventh prenatal month, and this establishes

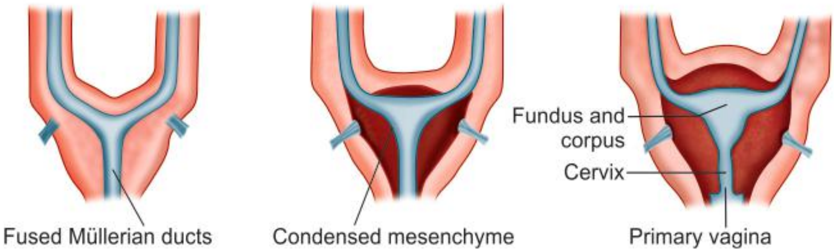


Fig. 1.20: Diagrams of the later progress of the transverse limbs and fused Müllerian ducts

the endometrium; yet, they remain small until the child reaches puberty. A distinction between uterus and vagina becomes evident at the middle of the fourth month when the fornices appear. The muscular wall, or myometrium, of the uterus is indicated at 3 months by mesenchyme of the genital cord condensing into smooth muscle fibers that invest the endometrium. The parametrium differentiates from the exterior of the genital cord into a peritoneal covering (mesothelium and connective tissue).

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CHAPTER 2

Instrumentation in Hysteroscopy

Hrishikesh D Pai

Recent technological advances have revolutionized the field of diagnostic and operative hysteroscopy. Diagnostic and surgical hysteroscopy have become gold standards in the gynecological practice. Numerous pathologies like uterine malformations, intrauterine synechiae, fibroids, management of abnormal uterine bleeding, etc. which were conventionally treated with laparotomy have now become a domain of the hysteroscopic techniques.

Selection of the proper and most appropriate instruments is one of the keystones for the performance of a successful hysteroscopic surgery. The variety of instruments available in the marketplace can get overwhelming and therefore one must consider only those instruments that fit his or her needs and budget. The two major elements of a hysteroscope are the telescope or lens and the sheath. Two features pertinent to all endoscopes are, first, the angle of view, which ranges from straightforward (0°), fore-oblique (30°), lateral (70°), right angled (90°) to a retrospective view (120°), and second, the field of view, which is the peripheral coverage of the optical system or how much of the object is seen at a given distance from the object. The field of view varies according to the refractory index of the medium used.

As in all endoscopic procedures, it is imperative to have a thorough understanding of the instrumentation and devices in use. This knowledge allows the surgeon to overcome possible malfunctions and make the procedure more effective, less time-consuming and safe.

The hallmark of a successful hysteroscopist is totally based on the type and quality of instruments one uses to do the procedure. There are numerous companies and vendors in the market. One has to base the choice of equipment based on the following criteria:

1. Past and present reputation of the company
2. Optical clarity of the scopes
3. Durability and performance of allied parts such as sheaths, scissors and forceps.
4. Costs
5. After sales service
6. Upgradability of the instruments.

The instrumentation can be divided into the following parts:

1. Endoscopes
2. Sheaths
3. Light cable
4. Light source
5. Camera
6. Recording devices
7. Monitors
8. Distention systems
9. Electrocautery sources
10. Electrodes.

ENDOSCOPES

Rigid Hysteroscope

There is a range of hysteroscopes starting from the 1.2 mm flexible hysteroscope with a 2.5 mm diagnostic sheath, to the standard 4 mm scope with a 5 mm diagnostic sheath. The 1.2 mm scope is a flexible scope which can be easily passed into the uterine cavity without dilatation. However, it is very fragile and generates a small image. Neither does it allow any degree of operative work to be performed. On the other hand, a standard 4 mm Hopkins scope is rigid and gives a very good image. The 4 mm scope is available with varying directions of view: 0°, 12° and 30°. Normally, a 30° scope is used for diagnosis while a 12° scope is used for resection. However, a 30° scope can also be used for resection. In case of doing operative procedures the 4 mm scope needs to be combined with an operative sheath with a diameter of 7.0 to 8.5 mm, necessitating anesthesia and cervical dilatation procedures. In order to overcome the above shortcomings, there have been evolved two systems that can be effectively utilized for diagnostic and operative office hysteroscopy. With these systems it is possible to perform operative procedures such as polypectomy (<4 cm diameter), adhesiolysis, tubal cannulations, and myomectomies (<2 cm) in an office setting.

Bettocchi Hysteroscope (Karl Storz & Company)

1. The standard Bettocchi hysteroscope with Hopkins based rods lens system is a miniature version of the famous Hamou 2 hysteroscope. The scope has an external diameter of 2.9 mm. It can be used as a panoramic hysteroscope (1x) as well as a micro contact hysteroscope (80x). For diagnostic purpose, it can be used with a single flow outer sheath of 3.6 mm or a continuous flow outer sheath of 4.4 mm. In case of operative office hysteroscopy it can be combined with a continuous flow operative sheath of 3.9 mm × 5.9 mm (average diameter 5 mm). This sheath has an operative channel to accommodate 5 French instruments to pass through for operative purpose.

2. *The modified Bettocchi:* This is a new version with a 1.9 mm diameter optic along with corresponding decreased diameters of diagnostic and operative sheath.

Versascope System (Johnson & Johnson Gynecare Division)

The Versascope is a flexible telescope made up of a set of 50,000 fused optical fibers, providing a 0° field of vision with an outer panoramic angle view of 75°. The scope has an external diameter of 1.8 mm and a length of 28 cm. The density and optical quality of the image system produces an image, which is similar to the conventional rod lens panoramic hysteroscope. The scope is used with a continuous flow diagnostic-cum-operative sheath, which has an outer diameter of 3.5 mm and a distal curvature of 10°. A proximal collar is rotatable. This allows manipulation of the scope for full peripheral viewing, without disturbing the instrument position. The operative channel has an expandable instrument channel which can easily accommodate instruments till 7 French in diameter. This operative channel also simultaneously functions as an independent outflow port for continuous flow during the procedures.

Unlike Storz, the Versascope has got a disposable sheath. However, in practice the sheath can be reused, after re-sterilization in cidex, at least 10 to 20 times, making the instrument much more cost effective.

Both the scopes come with fiberoptic cables.

Flexible Hysterofibroscopes

These are very fine instruments with diameters of less than 2 mm. They are extremely costly and very delicate. They can be used for diagnosis as well as fine operative procedures such as embryo transfer. They are not commonly used in practice because of their costs, fragility and also they cannot be autoclaved.

Contact Hysteroscopy

The contact hysteroscope differs in the following aspects:

i. It does not require any distending medium.
ii. It is applicable for diagnostic purposes only and does not require a sheath.
iii. No fiberoptic illumination system is needed, since the instrument traps and collects directed as well as ambient light.

It is composed of three major parts. A solid core of optical mineral glass supported and surrounded by an interior mirrored and exterior steel sheath. The outer diameter of the most popular model is 6 mm, and the core measures 350 mm in length (with magnifier). The second component is a cylindrical light trap onto which an external light source (e.g. the examination room light) is directed. A magnifying eyepiece with focusing mechanism enlarges the image threefold. This endoscope provides discrimination to 20 mm. It is a portable instrument with a simple but ingenious optical system and is ideal for office and outpatient hysteroscopy.[1]

The modern contact hysteroscope is a highly refined, precise instrument compared with its primitive ancestor and provides the endoscopist with the simplest and most portable system available. The quality of the image obtained with the contact optical system is excellent and can discriminate between two points that are just 20 mm away. The basis for contact hysteroscopy is completely different from that of panoramic hysteroscopy since the endoscope lies within the tissue itself, whereas in panoramic hysteroscopy, the tissue is viewed from a distance. Also, accurate interpretation depends on an intact vascular supply to allow proper color differentiation. Since the uterine cavity is not distended, the endometrium is viewed in its natural state, which is with the anterior and posterior endometrial walls in apposition. In a manner analogous to colposcopy, patterns seen by the hysteroscope are then interpreted.[2]

Panoramic Telescopes

Telescope is the most important component of the endoscopic system. The optical features of the telescope include lenses, prisms, glass windows and fiberoptics.[3] Three different optical systems are used: the bead-lens system, the rod-lens system, and the graded index system. Bead-lenses are made of glass no thicker than their diameter, whereas in the rod-lens system designed by Hopkins,[4] the lenses' thickness is larger than the actual diameter, with very small spaces in between. This provides a larger viewing angle and a brighter image, which is transmitted by an array of long cylinders of superior optical-quality glass. The third optical system is the graded index (GRIN) system, in which the entire system includes a slender rod of glass with a progressively increasing refractory index from the axis to the periphery. This latter system is used with very slender optical systems. A new system using fiberoptic imaging technology has been introduced that permits better use of light thus permitting a decrease in the size of telescopes without impairing resolution. The higher the refractory index, the smaller the field of view.[5]

With the use of fiberoptic, potent lights can be transmitted through an appropriate light source to the endoscope without producing excessive heat or breakage of distal bulbs. The many thousands of small glass fibers (10 μm) with a high refractory index core and low index cladding delivers brighter light efficiently with minimal loss. All this have resulted in high-quality, small-diameter telescopes capable of producing high-quality images with wide fields of view.

SHEATHS

Before entering a hollow organ like the uterus, the telescope must be fitted to a sheath through which a distending medium can be infused to provide necessary distention for panoramic viewing.[6] The typical sheath measures 5 mm in diameter to accommodate the 4 mm telescope. As mentioned above the sheath's diameter is based on the type of scope used. The new small diameter continuous flow hysteroscopes with a 5 French operative channel have been introduced and manufactured by most instrument companies, such as Storz, Olympus, ACMI, Wolf, and so on.

Quality and construction should be evaluated periodically to ensure safety of the procedure. The input and output stopcocks, locking mechanism of the sheath, etc. should be checked regularly.

Most modern continuous flow systems have isolated inflow and outflow channels and provide excellent washing of the uterine cavity. The gold standard for a 21st century operative hysteroscopic sheath is a continuously flushing mechanism. This system uses an inner sheath to deliver fresh fluid into the uterine cavity and an outer perforated drain sheath to evacuate cloudy or discolored fluid from the cavity.

a. *Versascope sheath:* This is a disposable sheath having a continuous flow inflow and outflow channel. This 3.5 mm sheath can be used for both diagnostic as well as operative procedures. This enables it to have a good distention and good vision. It also has an operating cannel through which one can pass 2 mm diameter instruments such as Versapoint electrodes (twizzle, spring, ball) or forceps.
b. *Sheath for 2.9 mm Bettocchi scope:*
    1. Single flow 3.6 mm diagnostic sheath.
    2. Continuous flow 3.6 mm inner sheath along with 4.4 mm outer sheath for diagnostic hysteroscopy.
    3. Single flow 4.3 mm operating sheath which has got a channel for introducing 2 mm operating instruments.
    4. Continuous flow 4.3 mm inner sheath along with 5 mm outer sheath for diagnostic as well as all operative procedures. This combination is the best to have.
    5. Recently there is a new smaller diameter resectoscope with inner and outer channels along with smaller diameter electrodes (Loop, ball, cylinder and knife) which can be used with the Bettocchi.
c. *Sheaths for the 4 mm standard hysteroscope:*
    1. Single flow sheath for diagnosis
    2. Continuous flow with inner and outer sheath for diagnosis.
    3. Continuous flow inner and outer sheath for operative purpose along with operative channel.
    4. Standard 26 mm resectoscope with inner sheath, outer sheath, working element, electrodes for using unipolar current.
    5. Standard 26 mm resectoscope (Gynecare Johnson) with inner sheath, outer sheath, working element and bipolar electrodes to be used with Versapoint bipolar current. It is important to note that this sheath has to be used with standard 2.9 mm or 4 mm Hopkins rigid hysteroscope. It cannot be combined with the Versascope.

LIGHT CABLES

1. Special fused fiber light cable to be used with Versascope. This cable can be attached to any type of light source with special adaptors. It is important to note that one has to exclusively use this cable in combination with Versascope. If one uses the standard fiberoptic cable, by mistake, there is a possibility of damage to the Versascope.

2. Standard fiberoptic cable to be used with Hopkins endoscopes and cold light source or xenon light source. The cable is normally 5 mm in diameter and 180 cm in length.

LIGHT SOURCE

The type of light source has a major impact on image quality. A high quality light source such as a xenon source gives the best results. There are various light sources which one can use for illumination. The metal-halide light sources produce a bluish coloration to the delivered light. Although a 175 W light source is satisfactory for most hysteroscopic procedures, a miniature telescope could require a brighter (300 W) source. This 300 W source is also recommended for video-control hysteroscopy as well as for photography. The light is transmitted through a fiberoptic or fluid light cable 2.5 to 4.8 mm in diameter and 180 to 300 cm long. Light cables for standard hysteroscopy are 2.5 to 3.5 mm in diameter and 180 cm in length.

a. *Halogen:* This 150 to 250 W cold light source is sufficient for vision. However it tends to give a reddish tinge to the image.
b. *Xenon:* A 175 W xenon light source provides an outstanding illumination and enables a good depth of field. Although the light is extremely hot at its source, most of the heat gets dissipated along the length of the fiberoptic cable. Despite of this, a significant amount of heat can be generated at the distal tip. This can cause thermal injury to the patient or burn paper drapes or clothing with prolonged contact. Hence, one should keep the intensity of the light as less as possible.

ENDOSCOPIC CAMERA AND MONITOR

It is important that the operators learn how to work in a comfortable and ergonomically sound position while watching the video-hysteroscopic image on the monitor. In office hysteroscopy, the image size is quite small. Hence it is preferable to use cameras with zoom system to select the appropriate size of the picture. A single-chip endoscopic camera is sufficient for diagnostic and minor operative work. A three-chip camera will not be of additional help, unless it has additional filters to eliminate the pixelization and digitalization of the image. Newer high definition cameras provide extremely sharp and realistic images that facilitate video endoscopy and reduce operator fatigue.

The technical criteria of a good camera are:

1. *Good resolution:* Based on the number of lines or pixels.
2. Minimum sensitivity (lux).
3. High quality of video output/images.
4. *High signal to noise ratio:* This which means the change in video signal occurring in an extreme situation (e.g. bleeding) causes minimal loss of light intensity.
5. Method of sterilization.

RECORDING DEVICES

Analog and digital peripheral equipment for recording, transferring, and storage of image data such as video recorders, video printers, and digital documentation units with the ability to burn CDs and DVDs are commercially available. Tele Pack is a video monitoring system, especially designed for hysteroscopy in an OPD setting. This combines image display functions with a camera unit, illumination, and documentation in one compact and convenient system.

MONITORS

One can use high resolution Sony monitors or digitalized flat screen computer monitors for good clarity. One can also use the newer generation flat screen televisions to cut costs.

DISTENTION SYSTEMS

Virtually all hysteroscopic procedures require adequate distention of the uterine cavity. When a hysteroresectoscope is used for intrauterine electrosurgery, additional safety measures are required. Although liquid media are most commonly used, gaseous media may also be used for diagnostic hysteroscopy.

Fluid Distention Systems

There are various distention systems that can be used. These are:

1. *Gravity:* About 90 to 100 cm height of the bag is sufficient to achieve a pressure of about 70 mm Hg. Irrigation is achieved by connecting the tubing of the outflow to a connection basin. Connecting the outlet to a suction pump is not usually preferred.
2. *Pressure cuff:* Inflating the cuff around the bag is a very useful method to attain adequate pressure. However, the pressure drops as the bag is gradually emptied. Irrigation is achieved in the same way as the gravity fall system.

Electronic Suction and Irrigation Pump

This includes:

i. Hysteromat
ii. Endomat
iii. Total inflow-outflow system.

Automatically controlled suction and irrigation are very important to maintain a clear field of view in hysteroscopic surgery and also for constant dilatation of the uterine cavity. There are newer versions available that allow automatic monitoring and control of the pre-set volume difference between irrigation liquid inflow and outflow and the change in this parameter per minute. Generally, flow rate of about 200 mm Hg, outflow pressure of 75 mm Hg and suction pressure of 0.25 bar is usually used. The HAMOU Endomat can be used both in hysteroscopy and laparoscopy by simply changing the irrigation set.

Of these, the Endomat is the ideal system especially for office hysteroscopy purposes, as it correctly maintains intrauterine pressure to around 70 mm of Hg, thus preventing peritoneal reflux and resultant discomfort. However, the Endomat is very costly and a simple pressure cuff in conjunction with low intensity outflow suction can do the trick.

Gas Distention Systems

One can use a CO_2 hysteroflator. Care should be taken, not to use laparoscopic pneumo insufflator for distending the uterine cavity as this can lead to death on table.[7]

Normally, the uterine walls are in apposition and it requires distention of the true uterine cavity for the purpose of detection of any intrauterine pathology by a hysteroscope. Hence various distention media are available for the purpose of creating a cavity by overcoming the myometrial resistance. It also creates sufficient pressures, which prevents bleeding that occurs during operative hysteroscopy.

Types of Media

The different types of media available are as follows:

a. Gas CO_2 gas
b. Fluids
   - Low viscosity fluids
     - Electrolyte/Ionic
     - Nonelectrolyte Nonionic
   - High viscosity fluids

Carbon Dioxide Gas

Carbon dioxide (CO_2) gas using an insufflation pump with an automatic pressure control was introduced to hysteroscopy by *Lindemann* in 1972. It is highly diffusible and soluble, allowing continuous elimination of small quantities of intravasated gas by the lungs so the risk of air embolism is negligible. It requires electronic machines, which measures the intrauterine gas pressure and also the gas delivery flow rate.

Most hysteroscopic examination can be performed at a flow rate of approximately 30–40 ml/min with an intrauterine pressure at approximately 60 to 70 mm Hg. These two parameters are inversely proportional to each other and thus compensate each other to maintain proper balance.

Advantages

1. Provides clean medium and detailed assessment of endometrial pathology.
2. Permits excellent visualization, as there is no interposition of a substance to cause refraction.
3. Provides adequately maintained distention of the uterine cavity.

Disadvantages

1. When mixed with blood, it may produce bubbling which is cumbersome and may obscure view. It may rarely lead to gas embolism and death.
2. Specific machines are necessitated for electronic calibration of CO_2 flow rate and pressure.
3. Laser use is cumbersome, as the smoke and fumes cannot be easily evacuated without deflating the uterine cavity.

However, it remains the best distention media for diagnostic hysteroscopy with smaller diameter hysteroscopes.

Low Viscosity Fluids

Low viscosity fluids are mainly used during operative hysteroscopy as they permit uterine cavity lavage of the blood clots and tissue debris formed during the operation.[8] A less favorable property of the low-molecular weight media is that they mix very well with blood, so the uterine cavity must be continuously perfused with the fluid to maintain distention. The basic parameters to be controlled in using low-molecular weight media are flow rate—which must be high enough to ensure rapid irrigation of the cavity, and outflow pressure which ensures adequate uterine cavity distention. High pressures can lead to significant intravasation and further complications. Both electrolyte-free solutions (glycine, sorbitol/mannitol) as well as saline or physiological solutions are generally available in 1.5 or 3 liter bags and are delivered to the resectoscope by a special high-flow irrigation pump. Touhy-Borst adapters are excellent for this purpose.

Electrolytes/Ionic distention media: The most commonly used ionic media are:

- Normal saline (0.9% NaCl, i.e. sodium chloride)
- 5 percent and 10 percent dextrose
- 4 percent and 6 percent dextran solutions
- 50 percent saline (0.45% NaCl)
- Ringer's lactate solution.

Advantages

1. The presence of electrolytes makes the operation somewhat safer by preventing hyponatremia, should excessive amount of fluid be used and absorbed.
2. Inexpensive and readily available.
3. Normal saline is iso-osmolal (at 280 mOsm/L) and metabolically inert.
4. Solution for use with bipolar electrosurgery.

Disadvantages

1. Volumes overload from excessive intravasation (> 2.5 liters) of media. This can cause left heart failure and pulmonary edema (noncardiogenic origin).
2. Available in one liter plastic bags and requires pumps.
3. Hence the quantity of fluid used should be carefully monitored.
4. Contraindicated for monopolar electrosurgery.

2. *Nonelectrolytes/Nonionic distention media:* Available solutions are:
- 3 percent sorbitol (sugar solution, metabolizes into fructose and glucose)
- 1.5 percent glycine (mixture of amino acids, metabolizes into ammonia, urea and oxalate)
- 5 percent mannitol (sugar solution, osmotic diuretic and minimal metabolism)
- Combination of sorbitol 2.8 percent and mannitol 0.5 percent.
- Most of these fluids are available in 3 liters plastic containers.

Advantages

1. Inexpensive and readily available.
2. When attached to large bore tubing, and elevated to approximately 80 cm, enough pressure is obtained to distend the uterine cavity by gravity and does not require any tourniquets or pumps.
3. It is a media of choice for monopolar resectoscope surgery, because there are no electrolytes to disperse the current, and impede the electrosurgical effect.

Disadvantages

1. Both sorbitol and glycine solution are hypo-osmolal and are readily metabolized by specific pathways. The remaining surplus of free water in the intravascular tree can be manifest as the transurethral resection (TUR) syndrome. This is manifested as dilutional hyponatremia and hypervolemia.
2. Associated with multisystem morbidities including cerebral edema, cardiac and skeletal muscle dysfunction from alteration of nerve impulses and membrane potentials.
3. Mannitol is relatively iso-osmolal and is minimally metabolized (6–10%). This reduces the risk of fluid overload and hyponatremia.

High Viscosity Fluids

The most commonly used high viscosity fluid is Hyskon—a 32 percent high molecular weight dextran solution (70,000 Da). It is instilled using a 50 ml syringe and 100 ml are generally enough to distend the cavity.

Advantages

1. Being highly viscous, small quantities are required for examination.
2. Provides excellent visualization due to its high refractory index and as it does not mix with blood.

Disadvantages

1. Expensive
2. Tends to "Caramelize" on instruments, which must be disassembled and thoroughly cleaned in warm water after each use. It may 'freeze' the stopcocks of the instruments, making them inoperable.

3. Morbidities caused:
   - Pulmonary edema (noncardiogenic origin)
   - Coagulopathies
   - Electrolytes imbalance
   - Anaphylactic reaction.
4. Mechanical pump is necessary to deliver these fluids.

Useful Tips while Using Distention Media

A. *To improve visualization:*
   - Overdilate the cervix to facilitate the overflow
   - Use of continuous flow sheath, promoting lavage of blood clots and debris
   - Direct aspiration with a disposable outflow catheter.

B. *Uterine inflow depends upon:*
   - Length, diameter and patency of inflow tubing
   - Viscosity of distention medium.

   Uterine outflow depends upon:
   - Transtubal passage into the peritoneal cavity
   - Intravasation into the vascular tree
   - Leakage of the media through cervix
   - Continuous flow sheath interface.

C. *Intrauterine pressure depends on:*
   - Pressure of infusion device
   - Rate of inflow of media
   - Rate of outflow of media.

   Intrauterine pressure can be increased by:
   - Raising the height of media bag
   - Lowering the patient's table
   - Closing the outflow part
   - By application of tenaculum on either side of an overdilated leaky cervix
   - Increasing pressure of infusion device.

   Intrauterine pressure can be decreased by:
   - Overdilating the cervix and making it leaky
   - Use of intermittent or constant suction to the outflow sheath.

There is minimal drop in pressure due to transtubal passage and intravasation into the vascular tree.

Sudden profound drop in intrauterine pressure should make one think of either obstruction of the inflow channels or uterine perforation.

D. *Intravasation:*

   Mean arterial pressure (MAP) is the intrinsic resistance of superficial layers to significant fluid absorption. Thus, maintaining intrauterine pressures below MAP can prevent significant intravasation.[9]

   Since the pressure of the uterine veins is typically < 20 mm Hg, some absorption of fluid occurs inevitably. While surgical entry into the deeper intramyometrial veins abolishes the protective effects of the MAP and can lead to unpredictable and dangerous intravasation.

The other contributory factors are the:
- Length of surgery
- Partial perforation
  - False passage
  - Cervical tears/injury.
- Surgery that leads to entry into myometrium opening larger vascular channels—myoma resection/division.

To prevent intravasation:
- Limit bag height of distention media bag to 1 meter above the patient's table
- Use of electronic machine, which can calibrate the flow rate and intra-uterine pressures
- Monitor input/output and calculate the deficit.

If 500 to 1000 ml (less if the patient is medically compromised) is believed to be absorbed, the following should be undertaken:
1. The procedure should be suspended until fluid status is ascertained.
2. A Foley catheter should be placed, if not already in place.
3. Consideration should be given to rapid conclusion of the operative procedure as appropriate, as once fluid absorption is started, it progresses rapidly.

If greater than 1500 ml is absorbed or serum sodium is less than 125 mmol/L, the procedure should be terminated as rapidly as reasonable. Patients with a serum sodium level below 120 mmol/L should be considered for treatment in a critical setting, especially if a hypotonic distending medium was used. The best strategy to treat symptomatic hyponatremia is:
- Early detection and rapid initiation of treatment
- Early diuresis with frusemide
- Monitoring input/output and electrolytes
- Restrict fluid intake
- Supplement oxygen
- Correct sodium levels (if sodium < 120 mmol/L → critical care).

Thus, the surgeon must be vigilant to recognize and quantify the volume deficit of distention media and act promptly.

ENERGY SOURCES

a. *Mechanical energy:* These are in the form of 2 mm semirigid sharp as well as blunt scissors, biopsy forceps and the Myoma screw. These instruments can be passed through the operating channel to obtain biopsy specimens, transecting base of small polyps, excising uterine septa and synechiae.
b. *Monopolar:* This has been the traditional energy used for operative hysteroscopy. However, one cannot use this energy in the office hysteroscopy as the fully conscious patient will not tolerate it and will complain of pain.[10]
c. Bipolar standard electrode.[11,12]
d. *Bipolar Versapoint:* This bipolar cautery, marketed by Gynecare division has many advantages:[13]

- It can be used with saline thus eliminating the side effects of using glycine
- The electrodes can easily pass through the operative channel of office hysteroscopy
- Instant vaporization and desiccation can eliminate resection chips
- Decrease in the amount of blood loss.
- The pain is minimal if you restrict the surgery to the endometrial level.

These are further elaborated in the chapter on distention media.

e. *Laser:* Laser beams are collimated, or parallel, which creates a minimal amount of divergence as the light is transmitted from its source; the laser energy is coherent (i.e. all of the waves are in phase); and the laser light is monochromatic (i.e. a single color).

When laser light strikes an object including cellular tissue, it may be reflected, transmitted, scattered, absorbed, or a combination of these. To exert a biologic action, the beam must be absorbed. The principal effects on tissue of the lasers used in gynecology are thermal (i.e. light energy is converted to heat). In many aspects, the thermal action of lasers and electrosurgical devices are identical. Cutting of tissue occurs when temperatures of 100°C are reached rapidly (i.e. vaporization or explosive evaporation).

Risks: For the patient, the principal risk is occult damage to pelvic contents if the beam penetrates through the uterine wall. Although the safety record of hysteroscopic laser surgery has been good, prospective laser surgeons should attend preceptorship programs by surgeons experienced in hysteroscopic laser techniques.[14,15]

ELECTRODES

1. *Monopolar electrodes:* This 2 mm electrode uses monopolar energy and has to be used in combination with nonionic media such as glycine.
2. *Bipolar electrode:* This 2 mm electrode uses bipolar energy and has to be used in combination with either nonionic media such as glycine or ionic media such as saline.
3. *Bipolar Versapoint electrodes:* These 2 mm electrodes use bipolar energy and have to be used in combination with Versapoint bipolar generator. These are of three types:
   a. Twizzle electrode
   b. Ball electrode
   c. Spring electrode.

These are used in combination with ionic distention media such as saline.

- Unipolar resectoscope electrodes used in combination with working element. These are of four types: loop, rollerball, cylinder and Colvin's knife. These have to be used in combination with monopolar cautery and glycine.
- Bipolar Versapoint resectoscope electrodes used in combination with working element. There are of two types: loop and zero degree electrodes. These have to be used in combination with Versapoint bipolar cautery and saline.

Resectoscopes

The gynecological resectoscope is specially designed for the resection and retrieval of abnormal intrauterine tissue as well as endometrial ablation and septal dissection. The resectoscope may be used with 0°, 9 to 12°, 30° or even 120° telescopes. It consists of a classic 4 mm telescope—preferably with a 120° viewing angle to keep the electrode within the field of view—combined with a cutting loop actuated by a passive spring mechanism and two concentric sheaths for continuous irrigation and aspiration of the distention medium. A clear unobstructed panoramic view of the lesion and the surrounding normal endometrium is essential to avoid accidental perforation.[16]

A variety of other electrodes like microknives can be used with the working element of the resectoscope. Two main types of resectoscopes are used which differ in their outer diameter (Fr 22 and Fr 26) and the type of current used (unipolar or bipolar). The 26 Fr resectoscope is usually used unless the uterine cavity is small when it would be better to use the smaller resectoscope. A new instrument—the Opera Star system is being tested for resectoscopy that provides capabilities of resection and/or coagulation of intrauterine lesions, as well as simultaneous morcellation of resected tissue with continuous aspiration. No clinical acceptance and approval has occurred as of yet, nonetheless.

Sterilization

The current standard for sterilization of endoscopes is gas sterilization with ethylene oxide. Some newer telescopes may be steam autoclaved on an emergency basis without damaging the lenses; however, this cannot be a routine.[17]

Low-temperature sterile processing systems such as the Steris System 1 offer rapid and safe sterilization of instruments using peroxyacetic acid (PAA). The new generation disinfectants are the Cidex OPA (0.55% ortho-phthalaldehyde [OPA]) solutions that have practically replaced the glutaraldehyde, making the process of sterilization more rapid, a 12 minute soak time at 20°C or a 5 minute soak time at the minimum of 25°C in an automatic endoscope reprocessor (AER). Furthermore, it enhances safety and reduces instrument damage. This solution is bactericidal, including spores, fungicidal, tuberculocidal, as well as virucidal. It however requires three 1 minute rinses to remove residual Cidex OPA solution before use.

CONCLUSION

To date, the technology and sophistication of endoscopic simulation remains in its infancy. The operations and schematics are rather simplistic; nevertheless, they permit a novice to experience manipulation of devices in an interactive manner.[18] Unfortunately, the key skills of maintaining distention and a clear visual field are not part of the simulation.[19,20]

The advancement of hysteroscopy, both diagnostic as well as operative, has significantly contributed to better management of gynecological surgeries related to the uterus. Proper instrumentation is essential in achieving a complication free optimal outcome. The newer smaller diameter hysteroscopes coupled with advanced bipolar Versapoint technology, usage of saline as a distention media, and outpatient minimal anesthesia procedures have revolutionized present day hysteroscopy.

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CHAPTER 3

Indications and Contraindications of Hysteroscopy

PK Shah, V Lakshmi

Hysteroscopy is the process of viewing and operating in the endometrial cavity from a transcervical approach. Hysteroscopy is a minimally invasive intervention that can be used to diagnose and treat many intrauterine and endocervical problems. Given their safety and efficacy, diagnostic and operative hysteroscopy have become standards in gynecologic practice.

The main diagnostic indications are:

ABNORMAL UTERINE BLEEDING

Hysteroscopy has nearly replaced the standard dilation and curettage (D and C) procedure for the management of abnormal uterine bleeding (AUB), as it allows for direct visualization and diagnosis of intrauterine abnormalities, and it often offers an opportunity for simultaneous treatment.[1] Hysteroscopic diagnosis of intracavitary abnormalities in women with AUB carries a sensitivity of 94 percent and specificity of 89 percent[2] and compares favorably with the accuracy of saline infusion sonography, which has a reported 95 percent sensitivity and 88 percent specificity.[3] One of the largest case series tabulating indications for hysteroscopy was authored by Bettochi and colleagues and in that more than half of the women underwent hysteroscopy for abnormal uterine bleeding (Table 3.1).[4]

Table 3.1: Indications

Diagnostic	*Operative*
• Evaluation of abnormal uterine bleeding • Along with laparoscopy as part of routine infertility workup • Prior to IVF • Postoperative evaluation	• Location of lost IUCD • Artificial reproductive techniques • Hysteroscopic metroplasty • Hysteroscopic adhesiolysis • Endometrial ablation • Submucous myomectomy • Polypectomy • Tubal cannulation • Sterilization

As a Part of Routine Infertility Workup

The endocervical canal, the uterine cavity and the tubal ostia are visualized through the hysteroscope. A simultaneous diagnostic laparoscopy is usually performed.

Prior to *In Vitro* Fertilization

In vitro fertilization (IVF) requires a normal uterine cavity. Before initiating each cycle, assessment of cavity is necessary. Office hysteroscopy and saline infusion sonography (SIS) provide similar sensitivity and patient preference often determines the approach.

POSTOPERATIVE EVALUATION

Diagnostic hysteroscopy is performed to inspect the uterine cavity following hysteroscopic myomectomy, polypectomy and following hysteroscopic septum resection. This procedure is usually undertaken two months postoperatively to evaluate the success of surgery.

The main operative indications are:

Location of Lost Intrauterine Device

When the threads of the intrauterine contraceptive device (IUCD) are not visible or palpable, a search must be done to locate the IUCD. X-ray abdomen, USG and hysterograph can aid the search for occult IUD but use of hysteroscope allows simultaneous detection and removal.

Hysteroscopic removal is reserved for intrauterine misplaced/occult IUD or IUD that has partially perforated the myometrium.

ARTIFICIAL REPRODUCTIVE TECHNIQUES

Several methods of tubal transfer of gametes during hysteroscopy are possible using CO_2 as distending medium. These include intratubal insemination of washed sperms, transfer of washed sperms and oocytes, transfer of 2 to 4 cell stage embryo.

Hysteroscopic Metroplasty

Only septate uterus is amenable to hysteroscopic metroplasty. Division of a uterine septum has historically been performed by laparotomy but is now most commonly performed via a hysteroscopic approach. Rates of term-pregnancy outcomes after hysteroscopic resection are equivalent to those of abdominal metroplasty for uterine septum.[5] Live birth rates after treatment are as high as 80 percent.[6]

Hysteroscopic Adhesiolysis

Intrauterine adhesions (IUA) are often associated with amenorrhea or infertility. Hysteroscopy is the gold standard used to diagnose and treat these adhesions. Advantages over hysterosalpingography (HSG) include the ability to precisely locate the adhesions, perform lysis under direct vision and the value of treatment can be ascertained in a follow–up hysteroscopic examination.

Endometrial Ablation

When hormonal treatment and repeated curettage failed to control menorrhagia, hysterectomy was, until a few years ago, the ultimate choice of treatment. As an alternative to hysterectomy, hysteroscopic endometrial ablation can be used to destroy the endometrium and control excessive bleeding. Under hysteroscopic control, using either laser/electrosurgery, it is possible to ablate the endometrium and create severe intrauterine adhesions with subsequent amenorrhea or hypomenorrhea.[7]

Submucous Myomectomy

The effect of myomas on reproduction is not definitive but it is generally accepted that fibroids causing distortion of the endometrial cavity may adversely influence fertility.[8]

For patients with recurrent miscarriage and intracavitary fibroids, surgery increases rates of viable pregnancy outcomes.[9]

Polypectomy

Endometrial polyps can cause abnormal uterine bleeding but infertility is infrequent. If radiographic examination reveals suspicion of a polyp, need for hysteroscopic confirmation and subsequent removal under hysteroscopic control is indicated.

Tubal Cannulation

Cornual spasm causing pseudo-occlusion is always a possibility when tubes fail to opacify on HSG or do not fill during laparoscopy. Selective hysteroscopic cannulation of fallopian tubes can be used to diagnose and treat selected cases of proximal tubal obstruction.

STERILIZATION

Potential advantages of hysteroscopic sterilization include elimination of general anesthesia, avoidance of abdominal incision and the potential for intra-abdominal adhesions.

It can be performed by two methods:
- Mechanical occlusion of tubal ostia using silastic plugs or devices
- Destructive surgery where intramural segment is destroyed by electrosurgery or sclerosing agents like silver nitrate/quinacrine.[7]

Pelvic Inflammatory Disease

Pelvic inflammatory disease (PID) is an absolute contraindication (Table 3.2) to hysteroscopy. If patient has known history of tubal occlusion or

Table 3.2: Contraindications

Absolute	*Relative*
• Pelvic inflammatory disease • Cervical cancer	• Pregnancy • Uterine bleeding • Inexperienced physician/reluctant patient • Unstable patients

hydrosalpinx, prophylactic antibiotics to be considered before and after the procedure. A pelvic examination is a must before performing hysteroscopy to determine size of uterus, evaluate uterine/adnexal tenderness and to look for adnexal masses.

After a hysteroscopy, patient with history of recent pelvic infection can develop salpingitis/peritonitis, when either gaseous or liquid medium is used for distention.

If PID is suspected, procedure should be postponed till symptoms improve and cultures are negative.

Carcinoma Cervix

To avoid spread of the disease, patients who have a cervical malignancy should not undergo hysteroscopy.

PREGNANCY

Pregnant patients are not usually candidates for hysteroscopy due to risk of abortion, bleeding and infection. In select circumstances, such as removal of IUD in a patient who inadvertently becomes pregnant, hysteroscopy can be done without disturbing the pregnancy.

UTERINE BLEEDING

Scanty or mild uterine bleeding does not prevent adequate observation of uterine cavity. In cases of excessive bleeding, bubbles are created with the use of CO_2 and leads to difficulty in visualizing the endometrium. Alternating between CO_2 and saline irrigation can overcome visualization difficulties.

- Inexperienced physician/reluctant patient—are relative contraindications to hysteroscopy.
- Unstable patients and those with impaired ventilation should preferably not undergo hysteroscopy.

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CHAPTER 4

Monopolar Energy in Hysteroscopy

Pritesh R Naik, Prashant S Mangeshikar

INTRODUCTION

The development of hysteroscopy is rooted in the work of Pantaleoni, who first reported uterine endoscopy in 1869.[1] However, at that time, instrumentation was elementary, and expansion of the uterine cavity was insufficient. In 1925, Rubin first used CO_2 to distend the uterus. Around the same time, Gauss was experimenting with the use of fluids to achieve uterine expansion.

Hysteroscopy did not become popular until the 1970s, when technology offered more practical and usable instruments than before. The use of liquid distention media became routine by the 1980s, and many new hysteroscopic procedures like polypectomy, myomectomy, and endometrial ablation were developed. Initially used by urologists for transurethral resection of the prostate, the resectoscope was modified for hysteroscopic procedures, allowing for resection of intrauterine pathology with monopolar cautery. By the mid-1980s, hysteroscopic procedures had nearly replaced dilation and curettage (D and C) for diagnosing intrauterine pathology.[2]

Given their safety and efficacy, diagnostic and operative hysteroscopy have become standard in gynecologic practice. The use of electrosurgery in the form of monopolar and bipolar energy using an electrosurgical generator has made the performance of operative hysteroscopy one of the most commonly performed procedures in gynecological practice.

ELECTROSURGERY

Electrosurgery refers to the cutting and coagulation of tissue using high-frequency electrical current.[3] Physicians using this technique must be knowledgeable about prevention and management of the potential complications of electrosurgical procedures. In addition, they should understand the mechanism of action and how to troubleshoot equipment. Education on the principles of electrosurgery is important,[4] as electrosurgical complications are relatively common.[5]

Basic Principles

Electrical current is created by the movement of electrons; voltage is the force that causes this movement. There are two types of electrical current: direct current (DC), where the electrons always flow in the same direction (e.g. simple battery), and alternating current (AC), where the current changes direction periodically (e.g. electrical wall outlet). Each time an AC current reverses direction is considered one cycle; frequency refers to the number of cycles in one second and is measured in hertz (Hz). Electrosurgical units (ESU) used in operating rooms convert standard electrical frequencies from the wall outlet, which are 50 to 60 Hz, to much higher frequencies, 500,000 to 3,000,000 Hz.[1] This is important to minimize nerve and muscle stimulation, which occurs at electrical currents below 10,000 Hz.[5,6] The surgical electrode does not shock patients because the high frequency of electrosurgery does not stimulate the neuromuscular tissue but burns and vaporizes tissue.

There are three types of currents—cutting current, coagulating current and blended current. These types of currents are not absolutely different from each other but the only difference lies in the fact that the delivery of the current wave is changed, which produces variable effects.

Cutting Current

It is the least penetrating and perhaps the safest form. This type of effect is produced with a high current low voltage (continuous) waveform of the electrical energy. This effect is produced even when the electrode is not in contact with the tissue. The high electrical current delivered with the use of a fine electrode, yields a very high power density that generates intense heat that leads to boiling of intracellular substance and vaporization of the cell. Dissipation of heat prevents thermal damage to the adjacent tissue. To obtain a cutting effect the electrode must be activated before the electrode touches the tissue.

Coagulating Current

Coagulating current results when current flow is interrupted leading to a rise in the voltage. When this happens periodically, bursts of high voltage current are periodically released. Therefore, coagulating current is characterized by low flow (current) but high force (high voltage) thus, coagulating current is more penetrating and inflicts more tissue damage than cutting waveform. There are three types of different coagulation modes namely, soft coagulation, forced coagulation and spray coagulation.

Blended Current

The blended waveforms interrupt the current at various intervals, delivering varying degrees of coagulation and cutting properties. The blend waveform due to the interrupted delivery of the current, will take a longer period of time to dissect the same length of the tissue than the cutting waveform, leading to an increase in the thermal spread thus, improving coagulation of blood vessels.

The possible types of effects of applying current to tissue are fulguration, desiccation/coagulation, or vaporization/ablation. Operative hysteroscopy can be performed using either a monopolar or a bipolar instrument. The main difference between these two modalities is that in monopolar surgery, the current goes through the patient to complete the current cycle, while in bipolar surgery, the current only goes through the tissue between the two electrodes of the instrument.

ENERGY SOURCES AND USES

Monopolar and bipolar electricity, as well as laser energy, all have uses in hysteroscopy.

Monopolar Cautery

The resectoscope is a specialized instrument often used with a monopolar, double-limbed electrode and a trigger device for use with hypotonic, nonconductive media, such as glycine. It cuts and coagulates tissue by means of contact desiccation with resistive heating. The depth of thermal damage is based on several factors: endometrial thickness; speed, pressure, and duration of contact during motion; and power setting. A thin electrode can cut tissue, whereas one with a large surface area, such as a ball or barrel, is best suited for coagulation.

Bipolar Cautery

The VersaPoint system (Gynecare, Inc, Somerville, NJ), uses bipolar circuitry for electrosurgery, which can be performed in isotonic conductive media like normal saline. This system includes a spring tip for hemostatic vaporization of large areas, a ball tip for precise vaporization, and a twizzle tip for hemostatic resection and morcellation of tissue. There is also a cutting loop similar to traditional resectoscopy. Bipolar resectoscopes have been designed by both Karl Storz (Tuttlingen, Germany) and Richard Wolf Medical Instruments Corporation (Vernon Hill, Il). The latter has developed the Princess (Petite Resectoscope Including E-Line and S-Line Systems), a 7 mm resectoscope—the smallest bipolar resectoscope available. In addition, the Chip E-Vac System (Richard Wolf Medical Instruments Corporation, Vernon Hill, Il) can be used with bipolar and monopolar energy.

SURGICAL INSTRUMENTS

The instruments that are used include:

1. 4 mm 30° hysteroscope (a 2.8 mm 30° hysteroscope may also be used).
2. Hysteroscopy operating sheath through which the semirigid Bugby's electrode can be passed.
3. Resectoscopy system including the inner and outer sheaths, passive mechanism working element and operating loop electrodes.

Examples of surgical instruments and their uses are listed below:

- Rollerball, barrel, or ellipsoid—to perform endometrial ablation and/or desiccation (This instrument is used with a resectoscope)
- Loop electrode—to resect a fibroid or polyp or endometrium (This instrument is used with a resectoscope)
- Bugby's electrode
- Vaporizing electrodes—to destroy endometrial polyps, fibroids, intrauterine adhesions, and septa; also used for endometrial ablation (This instrument is used with a resectoscope).

4. Hamou hysteromat fluid infusion system (Karl Storz, Tuttlingen, Germany)
5. Electrosurgical generator with the connecting high frequency cable cord.

Monopolar electrosurgery can be delivered through probes or loops introduced through either an operating sheath or a resectoscopy set.

Improvements in hysteroscope design have improved the effectiveness of the inflow-outflow channels and of specific operating instruments. For example, the Chip E-Vac System (Richard Wolf Medical Instruments Corporation, Vernon Hill, Il) incorporates a suction channel and a pump to aid in removing chips of tissue during resection. This feature improves visibility and may decrease time otherwise spent emptying the pieces from the endometrial cavity.

TECHNIQUE OF OPERATIVE HYSTEROSCOPY

Operative hysteroscopy is best performed in the proliferative phase of the menstrual cycle after menstrual flow is over, when the endometrium is thin. Use of various agents (i.e. progestins, combined oral contraceptive pills, gonadotropin-releasing hormone [GnRH] agonist, GnRH antagonist, or danazol) may be used to induce endometrial atrophy.[7] Appropriate antibiotics may be used. Once adequate anesthesia is obtained a Foley's catheter is placed into the bladder and the surgeon may proceed. Visualization of the cervix must first be obtained. The cervix is grasped and traction is given using a single-tooth tenaculum.

The typical diameter of an operative hysteroscope ranges from 7 to 10 mm, and dilatation of the cervix is usually required. Preparing the cervix for dilatation may be achieved with laminaria tents, misoprostol (Cytotec, Pfizer; New York, NY). One hundred micrograms of misoprostol, a synthetic prostaglandin E_1 analog, orally or vaginally the evening prior to the procedure has also been shown to be effective at decreasing the difficulty of and pain associated with cervical dilation. However, misoprostol is potentially less effective in postmenopausal women. The cervix is then progressively dilated to the required diameter (depending on the operative hysteroscope being used) with Hegar's dilators.

After all hysteroscopic equipment is set up and functional, the flow of distention medium is started and flushed through the hysteroscope. The scope is then introduced to the external cervical os and advanced into the dilated cervical canal. At this time, attention is directed to the viewing monitor, and care should be taken to maintain the endocervical canal in the middle of the viewing field. Visualization of the endocervical canal is important when advancing the hysteroscope to prevent cervical injury.

As the hysteroscope is slowly advanced into the uterine cavity, continuous gentle counter-traction is applied with the tenaculum. Once the distal tip of the hysteroscope negotiates the internal os and is within the uterine cavity, the distention medium is allowed to expand the intrauterine space. In addition to pathology, cervical and intrauterine landmarks should be noted at this time. Pathology may be treated as described below. Following conclusion of the procedure, the distention medium is evacuated and all instruments are removed from the uterus and vagina.

INDICATIONS AND TECHNIQUES

Abnormal Uterine Bleeding

Hysteroscopy has nearly replaced standard D and C for the management of abnormal uterine bleeding (AUB), as it allows for direct visualization and diagnosis of intrauterine abnormalities, and it often offers an opportunity for simultaneous treatment.[8] To diagnose the cause of AUB, a full workup is required to rule out endocrine or hormonal disorders, benign lesions, premalignant, or malignant pathology. Uterine sampling can be done by means of endometrial biopsy, D and C, or direct visualization with hysteroscopy and specific biopsy procedures.

For patients with AUB for whom fertility is not an issue, in whom no endocrine or hormonal cause is isolated, and in whom endometrial atypia or malignancy is ruled out, endometrial ablation has become an acceptable alternative to hysterectomy.

Techniques of Endometrial Ablation

Transcervical Resection of Endometrium

Transcervical resection of endometrium (TCRE) is performed using a 26 F continous flow passive mechanism resectoscope with a cutting loop. A hysteromat is used to maintain pressures between 80 and 120 mm Hg. Resection of the endometrium is started with a pure cutting monopolar current of 100 to 120 watts. If submucus fibroids are present they must be first resected with a loop electrode. The upper part including the fundus and posterior wall of the cavity is done first followed by the anterior wall. Subsequenty the lower part of the posterior wall and then the lower anterior part is completed. The depth of resection is judged by the appearance of the circular muscle fibers. Too deep a cut has the risk of excessive bleeding or perforation of the uterus, the strips of resected bits are pushed towards the fundus and the procedure is completed. The resectoscope is removed and the strips are removed using an ovum forceps or curette. The cavity is reinspected and the bleeding points if present are coagulated using a rollerball electrode.

Rollerball Endometrial Ablation

A rollerball electrode is used instead of the loop electrode. This ball is moved across the endometrial surface, employing a blended cutting current to cause endometrial blanching and tissue ablation. The success rate of rollerball endometrial ablation is similar to TCRE but has the disadvantage of the lack of tissue specimen.

In the short term, ablation for a benign disorder results in amenorrhea in approximately 30 percent of patients. Studies show that approximately 26 percent of patients have spotting after ablation, 34 percent have a decreased flow, and 10 percent have no change or increased symptoms.[9] The same data suggested that the long-term effectiveness of endometrial ablation for menorrhagia or fibroids is 60 to 90 percent, with 90 percent of patients noting an overall decrease in flow and amenorrhea, which occurs in 30 to 50 percent.[10]

Reported reoperation rates after endometrial ablation (resectoscope, vaporization or thermal balloon method) have been reported to be as high as 38 percent at 5 years. Review including only first generation endometrial ablation techniques estimated that 6 to 20 percent of women require further surgery for control of menorrhagia after 1 to 5 years of follow-up. Patients who are taking estrogen still require progesterone for endometrial protection from estrogen-induced endometrial changes.

Infertility

Intracavitary lesions are implicated as causes of infertility and their removal may increase fertility. However, literature supporting the significance of this association is scant. Overall, pregnancy rates of 50 to 78 percent in previously infertile women have been reported after hysteroscopic polypectomy.[11-14]

Pregnancies were conceived spontaneously or with the use of intrauterine insemination or *in vitro* fertilization. The only randomized control trial comparing pregnancy rates after polypectomy versus no treatment in infertile women concluded hysteroscopic polypectomy prior to IUI increased the odds of pregnancy, with a relative risk of 2.1 (95% CI, 1.5–2.9). Of note, 65 percent of the women who were randomized to polypectomy became pregnant prior to the first IUI.

The incidence of myomas in women without another obvious etiology for infertility is small, estimated to be 1 to 2.4 percent. The effect of myomas on reproduction is not definitive but it is generally accepted that fibroids causing distortion of the endometrial cavity may adversely influence fertility.[15]

Location, size of myomas, and coexisting fertility diagnoses are believed to be major considerations when determining management options.

Surgical management with hysteroscopic myomectomy has been reported to yield pregnancy rates of 16.7 to 76.9 percent (mean of 45%) in infertile women.[16]

For patients with recurrent miscarriage and intracavitary fibroids, surgery increases rates of viable pregnancy outcomes.[17]

Myomas may adversely affect outcomes for women undergoing IVF but there again remains no definitive consensus on management of fibroids prior to an IVF attempt. A negative impact of submucosal fibroids on pregnancy rates has been demonstrated in three separate meta-analyses. Intramural fibroids have also been reported to have a significant negative influence on pregnancy rates.[18]

Polyps and Fibroids

Endometrial polyps and fibroids are well known to cause irregular vaginal bleeding. Fibroids are the most common solid pelvic tumor in women, found in 20 percent of women older than 35 years. Menorrhagia due to symptomatic submucosal fibroids is the most common indication for surgical intervention. Other indications include infertility, dysmenorrhea, and pelvic pain.

Polyps and submucosal fibroids can be definitively diagnosed and effectively treated with hysteroscopy. Diagnosis of endometrial polyps via hysteroscopy is 94 percent sensitive and 92 percent specific. For submucosal myomas, diagnostic hysteroscopy is 87 percent sensitive and 95 percent specific. Only 16 percent of treated patients require further surgery.[19]

Hysteroscopic polypectomy is done using a resectoscope loop with pure cutting current of 100 W using 1.5 percent glycine as distention medium. Bleeding if present can be coagulated or the base ablated using a rollerball electrode. When AUB is present, polypectomy has been reported to successfully alleviate symptoms 75 to 100 percent of the time. Initial hysteroscopy is estimated to successfully remove fibroids in 85 to 95 percent of cases, with additional surgery required in approximately 5 to 15 percent. If a fibroid is predominantly submucosal, complete resection is possible. A two-step procedure is sometimes needed to resect a fibroid that is partially intramural or large.

Hysteroscopic myomectomy is the treatment of choice for the treatment of submucus myomas that is almost entirely (Type 0) or mostly (Type 1) located inside the uterine cavity. Fibroids that extend deep into the myometrium (Type 2) can also be removed hysteroscopically using techniques such as uterine massage and dissection with a cold knife electrode. The likelihood of complete removal of this type is 50 percent. Pure 100 W cutting current and 50 W of coagulating current is used.

To minimize thermal injury and risk of uterine perforation, electrical energy should only be applied while the loop is being retracted. As the electrode retracts back, a strip of leiomyoma is excised and floats in the endometrial cavity. This technique is repeated numerous times until the fibroid is removed in entirety. The created chips of fibroid tissue may begin to obstruct visualization. If this occurs, the hysteroscope is removed from the cavity and the fibroid chips are evacuated from the uterine cavity blindly with ovum or polyp grasping forceps and sent for histopathologic examination. Alternatively, a chip evacuating system by R Wolf may be used. Repeated removal and insertion of the hysteroscope increases the risk of uterine perforation, air embolus, and fluid deficit miscalculation or intravasation and should be avoided.

The resection is complete when the fibroid base is even with the adjacent myometrium because resection beyond this point increases the chance of uterine perforation. Alternatively, the surgeon may halt the resection and allow the surrounding myometrium to contract and deliver the remaining fibroid tissue into the cavity. Administration of the prostaglandin $F_{2\alpha}$ carboprost (Hemabate, Pfizer; New York, NY) directly into the myometrium has been shown to aid in delivery of residual tumor into the uterine cavity. Resection can then be resumed.

Some investigators report improved results and decreased adhesion rates after pretreatment with a gonadotropin-releasing hormone (GnRH) agonist or medroxyprogesterone acetate (Depo-Provera) on the day of surgery, while others report no benefit and possibly increased difficulty of surgery. Postoperative use of estrogen decreases adhesion formation.[20]

Intrauterine Adhesions

Asherman syndrome was identified in 1948 as uterine synechiae.[21] These intrauterine adhesions (IUA) are often associated with amenorrhea or infertility. Hysteroscopy is the gold standard used to diagnose and treat these adhesions. Benefits include visually directed lysis. Flimsy adhesions are often lysed by distention alone, whereas the dense adhesions often require cutting or excision with blunt, sharp, electrocautery, or laser techniques.

Hysteroscopic adhesiolysis can be done mechanically using a hysteroscopic scissors 5 F or using a Bugby's electrode inserted through the operating sheath. Pure cutting current of 80 W is used with glycine as distension medium. The adhesiolysis is started at the level of the internal os and gradually progressing towards the fundus and lateral walls. Adhesiolysis should begin with the most centrally located adhesions and proceed to those located at the periphery of the cavity.

An intrauterine contraceptive device may be placed at the end of the procedure and removed after 4 weeks. If there is bleeding, tamponade can be given using a pediatric Foley's catheter with the bulb inflated to 5 ml for 10 to 15 days. Hysteroscopic adhesiolysis is followed up by use of conjugated estrogen in high dosages for 2 months to stimulate the growth of endometrium. Complications include perforation, recurrence of adhesions, increased risk of abortions and placenta accreta. A second look operative hysteroscopy may also be done.

Müllerian Anomalies

Approximately 1 to 2 percent of all women, 4 percent of infertile women, and 10 to 15 percent of patients with recurrent miscarriage have Müllerian anomalies. These anomalies range from didelphys to Müllerian agenesis. Uterine septum and *in utero* diethylstilbestrol (DES) exposure are more likely to be associated with miscarriage than is uterus didelphys.

Patients with a bicornuate uterus have a >50 percent live birth rate compared with those with a uterine septum, who have a <30 percent live birth rate. Patients with *in utero* DES exposure are likely to have a T-shaped uterus with cornual restriction bands, pretubal bulges, lower-uterine-segment dilation, and a small and irregular cavity with borders resembling adhesions. Septate uterus is the most common structural uterine anomaly, accounting for 35 percent of anomalies, and is associated with the highest incidence of reproductive failure.[22]

The diagnosis of septate uterus is made after excluding the diagnosis of a bicornuate uterus. Once two hemicavities are visualized on imaging, the uterine fundus must be evaluated. Evidence of fundal indentation is an indication of bicornuate uterus, whereas, a smooth fundus is present with uterine septum. HSG, transvaginal ultrasonography, 3-dimensional ultrasonography, and MRI have all been used to make an accurate diagnosis but concurrent hysteroscopy and laparoscopy remain the gold standard.

Division of a uterine septum has historically been performed by laparotomy but is now most commonly performed via a hysteroscopic approach. Edstrom reported the first hysteroscopic resection of a septum and Bret and Guillet were the first to recommend incising vs. excising the septum. Surgical complications are fewer with the hysteroscopic approach than with other procedures, such as Jones, Strassman, or Tompkins metroplasty. Of patients undergoing hysteroscopic resection for Müllerian anomalies, 20 percent have dysmenorrhea after surgery compared with 50 percent after abdominal procedures. Rates of term-pregnancy outcomes after hysteroscopic resection are equivalent to those of abdominal metroplasty for uterine septum. Live birth rates after treatment are as high as 80 percent.

Significant improvements are seen in pregnancy outcomes following hysteroscopic metroplasty in women with recurrent miscarriage. Pregnancy rates have been estimated to increase from 3 percent prior to surgery to approximately 80 percent after hysteroscopic correction with a significant decrease in miscarriage rates.[23]

Septum resection can be performed using a cold 5 F hysteroscopic scissors or Bugby's electrode passed through an operating sheath with glycine as distention medium. A thick septum is usually divided using a resectoscope with the Collin's knife electrode. The septum is divided using 80 W pure cutting current in the midline starting at a point closest to the cervix and continuing up to the uterine fundus. Bleeding starts when the myometrial fibers are reached. This can be checked by temporarily constricting the influid inflow tube between two fingers of the assistant. This helps in transiently reducing the pressure and the bleeding points are visualized. Bilateral visualization of the fallopian tube ostia is crucial because the ostia serve as landmarks throughout the resection. The procedure is terminated at this stage.

Although, a septate uterus is not a cause for infertility, the literature suggests women with a septate uterus and otherwise unexplained infertility may benefit from metroplasty, but to a more modest extent. In comparison to women with unexplained infertility and a normal uterine cavity, pregnancy rates have been shown to be significantly higher in women with a septum after removal, 20.4 percent versus 38.6 percent (after 12 month of follow-up). Live birth rates of 18.9 percent versus 34.1 percent were also reported.

Metroplasty for a T-shaped uterine cavity should also be considered for women who plan to undergo IVF. Retrospective review has also indicated that pregnancy outcomes may improve with IVF after the incision of an incomplete septum, but continued investigation is needed.

CONCLUSION

Monopolar electrosurgery if used safely can successfully accomplish all the major hysteroscopic operative procedures like endometrial ablation, septum resection, resection of polyps and fibroids as well as lysis of uterine adhesions in a safe and effective manner, that too, without the use of very highly specialized and expensive equipment, but it is very important for the surgeon to be very well versed with the principles of electrosurgery, safe use of the electrosurgical generator that produces and transmits monopolar energy to cause the desired tissue effects and optimum clinical outcome.

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CHAPTER 5

New Bipolar Technology for Hysteroscopy

Sunita Tandulwadkar, Bhavana Mittal, Pooja Lodha

Energy sources are of paramount importance in doing endosurgical procedures. A clear understanding of their physics and application in surgical procedures is necessary. It is equally important to maximize safe use of these energy sources.

Electrosurgery is the generation and delivery of current between active electrode and dispersive electrode in order to elevate the tissue temperature for purposes of cutting, fulguration and desiccation.

1. *Cutting:* Requires a high current, low voltage continuous wave form.
2. *Fulguration:* A high voltage low current non continuous wave form designed to coagulate by spraying long electrical sparks best to control capillary oozing.
3. *Desiccation:* This is a form of coagulation.

Two types of electrical circuits can be employed in electrosurgery—unipolar and bipolar:

UNIPOLAR CURRENT

In monopolar/unipolar current, the current flows from the electrosurgical unit through the operating electrode through the patient to the dispersing or ground electrode and finally back to the generator. It uses high frequency continuous wave form mainly for cutting.

Thermal injuries and lateral damage is more common. Faulty contact between the ground electrode and the patient can result in current dispensing through unwanted pathways of lesser resistance, resulting in undesired thermal injury.

Bipolar Current

In bipolar current, the circuit is closed by placing the tissue between two electrodes, so that the current goes through the intervening tissue. This type of current can coagulate, and desiccate but not achieve cutting.

The biggest advantage of this bipolar technology is the same that exists for the ND-YAG laser; that is saline, may be used as the distending medium for the operative hysteroscopy. This obviates the risk of hyponatremia. Hyponatremia and subsequent cerebral edema caused by the glycine media, frequently used during monopolar hysteroscopic surgery, is the most serious complication.

Cutting power and coagulation appears sensibly better in comparison with monopolar resection, thanks to plasma effect. The vision during resection is not disturbed by the presence of the technical characteristics of the instruments. Results in terms of time of surgery, intraoperatory bleeding and complete removal of the pathology were better compared with traditional monopolar resection.

The bipolar resectoscope presents some advantages in comparison with the monopolar such as: better cut and coagulation by plasma effect of bipolar current, minor risks due to the use of saline solution, lower alterations of the tissue, less bleeding during resection, better visibility.

The main evolution derived from introduction of bipolar devices is probably represented by a safe shifting of inpatient procedures to the office, leading to saving of medical costs.

VersaPoint

The VersaPoint® bipolar vaporization system (Gynecare; 92787 Issy-Les-Moulineaux, France) consists of a dedicated bipolar electrosurgical generator and three types of electrodes (spring, twizzle and ball).

The *spring electrode* is 1.2 mm in diameter and 1.6 mm long. Its active electrode has a large surface area, which makes it suitable for tissue vaporization and debulking. Leiyomyoma vaporization is best carried out with this electrode. The *twizzle electrode* is 0.6 mm in diameter and 3.0 mm long. Endometrial polyps and type 0 myomas are easily resected using this electrode with minimal tissue destruction. The *ball electrode* has a spherical tip of 1mm diameter. This allows precise tissue vaporization and desiccation. The ball is most suited for resecting uterine septae or intrauterine synechiae.

Each electrode consists of an active electrode located at the tip and a return electrode located on the shaft, separated by a ceramic insert. Only tissue in contact with the active electrode involved in the electrical path circuit will be desiccated or vaporized. Similar to other electrosurgical equipment, the generator is designed to be located outside the sterile field with adjustment of settings performed by ancillary operating staff. The generator provides five modes of operation (waveforms) and different power settings between 1 and 200 W. The selected mode of operation and the power setting is indicated on the generator display. The vaporize and blend acronyms of vapour cut, `VC1', `VC2', `VC3' and Blend, `BL1' and `BL2' waveforms are assigned the traditional `cut' (yellow pedal) and are used to vaporize and excise tissue. Power settings needed for bipolar energy system is 60 W (desiccation) and 130 W (cutting).

There is only ~1 mm^2 area of collateral damage to tissue. The generator is connected to the electrode via a flexible cable. The electrodes are designed for insertion down the 5 F-working channel of the 5.5 mm hysteroscope (Karl Storz GmbH & Co, Tuttlingen, Germany).

A new intriguing bipolar system marketed under the trade name of Versapoint permits cutting and ablation via operative hysteroscopes or via a dedicated bipolar resectoscope. The coiled bottom portion is the active electrode, and the upper metal portion serves as the return electrode. The saline medium facilitates the conduction of current between the two poles. The electrode measures 5 F diameter (i.e. < 2 mm) and therefore can be accommodated by standard and isolated hysteroscopic channels.

Bettaocchi et al evaluated treatment efficacy and patient acceptability of a new bipolar probe used during office hysteroscopic treatment of benign intrauterine pathologies. In this observational clinical study, 501 women were treated for benign intrauterine pathologies using an office hysteroscopic procedure, without analgesia or anesthesia. At follow-up, the uterine cavity was normal in all patients without any recurrence or persistence of the pathology. One focal adenocarcinoma was discovered at histology in an endometrial polyp of a menopausal patient. Patient acceptance was satisfactory; 47.6 to 79.3 percent of the patients underwent the procedure without discomfort.

The combination of a new generation small diameter hysteroscope and a new bipolar 5 Fr electrode enables the gynecologist to treat intrauterine pathologies in an office setting without anesthesia. Experimentation of a special set-up of the electrical generator reduced patient discomfort during the operative part of the hysteroscopic procedure (Bettocchi S, et al. Advanced operative office hysteroscopy without anesthesia: analysis of 501 cases treated with a 5 Fr bipolar electrode. Human Reproduction. 2002;17(9):2435-8).

A clinic-based, prospective, nonrandomized trial conducted in Florence, Italy in 2009 proved the effectiveness and security of bipolar resectoscope in hysteroscopic surgery. The study emphasized that bipolar resectoscope presents some advantages in comparison with the monopolar such as: better cut and coagulation by plasma effect of bipolar current, minor risks with the use of saline solution, lower alterations of the tissue, less bleeding during resection, better visibility and reduced cost.

The surgeon must be familiar with the physics governing the action of electrosurgical tools and with the tissue actions exerted by these energized devices. High power applied for a long period of time is risky, is inappropriate, and will inevitably lead to unwanted tissue injury. Regardless of whether a laser, resectoscope, or hand held electrode is used, depth of tissue action is extremely important; transmural injury is possible at high power densities or with prolonged exposure. The distended uterine wall (0.5 to 1 cm) is considerably less than the nondistended uterine wall (1.5 to 2 cm).

Uterine perforation by either a laser fiber or an electrode is much more serious than perforation by a mechanical device, because the thermal energy can inflict great damage to surrounding structures (e.g. bowel or bladder). The injury may not attain its maximum damage until 2 or 3 days after surgery. Therefore, either laparoscopy or laparotomy is indicated to determine the extent of injury.

Advantages

Current techniques of operative hysteroscopy used for treating infertility such as removal of submucous myoma, metroplasty and Asherman's syndrome use a monopolar electrosurgical system which needs glycine as distension medium and limits the operative time in order to decrease the incidence of fluid overload, which may lead to hyponatremia and subsequent cerebral edema and death. In contrast with the bipolar electrosurgical system, the normal saline used has ion concentrations similar to human plasma and may reduce electrolyte changes and hyponatremia. However, if there is excessive absorption of saline solution, pulmonary and brain edema and even death may still occur (Vilos, 1999). Therefore, the total amount of saline solution must be closely monitored and recorded at the end of the procedure, just as with the use of sorbitol or glycine.

A second advantage of the bipolar electrode system is that cervical dilatation is not required, if one is using office hysteroscope. Such dilatation is often difficult in nulliparous women with a stenosed cervix. Avoiding cervical dilatation should prove advantageous in reducing the risk of cervical laceration, uterine perforation and in postoperative analgesia requirements.

A third potential advantage is that this bipolar system might prevent electrosurgical genital tract burns, previously reported (Vilos et al, 1997, 2000). The return electrode must always be exposed and lie outside the sheath of the hysteroscope to complete the circuit and achieve the most efficient vaporization.

Excellent hemostasis was achieved in the vapour cut mode requiring the infrequent desiccation mode which is likely to be advantageous in infertility surgery. Total vaporization of the myomata also avoids the process of having to remove chips from the field of vision. All intrauterine lesions should be biopsied prior to complete vaporization to minimize the risk of missing a malignancy.

In conclusion, the Versapoint® bipolar electrosurgical system appears advantageous in infertility surgery. Those experienced with operative hysteroscopy should be able to adapt readily to this technique.

GUIDELINES FOR HYSTEROSCOPIC SURGERIES WITH BIPOLAR ELECTRODES

Timing of Surgery

- Hysteroscopic surgeries should be preferably performed postmenstrually
- If there is amenorrhea, surgery can be performed anytime.

Instrumentation (Figs 5.1 to 5.4)

- Therapeutic hysteroscope with Versapoint or a bipolar needle electrode
- Hysteromat/Pressure bag
- Normal saline as distention medium.

INSTRUMENTATION

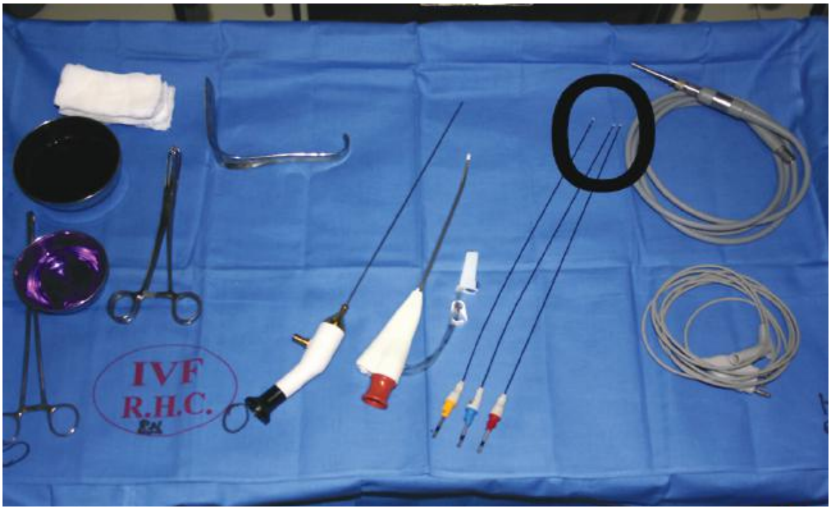
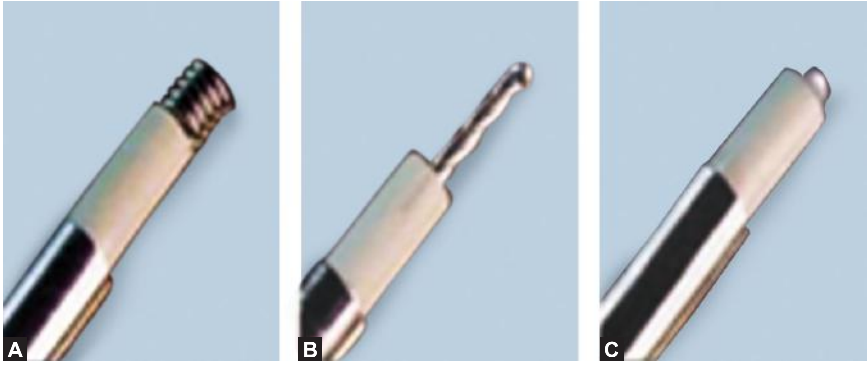


Fig. 5.1: Trolley of office hysteroscopy with versascope and electrodes



Figs 5.2A to C: Spring, twizzle and ball electrodes from left to right

Fig. 5.3: Conventional hysterescope with bipolar needle (re-usable)

Fig. 5.4: Bipolar/Versa electrode can be passed through the versascope or the conventional hysteroscope

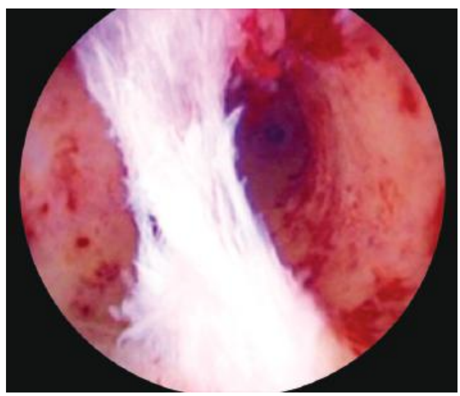


Fig. 5.5: Adhesion band in the lower part of cavity

INTRAUTERINE PATHOLOGIES THAT CAN BE TACKLED USING BIPOLAR ENERGY SOURCES

Intrauterine Adhesions (Asherman's Syndrome) (Fig. 5.5)

Usually done immediate postmenstrually, but in patients who have amenorrhea, it can be planned anytime.

Procedure (Figs 5.6 to 5.14)

1. Gradual gentle dilatation of the internal os is done.
2. Diagnostic hysteroscopy should be done (usually by using therapeutic sheath) to confirm the diagnosis.
3. The set pressure of hysteromat should be between 180 to 200 mm Hg.
4. Versapoint is passed through therapeutic sheath to release adhesions.
5. In case of extensive adhesions, one should withdraw the scope till internal os from time to time, to have a panoramic view for re-orientation of cavity and to avoid going in the wrong plane.
6. Adhesiolysis should be stopped once the pink myometrium is reached.

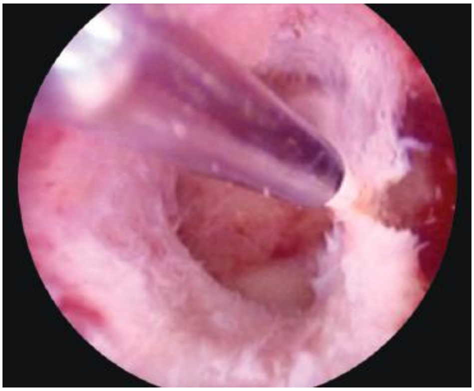


Fig. 5.6: Adhesiolysis (band release) with versa electrode

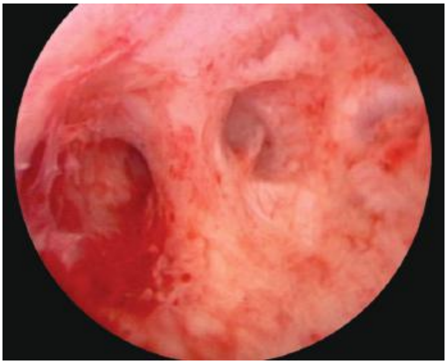


Fig. 5.7: Adhesion band in front of right cornu

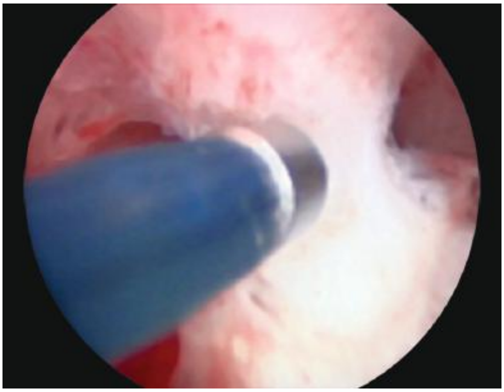


Fig. 5.8: Adhesiolysis with bipolar needle electrode

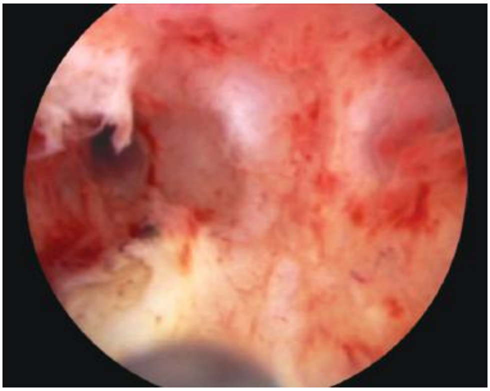


Fig. 5.9: View of cavity postadhesiolysis end

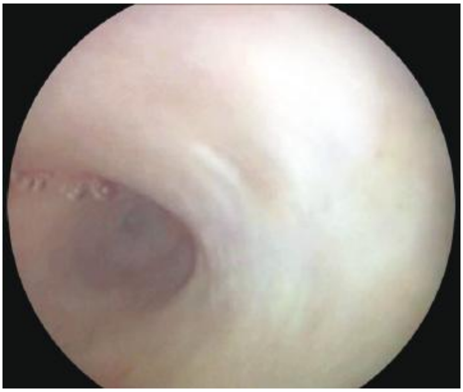


Fig. 5.10: Adhesion band over the fundus and left cornu

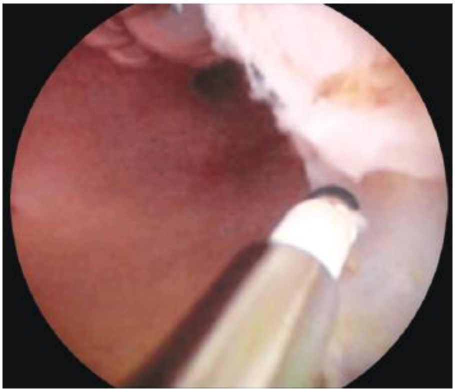


Fig. 5.11: Adhesiolysis using Versapoint electrode

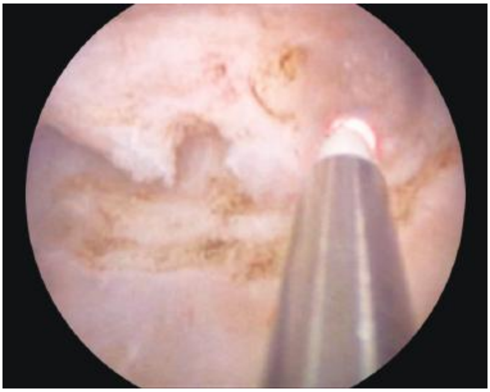


Fig. 5.12: Adhesiolysis in progress

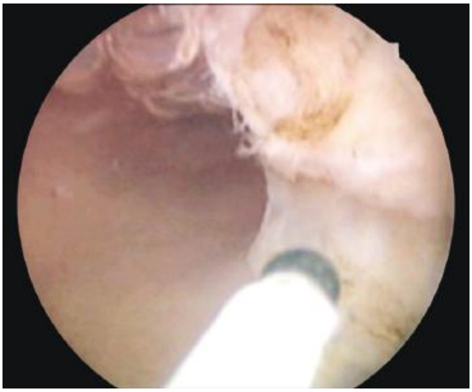


Fig. 5.13: Adhesiolysis continued

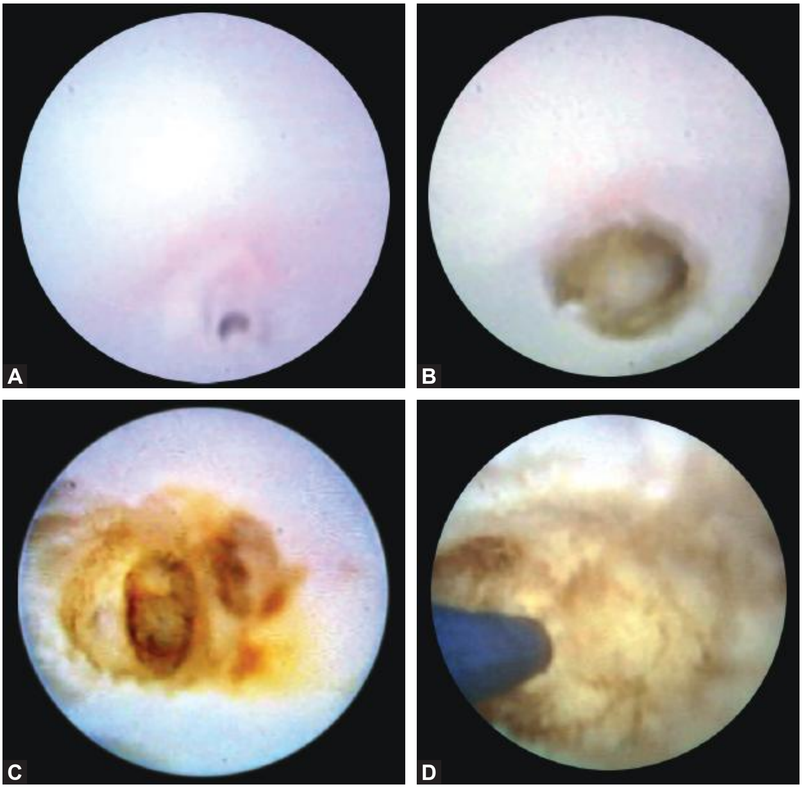
In case of completely obliterated endometrial cavity, the steps may be different:

1. Office hysteroscopy is preferred to visualize the internal os as, usually, it is stenosed (It is not advised to do blind dilatation).
2. With Versapoint or bipolar needle electrode passed through the operative channel, lysis of adhesions done slowly in the midline, from internal os upwards (Fig. 5.14B). This needs tremendous experience. (Preoperative TVS is of great importance to know the position and size of the uterus and hence, in which direction to proceed).
3. Once 2 to 3 cm lower cavity is formed, serial dilatation can be done if one wishes to shift to conventional hysteroscope or further adhesiolysis can be completed with office hysteroscope. Good intrauterine pressure can be obtained by using a conventional hysteroscope (Fig. 5.14C).
4. Further lysis of adhesions is performed, by giving horizontal cuts at the highest point and vertical cuts at the lateral walls (Fig. 5.14D).
5. Close examination of the cavity during cuts is important to see any endometrial flakes or myometrial pink fibers (Fig. 5.14E).
6. Change of intrauterine pressure helps to detect bleeding points (Fig. 5.14E).

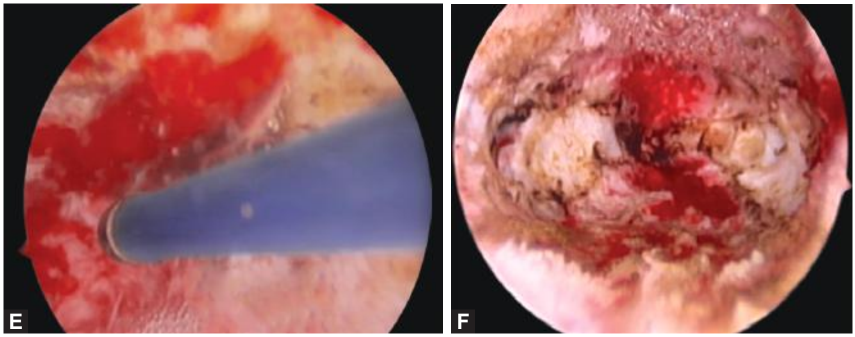
7. One can usually stop once 70 to 80 percent cavity is formed and pink myometrial fibers are seen, as over enthusiasm or overdoing can cause perforation.
8. Any kind of intrauterine device placement after surgery is not advised.
9. The prognosis in such cases is poor and if at the time of 2nd look hysteroscopy, adhesions are reformed, one should not progress with the surgery, but should advice surrogacy as an option.
10. Few advice surgery under laparoscopic control.

Postoperative Care

- *Estrogen and progesterone treatment:* Premarin 0.625 mg (2 tablets), 6 weeks + Duphaston 10 mg for latter 4 weeks.
- Second look hysteroscopy is advisable after 6 weeks if adhesions are moderate to severe and patient is for IVF
- The only criterion for success is a subsequent pregnancy resulting in a viable birth.



Figs 5.14A to D



Figs 5.14E and F

Figs 5.14A to F: A case of extensive Asherman's syndrome where the triad of office hysteroscopy, bipolar electrode and surgical expertise created a cavity

Tips and tricks

- Prior TVS and bimanual examination to know the size and position of the uterus is a must.
- In initial years of practice, the case can be done under laparoscopic guidance, though the above case has not been performed under laparoscopic guidance.
- Do not try to get 100 percent cavity in the 1st sitting as one can land up in perforation.
- These patients are put on high dose of estrogen for 6 weeks with add on progesterone in the latter few days.
- Usually, the 2nd look hysteroscopy is planned after 6 weeks, and one can proceed for the further release of adhesions if the cavity is not completely obliterated.
- Repeated orientation from the internal os is necessary, and one can achieve good cavity with practice.
- Usually 2–3 sittings are required for such an extensive case.

Metroplasty

i. Central metroplasty (Septum)
ii. Lateral metroplasty (T-shaped uterus).

HYSTEROSCOPIC SURGERY FOR INTRAUTERINE SEPTUM

First, a diagnostic hysteroscopy is performed to confirm the diagnosis of the septum.

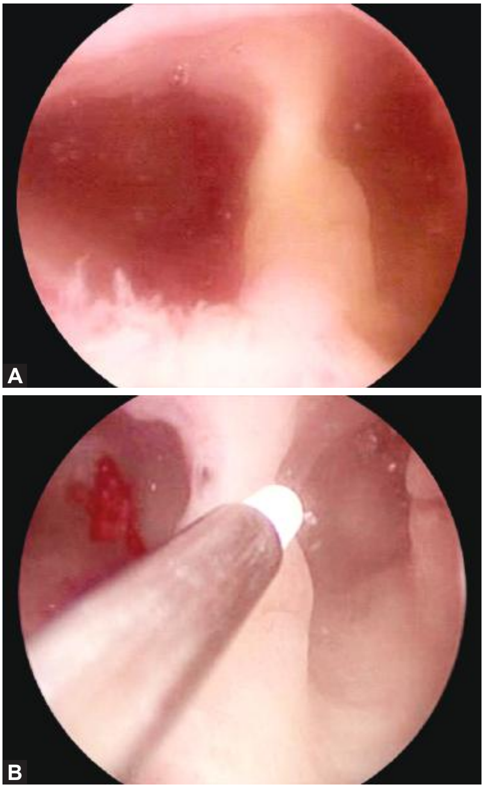
1. Bimanual palpation should be done to evaluate the position of uterus.
2. Gradual gentle dilatation of the internal os is done.
3. Diagnostic hysteroscopy should be done by using therapeutic sheath to confirm the diagnosis.
4. The set pressure of hysteromat should be between 180 to 200 mm Hg.
5. Both the ostia are visualized before the resection of the septum.
6. The septum is visualized.

7. Versapoint (Figs 5.15A to D) is passed through therapeutic sheath to release adhesions.
8. Incision is taken from the distal to the cephalic end.
9. When it is thin septum, incise it from distal to cephalic which causes fibroelastic band to retract.
10. In case of broader septum, 1st step is a lateral alternating technique of side-to-side resection up to 0.5 cm from fundus. Then the remainder is removed sweeping from cornu to cornu to avoid damage to this area.
11. End result is visualizing both ostia in one line.
12. Panaromic view is obtained from time to time by withdrawing the telescope till the internal os for getting judgment in cases of broad septum.

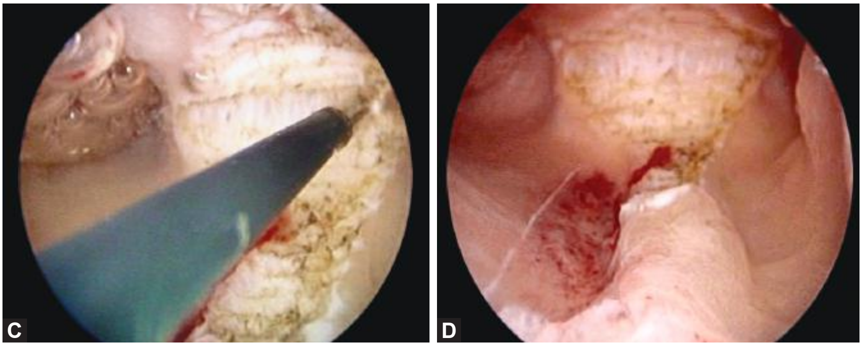
Tips and tricks

- Always see both ostia before starting for resection of septum.
- Try to use Versapoint in case of small septum.
- While resection, always stay in the midline of the septum.
- Care should be taken not to damage the basal endometrium that may interfere with rapid re-epithelialization of the area.

Good intrauterine pressure should be maintained.



Figs 5.15A and B



Figs 5.15C and D

Figs 5.15A to D: Resection of a complete septum with Versapoint—(A) Complete septum up to internal os; (B) Resection with Versapoint; (C) Resection in progress; (D) Resection towards the end

LATERAL METROPLASTY FOR T-SHAPED CAVITY (FIG. 5.16)

On hysteroscopy, from the internal os, the ostia are obliterated due to the bulge of the lateral pelvic wall (Fig. 5.17).

Procedure

1. A thorough visual exploration of the uterine cavity is done.
2. The resection is performed in a progressive manner by means of a repetitive contact between the electrode and the lateral wall of the uterus.
3. Vertical slits are made in the sides of the uterine wall to enlarge the uterine cavity from cranial to the caudal direction up to the internal os.

Fig. 5.16: T-shaped cavity on HSG

Fig. 5.17: T-shaped cavity on hysteroscopy

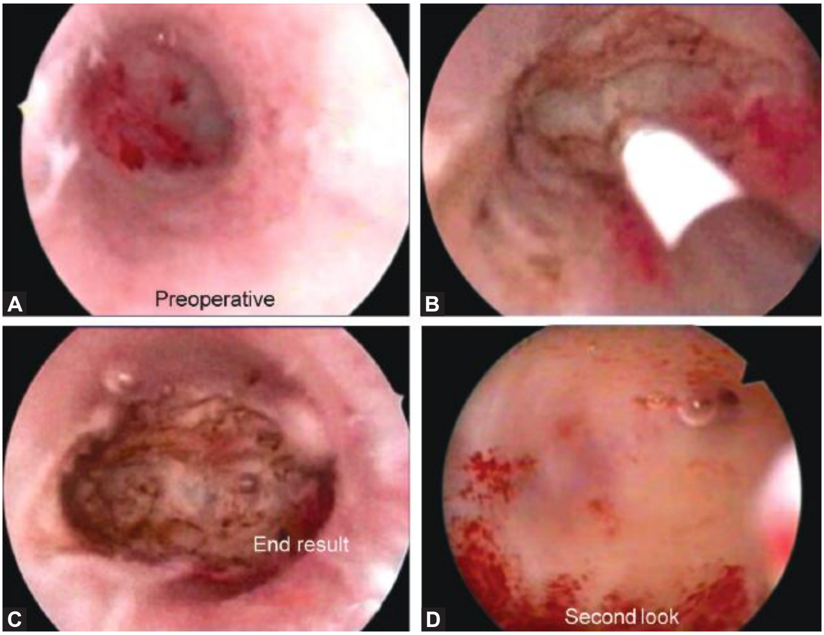
4. Usually, one finds an easy separation of anterior and posterior walls as one keeps on performing the lateral cuts.
5. Initially, Collins' knife was used (monopolar energy source). But after the advent of bipolar hysteroscopic energy sources, unipolar energy sources were more or less withdrawn from the practice, because of the undesired side effects of damaging the basal endometrium.
6. This surgery is usually not advised for the infertile woman, but for those with recurrent pregnancy loss (RPL).

AN INNOVATIVE HYSTEROSCOPIC SURGERY FOR UNICORNUATE UTERUS

Procedure

1. In cases of RPL of increasing gestation with unicornuate uterus, one can think of increasing the intrauterine volume by performing unilateral metroplasty instead of having few more further losses.
2. This is an innovative surgery, which we designed at IVF and endoscopy center, Ruby Hall Clinic. With Versapoint, the uppermost point on the vertical wall of the unicornuate uterus is marked.
3. This is taken as the upper and lateral most point (point P) beyond which, we should not go in the upward direction, to avoid perforation, but can go laterally.
4. First 2 to 3 horizontal cuts of 1 to 2 mm depth are given from one side of the cornu to the upper most point and then serial vertical cuts are given in the caudal direction till the internal os.
5. First horizontal, then vertical cuts allow us to make a tubular cavity into a triangular cavity with increased volume (Figs 5.18A to D).
6. After 6 weeks of estrogen and progesterone (in the 2nd half), 2nd look hysteroscopy is planned to confirm a good cavity.

The increase in volume of the cavity in the second look hysteroscopy (Fig. 5.18D) is evident as compared to the preoperative picture of 6 weeks ago (Fig. 5.18A).



Figs 5.18A to D: Hysteroscopic surgery for unicornuate

HYSTEROSCOPIC POLYPECTOMY/MYOMECTOMY

Hysteroscopic polypectomy can be done using Versapoint for polyps usually of less than 2 to 3 cm size (Figs 5.19A to C).

The polyp can be vaporized if it is benign or resected with versa electrode or bipolar resectoscope.

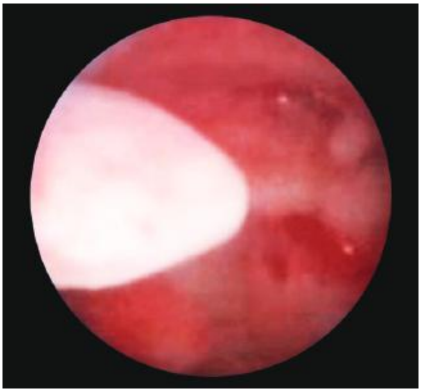
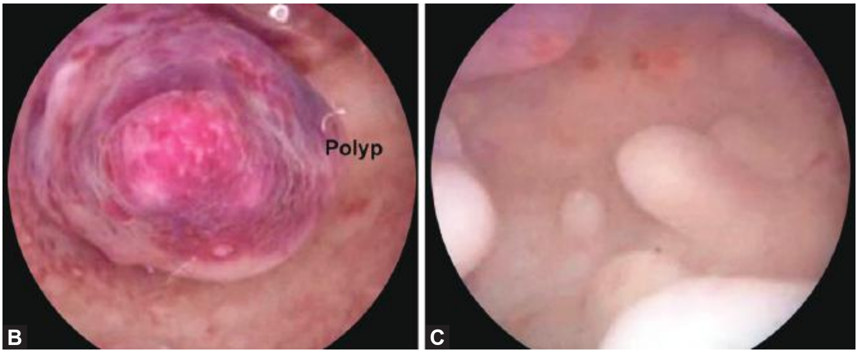


Fig. 5.19A



Figs 5.19B and C

Figs 5.19A to C: View of various polyps through the office hysteroscope—(A) A polyp that can be removed using Versapoint; (B and C) Large and multiple endometrial polyps, preferable to be removed by resectoscope, as polyp vaporization will be very time consuming

If one wishes to use the versa electrode, instead of vaporizing the whole fibroid polyp, one can detach it from the base of the pedicle and the polyp can be removed with forceps.

CHAPTER 6

Office Hysteroscopy

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Mariateresa Achilarre, Silvana Grasso, Luigi Selvaggi

INTRODUCTION

Hysteroscopy today can be considered as the gold standard for the evaluation of the uterine cavity and for the treatment of intracavitary pathology.[1,2]

It can be performed in an office setting (*outpatient hysteroscopy*) or as a day-case procedure, under general anesthesia (*inpatient hysteroscopy*). Outpatient hysteroscopy has shown good correlation of findings compared with inpatient hysteroscopy; furthermore it has distinct advantages as reduced anesthetic risks, enhanced time-cost effectiveness and patient's preference.[3-5]

Office hysteroscopy may be indicated in any situation in which a major or minor intrauterine or cervical anomaly is suspected and for the purpose of endometrial surveillance during hormonal treatment (Table 6.1).

Instead of inpatient hysteroscopy, outpatient hysteroscopy might be offered to patients who do not wish or cannot undergo general or local anesthesia and to virgin patients who wish to preserve the integrity of their hymen (vaginoscopic approach).

Although the international literature suggests that outpatient hysteroscopy, without any kind of analgesia or anesthesia, is a well tolerated procedure with a high success rate,[2-16] pain continues to represent an important limiting factor to a large-scale use of office hysteroscopy [5,14] and many patients still prefer the inpatient approach, believing that it will be pain-free.

Today by using liquid distention medium, atraumatic insertion technique of the scope (vaginoscopic approach) and improved equipment based on small-diameter rigid and flexible hysteroscope, we can minimize patient discomfort and to improve the chance of success of the procedure.

To better understand the "technical" points that will be discussed ahead it is important to underline some anatomical details of the uterus.

Table 6.1: Indications for office hysteroscopy

- Abnormal uterine bleeding
- Infertility
  - Routine infertility
  - Pre-IVF evaluation
  - Recurrent miscarriage
  - Suspicion of intrauterine adhesions
  - Suspicion of Müllerian anomalies
- Evaluation of the endometrium (Physiology/pathology)
- Preoperative surgical planning
- Suspected intrauterine growth
- Minor surgical procedures (Office operative hysteroscopy)
  - Biopsies
  - Polypectomy
  - Myomectomy
  - Metroplasty
  - Adhesiolysis
  - Tubal sterilization
- Follow-up of medical or surgical treatment

CERVICAL ANATOMY AND UTERINE INNERVATION

Cervical canal: The external cervical orifice (ECO) appears circular (4-6 mm in width) in the nullipara and as a transverse oval aperture (10-15 mm in width) in the multipara. The cervical canal is approximately 3 cm long, including the internal cervical orifice (ICO), which has an oval profile and a diameter varying from 4 to 5 mm in the nullipara, while it may be as much as 7 to 8 mm in the multipara. The anterior and posterior walls of the cervix have a system of folds applied one on the other, consisting of a longitudinal ridge along the median line known as the "arbor vitae", with smaller secondary crests arising on the left and on the right, the "plicae palmatae" (palmate folds) which extend mediolaterally and upward. The arbor vitae ends 5 mm before the ICO. The cervix is made of a thick connective tissue containing relatively little amount of smooth tissue. The innervation includes receptors, syncytial networks and sympathetic and parasympathetic fibers.[17]

Uterine corpus: The myometrium consists of bands of muscle fibrocytes arranged on a fibroelastic support. Around each muscular fascia and among the fibrocytes, there are many different structures including collagen fibrils running in various directions, isolated connective tissue cells, blood vessels and amorphous matter. No sensitive nerve terminals have been demonstrated on the endometrial layer, unlike in the myometrium which features medullary fibers branching out.[17]

Passage of a round hysteroscope of a size of 5 mm will modify the spatial disposition of the muscle fibers of the ICO, especially in the nullipara, stretching some of them (Fig. 6.1) and stimulating the sensitive fibers causing

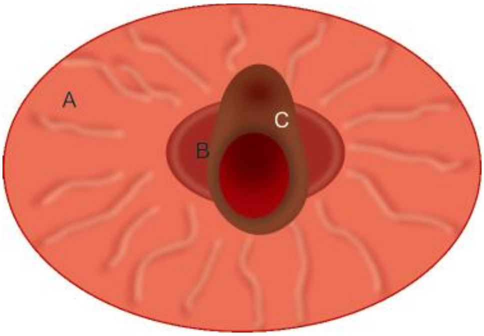


Fig. 6.1: Perspective view of the internal cervical os and the hysteroscope profiles in a traditional introduction: A–Cervix, B–Internal cervical os, C–Hysteroscope profile

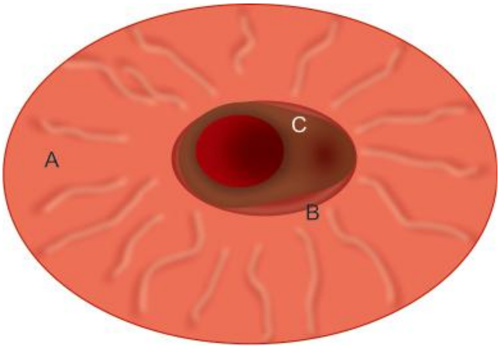


Fig. 6.2: Perspective view of the internal cervical os and hysteroscope profiles after 90° rotation: A–Cervix, B–Internal cervical os, C–Hysteroscope profile

pain to the patient. The new generation of hysteroscopes, featuring an oval profile and a total diameter between 4 and 5 mm, is more strictly correlated to the anatomy of the cervical canal. is enough to rotate the scope on the endocamera by 90° to align the longitudinal main axis of the scope with the transverse axis of the ICO (Fig. 6.2).

Anatomical impediments, frequently found in perimenopausal and menopausal women, are considered an obstacle to the correct execution of the hysteroscopic procedure. The use of a small diameter operative hysteroscope enable treatment of the problem before having a "diagnostic" view" of the uterine cavity. All anatomical obstacles, usually fibrotic processes involving the ECO as well as the ICO. and resulting in a reduction of the diameter, can easily be treated by cutting the "fibrotic ring" at two or three points (at 3 and 9 hours, for example). The correct distinction between fibrotic and muscular tissue allows to avoid pain.

TECHNIQUE AND INSTRUMENTATION

For more than ten years, the cervix and the uterine cavity have been examined using a diagnostic hysteroscope (DHS) with a total diameter of 5 mm, consisting of a 4 mm rod lens system scope inserted in a simple sheath, necessary to guide the distention media (CO_2) into the uterine cavity. A speculum was inserted in the vagina to visualize the cervix and the external cervical orifice, while a tenaculum was used to facilitate the insertion of the scope. To avoid pain related to the application of the tenaculum and to the traction of the cervix, local anesthesia or a paracervical block were frequently used.[18-20] Diagnosis was based on the “visual” examination of the cervical canal and of the uterine cavity—the reliability of the procedure was strictly related to the gynecologist’s experience—the biopsy was performed as a “blind” procedure (like D&C, Vabra, Pipelle, etc.) and it didn’t ensure all the time adequate and representative sampling of the endometrial cavity in the detection of intrauterine pathologies.[21-25]

Using an operative sheath over the existing 4 mm scope was possible to perform targeted hysteroscopic biopsy (THB), but it needed dilatation of the cervical canal and anesthesia due to the large diameter of the operative hysteroscope (around 6.5/7 mm).

Instruments

Since the introduction, at the beginning of the ‘90s, of new scopes (especially fiberscopes) with a diameter ranging between 1.2 and 3 mm., it has been possible to produce not only very thin diagnostic sheaths, but also operative sheaths including the working channel and continuous flow features with a diameter equal or less than 5 mm. This enabled the physicians to examine the uterine cavity and take targeted biopsies utilizing an operative scope with a final diameter not exceeding 5 mm. After acquiring enough experience in “handling” an operative hysteroscope equipped with miniaturized instruments, physicians became able not only to perform biopsies but also to treat small intrauterine pathologies. This has been defined as a “see and treat” procedure.[12]

One of the newest, world-widely used hysteroscopes is the office continuous flow operative hysteroscope “size 4” (Karl Storz, Tuttlingen, Germany), based on a 2.0 mm rod lens system with 30° fore-oblique view, with an outer diameter reduced to 4.0 mm. This instrument has two sheaths (one for irrigation and another one for suction), an operative 5 Fr canal (approximately 1.6 mm) and are oval in shape, ideal for atraumatic insertion of the scope into the cervix. These new lens-based “minihysteroscopes” have a very high visual quality, brightness, angle of view, and field of view comparable to standard 4.0 mm telescopes[11] (Fig. 6.3). A recent study has demonstrated[14] that the miniaturization of the instruments reduced the difficulties determined by both the operator experience and the patient’s discomfort.

A 1 to 2 mm reduction in the telescope diameter and consequently in the total hysteroscope size reduces the area of the instrument by about 50

Fig. 6.3: Hysteroscope "size 4" and "size 5"

to 75 percent, making its introduction easier and less painful compared with conventional ones.[15-16]

The oval profile of the hysteroscope together with the possibility of introducing grasping forceps or scissors through the working channel now allows to overpass most of the anatomical impediments.

Distention of the uterus is obtained using an electronic suction/irrigation pump (Endomat, Karl Storz, Tuttlingen, Germany) that can maintain a constant intrauterine pressure around 30/40 mm Hg, necessary to avoid overdistention of the muscle fibers and reduce patient discomfort (Fig. 6.4). Different 5 Fr mechanical instruments, as well as 5 Fr bipolar electrodes, are now available (Fig. 6.5).

A hight intensity xenon or halogen light of at least 250 watts is necessary for the best visualization (Fig. 6.6).

In the last few years smaller diameter flexible hysteroscopes demonstrated in several studies some advantages in term of patient discomfort, comparing with standard rigid ones. Disadvantages are a higher cost for equipment purchase and maintenance, difficult cleaning, disinfection and sterilization, more fragility, standard 0° angle of vision and reduced image size on the monitor compared with the standard hysteroscopy.[26]

Recently the improvement in fiber-optic technology allows the realization of a semi-rigid 3.2 mm minihysteroscope (Versascope, Gynecare, Ethicon Inc., Sommerville, NJ, USA) consisting in a 1.8 mm scope with 0° angle of vision and a single disposable outer sheath.

This sheath has an additional expanding, plastic, collapsible, outer sheath that permits CO_2 gas insufflation or low viscosity fluids under a continuous flow system, to be used for uterine distension. It also provides operative capabilities with 7 Fr semi-rigid mechanical instruments or 5 Fr bipolar electrodes.

Fig. 6.4: Electronic pump Endomat

Fig. 6.5: 5 Fr mechanical instruments

The main advantage of these instruments is to be atraumatic and easy to use. Despite of the great improvements in optic-fiber technology, it cannot match image quality of rod-lens-based telescope system and the flat tip of the scope with standard 0° angle of vision may interfere with cervix and cavity exploration in comparison with 30° fore-oblique scopes.[11,27]

Distention Media

For many years CO_2 was “the” distention media. Only in the last 8 years saline solution took its place for both diagnostic and operative procedures.

As long as the intrauterine pressure does not exceed 30 to 40 mm Hg, and the flow rate does not exceed 60 ml per minute CO_2 distention is extremely safe and if the procedure takes only a few minutes the amount of CO_2 entering the abdominal cavity is small (few hundred ml) and is rapidly absorbed.

Fig. 6.6: Xenon light

The hysteroscope should be advanced slowly under direct vision, creating a series of gas bubbles just ahead of the tip of the hysteroscope. The main disadvantage of CO_2 is that there is a tendency to form gas bubbles, expecially when the gas mixes with blood; the bubbles can obscure vision. Blood and mucus should be carefully removed from the cervical os with a dry swab.

Another disadvantage of CO_2 gas is that the gas bubbles can occasionally create artefacts wich can be confused with intrauterine adhesions or synechiae. Some soft and small intrauterine pathologies can be missed using the CO_2 due to the compression of the gas on the tissues.

Compared to CO_2, normal saline resulted to be more comfortable for the patient, more cost-effective and it provides superior hysteroscopic view in case of intrauterine bleeding.[8,28-32] Normal saline is preferred in office hysteroscopy, especially for operative procedures.

A correct flow between 200 and 350 ml/min, together with a negative aspiration of around 0.2 bar, using a pump, is normally enough to obtain good dilatation of the uterine cavity, at approximately 30 to 40 mm Hg,[33] and to avoid values higher than the 60 to 70 mm Hg, present within the tubes for the abdominal counter-pressure,[34] that prevents the passage of distension media into the abdomen and eliminate pain and the risk of the vagal reflex.

In the past, before the continuous flow sheath became available, we were compelled to use the single flow sheath designed for carbon dioxide examinations. In these cases, the saline solution was injected at atmospheric pressure (two 5 Lt bags connected by an urologic "Y" outflow and located 1.5 m above the patient). That way we obtained a flow of 150 to 200 ml/min with a resulting intrauterine pressure of around 40 mm Hg. If the diameter of the instrument is smaller than the one of the cervical canal the liquid could flow out of the cavity through the small space sheath and in this way, wash the uterine cavity.

The problem occurs when the cervical canal and the OUI (internal uterine orifice) are the same size or smaller than the hysteroscope. The liquid drains into the uterine cavity, because it cannot flow out or pass through the tubes into the abdomen. The view will be unclear due to the presence of hanging mucosa particles. In these cases, many endoscopists use compression cuffs to raise the flow and so the pressure. However, as the compressed liquid cannot flow out of the cervical canal, it will be forced to move into the abdomen through the tubes, causing pain and risk to the patient.

To perform even basic operative procedures (i.e. biopsies), the use of a continuous flow system together with an electronic suction/irrigation device is extremely important and strongly recommended to have always a clear vision even in case of bleeding or presence of thick mucus.

Versapoint System

The advantages of bipolar over monopolar technology are well accepted in the medical field. The most important benefit in hysteroscopy is the use of saline solution rather than nonionic distention media (i.e. glycine, sorbitol, mannitol, etc.), as well as the reduction of energy spread to the tissue during resection.

A versatile electrosurgical system dedicated to hysteroscopy [Versapoint bipolar electrosurgical system (Gynecare; Ethicon Inc., NJ, USA)] was introduced in 1997. It consists of a high-frequency bipolar electrosurgical generator and co-axial bipolar electrodes designed to cut, desiccate (coagulate) and vaporize tissue (Fig. 6.7). The 1.6 mm diameter (5 Fr), 36 cm long, flexible bipolar electrode can be used through any operating hysteroscope. Each electrode consists of an active electrode located at the tip and a return electrode located on the shaft, separated by a ceramic insert.

The coaxial bipolar mode involves the completion of the circuit from the active tip to return coaxial (2 mm proximally) through normal saline distending solution. When the electrode is activated in a conducting solution such as saline, an extremely high impedance vapour pocket is generated that surrounds and insulates the active electrode, preventing completion of the circuit until tissue contact is achieved. After tissue contact, the circuit is completed and the tissue between the active and return electrodes is cut, desiccated, or vaporized accordingly.

This system avoids both stray electrical energy and the risks of nonelectrolyte distending media. Because it vaporizes the tissue, the procedure can be accomplished more quickly, as vision is not obscured by chips. More precise

Fig. 6.7: Electrosurgical generator

Fig. 6.8: 5 Fr bipolar electrodes

vaporization also avoids cutting into the myometrium. Although tissue is vaporized, it is possible to leave pieces of tissue for pathologic examination.

There are three types of electrodes: the twizzle, specifically for precise and controlled vaporization (resembling cutting), the Spring, used for diffuse tissue vaporization and the ball to coagulate tissues (Fig. 6.8). The twizzle electrode is preferred to the others because it is a more precise "cutting" instrument and it can work closer to the myometrium with lower power setting and consequently with less patient discomfort.

The generator provides different modes of operation (waveform): the vapour cut waveform, resembling a cut mode (the acronyms are VC1, VC2, VC3, where VC3 corresponds to the mildest energy flowing into the tissue), the blend waveform (BL1, BL2) and the desiccation waveform, resembling a coagulation mode (DES). The generator is connected to the 5 Fr electrode via a flexible cable. Once connected, the generator automatically adjusts to the default setting (VC1 and 100 W).

The Versapoint system has been used to treat a variety of intrauterine lesions with the administration of conscious sedation, with or without paracervical block, with the use of general anesthesia and recently also without any analgesia or anesthesia.

Regarding the latter possibility, Bettocchi et al have demonstrated that lowering the power of the generator from the default setting of VC1/100 W down to the mildest level, VC3 and reducing by half the power setting (50 W) it was possible with the twizzle electrode to produce minimal dissection of the tissue (resembling a precise "cut") with minimal generation of bubbles obscuring the visual field and with a high patient tolerance.[35]

VAGINOSCOPIC APPROACH

The availability of light endocameras at a reasonable price made physicians able to handle the hysteroscope comfortably seated on a chair. Therefore, the use of a speculum and a tenaculum are no longer necessary: the vagina, being a cavity, can be distended by introducing a distention media, in order to locate the cervical canal, so there is no more need to "assist" the introduction of the scope into the cervix using the tenaculum. The scope is then driven to the posterior fornix to visualize the cervix and slowly backwards to identify the OUE (external uterine orifice). When the cervix and the OUE are visible, the scope is introduced into the cervical canal and after achieving its distension, the scope is carefully moved forward to the internal uterine orifice (OUI) and then to the uterine cavity with the least possible trauma. The anatomy can be followed by gentle movements of the hands that will correctly drive the hysteroscope into the cervix and through the ICO.

Only in presence of clinical or subclinical signs of a vaginal infection is hysteroscopy subordinated to the results of a vaginal smear. [9] This technique has permitted complete elimination of any type of premedication, analgesia or anesthesia, making the procedure faster and complication-free.

The vagina is distended with the same media (saline solution) and at the same pressure (around 30/40 mm Hg) used for the subsequent distention of the uterine cavity. There is no need to close the vulval labia using the fingers because the "weight" of the liquid is enough to distend the vagina and provide a correct visualization of the cervix.

Several retrospective and randomized studies have shown that vaginoscopic approach is effective, reduces patient discomfort and increases the possible applications of office hysteroscopy, being ideal in patients who otherwise might require general anesthesia, such as older women with somewhat stenotic vaginas and virgin patients.[9,10,27,28]

The fore-oblique view of 12° to 30° (typical of all the modern lens-scope based hysteroscopes) is particularly useful to examine the uterine cavity but can complicate the introduction of the scope into the OUE and into the narrow cervical canal.

The image localized in the middle of the screen is in fact located 30° (or 12°, depending on the scope) lower. Therefore, the required image (i.e. the

OUE or the cervical canal) should appear in the lower half of the screen and not in its center (Figs 6.9 and 6.10). In this way, the scope will be located in the middle of the canal, avoiding stimulation of the muscle fibers.[12]

A fore-oblique view is useful not only to find out the localization of OUE, mostly in case of very anteverted or retroverted uteri, but it also allows a correct and quick examination of uterine cavity with minimal patient discomfort. A view of the whole cavity and tubal ostiae can be gained simply by rotating the instrument on its axis, without any other lateral movement of the scope which might cause pain to the patient.[36]

This method, defined as "Vaginoscopic Approach" has definitively eliminated the patient discomfort associated with the traditional approach to the uterus as we confirmed on our data on more than 10,000 cases.[9]

DIAGNOSTIC HYSTEROSCOPY

Hysteroscopy must be performed in the early proliferative phase of the cycle (week following menstruation) when the endometrium is thin, usually quite flat and atrophic, and similar to the appearance of the endometrium of a postmenopausal woman (Figs 6.11A and B).

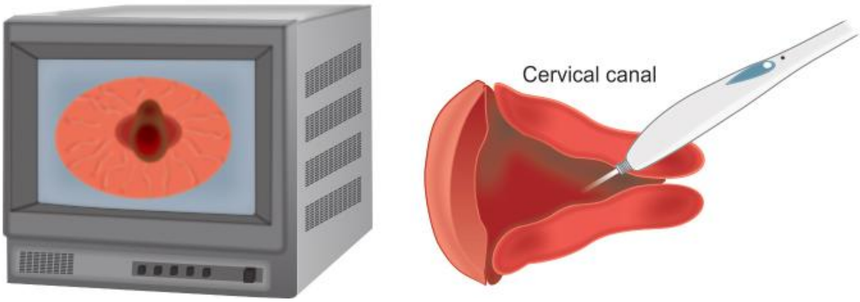


Fig. 6.9: Wrong view on the screen corresponding to wrong alignment of the instrument with the cervical canal

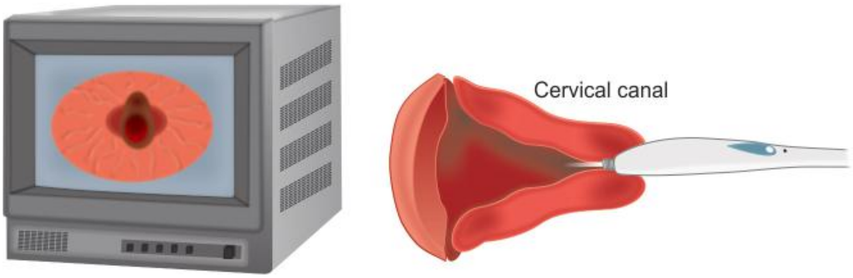
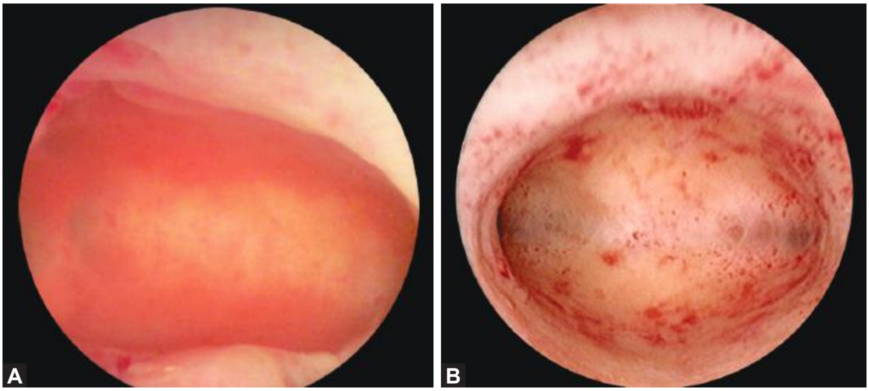


Fig. 6.10: Correct view on the screen corresponding to a correct alignment of the instrument with the cervical canal



Figs 6.11A and B: Normal cavity

The improvements in technique and instrumentation has allowed to achieve more reliable diagnostic results regarding the absence of pathology and diagnosis of all the endocavitary benign pathologies, such as polyps, myomas, synechiae, and septae. By placing the telescope close to the endometrium we also have the opportunity to see the vascular pattern, gland openings, and pathological features such as endometrial hyperplasia and endometrial cancer. We suggest to take a directed biopsy in suspected cases

A problem may be differential diagnosis between polyps and myomas, in particular in presence of large endocavitary pedunculated formations but the type of required surgical treatment is the same for both of them. It is possible to claim a satisfactory reliability of hysteroscopy also in these cases.

Precise diagnosis of hyperplasia, it must be underlined, can be established only by pathologic examination of the endometrium.[16,37,38] Endometrial hyperplasia is an irregular proliferative process of the uterine mucosa, resulting in an abnormal glands/stroma ratio, with or without cellular atypia. It has been related to an unopposed estrogenic stimulation of the endometrium and represents a frequent cause of abnormal uterine bleeding (AUB), in pre and postmenopausal women.

Hysteroscopic appearance of endometrial hyperplasia is variable and sometimes is very difficult to be distinguished from secretory endometria. Simple hyperplasia is characterized by a thick endometrium sometimes with a polypoid aspect; glandular ostium appears dilated and yellowish in color. Atypical hyperplasia is characterized by hemorrhagic, necrotic areas and gross proliferations that could distort the entire uterine cavity. Endometrial vessels appear irregular in shape and[19] branching. Hysteroscopic appearance of atypical hyperplasia could generate problems in differential diagnosis with endometrial carcinoma, so the histological confirmation is mandatory.[37]

The hysteroscopic criteria for the diagnosis and classification of endometrial hyperplasia can be insufficient, mainly in premenopausal women, because of its likeness with normal, late secretory endometrium.[38]

Considering the potential malignant evolution of endometrial hyperplasia, early hysteroscopic diagnosis of this condition may represent an important advance for the gynecologist only if associated with THB.

TARGETED HYSTEROSCOPIC BIOPSY

Endometrial lesions like focal endometrial hyperplasia and adenocarcinoma can easily be missed with endometrial sampling devices like Vabra, Pipelle or Novak, due to their "blind" nature.[15,23,25,39]

The availability of the new smaller hysteroscopes, including a 5Fr operative channel, has enabled the surgeon to perform targeted hysteroscopies biopsies (THBs) to confirm the endoscopic "visual" diagnosis. The standard technique widely used is defined as a "punch" biopsy—the biopsy forceps bite and close into the endometrium. The instrument is then extracted through the operative channel while the hysteroscope remains inside the uterine cavity collecting a small quantity of tissue often insufficient for histological examination. Bettocchi et al proposed the so-called "grasp biopsy" to collect enough endometrium for a correct histological examination.[12] The biopsy forceps are placed, with the jaws open, in contact with the endometrium; then they are pushed into the tissue for around 0.5 to 1 cm, avoiding touching the muscle fibers. Once a large portion of mucosa has been detached, the two jaws are closed and then the whole hysteroscope is pulled out of the uterine cavity, without pulling the tip of the instrument back into the channel. In this way, not only the tissue inside the forceps jaws but also the surrounding tissue outside the jaws can be retrieved, thus providing the pathologist with a large amount of tissue.

We also have the chance to perform targeted biopsies of suspicious, focal lesions.[39] In some cases, the hysteroscopic visual diagnosis may not correlate with the final histologic diagnosis; it is therefore advisable to do endometrial sampling in all doubtful cases.

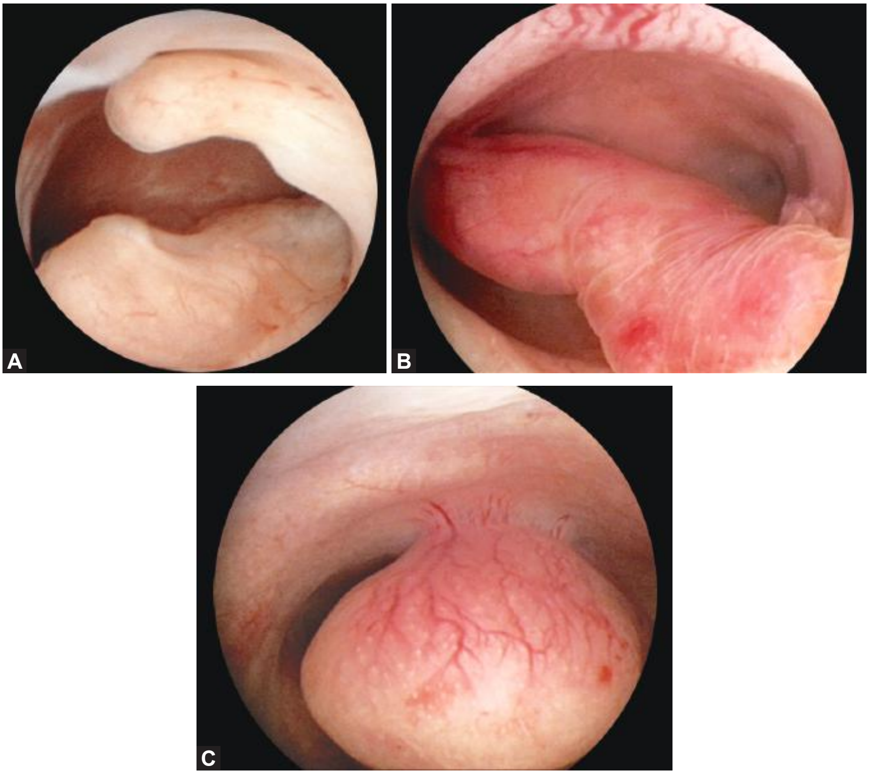
OFFICE OPERATIVE HYSTEROSCOPY

At present, with the development of smaller diameter scopes with working channels and continuous flow systems is possible to treat several uterine, cervical and vaginal pathologies in an office setting without cervical dilatation and consequently without anesthesia or analgesia.

Mechanical operative instruments (scissors, biopsy cup, grasper, corkscrew) have been for long time the only way to apply the "see and treat" procedure in the office setting.[40] The advent of bipolar technology, with introduction of several types of 5 Fr electrodes, increased the number of pathologies treated reserving the use of resectoscope and operating room for few cases.[35]

Polypectomy

Endometrial polyps (Figs 6.12A to C) are the most common pathological findings in hysteroscopy. Most of the times they can be asymptomatic



Figs 6.12A to C: Endometrial polyps

but in some cases they become necrotic and ulcerated at the tip causing intermenstrual bleeding. Some adenomatous polyps are associated with atypical or cystic endometrial hyperplasia and histological examination will differentiate between these various conditions. Very rarely there can be malignant changes in the base. For this reason, we suggest to remove all the endometrial polyps also if they are asymptomatic.

Small polyps (< 0.5 cm) should be removed using 5 Fr mechanical instruments (scissors and/or crocodile forceps).

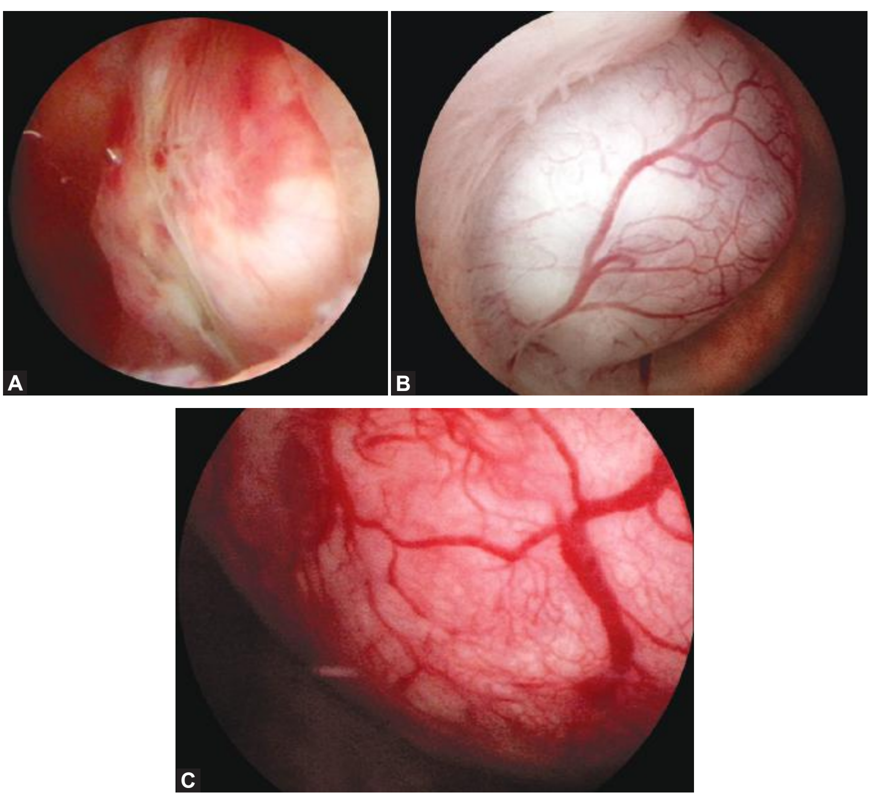
Cervical polyps have to be treated with scissors because of their fibrotic base which precludes the use of grasping forceps. For endometrial polyps the technique is to grasp the base with open jaws, close the instrument and push it gently toward the uterine fundus. The procedure has to be repeated several times up to the detachment of the polyp from its implant in myometrium.

Larger polyps can be removed intact, with the Versapoint twizzle electrode, only if the internal cervical os size is wide enough for their extraction. Otherwise, they are sliced from the free edge to the base into two/three fragments, large enough to be pulled out through the uterine cavity using 5 Fr grasping forceps with teeth. To remove the entire base of the polyp without going too deep into the myometrium, in some cases the twizzle electrode is bent by 25 to 30°, enough to obtain the shape of hook electrode.[35]

Myomectomy

The intrauterine myomas (Figs 6.13A to C) are classified on the basis of percentage of fibrotic tissue within cavity and myometrium. The fibroid should be examined from different angles by rotating the telescope to check the presence of a pedicle and if there is sufficient room between the fibroid and the uterine wall in order to insert instruments to remove it. They usually are relatively avascular with whitish aspect and occasionally they have large blood vessels over the surface. Sometimes, they are associated with adenomyosis or endometrial hyperplasia and rarely, they can co-exist with endometrial carcinoma. Clinically, they can present with menorrhagia and in some cases with dysmenorrhea as the uterus tries, and occasionally succeeds, in expelling them.

The dimension limit for the office hysteroscopic myomectomy is 1.5 to 2 cm. A technique similar to polypectomy is applied in office to remove submucosal myomas[35] with the difference that due to their higher tissue density, they have to be first divided into two half-spheres and then each of these is sliced and removed with the grasping forceps with teeth.



Figs 6.13A to C: Submucous myoma

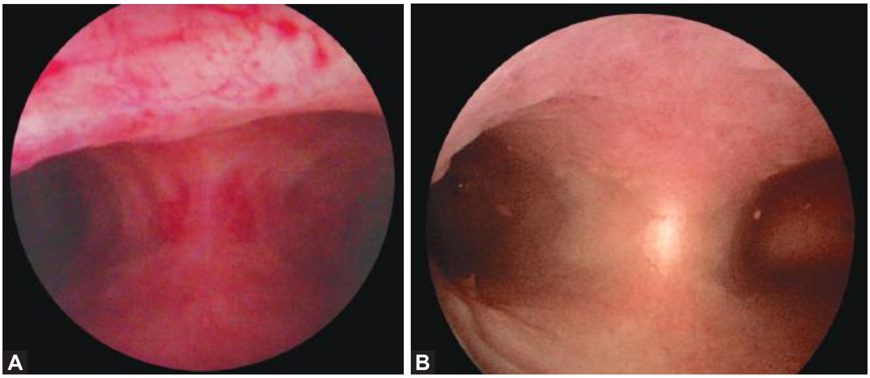
Particular attention has to be paid to the intramural part of the myoma, if present. First the myoma is gently separated from the capsule using mechanical instruments (grasping, forceps or scissors) to avoid any myometrial stimulation or damage of the surrounding healthy myometrium, as already described for "cold loop" resectoscopic myomectomy.[41] Once the intramural section becomes submucosal then it is sliced with the Versapoint twizzle electrode. If there is an appreciable amount of the fibroid projecting into the myometrium it is safer to administer a course of GnRH analogues for 2 to 3 months to decrease its size and reduce the vascularization.

Synechiae and Septae

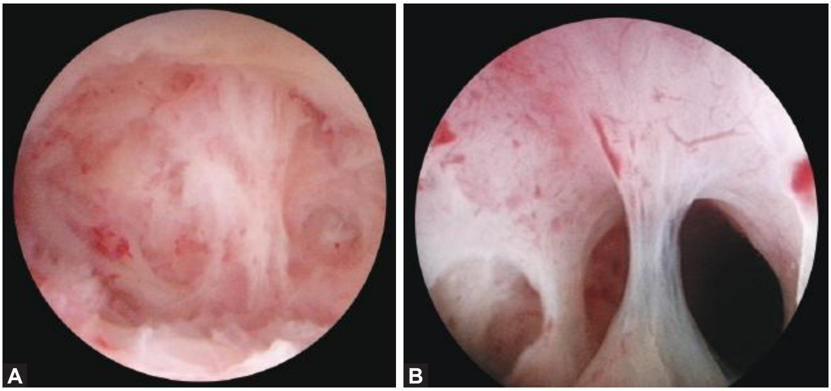
Uterine septae (Figs 6.14A and B) or adhesions might be contributing to infertility or recurrent pregnancy loss. Intrauterine synechiae (Figs 6.15A and B) can be treated by using scissors or bipolar electrodes to cut them in the middle. The extent of the septum can involve part of the uterine cavity, or completely divide both the uterine cavity and the cervical canal into two equal or unequal parts.[41,42]

Attention should be directed to the fundus of the uterus to make sure that there is no asymmetry and no evidence of a septum. We suppose that the shape of bicornuate uterus is absolutely obvious in hysteroscopy. Sometimes, it happens that the septum extends almost to the endocervical canal and if the telescope is passed to one side of the septum, the diagnosis can easily be missed.

The absolute indication for treatment of the uterine septum is infertility, failure of pregnancy (usually late first trimester or early second trimester miscarriages) preterm labor or abnormal fetal presentation occur in 20 to 25 percent of patients with uterine septum.[41-45] In patients with a history of primary infertility, hysteroscopic treatment of a uterine septum can be applied as a prophylactic procedure in order to improve the chances of a subsequent pregnancy.[46-50]



Figs 6.14A and B: Septum



Figs 6.15A and B: Synechiae

To diagnose a uterine septum, transvaginal ultrasonography has a high accuracy, making possible the differentiation between bicornuate and septate uterus and can define the thickness and the length of the septum.[51] Hysteroscopic visualization cannot always differentiate a bicornuate uterus from a septate uterus. Some techniques (i.e. TVS and three-dimensional US) are accurate for assessing the external aspect of the uterine fundus. The combined use of hysteroscopy and laparoscopy is actually considered the gold standard for differentiation between a bicornuate and a septate uterus.[52-53]

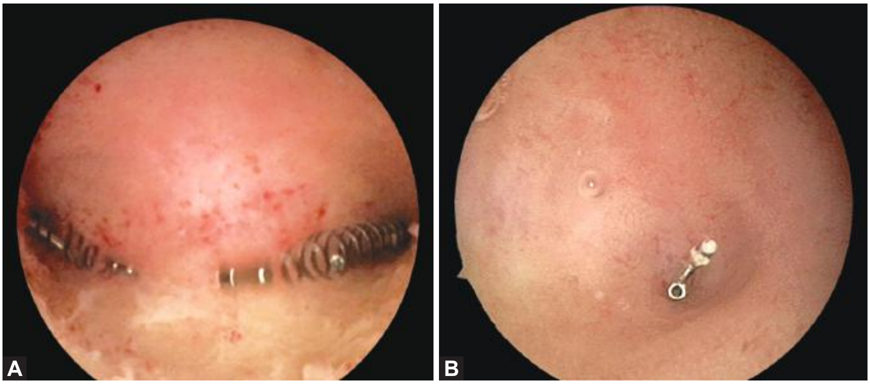
Reproductive outcome following hysteroscopic treatment of the symptomatic uterine septae brought rates of term deliveries to ~ 75 percent and live births to ~ 85 percent.[41,48] The fibromuscular tissue of the uterine septum is generally characterized by a greater collagen component, a poorly developed endometrium and the vascularization also appears less developed.[54] During office hysteroscopy, the septum is progressively cut starting from the proximal part, equidistantly from the anterior and the posterior uterine walls. The decision to stop the incision of the septum is taken when significant bleeding was observed, as well as pinkish tissue.

We believe that office hysteroscopic metroplasty, in awake patients, can alert the surgeon as soon as the muscular tissue is reached by the incision, causing the patient pain. In that instant, the metroplasty must be stopped regardless of the length of the septum left. This made possible to preserve the myometrium from unnecessary damage.

Tubal Sterilization

One of the most recent hysteroscopic procedures approved by the US Food and Drug Administration (FDA) is female sterilization (Essure, conceptus, incorporated, mountain view, calif), which can also be performed in office setting (Figs 6.16A and B).

This new device appears safe, effective and suitable for use in the outpatient setting. It is a titanium stainless steel and nickel expanding spring device



Figs 6.16A and B: Essure

(2 mm in diameter and 4 cm long), which contains Dacron fibers that induce an inflammatory reaction and a subsequent fibrosis of the intramural tubal lumen. The device can be inserted into the tubal ostia under hysteroscopic vision and although it requires special training to perform sterilization by this method, it is relatively easy to learn by an experienced hysteroscopist.

It would seem that this technique is a much safer and simpler technique than laparoscopic sterilization, which is still in widespread use in most countries.

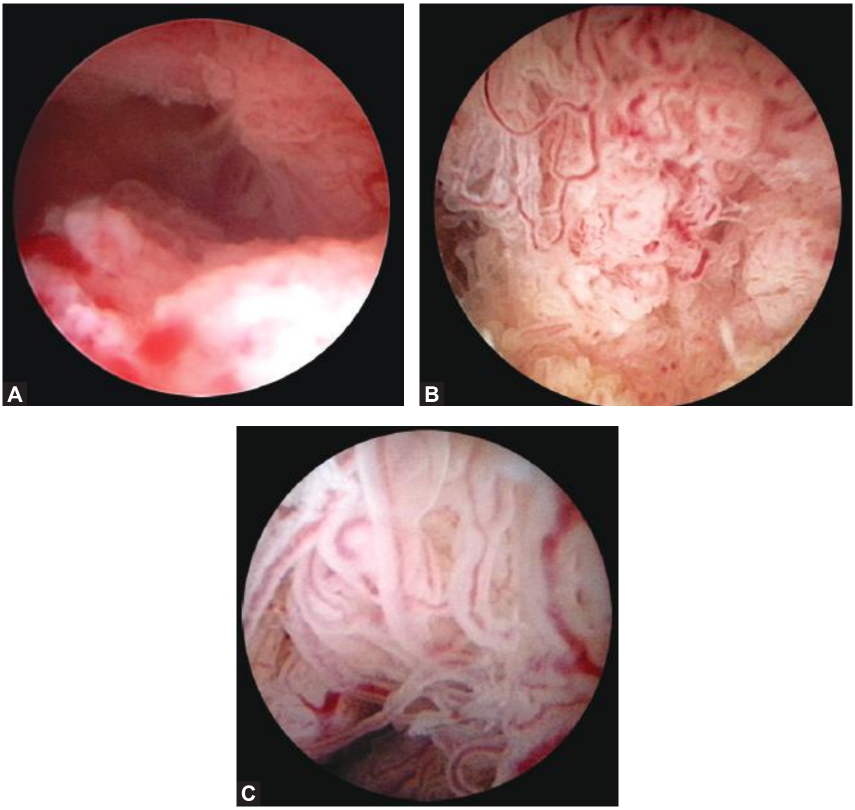
Endometrial Cancer

Endometrial cancer (Figs 6.17A to C) is the most common neoplasia of the female genital tract.[55,56] In over 90 percent of cases abnormal uterine bleeding in postmenopausal women is the first symptom. Uterine bleeding can be the first clinical sign of endometrial cancer.

Endometrial carcinoma is up to eight times more common in women with postmenopausal bleeding than in premenopausal women presenting with abnormal uterine bleeding, and high-risk hyperplasia is five times more common.[57] The menopausal status needs screening because of its elevated risk of a large number of benign and nonbenign pathologies of the female genital tract. Uterine bleeding is a common symptom occurring in 10 to 15 percent of postmenopausal women. In 15 to 40 percent, it is related to morphologic endometrial abnormalities[58] and in 50 percent of these patients no organic cause is found.[23,59]

Hysteroscopy allows the diagnosis, histologically confirmed after the targeted direct biopsy. It also allows to visualize the limits of the tumor and, in particular, if it is invading the endocervical canal, which would require a different treatment.

Endometrial carcinoma is often preceded by different types of endometrial hyperplasia. The differentiation between adenomatous hyperplasia, especially the atypical variety, and endometrial cancer is possible only after the histological evaluation of multiple biopsies.



Figs 6.17A to C: Endometrial cancer

CONCLUSION

The correct knowledge of the indications, the possibility to perform it with a high patient's compliance and the opportunity to carry out in office setting some operating room-procedures should increase and promote the feasibility, acceptability and spreading of office hysteroscopy. Novel instruments and techniques continue to emerge, and the prospects for improvement seem unlimited. Thus, it may be hypothesized that in the near future, office hysteroscopy would be proposed as a first-line diagnostic and operative tool for the investigation of abnormal uterine bleeding and infertility.

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CHAPTER 7

Diagnostic Hysteroscopy

Biswa Bhusan Dash, Reeta Mahey,
Alka Kriplani

INTRODUCTION

Direct visual inspection of the cervical canal and uterine cavity by telescope is called diagnostic hysteroscopy. Hysteroscopy was first described by Panteleoni in 1869 but the technique did not excite substantial interest within the specialty until 1970s. Presently hysteroscopy has become a standard procedure for diagnosis and treatment of uterine pathology. Simple exploration of endometrial cavity by diagnostic hysteroscopy is highly accurate for differentiating normal and abnormal endometrium,[1] in detecting endometrial inflammation.[2]

INSTRUMENTATION (FIGS 7.1A TO F)

Telescope

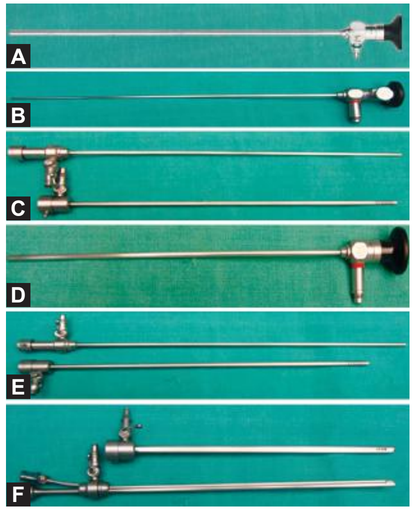
A 4 mm telescope (lens) is traditionally used for diagnostic hystero- scopy. Both 0° and 30° telescopes are used for hysteroscopy. Thirty degree scope is better for visualization of the uterotubal ostia, complete exploration of the uterine cavity and for operative hysteroscopy. The minihysteroscope (diameter < 3.5 mm) are increasingly used for diagnostic hysteroscopy for office hysteroscopy. 2.9 mm and 1.9 mm hysteroscope by Karl Storz and the versascope by Gynecare are excellent for diagnostic hysteroscopy. Versa- scope is especially helpful in taking biopsy and doing polypectomy at the same sitting.

Diagnostic Sheath

Diagnostic sheath is required for flow of distention media.

Continuous Outflow Sheath

Outflow sheath is usually not required for diagnostic hysteroscopy. But when there is bleeding in the uterine cavity after cervical dilatation or debris in the uterine cavity, it is helpful in clearing the debris and better visualization.



Figs 7.1A to F: (A) 4 mm 0° hysteroscope; (B) 2.9 mm minihysteroscope; (C) Diagnostic sheath and continuous outflow sheath of 2.9 mm hysteroscope; (D) 4 mm 30° hysteroscope; (E) Diagnostic sheath and continuous outflow sheath of 4 mm hysteroscope; (F) Operating channel with sheath used for taking targeted endometrial biopsy

Operating Channel

It is used for taking endometrial biopsy in infertility patients and take hysteroscopy guided biopsy in patients with postmenopausal bleeding and abnormal uterine bleeding.

INDICATIONS OF DIAGNOSTIC HYSTEROSCOPY

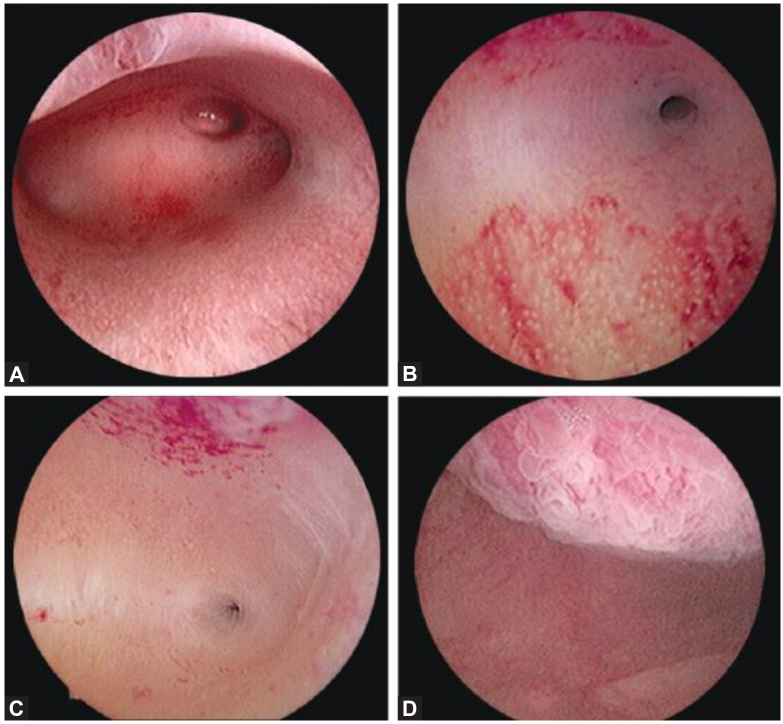
Infertility

While hysterosalpingography (HSG) and endometrial biopsy are important and well established techniques in the investigation of infertility, only hysteroscopy permits an accurate assessment of the uterine cavity in infertile women. Direct visualization of the uterine cavity and tubal ostia coupled with targeted endometrial biopsy provide more specific information which may clarify the cause of the infertility.

Hysterosalpingography has limitations as a diagnostic tool. Dubious or erroneous results have been reported in as many as 40 percent of the cases when HSG is compared with hysteroscopy and laparoscopy. The need for hysteroscopy becomes clear when filling defects are seen on HSG. A study conducted in 1983 showed that the uterine cavity as seen at hysteroscopy was normal in 45 percent of the women in whom a prior HSG had suggested a uterine anomaly (Figs 7.2A to D).

Hysteroscopy is recommended for the:

- Diagnosis and treatment of *intrauterine adhesions*
- To assess the anatomical and functional condition of the uterotubal ostia. Hysteroscopy is the best means of studying and evaluating the anatomy and function of the uterotubal ostium (Figs 7.2B and C).



Figs 7.2A to D: (A) Panaromic view of normal uterine cavity; (B) Left tubal ostium; (C) Mucosal folds at uterotubal junction; (D) Anterior wall grade 2 myoma

- To determine and guide postsurgical management of metroplasty and salpingoplasty
- To identify and treat suspected intrauterine pathology such as submucous myomas, endometrial polyps and hyperplasia. Intrauterine pathology, including submucous myomas, polyps, and hyperplasia, may occur in a relatively high percentage of asymptomatic, infertile patients. These conditions can be easily identified and classified through hysteroscopy
- To assess the status of the uterine cavity in cases of repeated abortion. Additional pathology which can interfere with embryo implantation and development are uterine malformations, particularly a septate uterus.

Hysterosalpingography (HSG) may give false results because pressure of distention medium in the uterine cavity and intramural portion of the fallopian tube may provoke contraction of the sphincteric muscle. Hysteroscopy allows the observation of the ostium under almost normal conditions. Falloposcopy, which may be controlled with or without hysteroscopy allows examination of the tubal lumen as far as the isthmo-ampullary junction and, occasionally, as far as the fimbrial opening. This is less invasive and traumatic than laparoscopic salpingoscopy or intraoperative microbiopsy.

Hysteroscopy and laparoscopy allow precise classification and consequently appropriate treatment of uterine malformations. When facing the problem of recurrent abortion, visualization of the uterine cavity becomes indispensable for a correct diagnosis, and forms the basis for an appropriate therapy.

Abnormal Uterine Bleeding

One-third of all gynecologic consultations are because of abnormal uterine bleeding (AUB) and this constitutes the second indication for hysteroscopy. This proportion rises to more than two-thirds when the peri- and postmenopausal age groups are considered.

Excessive menstrual blood loss is a strong indication for exploring the uterine cavity and determining the underlying pathology. The only other method available in such cases is dilatation and curettage (D and C). D and C provides a histological diagnosis, but it often requires general anesthesia and, in many hospitals an overnight stay. The main drawback of D and C is that it is a blind procedure that may not identify focal lesions. Hysteroscopy has replaced conventional cervical dilatation and curettage under general anesthesia, which has been shown to be diagnostically relatively inaccurate,[3] for the investigation of abnormal uterine bleeding.

Hysteroscopy with an endometrial biopsy is the procedure of choice in patients with abnormal uterine bleeding. Biopsy is especially important if hyperplasia, polyps (Figs 7.3A to D) or endometrial cancer are suspected. DH was found to have a significantly better diagnostic performance compared to SIS and TVS. In addition, after comparing the receiver operating characteristic curves, DH was found to be significantly more precise in the diagnosis of intracavitary masses than TVS and SIS.[4]

Recurrent Pregnancy Loss

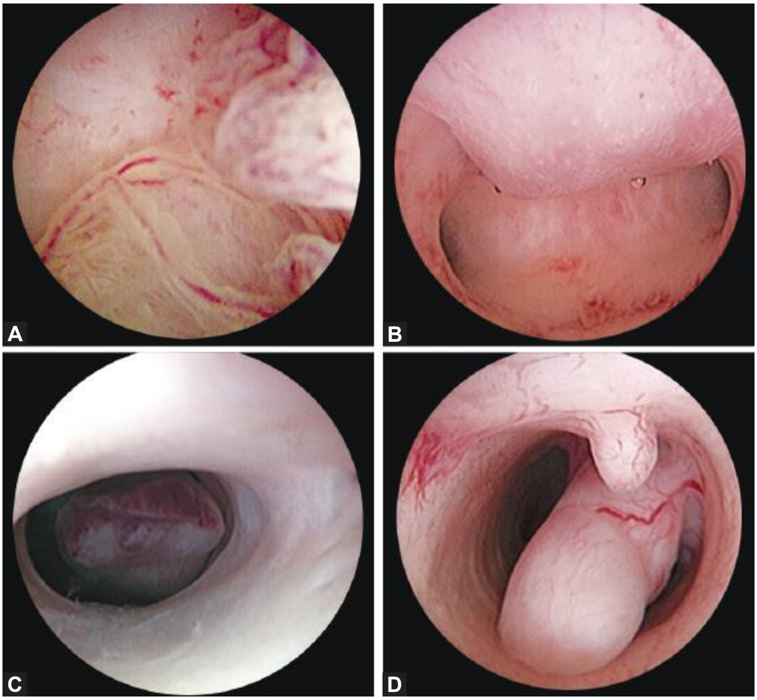
In patients with recurrent pregnancy loss, hysteroscopy is required to rule out any intracavitary pathology. Fibroids bulging into endometrial cavity (Figs 7.2D and 7.3B), uterine septum and intrauterine adhesions can cause recurrent pregnancy loss. Hysteroscopy is the investigation of choice in detecting these abnormalities.

Endometrial Hyperplasia and Cancer

The third area in which hysteroscopy can provide valuable information is in the prevention and early diagnosis of neoplastic lesions of the endometrium. Early diagnosis of endometrial adenocarcinoma may be difficult in premenopausal women, since this type of neoplasm may be asymptomatic for a long period.

Although D and C and endometrial biopsy are also reliable for the diagnosis of endometrial neoplasia, hysteroscopy has the advantage of permitting a *targeted biopsy* in the event of localized lesions, reducing the possibility of false negatives. In addition, it permits proper classification of the extent and degree of hyperplasia.

The gold standard modality of investigation to visualize the uterine cavity is hysteroscopy, but transvaginal scanning is recommended as the first-line investigation to select those who need further diagnostic evaluation. Hysteroscopy should be performed in women with a thickened endometrium



Figs 7.3A to D: (A) Vascular polyp in a patient with postmenopausal bleeding; (B) Anterior wall submucous myoma in a patient with recurrent pregnancy loss; (C) Endometrial polyp in an infertile patient with thickened endometrium in ultrasound; (D) Polyp in the endocervical canal in an infertile patient

on scan and women with recurrent episodes of bleeding despite negative scan findings.[5]

Intrauterine Foreign Body/Misplaced Intrauterine Contraceptive Device (IUCD)

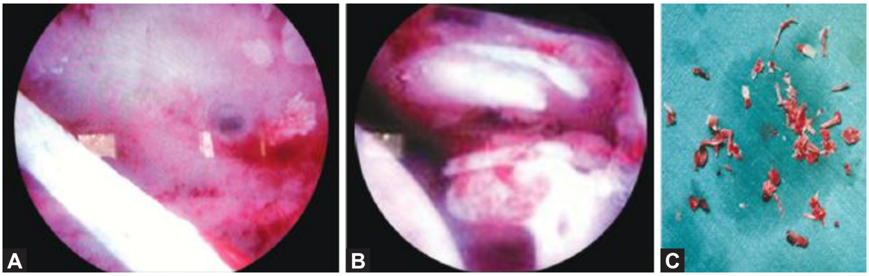
Hysteroscopy is very informative in cases of misplaced intrauterine contraceptive devices when the thread is not visualized. The device can be removed at the same time. Intrauterine foreign bodies including fetal bones can be detected and removed by hysteroscopy (Figs 7.4A to C).

Classification of Submucous Myomas

Hysteroscopy helps in localization of uterine fibroids which is an important factor in determining frequency and severity of symptoms. Submucous fibroids may induce severe clinical symptoms such as excessive bleeding, colicky dysmenorrhea and are thought to predispose patients to reproductive failure.[6]

Before IVF Cycles

The role of routine diagnostic hysteroscopy before ART cycles was not clear till date. However several studies are going on. The office hysteroscopy should



Figs 7.4A to C: (A) Hysteroscopic view showing small bone spicules near left ostium and a large bone; (B) Fetal bones in center of uterine cavity; (C) All bones removed during the procedure

be part of the infertility workup before ART even in patients with normal HSG and/or TVS. This is especially relevant in cases with prior failed ART cycles.[7]

CONTRAINDICATIONS

1. Presence of an *active pelvic infection.*
2. *Cervical cancer* is a relative contraindication. In these cases the examination can be performed, but the surgeon must observe adequate precautions. The potential spread of an infection caused by intrauterine manipulation and the pressure of the distending medium may increase the risk of spreading infection so prophylactic antibiotics should be given. Hysteroscopy can be performed without any major risk of spreading malignant cells in patients with invasive cervical carcinoma. However, hysteroscopy in the presence of invasive cervical cancer has no practical value if we exclude the differential diagnosis of a primitive adenocarcinoma of the endocervix, a very rare form of cancer.
3. *Pregnancy* should be ruled out before doing hysteroscopy in patients in reproductive age group. Special care is required in discussing hysteroscopy in early pregnancy. This can be performed without affecting the pregnancy, although the indications are few. They include the removal of a "lost IUCD" to avoid the risk of a septic abortion.

DISTENTION MEDIA

The uterine cavity is a potential cavity and needs to be distended to allow for inspection. The thick muscle of uterine wall requires a minimum pressure of 40 mm Hg to distend the cavity sufficiently to see with a hysteroscope. A pressure of 70 mm Hg clears the uterine cavity by propelling the fluid along with minor bleeding into the peritoneal cavity.

Current recommendation is to use normal saline (0.9% sodium chloride), and in operative cases in which mechanical, laser, or bipolar energy is used. This is the safest media for diagnostic hysteroscopy. Several studies have confirmed that distention using normal saline solution is more acceptable to the patient[8] because the procedure is smoother and without the irritant effect of CO_2; is quicker to perform; offers advantage in terms of good visualization of the uterine cavity in the presence of blood clots, mucous, and debris and enables increasing confidence in diagnosis.[9]

PROCEDURE

The traditional technique of diagnostic hysteroscopy was based on use of 5 mm hysteroscope, speculum, tenaculum, cervical dilators and normal saline for distention which causes a lot of discomfort and vasovagal reactions. But with the innovation of thinner hysteroscopes and cervical softening with misoprostol diagnostic hysteroscopy is gradually becoming more simpler and it has increased the feasibility and acceptability of the procedure.[10]

Technologic improvement have made it possible to minimize the caliber of instruments; thus with the use of thin endoscopes, diagnostic hysteroscopy is considerably less painful and easier to perform, even for operators with minimal training, and is becoming a popular technique.[11] Diagnostic hystero scopy has been done in the hospital, surgical centers and the office. It is best done when the endometrium is relatively thin, that is after a menstruation. Diagnostic hysteroscopy can easily be done in an office or clinic setting. Local anesthesia can be used. The patient is in a lithotomy position.

After cervical dilation, the hysteroscope with its sheath (Fig. 7.1) is guided into the uterine cavity, the cavity insufflated, and an inspection is performed. If abnormalities are found, an operative hysteroscope with a channel to allow specialized instruments to enter the cavity is used to perform the surgery.

OFFICE HYSTEROSCOPY

An office procedure is performed without the use of general anesthesia; it does not require a theater room and a routine office examination room is used. Performing this procedure under an office setting has many benefits both to the healthcare providers and patients, including decreased complication rates, shorter recovery time, and decreased costs.[12] The instrument, which can be either rigid or flexible, is passed through the cervix and into the uterus. A distention medium, usually saline, is used to expand the uterus. With an increasing emphasis on ambulatory gynecology, a move towards performing hysteroscopy in an outpatient or 'office' setting has been advocated due to substantial health and economic benefits.

Diagnostic minihysteroscopy (3.5 mm or less in size) is less painful and easier to perform than hysteroscopy performed with instruments sized around 5 mm. The main limitation to its widespread use is pain and low patient tolerance. Intrauterine surgical procedures involving only the endometrial mucosa (biopsies, adhesiolysis, cervical and endometrial polypectomies) are not painful and can be easily performed.[13]

VAGINOSCOPIC APPROACH/NO-TOUCH TECHNIQUE

The hysteroscope is first introduced into the introitus of the vagina. The vagina is then distended with the saline distention medium. This facilitates visualization of the anatomy. The hysteroscope is then directed towards the cervix, the cervical canal, and then into the uterine cavity.[14] This technique has less pain and more patient acceptability is more as speculum and tenaculum are not used.

PAIN RELIEF DURING DIAGNOSTIC HYSTEROSCOPY

Use of general anesthesia for diagnostic hysteroscopy is not an ideal practice. A beneficial effect of local anesthetics versus placebo or no treatment during and within 30 minutes after hysteroscopy. However, there was no evidence of benefit for the use of local anesthetics or oral analgesics over placebo or no treatment for pain relief more than 30 minutes after hysteroscopy.[15] Vaginal misoprostol, 400 μg, administered the day before office hysteroscopy considerably reduces pain and the time needed for hysteroscopy. This simple strategy may facilitate office hysteroscopy during an infertility work-up.[16] Instrument diameter and hysteroscopist experience, but not the distention medium, seem to be the primary variables that affect the perception of discomfort during office hysteroscopy.[17]

COMPLICATIONS

1. *Uterine perforation:* A possible problem is uterine perforation when either the hysteroscope itself or one of its operative instruments breaches the wall of the uterus.
2. *Bleeding:* Bleeding can result from uterine perforation and damage to other organs. If other organs such as bowel are injured during a perforation, the resulting peritonitis can be fatal.
3. *Cervical laceration:* Cervical laceration is uncommon in diagnostic hysteroscopy. In cases of cervical stenosis, cervical laceration can occur during the process of cervical dilation.
4. *Intrauterine infection:* Intrauterine infection is a rare complication of hysteroscopy especially in prolonged procedures and when there is associated cervicovaginal infection.

The overall complication rate for diagnostic and operative hysteroscopy is 2 percent with serious complications occurring in less than 1 percent of cases. As a result of technologic advancements and increased operator experience, an increasing number of gynecologic pathologic conditions traditionally treated in the operating room may be treated safely and effectively using office operative hysteroscopy.[18]

CONCLUSION

Hysteroscopy is a simple and effective method of evaluating uterine cavity. With the innovation of minihysteroscopes and office hysteroscopy it should be used liberally in infertility patients and in patients with abnormal uterine bleeding. Detection of endometrial pathology is more accurate with hysteroscopy with guided biopsy than traditional ultrasonography and D and C.

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CHAPTER 8

Lasers in Hysteroscopy

Nagendra S Sardeshpande, Aditi A Dani

INTRODUCTION

The term 'laser' is an acronym for '**L**ight **A**mplification by **S**timulated **E**mission of **R**adiation.' Lasers now have an established place in gynecological surgery. They offer unique advantages, which, in appropriate circumstances make the large financial and training outlay worthwhile.

The hysteroscope has been used for many years as a diagnostic instrument to evaluate and treat uterine intracavitary pathology. Various instruments can be used with the hysteroscope, including electrodes to cut and coagulate, operating graspers, scissors, as well as various laser fibers.

Lasers offer a high degree of surgical precision with varying combination of cutting, vaporizing and coagulating properties.[1,7,9] Understanding how the laser generates its beam of light is essential for effective and safe use of this technology. In general, lasers are very safe if used appropriately and carefully.[21,22] Lasers provide a range of surgical properties with unique advantages and disadvantages. Hence, it is important to "know your own laser" and know how to extend its scope with judicious use of ancillary equipment and techniques.

HISTORY

The key mechanisms of action of the laser were first discovered by Albert Einstein in the early 1900s.[2] The first laser developed by Theodore Maiman in 1960 used a ruby as the active medium, and in 1961 the CO_2 laser was introduced.[3,4,10,11] The CO_2 laser was used in gynecology for the first time in 1973 by Kaplan and colleagues for treatment of cervical erosions, and later by Bellina for treatment of cervical intraepithelial neoplasia (CIN) and for microsurgery of the fallopian tube.[5,6,18,19] The use of KTP, argon, and Nd:YAG lasers became popular in the early 1980s.[17,25]

LASER PHYSICS

Lasers are named according to the medium that is activated. The common lasers in gynecology are CO_2, argon, KTP, and Nd:YAG.[12,13] Each medium produces light waves of specific wavelength giving it a characteristic color (monochromatic). A simple way to understand how light is emitted is to look at an atom with its surrounding electrons (Fig. 8.1). These electrons occupy discrete orbits that shift to higher orbits when they absorb energy (Fig. 8.2). Whenever the medium is activated, electrons are displaced to higher energy orbits. In the case of the CO_2 laser, activation of the gas particles is done by using electrical current. The electrons that are displaced quickly return to

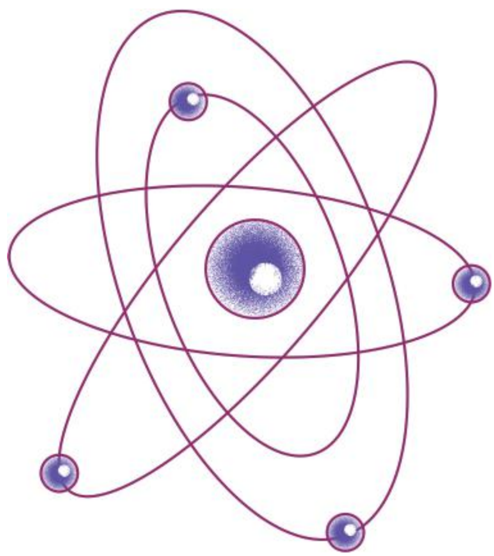


Fig. 8.1: Illustration of an atom with a nucleus and orbiting electrons

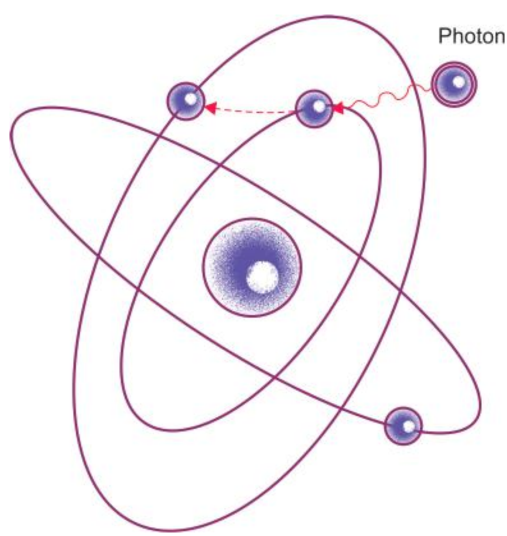
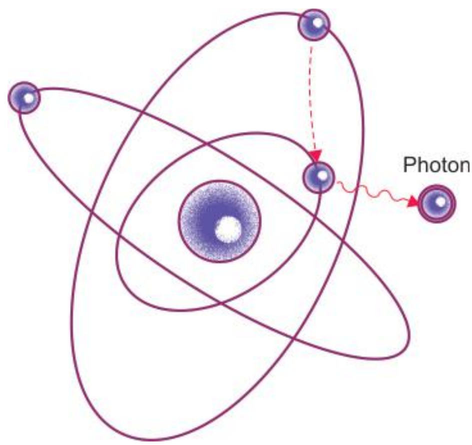


Fig. 8.2: Stimulated absorption occurs as a photon impacts on an electron, driving it into a higher orbit



Spontaneous emission

$\Delta E = hf$

ΔE = Difference in energy between 2 orbits

h = Planck's constant 6625×10^{-34} Joule/sec

f = Frequency

Fig. 8.3: Slow, natural decay causes an electron to drop into a lower orbit, resulting in a photon being emitted at a predicted frequency equal to the difference in energy between the two orbits

their resting orbits, releasing a package of energy in the process referred to as a photon (Fig. 8.3). This process of light generation is known as spontaneous emission. An example of this process is a light bulb, which emits light waves of different frequencies in all directions out of phase.

In a laser, these photons can further stimulate an already excited atom in its path to release an identical photon that is in phase (coherent), has the same wavelength and color (monochromatic), and travels in the same direction without divergence (collimated). This process is referred to as stimulated emission (Fig. 8.4).

In the case of the CO_2 laser, this process occurs within a tube located in the arm of the machine (Fig. 8.5). This tube is an optic resonator that has a totally reflective mirror and a partially reflective mirror at either end. Light generated is able to bounce back and forth from both mirrors, increasing the energy of the wave with each pass. Laser light is released through one of the mirrors which partially transmits the beam and is controlled by the foot pedal (Fig. 8.6).[16,24]

LASER INSTRUMENTATION AND USE

Different lasers have variable wavelengths (different colors). The argon laser produces a wavelength of 510 nm, making a blue-green light. The KTP produces a wavelength of 532 nm, making its light a green color. The CO_2 laser, in contrast, produces a wavelength of 10,800 nm, which is in the invisible part of the electromagnetic spectrum. Hence, a helium-neon laser is also used along with a CO_2 laser, which produces a red light to identify the location of the CO_2 beam.[14,20]

The laser beam comes out of the port as an unfocused beam. A lens system is used to focus the laser to a focal point. With the hand-held attachment, the

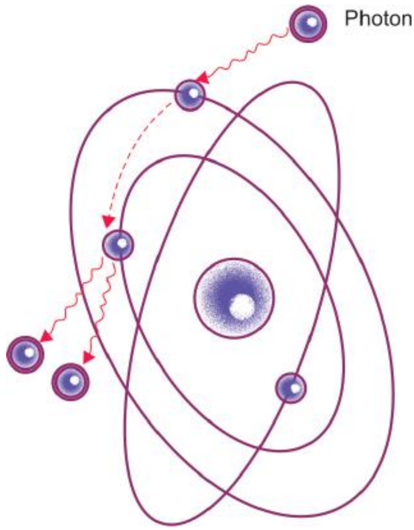


Fig. 8.4: The natural "slow" decay process may be stimulated by collision processes, resulting in many photons travelling at the same frequency as the inducing photons

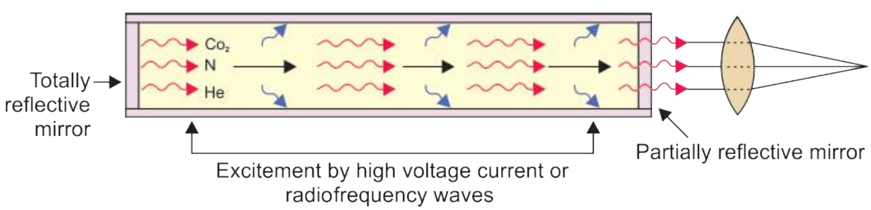


Fig. 8.5: Schematic diagram of a CO_2 laser tube. Protons reflect between the two mirrors (in phase) and eventually exit as the laser beam by way of the partially reflective mirror

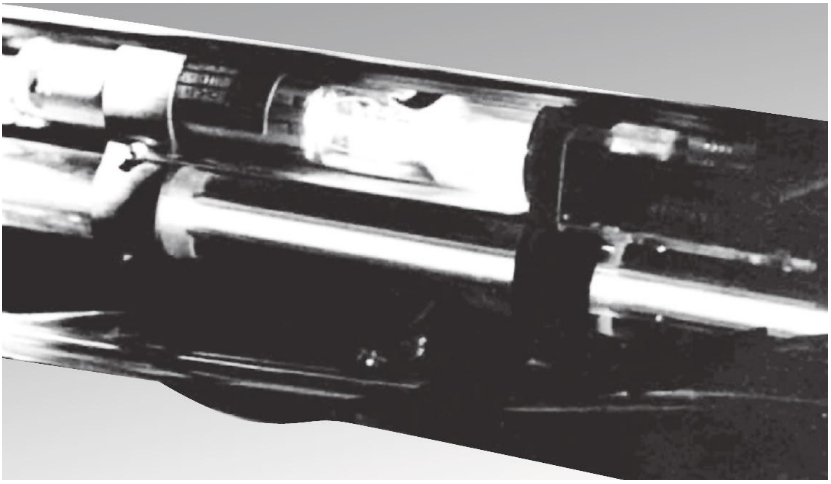


Fig. 8.6: Actual view of a CO_2 laser tube (below) and coincident helium-neon laser (above), which provides visible aiming target

focal point is usually 10 cm away from the focusing lens. With endoscopy, the focal length varies according to the length of the endoscope. Fine focusing can be done through a joystick or automatically with a coupler. Also, with the use of wave guides, one eliminates the problem of intermittent focusing of the beam that is associated with the joystick device (Fig. 8.7).

In contrast to the CO_2 laser, in which the energy is transmitted through long tubes and reflected by mirrors, the argon, KTP, and Nd:YAG lasers are transmitted via a fiber (Figs 8.8 and 8.9).

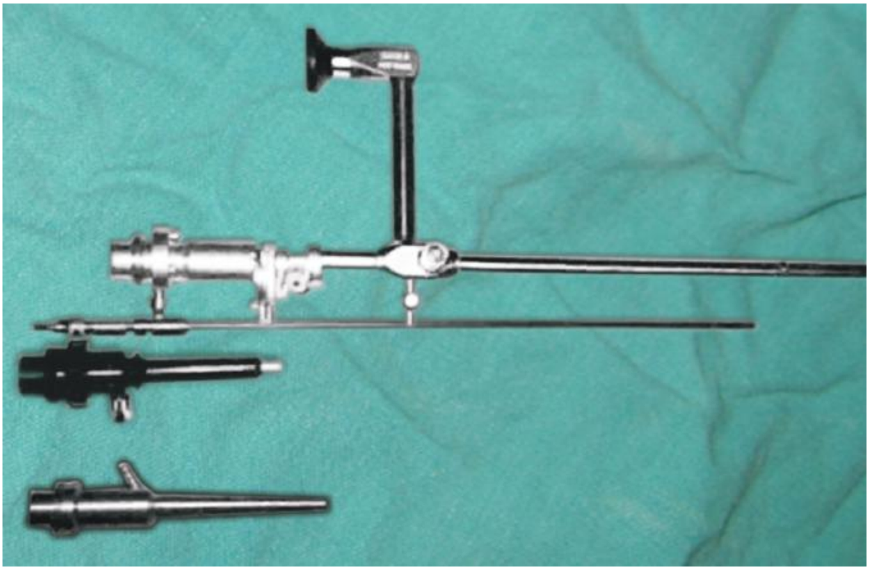


Fig. 8.7: Instrumentation (wave guides, hand piece, coupler) used for laser surgery

Fig. 8.8: Flexible fibers used for laser surgery

LASER SYSTEM COMPONENTS (FIG. 8.9)

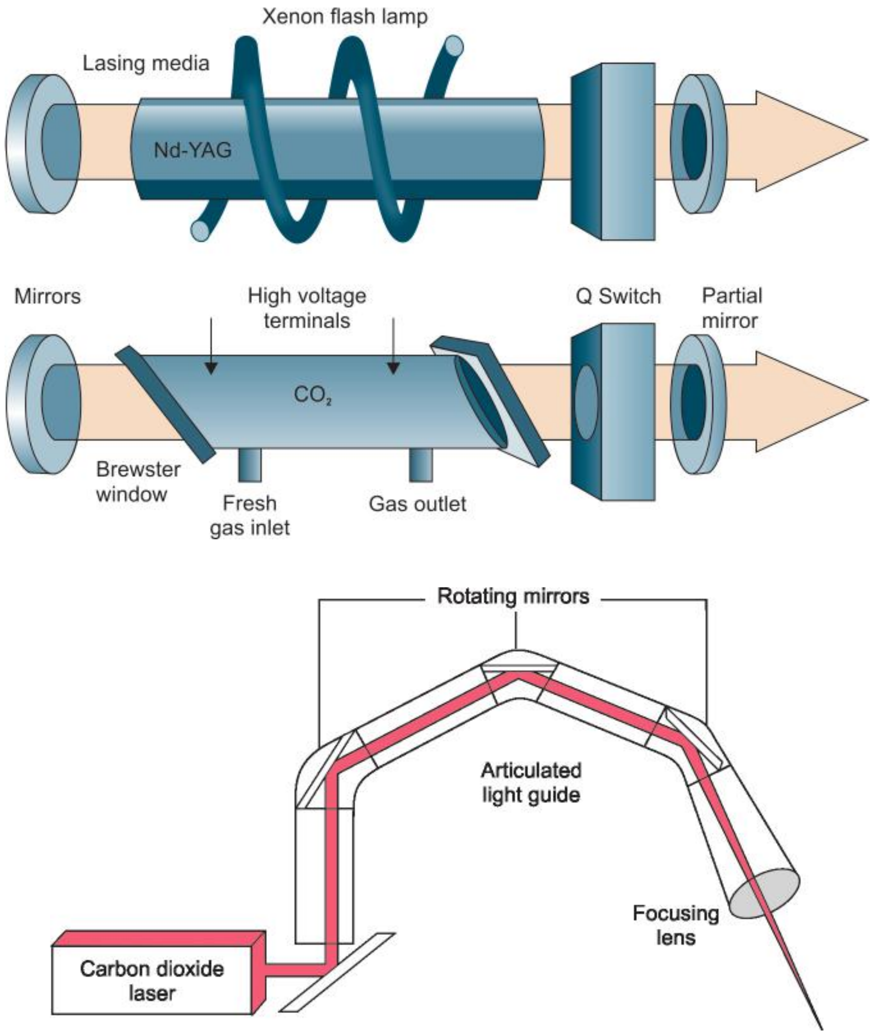


Fig. 8.9: Laser system components

LASER TISSUE INTERACTION

Three parameters determine the amount of energy being delivered to the tissue:

Wattage

For most gynecologic procedures using the CO_2 laser, one rarely exceeds 20 to 30 W, which is used primarily for excision purposes.

Time

The longer the laser remains focused on one spot, the more energy is applied to that area. To limit tissue damage, especially in critical areas, one can move the beam back and forth, or select an intermittent, timed pulse mode, usually in fractions of a second.

Spot Size of the Beam

As one gets closer to the target area, the spot size is made smaller, producing a more intense effect.

The combination of watts (power) and spot size determines the rate of tissue interaction. The higher the power density; the greater the laser's ability to vaporize and cut. This concept is expressed in watts/cm^2 (unit/area) and referred to as intensity or power density. Power density is, therefore, inversely proportional to the area of the spot size and to the beam diameter. Doubling the beam diameter reduces the power density to one-fourth. Conversely, by decreasing the diameter of the spot size, the power density is increased by 4.

Of the various lasers available, the CO_2 laser remains the most versatile and is relatively safe because of limited depth penetration. The CO_2 beam is readily absorbed by tissue because of its high water content. The instantaneous boiling of intracellular water causes cells to explode, forming steam. Depending on the power density, the CO_2 laser can be used effectively for vaporizing tissue, for excision, or for incision. Bleeding is reduced with the use of the CO_2 laser because of its coagulating properties; it seals small vessels as it cuts.

When compared with other lasers, the depth of penetration and the lateral thermal damage of the CO_2 laser are limited to less than 1 mm; thus, it can be used in areas of endometriosis on the pelvic side wall near the ureter. In contrast, the Nd:YAG laser has deeper penetration; thus, more caution is needed with its use (Table 8.1).

Table 8.1: Types of lasers used in gynecology

Type	*Wavelength (nm)*	*Color*	*Fiber*	*Depth of penetration*
Argon	488–512	Blue-green	Yes	0.5 mm
KTP/532	532	Green	Yes	1–2 mm
Nd:YAG	1,064	Infrared	Yes	3–4 mm
CO_2	10,600	Infrared	No	0.1 mm

As a result of a laser beam impacting on tissue, a crater is created. The diameter of this crater is a property of the divergence of the beam and the focal length of the lens through which the laser is focused. If the power of the laser is kept constant, the depth of the crater will vary inversely to the diameter of the spot.

Intensity or power density refers to the transfer of laser energy to a given mass of tissue and is expressed in terms of watts per centimeter squared (Fig. 8.10). Because 86 percent of the laser power is absorbed by the spot, this figure should be multiplied by 0.86 to determine the power density.

Three types of tissue injury may be identified following a laser wound. The zone of vaporization is characterized by an absence of tissue and a V-shaped

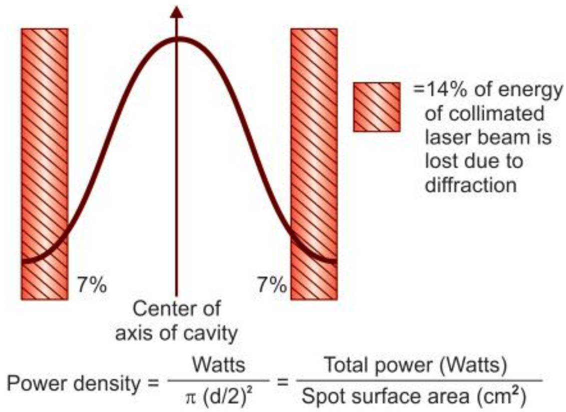
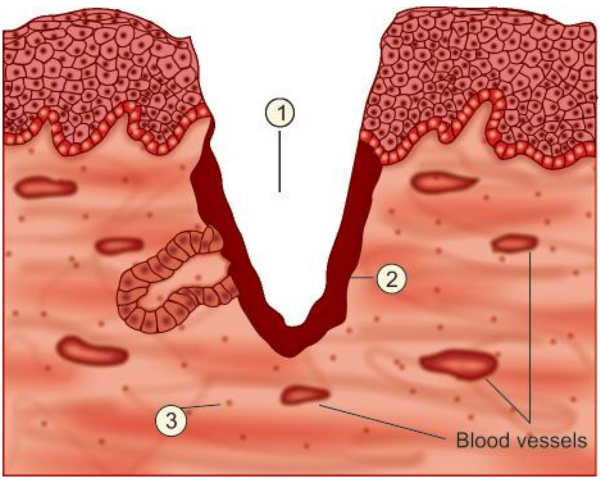


Fig. 8.10: An example of the distribution of a laser beam, whose intensity is greatest in the center of the axis. On either end of the bell-shaped curve, 7 percent of the energy is lost because of diffraction. The power density (intensity) is equivalent to laser power packed into a given spot. The smaller the spot, the greater the power density



1- Vaporization, 2- Necrosis, 3- Reversible injury

Fig. 8.11: A CO_2 laser beam produces a spot or crater in which three zones of tissue injury may be identified

defect, because energy is greater in the center of the beam than on the perimeter. Immediately below the zone of vaporization is a fixed zone of stromal necrosis measuring (in cervical tissue) approximately 50 to 100 µm in depth, regardless of the crater's extent. Within this zone, small vessels (<1 mm) are sealed. The third zone is one of reversible injury or potential repair. Laser wounds are similar to scalpel incisions producing minimal tissue damage compared with electrosurgery, in which substantial devitalized debris remains behind (Fig. 8.11). The CO_2 laser can be used as a cutting or excisional instrument, as a vaporizing or ablating instrument, and as a defocused cauterizing instrument.

The three types of lasers most often used in medical treatment are:

- *Carbon dioxide (CO_2) laser:* Primarily a surgical tool, this device converts light energy to heat strong enough to minimize bleeding while it cuts through or vaporizes tissue.[15]
- *Neodymium-doped: yttrium-aluminum-garnet (Nd:YAG) laser:* Capable of penetrating tissue more deeply than other lasers, the Nd:YAG makes blood clot quickly and can enable surgeons to see and work on parts of the body that could otherwise be reached only through open (invasive) surgery.[23]
- *Argon laser:* This laser provides the limited penetration needed for eye surgery and superficial skin disorders. In a special procedure known as photodynamic therapy (PDT), this laser uses light-sensitive dyes to ablate tumors.

CLINICAL APPLICATIONS OF LASER IN HYSTEROSCOPY

Lasers in Hysteroscopy

The main laser delivery systems available for hysteroscopy are the Nd:YAG and KTP 532. Both of these lasers use a flexible fiber that can be passed easily through the operating sleeve of the hysteroscope. The fiber can be directed by use of an Albarrán's bridge that is attached to the operating hysteroscope. Hysteroscopic procedures that can be accomplished with the laser include removal of fibroids and polyps, transection of uterine septa, lysis of adhesions, and endometrial ablation.[26,28]

Endometrial Ablation

Hysterectomy is the most common major operation performed in women. Although there are many indications for hysterectomy, dysfunctional uterine bleeding is the indication given in as many as half of these procedures when there is no organic cause. An alternative to hysterectomy to treat dysfunctional uterine bleeding, unresponsive to medical therapy, is endometrial ablation, which was first reported by Goldrath and associates in 1981.

The purpose of an endometrial ablation is to destroy the entire endometrium up to the basal layer (a depth of about 7 mm thus, including superficial myometrium and the endomyometrial junction) and reduce future regeneration and menstruation. Patients are initially pretreated with a gonadotropin-releasing hormone (GnRH) agonist or danazol for a period of 4 weeks to induce endometrial atrophy, thus facilitating the penetration of the energy to the level of the myometrium.[27]

After adequate visualization of the entire uterine cavity, the laser fiber can be inserted through the operating channel of the hysteroscope. The Nd:YAG fiber can be used as either a touch or nontouch technique. With the touch technique, the laser fiber is activated with 40 to 50 W of energy and dragged on the endometrial surface beginning on the fundus and travelling down toward the endocervix in successive strokes (Fig. 8.12). This is done in a systematic way so that the entire surface is eventually covered. With the no touch or blanching technique, the laser fiber is placed a few millimeters away

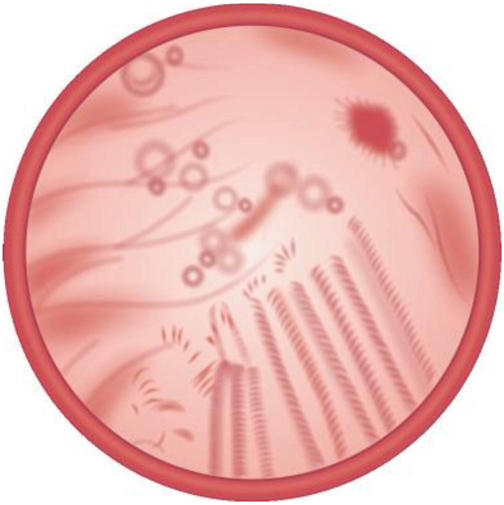


Fig. 8.12: Endometrial ablation with Nd:YAG laser fiber

from the endometrial surface while the laser energy is activated. Of the two methods, the touch technique is preferred because penetration is deeper, extending 4 to 6 mm into the uterine wall. This depth is sufficient for destruction of the endometrium.

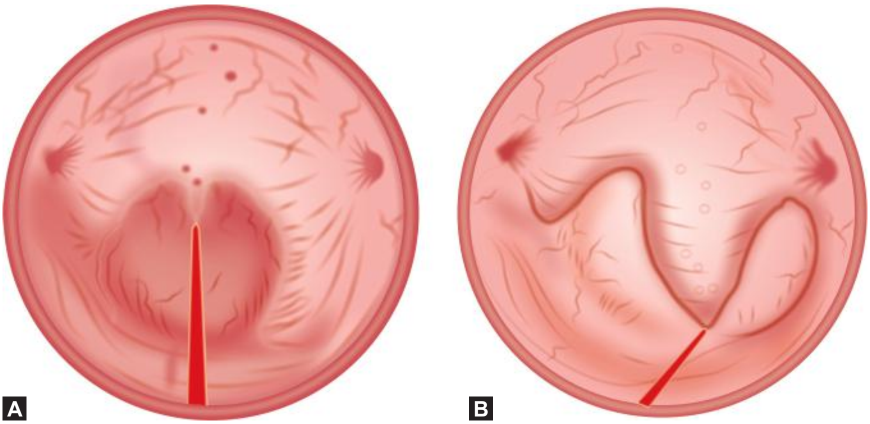
Patients requesting endometrial ablation as a treatment for dysfunctional uterine bleeding should understand that amenorrhea is possible only in 50 to 65 percent of patients, whereas oligomenorrhea is observed in 25 to 30 percent and no response to treatment is observed in 10 to 15 percent of patients.

Hysteroscopic Myomectomy and Polypectomy

In addition to endometrial ablation, the laser can be used via hysteroscopy for removal of submucous myomas and polyps. By using the laser fiber as a scalpel with the touch technique, the tissue to be removed can be morcellated and later removed with polyp forceps or a curette (Figs 8.13A and B). The advantage of the laser over scissors is that simultaneous coagulation can be accomplished. Media used for distention do not have to be free of electrolytes because electrical energy is not being used.

Myomas larger than 4 cm can be pretreated with GnRH agonists to decrease the size of the tumor, allow better visualization of the cavity, and decrease presurgical uterine bleeding. An alternative instrument to scissors and laser for removal of myomas is the resectoscope, which is now the preferred method.

Although the laser could be used for removal of polyps, these are usually of very soft consistency and are easily removed with hysteroscopic scissors. The laser should be reserved for larger myomatous lesions, where use of the instrument is more efficient and cost-effective.



Figs 8.13A and B: Submucous laser myomectomy

Septate Uterus

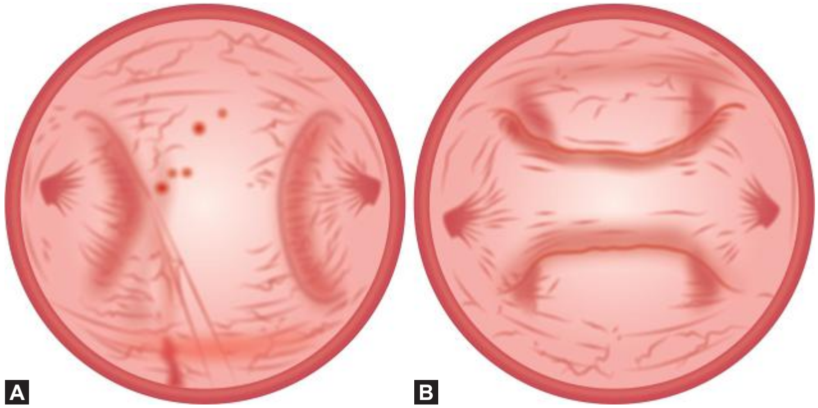
The uterine septum is one of several congenital uterine abnormalities that arise from incomplete resorption of the Müllerian ducts, and it occurs in approximately 1 to 3.5 percent of women.[23] The uterine septum is commonly associated with habitual miscarriage and is transmitted as a polygenic or multifactor pattern of inheritance. Diagnosis of a septate uterus is made by both hysterosalpingogram and diagnostic laparoscopy. This will exclude the possibility of an arcuate or bicornuate uterus, which does not necessitate surgical intervention.

Resection of a uterine septum can be performed with various instruments, including scissors, resectoscope, and Nd:YAG laser. Operative hysteroscopy is performed in conjunction with laparoscopy. This allows a more uniform depth of incision throughout the septum and warns the operator when a perforation is imminent.

The Nd:YAG laser fiber is usually set at 40 W and used by the touch technique, as if one were using a scalpel. The laser tip must be oriented so that it incises the septum at the midline and does not deviate from this line of incision (Figs 8.14A and B). This will ensure a relatively bloodless field of incision and avoids injury to the myometrium. The laser incision is continued until there is uniformity in light transmission throughout the fundus as observed by laparoscopy, or until bleeding from the fundal myometrium is visualized. The advantage of the laser fiber technique over the scissor technique is primarily one of diminished bleeding. The procedure usually takes 20 to 30 minutes, with gratifying results such as a 70 to 80 percent delivery rate, and it is similar to the more classic Tomkin's and Jones' intra-abdominal approach to metroplasty. The main advantages of operative hysteroscopy compared with the abdominal approach include quickness of surgery, minimal blood loss, no abdominal or uterine scar, minimal morbidity, no reduction in intrauterine volume, and diminished costs. In addition, patients are allowed to deliver vaginally.

Intrauterine Adhesions

Lysis of intrauterine adhesions can be readily accomplished with the Nd:YAG laser. Unlike curettage, with hysteroscopy one can selectively cut the scar



Figs 8.14A and B: Uterine septum treated with Nd:YAG laser

tissue, limiting trauma to surrounding normal tissue. An IUD or pediatric Foley catheter is left in the cavity for a few weeks while the patient takes exogenous estrogens and antibiotics.

ADVANTAGES OF LASERS

1. Reduced blood loss
2. Reduced infective morbidity
3. Reduced operating time
4. Faster postoperative recovery.

COMPLICATIONS WITH HYSTEROSCOPIC LASER SURGERY

Complications inherent to hysteroscopy include:

1. Uterine perforation:
   - Misdirected laser energy
   - Perforation may occur several days later when edema and necrosis are maximal.
2. Bleeding.
3. Fluid overload.
4. Infection.
5. Venous gas embolism:
   - At hysteroscopy, liquid (saline) coolant is the only safe option
   - If coolant gas must be used, CO_2 should be considered
   - The use of a sapphire tip with the Nd:YAG laser is contraindicated because its use with CO_2 gas for cooling has been implicated in several deaths due to gas emboli.
6. Inappropriate energy transfer:
   - Accidental activation of the laser control trigger
   - Tissue damage outside of surgical site

- Drape fire
- Eye injury (patient or other medical staff).

LASER SAFETY

The American Society for Laser Medicine and Surgery, Inc urges that:

- All operative areas should be equipped with oxygen and other drugs and equipment required for cardiopulmonary resuscitation (CPR)
- Nonphysicians performing laser procedures should be properly trained, licensed, and insured
- A qualified and experienced supervising physician should be able to respond to and manage unanticipated events or other emergencies within five minutes of the time they occur
- Emergency transportation to a hospital or other acute care facility should be available whenever laser surgery is performed in a nonhospital setting.

Laser surgery in gynecology has a good safety record. However, as with any device used in surgery, laser has the potential to cause serious injuries. Gynecologists requesting laser privileges should be certified for the specific type of laser used. Certification implies attendance of didactic instruction and practical use of the laser in the laboratory prior to its application in patients.

When using the laser, an appropriate warning sign, such as "Laser in Use," should be displayed on all doors of the operating room. Protective safety glasses appropriate for the laser in use should always be worn by surgeons and operating room personnel. When the laser is not being fired, it should always be in the standby mode. Surgical drapes near the operating field should be fire retardant and kept wet if possible.

Adequate suction should be available to collect all plume produced by laser use, because intact viral DNA and papilloma-virus have been detected in the plume.[8]

In addition, fibers used for transmission of laser energy are delicate and can break. If one is unaware of a broken fiber, laser energy will be delivered at the point of breakage, potentially injuring the patient and/or staff.

GUIDELINES FOR USE OF LASERS

Lasers manufactured after 08/01 should be classified under one of seven classes:

Class	Practical interpretation
Class 1	Safe under reasonably foreseeable operation
Class 1M	Generally safe—some precautions may be required.
Class 2	Visible light at low power, blink response limits the risk.
Class 2M	UV or IR light at low power, generally safe—some precautions may be required.
Class 3 R (A)	Safe for viewing with unaided eye.
Class 3 B	Viewing beam is hazardous, diffuse reflections are safe.
Class 4	Hazardous under all conditions, eyes and skin.

CONCLUSION

The main disadvantage of laser medicine is the expensive machinery. The maintenance and replacement of defective parts is expensive. The cost of the device and its maintenance sets the cost of a particular procedure.

Although lasers have been replaced by less expensive electrosurgical devices such as the monopolar and bipolar resectoscope, and plasmacision, one must remember that lasers were the first energy sources which improved the safety and feasibility of endoscopic surgery. Today, with due consideration of the costs, they still remain an important tool in the armamentarium available for endoscopic surgery.

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CHAPTER 9

Hysteroscopy in Infertility

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INTRODUCTION

Uterine pathologies such as endometritis, endometrial atrophy, polyps, submucous fibroids, intrauterine synechiae and malformations of the uterus can contribute to a less nutritive and/or hostile environment for the implanting embryo and can also impair the placentation or growth of the fetus.[1] Intracervical pathologies account for cervical factor infertility and are recognized causes of difficult embryo transfer during assisted conception treatments.[2]

The incidence of uterine pathologies in infertile women discovered by hysteroscopy varies in literature. Between 10 and 62 percent of women with infertility,[1,3,4] 10 and 60 percent of women undergoing pretreatment assessment for *in vitro* fertilization and embryo transfer (IVF-ET),[2,5-7] 19 and 50 percent of women who failed to conceive following ART procedures[8-11] and 28 and 32 percent of women with recurrent miscarriages following natural or assisted conception procedures[12] respectively showed evidence of some uterine pathology. It could be surmised by various studies that up to 33 percent of women would benefit from routine screening, diagnosis and selective treatment of relevant uterine pathologies before undergoing IVF treatment,[7,10,13] and up to 22 percent of women after repeated unsuccessful IVF treatments.[8,14] A large study of 1000 patients identified pathologies in 38 percent of unselected women[15] during pre-IVF assessment. It has been also reported that the presence of uterine pathologies lead to more IVF-ET attempts per baby delivered.[11] Higher live birth rates were reported following treatment of these uterine pathologies in a number of case-controlled studies.[5,7,8,16] Pregnancy rates were found to be good in women with no uterine pathologies, as well as in women who were successfully treated for such uterine pathologies, even when they had history of previous IVF attempt failures.[13,15,16]

METHODS TO ASSESS THE UTERINE CAVITY

Out of the four available methods—transvaginal sonography (TVS), hysterosalpingography (HSG), saline contrast sonography (SCS) and hysteroscopy, HSG is the most frequently used screening test, followed by pelvic ultrasound and hysteroscopy. In some international centers, hysteroscopy is done only if there is some pathology discovered by other modes of investigation.

Hysteroscopy allows direct visualization of the uterocervical canal and endometrial assessment, and is thus considered as the gold-standard reference test.[3] The availability of the newer small caliber systems enables one to diagnose and treat a range of uterine pathologies effectively and safely in one sitting on an outpatient basis without any need for cervical dilatation or general anesthesia, with great benefits to both the patient and service provider.[17,18] Indications for hysteroscopy would be patients with a history of recurrent IVF failures, if there is any abnormality seen on HSG or TVS, if there is any history of previous instrumental intervention or uterine scarring and even history of recurrent miscarriages. Absolute contraindications are pelvic infection, uterine bleeding and patient's refusal. Relative contraindications are a grossly distorted pelvic anatomy, suspected pelvic infection and anticipated technical difficulty.

Procedure

All hysteroscopies are planned taking care to avoid conception cycles. A simple oral analgesic such as paracetamol 1 g one hour prior to the procedure usually suffices for office and diagnostic hysteroscopy and also when a minor procedure such as a polypectomy is to be carried out. General anesthesia is desirable for medical indications, for those who request it and for operative interventions. However, general anesthesia is proven to be the safest in endoscopic surgeries and is also most comfortable to the patient. It is preferable to do TVS before the hysteroscopy to evaluate the size and direction of the uterus and to rule out any adnexal pathology. We use a Storz rigid hysteroscope (Bettocchi) with a 30° oblique view and a single-flow-channel outer sheath (2.9 mm). This is introduced slowly through the cervix and into the uterine cavity under video monitoring, avoiding contact with the mucosa with the aid of saline distention. A biopsy is taken before withdrawing the scope so that tissue could be sent for histopathology or TB culture, if required. The histopathology can be used to diagnose an out-of-phase endometrium, endometritis, neoplastic lesion, etc. The sample can also be used to co-culture the embryos that are produced in subsequent treatment cycles.

Distention Media

The distention medium depends on the modality used to carry out the hysteroscopy. If energy sources are not used, as for example surgery carried out with scissors, any standard irrigating fluid such as normal saline, Ringer's lactate or 5 percent glucose can be used. When monopolar energy source like a resectoscope is used, 1.5 percent glycine or sorbitol is preferred. Normal saline can be used safely with bipolar energy source and that is one of its advantages. Liquid media have the advantage of being cleared from time-to-time by aspiration or by flushing.

Instruments

Rigid instruments are still preferred because they are sturdy, reliable and offer a good vision. The conventional resectoscope works satisfactorily to perform most hysteroscopic surgeries conveniently. However, scissors are preferred whenever possible as resection or adhesiolysis can be carried out without the use of electric current which is helpful in preventing a decrease in vascularity of the endometrium which would happen after using energy sources.

DIAGNOSTIC HYSTEROSCOPY

Hysteroscopy is a very vital investigational tool for infertility. Despite advances in the field of artificial reproductive techniques over the past 20 years, implantation rates per embryo transferred still remains low, at about 15 to 20 percent.[19] The two key factors in question for this problem are the quality of the embryo and the receptivity of the uterus. Although it is possible to assess the embryo quality by microscopy and metabolic analysis, uterine receptivity cannot be fully evaluated. Some uterine factors that can be measured by transvaginal sonography are endometrial thickness, pattern and blood flow in the uterine and subendometrial arteries.[20]

A study by Godinjak Z et al[24] in 2008 involving 360 infertile women who all underwent simultaneous combined laparo-hysteroscopy showed that many patients had abnormalities discovered on hysteroscopy which would had otherwise been missed. Pelvic adhesions were found in 40 (11.11%), endometriosis in 51 (14.16%), dermoid cysts in 8 (2.22% and functional cysts in 16 (4.44%) patients laparoscopically. Out of the 42 patients (11.65%) in whom fibroid was found 31 were discovered through laparoscopy and 11 (3.05%) through hysteroscopy. Even more interestingly hysteroscopy revealed many other pathologies like endometrial polyp in 26 patients (7.22%), Asherman's syndrome in 3 patients (0.83%) and uterine anomaly in 19 patients (5.27%). Out of these 19, septate uterus was found in 7 (37.15%), bicornuate uterus in 5 (26.31%), arcuate uterus in 4 (21.26%) and unicornuate uterus in 3 patients (15.27%).

The place of routine hysteroscopy in the management of infertile women without other diagnosed or doubtful intrauterine pathologies is still a matter of debate.[21] The two main problems that argue against the case of hysteroscopy are: first, it is an invasive procedure, and second, there is still an ongoing debate about the real significance of the observed intrauterine pathology on fertility. Currently, the European Society of Human Reproduction and Embryology (ESHRE) guidelines indicate hysteroscopy to be unnecessary, unless it is for the confirmation and treatment of doubtful intrauterine pathology.[22] Nevertheless, in a study by Shoker et al, it was suggested that 26 percent of the patients with normal hysterosalpingography were with abnormal hysteroscopic findings.[7]

Several studies have also been performed to find out if hysteroscopic treatment of intrauterine pathologies increases the success of IVF-ET. Kirsop et al suggested that intrauterine abnormalities may be a cause for failure of

IVF-ET or gamete intrafallopian transfer (GIFT) and therefore, hysteroscopy should be part of the infertility workup for all patients, prior to undergoing IVF treatment.[11] Faghali et al have also recommended screening the uterus by hysteroscopy before proceeding with IVF, to minimize implantation failures.[16]

OPERATIVE HYSTEROSCOPY

Hysteroscopy has been a revolutionary tool in the diagnosis and management of infertility. Hysteroscopic correction of uterine anomalies and lesions is the best possible manner to maintain normal uterine anatomy and function thereby restoring fertility. Hysteroscopy has several advantages over open or laparoscopic surgery in that it has a low morbidity, decreased hospitalization time and absence of hysterotomy. Hysteroscopic septoplasty, polypectomy and synechiolysis have all been established as the gold standard methods in patients with subfertility. It is advisable to perform a second-look hysteroscopy after correction of these pathologies to ensure their proper correction before embarking on a costly IVF program.

Endometrial Abnormalities

Endometrial abnormalities include polypoid endometrium, corrugated/rough endometrium, pale/edematous endometrium, atrophic endometrium, endometritis, mixed distribution of blood vessels and glandular openings, neo-vascularization, endometrial ridges and focal elevations. Persistent benign-looking raised lesions can be subgrouped as polypoid, corrugated and edematous. Most of these pathologies contribute to infertility and/or IVF failure and can be diagnosed with hysteroscopy. Poor grade of luteal phase endometrium (consisting of pinpoint glandular openings and thinner blood vessels) resulted in fewer clinical pregnancies in their attempts to conceive.[47] Transvaginal sonography (TVS) has its limitations in accurately assessing the normality of the endometrium hence, any atypical appearance on TVS should be followed up with hysteroscopy to rule out such abnormalities.

Endometritis

A reddish appearing endometrium in which the white openings of the glands produce a strawberry-like pattern is characteristically seen in endometritis and is due to the significantly increased vascularity. Hysteroscopic diagnosis of endometritis is highly specific (93.2%).[16,46] Appropriate hormonal or antimicrobial treatment following hysteroscopic diagnosis of endometritis has been shown to improve clinical pregnancy rates following natural or assisted conception.[16] Hysteroscopy can aid in diagnosing genital tuberculosis by not only taking biopsy and sending it for culture and polymerase chain reaction (TB-PCR) but also by simple look of the endometrium. The finding of endometrial micropolyps at fluid hysteroscopy has been shown to be a marker for chronic endometritis.[65] Sequelae of old infection would include atrophic endometrium and scarring as in Asherman's syndrome.

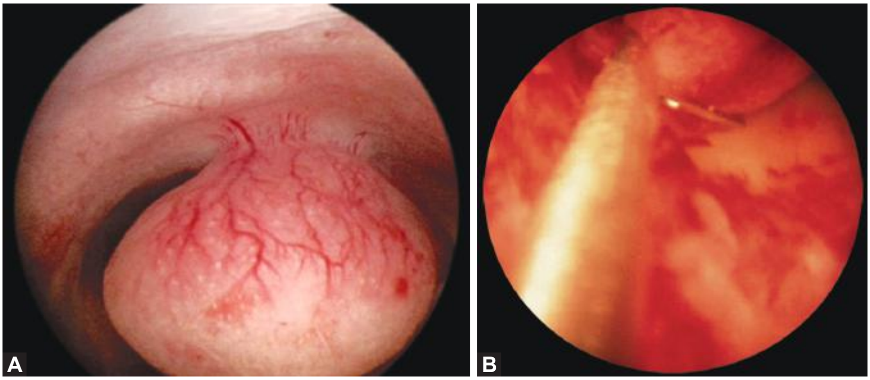
Endometrial Polyps

Endometrial polyps represent the most common intracavitary finding in the infertile patient population (Figs 9.1A and B). Even in the absence of abnormal uterine bleeding, endometrial polyps may be discovered in women with infertility. The incidence of asymptomatic endometrial polyps in women with infertility has been reported to range from 10 to 32 percent.[28,29] Grossly, endometrial polyps are pink–gray to white with smooth, glistening surfaces. The tip or the entire polyp may be hemorrhagic. Found most commonly in the uterine fundus and cornual regions, polyps range from lesions millimeters in size to those that occupy the entire endometrial cavity. A number of other entities, including endometrial hyperplasia and carcinoma and sarcoma, may have a polypoid appearance. Hence, it is important to obtain pathologic review of polyps, particularly large or unusual appearing forms.

The impact of polyps on infertility is mainly dependent of their size and location. Polyps may cause infertility by virtue of their location thereby causing mechanical block (e.g. tubocornual polyp), by their association with endometriosis, or by expression of the enzyme aromatase. A prospective randomized study of the impact of polyps on an IVF program, by Lass et al[28] concluded that small endometrial polyps (less than two centimeters) do not decrease the pregnancy rate after IVF, but a trend toward increased pregnancy loss exists. Polyp removal appeared to improve fertility and increase pregnancy rates in previous infertile women with no other reason to explain their infertility, regardless of the size or number of the polyps. A prospective study of 224 infertile women who underwent hysteroscopy suggested a 50 percent pregnancy rate achieved with polypectomy.[7]

Finally, a randomized prospective study of 215 infertile patients with sonographic diagnosis of endometrial polyps was conducted to evaluate the impact of polypectomy on fertility. Patients in the polypectomy arm evidenced a relative risk of 2.1 (95% CI, 1.5–2.9) of achieving pregnancy as compared with patients in the polyp biopsy arm, with 65 percent of pregnancies in the polypectomy group achieved spontaneously.[17]

Resection of a polyp is easier than that of a fibroid. Grasping it with a grasper is usually sufficient to excise it, though at times cauterization of the



Figs 9.1A and B: (A) Pedunculated endometrial polyp; (B) Dividing pedicle of polyp

base and extraction may be required. Sometimes transecting the base and removing the compressible mass through the cervix may be more convenient.

Uterine Fibroids

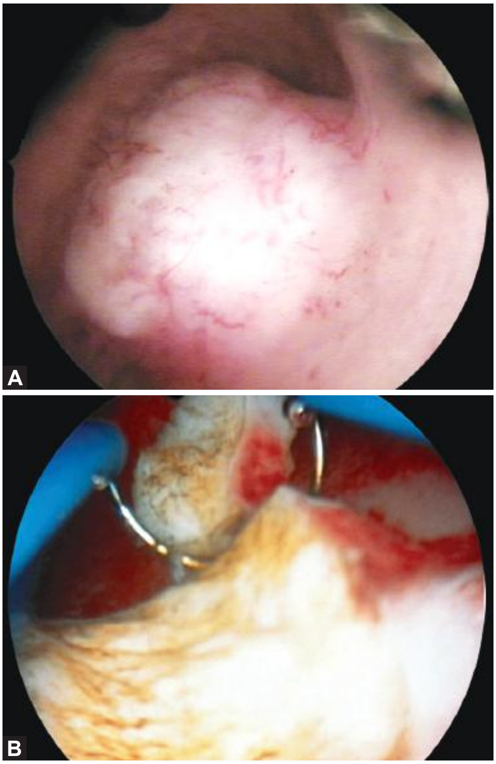
Leiomyomata are the most common tumors of the uterus, occurring most commonly in women of reproductive age, particularly in the 30s and 40s. The impact of fibroids on fertility depends on the parameters of location, number, and size. Types of leiomyomata include subserosal, intramural, and submucosal varieties. Submucous myomas, by virtue of their mass effect and inhospitable surface area for nidation, have been clearly associated with infertility and with pregnancy loss. These myomas appear as rounded masses that bulge to varying extents into the endometrial cavity, and the overlying endometrium may be atrophic, congested, ulcerated, or hemorrhagic. Because of their intracavitary location, submucosal fibroids may be effectively removed via a hysteroscopic approach (Figs 9.2A and B).

Table 9.1: Comparison of techniques to detect submucosal myomas (as compared with findings at hysterectomy)

Diagnostic method	*Patients no.*	*Sensitivity%*	*Specificity%*	*Study*
TVS	52	90	98	Cicinelli et al (1995)[30]
Sonohysterography	52	100	100	Cicinelli et al (1995)
Hysteroscopy	52	100	100	Cicinelli et al (1995)

A comparison of imaging modalities for the detection of submucosal leiomyomata is provided in Table 9.1. Sonohysterography and hysteroscopy are equivalent in the detection of submucosal myomas. Whereas SIS offers the advantage of allowing measurement of the overall dimensions of the lesion, office hysteroscopy may afford the removal of small submucous lesions in the same setting.

The impact of intramural (defined as greater than 50 percent volume within the myometrium) myomas upon fertility remains controversial. Although some studies showed reduced implantation and conception rates in women with intramural fibroids,[31,32] others have not demonstrated an adverse effect.[33,34] One study demonstrated a size-dependent impact of intramural myomas, with those measuring greater than 4 cm associated with lower pregnancy rates following IVF/ICSI treatment.[35] The mechanism by which intramural lesions may impair fertility is unproven. Alterations in uterine artery blood flow, local cytokine release, and/or gene expression profiles have been thought to be responsible. Meta-analysis of studies in women with submucous myomas demonstrated lower pregnancy rates (relative risk 0.30) and implantation rates (relative risk 0.28) than in infertile controls.[41] Because fibroids frequently accompany with other estrogen-dependent disorders, such as endometriosis, adenomyosis, and endometrial polyps, their role in infertility may be purely associative. Nonetheless, an in-depth review of six previously



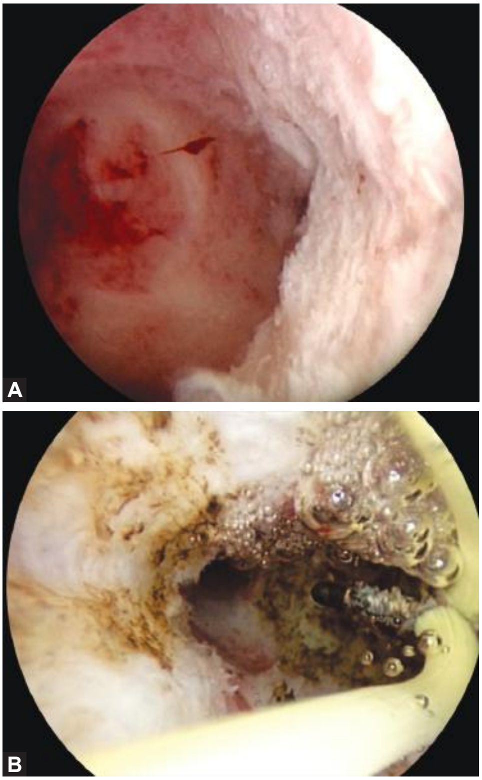
Figs 9.2A and B: (A) Submucosal leiomyoma; (B) Resection of a sessile submucous leiomyoma using a cutting loop

published trials concluded that only intramural fibroids that resulted in cavity distortion or impingement were deleterious to fertility.[36] The beneficial effect of removing such cavity-distorting lesions was validated in a case-controlled study.[37] Finally, studies have consistently failed to find an impact of subserosal leiomyomata (defined as ≥50 percent volume projecting beyond the *outer* uterine contour) upon fertility.

Intrauterine Adhesions

Asherman's syndrome, besides causing recurrent pregnancy loss and infertility can also cause amenorrhea if severe. Hysteroscopy is the gold standard of management because along with an accurate diagnosis it can offer treatment in the same sitting. Causes of intrauterine adhesions are often iatrogenic, with patient histories typically involving intraoperative or postoperative complications of uterine evacuations for menorrhagia, pregnancy termination, or postpartum hemorrhage. Other causes of intrauterine synechiae include intrauterine infection with pathogens such as *Schistosoma* and mycobacteria. Indeed, in India tuberculous endometritis is an important cause of infertility. After an optimal surgery with proper postoperative care a reasonable level of success with IVF can be expected. However, the patient needs to be counseled about the possibility of developing pregnancy complications, e.g. placenta accreta, IUGR, increased rate of miscarriages, etc. Based on their severity and nature Asherman's syndrome can be classified as—mild (flimsy and composed of endometrial tissue only), moderate (fibromuscular tissue covered with endometrium) and severe (composed of fibromuscular tissue only and partially/totally occluding the uterine cavity). The American Fertility Society has proposed a classification of intrauterine adhesions based on findings upon hysterosalpingography and hysteroscopy and correlation with menstrual patterns.[25]

Hysteroscopy has been aptly termed to be the "gold standard" for management of Asherman's syndrome.[26] Hysteroscopy permits the classification of the extent of the disease and most importantly allows one to lyse the adhesions under vision, making it a safe surgery. Use of energy sources, especially in inexperienced hands, is to be kept at minimum because the energy source itself can lead to surrounding tissue damage and further fibrosis. Complications specific to adhesiolysis include recurrent adhesion formation, extensive endometrial damage and perforation of the uterus—which happens particularly while operating near the cornual area. The surgical management of intrauterine (Figs 9.3A and B) adhesions is reported to be very effective,



Figs 9.3A and B: (A) Left lateral wall adhesions; (B) Resection of adhesions with an L-shaped electrode

with pregnancy rates above 80 percent among patients treated for mild-to-moderate disease.[27]

Müllerian Anomalies

Septate Uterus

With an incidence of 2 to 3 percent in general population, uterine septation represents the most common Müllerian fusion defect.[38] Clinical sequelae of this condition may include infertility, spontaneous pregnancy loss in the first or second trimester, or late-trimester pregnancy complications. However, pregnancy outcome in the presence of a septum depends on the site of embryo implantation in a particular cycle. This may explain the situation in which a woman with a septate uterus might encounter recurrent pregnancy loss even after having delivered a term infant.

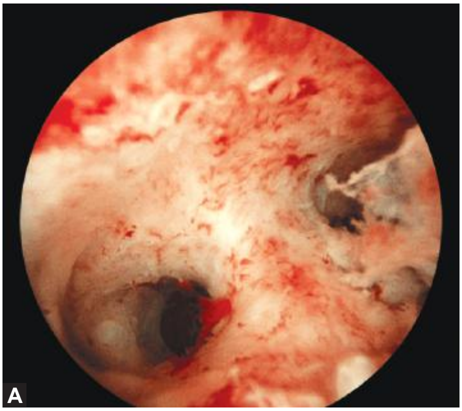
Hysteroscopic septoplasty has been demonstrated to decrease significantly the risk for spontaneous abortion in women with septate uteri, and surgical therapy is indicated in patients with known uterine septi and a history of recurrent spontaneous abortion.[39] However, if the presenting complaint is only infertility without any history of miscarriages then the indication is less straightforward. Among seven series of hysteroscopic metroplasties performed for infertility, the overall pregnancy rate after treatment was 48 percent.[39] It is still reasonable to consider surgical management in some infertile patients with uterine septi because septoplasty may maximize the chance of having a live birth by decreasing the associated risks for spontaneous abortion and preterm labor. The hysteroscopic approach to septum resection is often performed with microscissors, the resectoscope, or laser. The coaxial bipolar electrode surgical system is particularly advantageous in this setting as it enables one to operate in a crystalloid distention medium, and has been successfully applied toward hysteroscopic septum resection.[40]

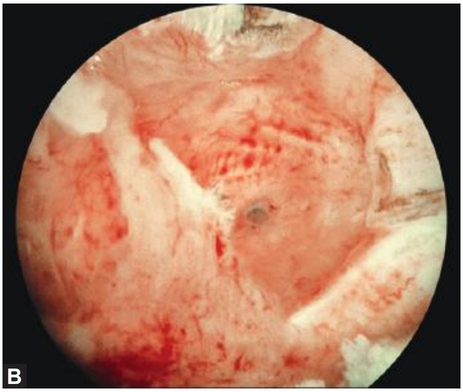
Other Müllerian Anomalies

The true clinical relevance of the mild-to-moderate uterine cavity anomalies is unclear. A higher incidence of arcuate, septate and subseptate uteri was reported by Salim and colleagues in women with history of recurrent miscarriages compared to women without (17% vs. 3.2%).[42] Moreover, a higher incidence of mid-trimester abortions, preterm deliveries and low live-birth rates following assisted conception treatments were reported in women with uterine malformations.[43,44] Metroplasy for a T-shaped (Figs 9.4A and B) uterus and infantile or hypoplastic uterus in women with RM has also been shown to increase live birth rates.[13,45]

Sperm Migration Test

Hysteroscopy has been used to assess the survival of spermatozoa in the upper genital tract. Using a CO_2 hysteroscope, spermatozoa are obtained from the uterine cavity and the tubal ostia following intercourse, and their motility is assessed.





Figs 9.4A and B: (A) Uterine septum; (B) After septoplasty

Removal of Intrauterine Foreign Bodies

Hysteroscopy is very useful in locating and removing displaced intrauterine contraceptive devices.[64] It might be necessary to perform a simultaneous laparoscopy to prevent and/or manage an inadvertent uterine perforation occurring while removing the foreign object.

Gamete Intrafallopian Transfer and Zygote Intrafallopian Transfer

Recently hysteroscopy has been used with the techniques of gamete intrafallopian transfer (GIFT) and zygote intrafallopian transfer (ZIFT) to transfer the gametes or zygotes into the fallopian tubes from the uterine side, rather from the usual fimbriated end through laparoscopy or minilaparotomy.[66] With further simplification and experience with hysteroscopy it is likely that this will become more common. Furthermore, it would be possible to transfer the early embryo under visual control with hysteroscopy guided embryo transfer.

Hysteroscopic Tubal Cannulation

Tubal cannulation is an effective and safe method to restore fertility in patients with proximal tubal blockade. It benefits the patient by avoiding going through a costly and potentially hazardous *in vitro* fertilization treatment while affording almost similar clinical pregnancy rates.[67]

Abortion

Hysteroscopy is very useful to check the presence of any retained trophoblastic tissue or hydatidiform mole. Moreover, removal of the retained products of conception could be done in the same sitting. This is safer than the conventional dilatation and curettage.

Abnormalities of the Cervix

Anatomical disorders of the cervical canal, isthmus and lower uterine cavity are associated with difficult embryo tranfers[48] and reduced pregnancy rates.[49] These include abnormalities of the cervical canal, endocervical mucosa and/or cervicouterine angle. Some of them are space-occupying lesions (e.g. synechiae, cysts, polyps, etc.), excessive cervicouterine angle and mixed lesions. These can lead to a difficult embryo transfer or inadvertent lodgment of the embryos in the cervical canal. Hysteroscopic diagnosis and treatment of these abnormalities resulted in easier embryo transfers[49,50] and improved pregnancy rates[50] in the subsequent attempts to conceive.

Hysteroscopy in Women with Unexplained Infertility

In one study, some abnormalities were reported in 15 percent of women with unexplained infertility hysteroscopically.[51] Moreover, 15 percent of women scheduled for IVF for male factor infertility had uterine abnormalities, and their correction led to improved pregnancy rates.[52]

Hysteroscopy in Women of Advanced Reproductive Age

In one study, it was found that women of an advanced age needed more IVF attempts to achieve a pregnancy and this was linked to the higher incidence of uterine pathologies in this age group.[53] This means that there is a genuine indication to evaluate the uteri in patients of this age group in order to treat any uterine pathologies before undergoing IVF treatment so as to avoid useless IVF attempts thereby reducing the costs and also avoiding iatrogenic complications of IVF treatment.

Hysteroscopy in Women with History of Multiple Previous IVF Attempt Failures

The occurrence of lesions such as endometrial hyperplasia, polyps, submucous fibroids, endometritis and adhesions in the uterus and/or cervix has been reported in 18 to 50 percent of women undergoing a second-look hysteroscopy after repeated failures of IVF treatment.[54] Hyperestrogenic environment caused by ovarian hyperstimulation and also iatrogenic trauma from embryo transfers, are thought to be responsible for these abnormalities. Thus, time diagnosis by performing a simple diagnostic hysteroscopy in this set of patients affords improved outcomes and saves the cost of repeated cycles.[54] A recent systematic review and meta-analysis of two randomized and three nonhysteroscopy control trials on 1691 patients concluded that hysteroscopy before a subsequent IVF attempt significantly increases the odds for conception in patients with at least two failed IVF attempts.[23] At our own study at the Lilavati Hospital and Research Center, we did a retrospective study with the aim of evaluating the importance of hysteroscopy prior to ART, to study the incidence of intrauterine pathology in the selected group and to study the success of IVF posthysteroscopic procedures in women with previous IVF failures. The study involved (Table 9.2) 248 women who attended our infertility clinic over a period of 18 months (January 2009 to June 2010). Only those patients who had one or more previous IVF attempt failure were included in the study.

Table 9.2: Hysteroscopic findings

Hysteroscopy finding	*Procedure done*	*No. of cases*	*No. of pregnancies post-procedure*	*% of conception after procedure*
Normal	Diagnostic	186	72	38.70
Polyps	Polypectomy	08	06	75
Submucous fibroid	Myomectomy	18	12	66.6
Septa	Septum resection	09	04	44.4
Blocked ostia	Fallopian tube cannulation	06	02	33.3
Synechiae	Synechiolysis	14	03	21.4
Cervical stenosis	Dilatation	01	00	0
T-shaped uterus	Lateral metroplasty	06	03	50

As can be seen from Table 9.2 of results from our study, out of the 248 women undergoing hysteroscopy, 186 (75%) had normal findings and 62 (25%) had some intrauterine pathology. Table 9.2 also gives a review about the conception rate postprocedure, which varied depending upon the pathology in the study group.

'Fertility Effect' of Diagnostic Hysteroscopy

Just as with HSG, it has been shown that improved spontaneous pregnancy rates are seen following diagnostic hysteroscopy.[59] Possibly distention of the cavity might clear any debris, casts, mucus plugs, filmy adhesions, etc. and thus help these women. It was also found that a deliberate local injury to the endometrium with sampling devices doubled the clinical pregnancy rates in patients with history of repeated IVF attempt failures undergoing repeat IVF.[60] Recently in a controlled clinical study published in *Fertility and Sterility,* a research team found that the expression of several genes was modulated by biopsy-induced local injury; prominent among which was the up-regulation of bladder transmembranal protein (UPIb). The ensuing inflammatory response is apparently beneficial for embryo implantation by improving uterine receptivity. Pregnancy outcome was positively correlated with MIP-1B (macrophage inflammatory protein 1B) and TNF-alpha expression, and the number of macrophages/dendritic cells. This is in concordance to other studies.[61-63]

SUMMARY

Most of the hysteroscopies today can be carried out as an outpatient procedure, without the need of general anesthesia or cervical dilatation and with high level of patient satisfaction. Hysteroscopy is the gold standard in evaluating and treating certain important uterine pathologies that can contribute to infertility and/or IVF failure by providing suboptimal conditions for the implanting embryo(s). A prehysteroscopy TVS can be complementary in evaluating myometrial and adnexal pathology but hysteroscopy is clearly more sensitive and specific for endometrial abnormalities. Evidence is strong in suggesting that uterine pathologies lead to fewer pregnancies and more miscarriages whereas absence of such pathologies is associated with a higher chance of clinical pregnancy and reduced risk of miscarriage. Conventionally, hysteroscopy was performed before a treatment cycle, but now the evidence suggests that it can be performed safely and effectively in the early phase of the ovarian hyperstimulation cycle, with added benefits to the patient.[58] Hysteroscopy, therefore, should be an integral part of the pretreatment evaluation of infertile women with or without a history of previous treatment failures to avoid unnecessary and expensive repeated treatments.[55,56] Cost-effective analysis indicates that hysteroscopy as a universal screening test even before the first IVF cycle is well justified even in a population where there is only a 10 percent prevalence of uterine pathologies.[57]

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CHAPTER 10

Hysterosalpingography vs Sonohysterography vs Hysteroscopy in Evaluation of Uterine Cavity in Infertility

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As a part of your evaluation for infertility, recurrent miscarriage, or in preparation for an embryo transfer, it is recommended that an anatomical assessment of the uterine cavity be performed at the outset. Hysterosalpingography, sonohysterography and hysteroscopy are the three modalities available for evaluation of the structural defects of the uterine cavity in patients of infertility and those being evaluated for ART procedures. The prevalence of uterine anomalies is around 19 to 50 percent in women who undergo *in vitro* fertilization (IVF) therapy.[1]

A brief description of each of the procedures is enumerated below before we discuss the comparison between each of them.

HYSTEROSALPINGOGRAPHY

Hysterosalpingography (HSG) is an X-ray procedure that is used to view the inside of the uterus and fallopian tubes. It checks for scarring or abnormalities in their size or shape, i.e. structural uterine anomalies, which can lead to infertility and pregnancy problems.

Timing: Hysterosalpingography is carried out within the first ten days after the last menstrual period and when menstrual flow has ceased. The patient is advised to abstain from sexual intercourse in the days after her menses and prior to the procedure, to ensure that she is not pregnant during the procedure.

Procedure: Using an aseptic technique, a speculum is used to distend the vagina and an 8 F Foley catheter or a cannula is inserted into the uterine cavity. Diluted, water soluble, hyperosmolar iodinated contrast agent is then hand injected into the uterine cavity via the Foley catheter.

A normal hysterosalpingogram depicts a smooth triangular uterine outline with opacification of both fallopian tubes and free spillage of contrast into the peritoneum (Figs 10.1 and 10.2).

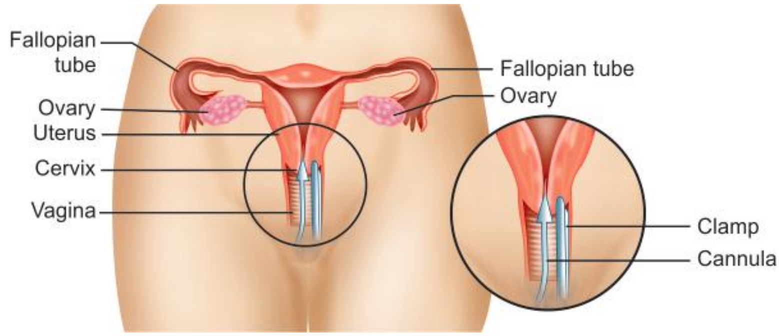


Fig. 10.1: During hysterosalpingography, a dye is injected into the uterus through a plastic tube or cannula. X-ray images are taken as the dye moves through the uterus and into the fallopian tubes

Fig. 10.2: Normal hysterosalpingogram shows a smooth triangular outline of the uterine cavity and free spillage of contrast from both fallopian tubes

A wide variety of uterine anomalies can be detected and demonstrated using hysterosalpingography. These include submucosal fibroids, endometrial polyps, septate uterus and intrauterine synechiae.

SONOHYSTEROGRAPHY

Also known as saline infusion sonography, it was first described by Randolph in 1988.[2]

Sonohysterography is a technique in which a fluid is injected through the *cervix* into the *uterus,* and *ultrasound* is used to make images of the uterine cavity (Figs 10.3 to 10.5). The fluid shows more detail of the inside of the uterus than when ultrasound is used alone. The procedure can be done in the outpatient department. During a speculum exam, a small catheter is placed

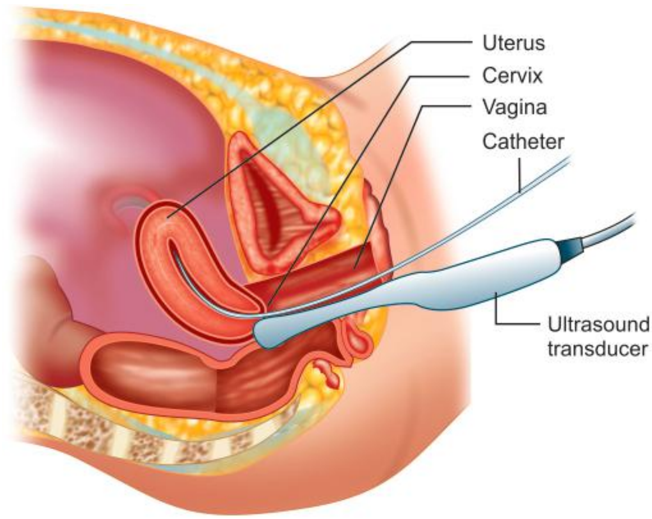
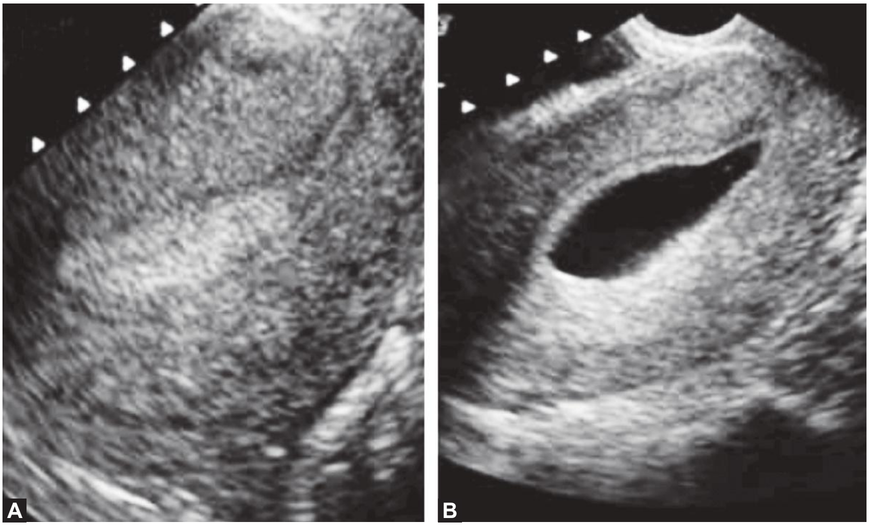


Fig. 10.3: Procedure of sonohysterography—in this procedure, a transvaginal ultrasound exam is done after fluid (saline) is injected into the uterus through a narrow catheter



Figs 10.4A and B: Normal sonohysterogram

within the cervix or lower part of the uterus, through which a small amount of sterile fluid (saline) can be injected. A transvaginal ultrasound examination is performed as the saline is injected, allowing visualization of the uterine cavity. The shape of the uterus can be seen, and abnormalities such

Fig. 10.5: Abnormal hysterosonogram showing intrauterine polyp

as uterine polyps and small fibroids that impinge upon the uterine cavity can be evaluated.

HYSTEROSCOPY

Hysteroscopy is a valuable diagnostic and therapeutic modality in the management of infertility (Fig. 10.6). Traditionally, hysteroscopy has been utilized for diagnostic and operative intervention for endometrial polyps, submucous and pedunculated myomas, intrauterine adhesions, and uterine septa (Figs 10.7 and 10.8). It is also useful for the diagnosis of congenital anomalies and evaluating endocervical anatomy.

Hysteroscopy is performed in the postmenstrual proliferative phase. Endoscopes can range from 2.9 mm in size to 4 mm in size. The choice of location, distension medium, and instrumentation depends on the availability of facilities and resources, the anticipated diagnosis, and the surgical plan. The optimum approach involves one which has a high probability of resolving the clinical issue at hand, with the major difference in approach depending on whether or not operative intervention will be required, safety, and cost.

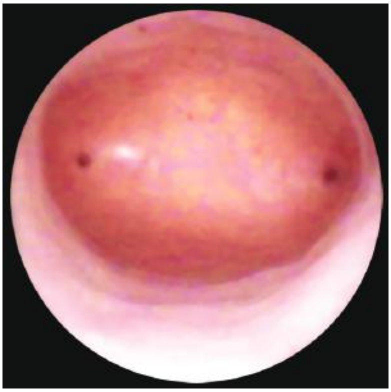


Fig. 10.6: Hysteroscopy picture of a normal uterine cavity. Tubal ostia (openings) seen on each side

Fig. 10.7: Uterine septum at "S" in the middle of picture. Right side of cavity at "R" and left side at "L"

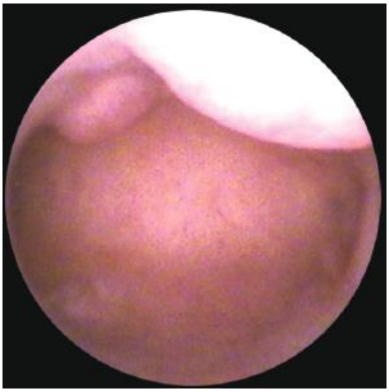


Fig. 10.8: Two small fibroid tumors are shown bulging down into the endometrial cavity

Complications of hysteroscopy are reported in 1 to 3 percent of cases. These include cervical laceration, uterine perforation, bleeding, reactions to the distention media, or complications due to anesthesia. Potential long-term complications include femoral injury resulting in intrauterine scarring or tubal obstruction, as well as injury to contiguous organs.

WHICH OF THE THREE DIAGNOSTIC MODALITIES IS THE BEST TO EVALUATE THE UTERINE CAVITY IN PATIENTS WITH INFERTILITY?

This question poses a clinical dilemma.

Several studies have been carried out to evaluate the efficacy of these three diagnostic modalities. Many authors have compared one with the other in terms of specificity and sensitivity in an effort to find out the most superior of the three.

The advantages of hysterosalpingography include the ease of the study, its safety and its lesser expense in comparison with hysteroscopy. Several disadvantages are inherent in the technique, however, including exposure to ionizing radiation, exposure to iodinated contrast material, and often a great deal of discomfort for the patient.[3] However, one study quotes that radiation risks from a typical hysterosalpingography are low.[4]

The disadvantage is that, looking at the shadows or the filling defects of the uterine cavity can lead to misleading results, as shown by a 24 percent rate of false positive and false negative findings as was stated by Siegler (1983).[5]

In a study carried out by C Prevedourakis et al on 323 women comparing hysteroscopy and hysterosalpingography it was observed that similar abnormalities were observed by both modalities with a global correlation of 74.8 percent. Hysterosalpingography also presented false positive results in 11.7 percent and false negative ones in 13.3 percent of all the studied cases. They concluded that the combined use of these techniques in infertility investigation gives complete and accurate information about the uterine cavity, despite the disadvantages of hysterosalpingography due to false positive and false negative results.[6]

The utility of hysteroscopy in infertility evaluation has been the subject of much discussion and has been well summarized by Taylor and Hamou.[7]

Whereas Valle [8] and Kessler and Lancet[9] have demonstrated the increased accuracy of hysteroscopy over hysterosalpingography, Snowden et al [10] found the hysterosalpingogram to be more reliable.

A more unifying approach was supported by Fayez et al[11] who found hysterosalpingography to be as accurate as hysteroscopy in the diagnosis of normal or abnormal cavities, whereas the nature of the intrauterine filling defects was revealed accurately only by hysteroscopy.

It is estimated that hysterosalpingography is an important screening procedure for the study of the uterine cavity and whenever it is combined with hysteroscopy the two techniques are complementary in their application to female infertility.[6]

A cross-sectional study was conducted on 72 infertile women at a hospital at Tehran by Qazizadeh, Nezhad and Hassan where hysterosalpingography and sonohysterography were performed prior to hysteroscopy, which was considered as the gold-standard test for the diagnosis of the structural abnormalities of the uterine cavity and endometrium.

The results, when compared to hysteroscopy, sonohysterography had a sensitivity of 30 percent, a specificity of 100 percent, a positive predictive value of 100 percent and a negative predictive value of 30 percent and hysterosalpingography had a sensitivity of 55 percent, a specificity of 68 percent, and a positive predictive value of 41 percent and a negative predictive value of 60 percent.

This study gave the opinion that due to high sensitivity, lower cost, and higher feasibility, sonohysterography seems to be a suitable choice for diagnosing intrauterine lesions.[12]

A prospective, randomized, study carried out at a tertiary infertility clinic at Virginia, USA, where evaluation of outpatient hysteroscopy, saline infusion hysterosonography, and hysterosalpingography in infertile women was carried outrevealed fifty-nine percent of infertile subjects to have an abnormality on at least one of three outpatient uterine evaluations.

When compared with the case of definitive operative hysteroscopy, 60 percent of abnormalities were correctly classified by HSG, 72 percent by hysteroscopy, and 52 percent by sonohysterography.

The results concluded that all the three diagnostic modalities were statistically equivalent regarding evaluation of uterine cavity pathology in infertile.[13]

Nass Duce et al concluded that sonohysterography was found to have a sensitivity of 100 percent, a positive predictive value of 90 percent and diagnostic accuracy of 90.6 percent.

Sonohysterography is a useful, minimally invasive and accurate technique to evaluate the pathologies involving endometrium and uterine cavity.[14]

Another study contradicting the above, compared the different techniques and their results found hysteroscopy to be the best technique for the diagnosis of endometrial pathology.[15]

Z Mahtab and Baleggi prospectively evaluated sixty six infertile women with hysterosalpingogram (HSG) and hysterosonogram as a part of their infertility work-up.

The result of each examination was compared with what was obtained by hysteroscopy as a golden standard. The results of hysterosonogram agreed with hysteroscopy in 95.5 percent while HSG agreed with hysteroscopy in 87.9 percent of cases. Sensitivity of hysterosonogram was 85.7 percent and its specificity 98.1 percent, while sensitivity of HSG was 71.4 percent and its specificity 92.3 percent. Hysterosonography was in general more accurate test and appeared to be an acceptable first-line evaluation for intrauterine structure. They recommend use of hysterosonography as a noninvasive, easy, inexpensive, effective and well-tolerated method of investigating the intrauterine cavity in infertile women instead of hysterosalpingography.[16]

Certain authors feel that sonohysterography is an invaluable diagnostic procedure which meets the needs of this ever changing medical environment. When compared to alternative procedures, it offers the advantages of a low cost, minimally invasive technique with superior results. In the future sonohysterography performed with ultrasound contrast media may replace HSG evaluation for infertility patients.[17,18]

J M Goldberg et al also observed that sonohysterography was more accurate than hysterosalpingography and provided more information about uterine abnormalities. Sonohysterography was in complete agreement with hysteroscopy. Diagnostic hysteroscopy can therefore be avoided if the sonohysterogram is normal.[19]

In a prospective cohort study, 1009 consecutive women were examined by saline infusion sonography (SIS) for infertility work-up. An SIS procedure for infertility work-up revealed a substantial percentage of infertile patients with intracavitary abnormalities and uterine anomalies. Because the technique is safe, well tolerated, and feasible in an outpatient setting, SIS should be considered routinely in the early stage of infertility and abnormal uterine bleeding investigation.[20]

After having gone through so many views and perspectives, we would like to conclude that though hysterosalpingography is the oldest, and cheapest method available for evaluation of the uterine cavity, it is likely to be replaced by saline infusion sonohysterography because of the high sensitivity and specificity of the latter.

It has also been observed that most studies have compared hysterosalpingogram and sonohysterogram with hysteroscopy which has been considered as the gold standard in the evaluation of the uterine cavity in infertile patients.

Each of the procedures are incomplete in isolation, hence we summarize that to give maximum benefit to the patients they would complement each other in the evaluation process, wherever indicated.

CONCLUSION

Sonohysterography is a highly sensitive, specific, and accurate screening tool for the evaluation of uterine cavitary defects which could be associated with recurrent pregnancy loss and offers several advantages over hysterosalpingography.

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CHAPTER 11

Hysteroscopy in Asherman's Syndrome

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It is no longer a question of what if, but with knowledge it is answering what now.

Asherman's syndrome (AS), also called "uterine synechiae" or intrauterine adhesions (IUA), presents a condition characterized by the presence of adhesions and/or fibrosis within the uterine cavity due to scars. A number of other terms have been used to describe the condition and related conditions including: traumatic intrauterine adhesions, uterine/cervical atresia, traumatic uterine atrophy, sclerotic endometrium, endometrial sclerosis.

It was first described in 1894 by Heinrich Fritsch (Fritsch, 1894)[1] and further characterized by the gynecologist Joseph Asherman in 1948.[2] And hence, it is also known as Fritsch syndrome, or Fritsch-Asherman syndrome (Figs 11.1 and 11.2).

INCIDENCE

The condition was found in 1.5 percent of women undergoing HSG[3] and between 5 and 39 percent of women with recurrent miscarriage.[4-6]

ETIOPATHOLOGY

The main reasons for referral of women with intrauterine adhesions are infertility and amenorrhea. The history of a pregnancy event followed by a D and C leading to secondary amenorrhea or hypomenorrhea is typical. Hysteroscopy is the gold standard for diagnosis.[7] Imaging by sonohysterography or hysterosalpingography will reveal the extent of the scar formation.

The cavity of the uterus is lined by the endometrium. This lining is composed of two layers, the functional layer which is shed during menstruation and an underlying basal layer, which is necessary for regenerating the functional layer. Trauma to the basal layer, typically after a dilation and curettage (D and C), a blind procedure performed after a miscarriage, or delivery, or for elective abortion, can lead to the development of intrauterine scars resulting in adhesions that can obliterate the cavity to varying degrees.

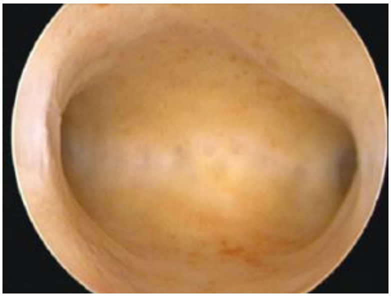

Fig. 11.1: Normal uterine cavity

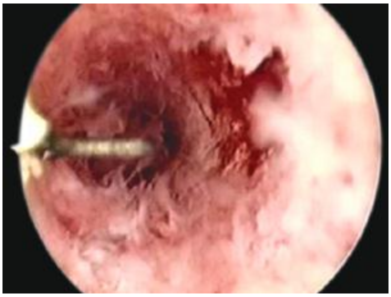

Fig. 11.2: Small tubular cavity in Asherman's syndrome

In the extreme, the whole cavity can be scarred and occluded. Even with relatively few scars, the endometrium may fail to respond to estrogens and rests. Often, patients experience secondary menstrual irregularities characterized by changes in flow and duration of bleeding (amenorrhea, hypomenorrhea, or oligomenorrhea)[8] and become infertile. Menstrual anomalies are often but not always correlated with severity. Chronic endometritis from genital tuberculosis is a significant cause of severe intrauterine adhesions in the developing world, often resulting in total obliteration of the uterine cavity which is difficult to treat.[9] Adhesions restricted to only the cervix or lower uterus may block menstruation. Asherman's syndrome can also result from other pelvic surgeries including Cesarean sections,[10,11] removal of fibroid tumors (myomectomy) and from other causes such as IUDs, pelvic irradiation, schistosomiasis[12] and genital tuberculosis (Fig. 11.3).[13]

CLASSIFICATION

Grades of Asherman's Syndrome Severity

[From European Society for Hysteroscopy and settled in 1989 (Site of adhesions)]:

I. Thin or filmy adhesions easily ruptured by hysteroscope sheath alone, cornual areas normal

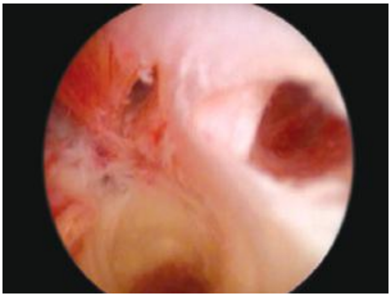

Fig. 11.3: Intrauterine synechiae following tuberculosis

II. Singular firm adhesions connecting separate parts of the uterine cavity, visualization of both tubal ostia possible, cannot be ruptured by hysteroscope sheath alone

IIa. Occluding adhesions only in the region of the internal cervical os. Upper uterine cavity normal

III. Multiple firm adhesions connecting separate parts of the uterine cavity, unilateral obliteration of ostial areas of the tubes

IIIa. Extensive scarring of the uterine cavity wall with amenorrhea or hypomenorrhea

IIIb. Combination of III and IIIa

IV. Extensive firm adhesions with agglutination of the uterine walls. Both tubal ostial areas occluded.

Valle and Sciarra's Table of 1988 Classification (Type of Adhesions)

I. *Mild*: Filmy adhesions composed of basal endometrium producing partial or complete uterine cavity occlusion

II. *Moderate*: Fibromuscular adhesions that are characteristically thick, still covered by endometrium that may bleed on division, partially or totally occluding the uterine cavity

III. *Severe*: Composed of connective tissue with no endometrial lining and likely to bleed upon division, partially or totally occluding the uterine cavity.

Donnez and Nisolle (1994) classification is as follows:

I. Central adhesions
   a. Thin filmy adhesions (Endometrial adhesions)
   b. Myofibrous (Connective adhesions)

II. Marginal adhesions (Always myofibrous or connective)
   a. Wedge like projection
   b. Obliteration of one horn

III. Uterine cavity absent on HSG
   a. Occlusion of the internal os (Upper cavity normal)
   b. Extensive agglutination of uterine walls (Absence of uterine cavity—true Asherman's syndrome).

RELEVANT ANATOMY

For any hysteroscopic procedure the surgeon must understand the thickness of the uterine wall allowing the surgeon to manipulate the surgery on the basis of the area of surgery. Table 11.1 lists the wall thickness for each area of the uterus:

Table 11.1: Thickness of the uterine wall

Location	*Mean (mm)*	*Range (mm)*
Anterior wall	22.5	17–25
Posterior wall	21	15–25
Fundus	19.5	15–22
Isthmus	10	8–12
Corpus	5.5	4–7

Sound spatial orientation and understanding of the uterine wall anatomy is the key to successful hysteroscopy in Asherman's syndrome.

ROLE OF HYSTEROSCOPY

Modalities

Plain Hysteroscopy

Plain distention of the uterine cavity with a hysteroscope can itself lyse flimsy adhesions. Blunt adhesiolysis with a flexible hysteroscope is effective for maintenance of cavity patency after primary treatment of intrauterine adhesions.

Monopolar Current

The resectoscope is a specialized instrument used with a monopolar, double-armed electrode and a trigger device for use in hypotonic, nonconductive media such as glycine. The current cuts and coagulates tissue by contact coagulation. The current settings usually involve the use of pure cutting current of 90 to 100 watts (Fig. 11.4).

Bipolar

This system again uses the bipolar circuitry for electrosurgery in isotonic media. The Versapoint system is a similar system which includes a spring tip for hemostatic vaporization, and a twizzle tip for hemostatic resection (Figs 11.7 and 11.8).

Laser

Nd-YAG: Laser energy is delivered to the tissues via a fiber inserted through operating hysteroscope. The laser energy provides a tissue penetration of

Fig. 11.4: Monopolar resectoscope

Fig. 11.5: Nd:YAG laser

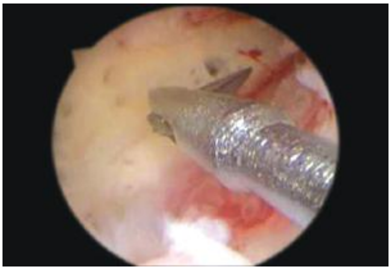

Fig. 11.6: Hysteroscopic scissors

5 to 6 mm. Two techniques are commonly described. The dragging technique requires the laser fiber to be in constant contact with the endometrium which ultimately results in vaporization of the tissue. And the blanching technique in which the fiber does not come in contact with the endometrium. Both techniques require constant motion to minimize risk of perforation. Choice of distention media includes normal saline or Dextran 70 (Fig. 11.5).

Scissors

Scissors can be used for mechanical cutting of the visible adhesions (Fig. 11.6).

Preparation of Nulliparous Cervix

In patients with known cervical stenosis or tortuous cervical canals preoperative vaginal or oral misoprostol (200 μg) 2 to 4 hours prior to the procedure is

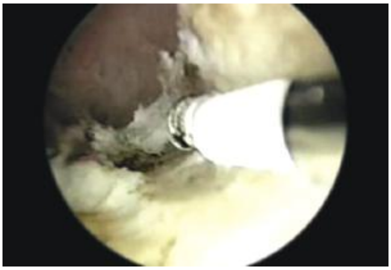

Fig. 11.7: Versapoint—twizzle tip

Fig. 11.8: Versapoint

known to increase ease of dilatation, reduce the need for mechanical cervical dilatation and lower the rate of cervical laceration thus, in turn lowering the risk of causing a false passage especially in cases of severe intrauterine adhesions. The potential side effects include vaginal bleeding, cramping, fever, diarrhea and nausea.

Role of Estrogens

Preoperative administration of estrogens is beneficial in cases of severe Asherman's syndrome so as to allow proliferation of the endometrial lining and allow better visualization of the cavity lining especially so when associated with cervical stenosis and ultrasound guided resection.

Postoperative Estrogen Therapy

Conjugated estrogens 5 mg for 25 days with medroxyprogesterone for the last 5 days. The purpose of the estrogen is to limit the amount of postoperative bleeding due to vasoconstriction of the small blood vessels and to rapidly rejuvenate the endometrial lining, which is less prone to form adhesions than a persistently raw, cut surface.

Optimizing Results and Preventing Recurrence

Postprocedure adhesion dissection can be technically difficult and must be performed with care in order to not create new scars and further exacerbate the condition. In more severe cases, adjunctive measures such as laparoscopy are used in conjunction with hysteroscopy as a protective measure against uterine perforation. Microscissors are usually used to cut adhesions. Electrocauterization is not recommended.[14]

As IUA frequently reform after surgery, techniques have been developed to prevent recurrence of adhesions. Methods to prevent adhesion reformation include the use of mechanical barriers (Foley's catheter, saline-filled Cook medical balloon uterine stent, IUCD) and gel barriers (Seprafilm, Spraygel, Autocrosslinked hyaluronic acid gel hyalobarrier) to maintain opposing walls apart during healing (Tsapanos, 2002); (Guida, 2004); (Abbott, 2004), thereby preventing the reformation of adhesions. Antibiotic prophylaxis is necessary in the presence of mechanical barriers to reduce the risk of possible infections. A common pharmacological method for preventing reformation of adhesions is sequential hormonal therapy with estrogens followed by a progestin to stimulate endometrial growth and prevent opposing walls from fusing together (Roge, 1996).

Additionally, an early second look hysteroscopy (2–4 weeks) postoperatively may facilitate treatment of new adhesions at an earlier, more amenable stage.

Amnion graft over an inflated Foley balloon of Foley catheter for 2 weeks also seems to be a promising procedure for decreasing recurrence of adhesions and encouraging endometrial regeneration.

To prevent recurrence of intrauterine adhesions after effective lysis, an 8 Fr pediatric Foley catheter with a 3 mL balloon can be inserted into the uterus and left in place for 7 to 10 days after surgery.[15-18] Insertion of an intrauterine device (IUD) immediately after adhesiolysis has been used successfully to prevent recurrence of adhesions,[15] but it may not be as effective as placement of a pediatric foley,[18] and has fallen from favor.

Our Experience

There are certain protocols that we maintain for all cases of Asherman's syndrome treated at our center:

- Routine preoperative investigations along with an ultrasonography to determine endometrial integrity
- Patients are started on tab estradiol valerate 8 to 16 mg/day at least 2 weeks prior to surgery
- Patients are administered misoprostol tablets (200 µg) 4 hours prior to the procedure either orally or vaginally. The vaginal route is preferred due to avoidance of systemic symptoms of chills, abdominal cramps, bleeding
- Monopolar current with resectoscope with settings of 110 watts pure cutting current and 80 watts coagulation current with 1.5 percent glycine as distending medium is used
- The type of anesthesia preferred is general anesthesia either with a laryngeal mask or endotracheal intubation
- The patient is in lithotomy position with return electrode in close proximity to the operative site
- The tubings and the wires are so arranged so as to allow free movement of the apparatus throughout the procedure

- A special absorbent mat with fluid reservoir attached so as to get an exact estimation of the spilled fluid
- The cervix is held with 2 tenaculum type towel clips so as to minimize space occupied and also to secure a firm grip over the cervix
- The cervix is dilated a bit more than that required for the regular resectoscope of 26 Fr (Hegar's dilator no. 10.5) to allow free movement of the resectoscope throughout the procedure
- The procedure is performed as per requirement with periodic reorientation so as to avoid any errors in reshaping the cavity
- The procedure is stopped just short of reaching the myometrial layer as evidenced by the appearance of pink myometrium or vascular channels
- The outflow tubing is placed in a labeled container. This gives us an estimate of the fluid flowing out allowing us to monitor inflow/outflow difference continuously during the procedure. The deficit has a bearing on the safety of the procedure
- A constant watch is kept all throughout the procedure on the inflow and the outflow by one personnel dedicated to the job who periodically informs the anesthetist and the surgeon the fluid deficit status
- Early administration of furosemide as soon as a large fluid deficit is anticipated
- Close postoperative monitoring of vital parameters
- Serum electrolytes and serum ammonia whenever increased fluid deficit especially over 1000 ml and the necessary correction postoperatively
- Patients are usually discharged on the same day if procedure uneventful.

Postprocedure

Patients are administered estradiol valerate 8 to 16 mg per day for 25 days along with medroxyprogesterone (10 mg) for the last 5 days from day 21 to day 25 for 2 or 3 cycles as per the individual findings. In cases of severe adhesions, estrogens are administered continuously without a break for a period of 2 to 3 months. Followed by a second look hysteroscopy with further adhesiolysis if required. Of all the adhesion prevention modalities like insertion of a Foley's catheter postprocedure, placement of an inert IUCD and postoperative estrogens we have found that the best results are obtained with priming of the endometrium with estrogens and continuous or sequential estrogen support from 1 to 3 months postprocedure.

We perform cervical os tightening only in indicated cases as per clinical and ultrasonological findings and not as a routine.

In our yet unpublished series of 478 cases of Asherman's syndrome over a period of 7 years, our results correlate well with the world statistics in terms of live pregnancy rates, return of menstruation, rate of abortion, etc.

IRRIGATION MODALITIES

The potential cavity inside the uterus requires the application of pressure to separate the uterine walls. The minimum required pressure to produce satisfactory degree of distention is 40 to 50 mm Hg. This can be achieved by:

Hydrostatic Pressure

A bag of infusion fluid suspended 60 cm above the uterus allowing the fluid to enter the cavity with a pressure of 45 mm Hg. Varying the height of the bag above the patient will clearly alter this infusion system for controlling the inflow pressure.

Pressure Cuff

Pressure cuff can be placed around the soft-walled infusion bag and the cuff inflated to a suitable level. Infusion rates can be varied by altering the pressure around the cuff.

Pressure Controlled Pump

Hamou has developed a pressure-limited rotatory pump (Hystromat). The rate of infusion can be altered by varying the pressure the pump can produce (Garry,1995).

Special Fluid Pump

A fluid pump is used to distend the uterus which includes a blood pressure monitor which preselects the maximum pressure for the pump at or slightly below the mean arterial pressure for the patient (awaiting patent).

Complications

The most alarming complications after hysteroscopy are due to fluid overload, bleeding and uterine trauma. An accepted range of complications during surgical hysteroscopy is 3.8 percent.

Mechanical Complications

Mechanical complications include perforation and cervical trauma. Risk factors include cervical stenosis, severe uterine anteflexion or retroflexion, infection, myomas of the lower uterine segments and synechiae.

A proper clinical examination and determination of the cervical angle and position of the uterus may limit the complications associated with cervical dialatation. Alternately a vaginoscopic guided or an ultrasonic guided entry may limit the said complication.

Uterine perforations can occur during operative maneuvers especially the region of the cornua. In general, a small midline or fundal injury with a blunt instrument with minimal bleeding may be of no grave significance but lateral rents or injuries of the lateral walls, or injuries with electrosurgical instruments may need diagnostic laparoscopy or interventional radiology or angiography to evaluate injury to the uterus as well as to the surrounding viscera.

Whenever electrical or laser injury to the viscera is suspected, laparoscopy or laparotomy is required for complete evaluation. For procedures in which electrical or laser energy is used, the surgical tip should be always kept in direct view to avoid inadvertent thermal injury.

In cases of electrosurgical energy being used, especially monopolar energy, proper grounding of the current is a must to prevent distal site injuries to the patient though the newer generation of electrosurgical units are programmed to stop function in the event of faulty grounding of current.

Media Related Complications

Fluid overload: Risk factors for clinically significant intravasation of fluid include prolonged operative procedures, use of large volumes of low-viscosity media, resection of large fibroids or adhesiolysis for advanced Asherman's syndrome involving the opening up of uterine venous channels or unidentified perforations. Intravasation can occur when the intrauterine pressure is greater than the patients mean arterial pressure.

Nonelectrolyte hypotonic media which are nonconductive are most often used for the prolonged complicated electrosurgical procedures. These media have serious adverse effects especially when large volumes of these solutions are absorbed, hyponatremia, hypervolemia, hypotension, pulmonary edema, cerebral edema and cardiovascular collapse can occur. Accurate monitoring of the input and output of the media is the key to prevent overload as also early detection of the signs of overload (parotid sign).

For every liter of hypotonic media absorbed the patient's serum sodium decreases by 10 mEq/L. If the patient's sodium level is less than 120 mEq/L changes due to hyponatremia like cerebral edema, seizures, even death can occur. In general, if the fluid deficit is greater than 1500 ml or if the sodium level is less than 125 mEq/L the procedure should be terminated. Forced diuresis with furosemide, fluid restriction and administration of 3 percent sodium chloride at a rate to correct hyponatremia by 1.5 to 2 mOsm/L/h may be instituted.

In cases with evidence of pulmonary edema, corrective medical measures along with a delayed extubation may be indicated.

Serum ammonia levels may also be needed to be monitored as ammonia is a byproduct of glycine in the body. Temporary visual disturbances have also been reported in cases of glycine overload.

Gas Embolism

It is one of the major complications reported though carbon dioxide gas in hysteroscopy as distention medium is not as popular as the other distention media available. When used the intrauterine pressure should be maintained below 100 mm Hg with maximal flow rates less than 100 ml/min.[19]

Air embolism can occur even with the use of other media especially when the circuits show presence of air which is inadvertently pushed under pressure.

When gas embolism occurs circulatory collapse can occur. If an embolus is suspected because of a change in patients vital signs (hypotension, tachycardia, desaturation, decreased end tidal CO_2), the hysteroscope should be removed, patient's positioned on left side and an intravenous bolus of sodium chloride solution should be delivered as a first line treatment.

Further evaluation with echocardiography and cardiopulmonary resuscitation attempted.Percutaneous aspiration of the embolus has been reported.

Uterine Trauma, Perforation and Bleeding

Bleeding during or after surgery is the second most common complication of hysteroscopy (0.25%). Distention media themselves may yield enough pressure to cause hemostasis during a procedure. In addition, the coagulating effects of surgical instruments can aid in controlling bleeding.

If bleeding persists after surgery, Foley catheter filled with 15 to 30 ml of fluid can be inserted into the cavity and removed 24 hours later. Vasopressin and misoprostol are alternate medications that can help with vasoconstriction and uterine contractions. As a last resort embolization of the uterine artery or hysterectomy is an option for definitive management.

Sequelae

Reformation of adhesions: Follow-up tests (USG monitoring of endometrial lining, hysteroscopy) are necessary to ensure that adhesions have not reformed. Further, surgery may be necessary to restore a normal uterine cavity. According to a recent study among 61 patients, the overall rate of adhesion recurrence was 27.9 percent and in severe cases this was 41.9 percent.[21] Another study found that postoperative adhesions reoccur in close to 50 percent of severe AS and in 21.6 percent of moderate cases.[7] Mild intrauterine adhesions, unlike moderate-to-severe synechiae, do not appear to reform.

Abnormal placentation: Patients who carry a pregnancy even after treatment of intrauterine adhesions may have an increased risk of having abnormal placentation including placenta accreta[20,22] where the placenta invades the uterus more deeply, leading to complications in placental separation after delivery. Abnormal adherent placenta (placenta accreta, increta) may require a cesarean hysterectomy. Premature delivery,[21] second-trimester pregnancy loss,[22] and uterine rupture[23,24] are other reported complications. They may also develop incompetent cervix.

Weakening of the Uterine Wall

There are certain studies which mention that the scarred uterus following treatment for Asherman's syndrome is more prone to uterine rupture during delivery but more definitive studies are required to support this. As most of the pregnancies following Asherman's syndrome correction are cases of infertility they are most often delivered by elective cesarean section.

Role of Lateral Metroplasty

Palmer and Meylan (1964) described three types of uterine hypoplasia:

1. *Simple hypoplasia:* The form of the uterus is normal, but it is small-scaled.
2. *Elongated hypoplasia:* The uterus has a normal or elongated length, but it has a narrow fundus.
3. *Malformative hypoplasia:* Arcuate fundus, T-shaped (seen in 31 percent of cases), or a Y-shaped uterus (has the worst prognosis). Moreover,

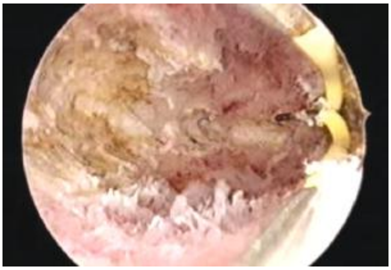

Fig. 11.9: Enlarging metroplasty

strictions in the form of a constriction ring may be seen in the miduterus in addition to the coexistence of irregular uterine contours, dilatations, adhesions, rudimentary horns, and diverticulae.

The enlarging hysteroscopic metroplasty (Fig. 11.9) is performed early in the follicular phase. The principle is based upon incising with a hook the lateral spurs (including the myometrium) and the Arcuate fundus to a depth of 7 mm in order to obtain an increase in the size of the uterus and ameliorate its shape while avoiding as much as possible the perforation of the uterus or the fundus.

Garbin et al (1998) published the reproductive outcome results before and after the enlarging hysteroscopic metroplasty performed on 24 cases. We can see a decrease in the rates of abortion from 88 to 12.5 percent. And the rates of term deliveries were increased from 3 to 87.5 percent.

Similarly, Barranger et al (2002) evaluated the reproductive outcome on 29 cases; 21 women (72.4%) had 30 pregnancies (follow-up for 13–67 months). Thirteen of them gave birth to 16 live infants. In this study, the rates of delivery increased from 3.8 to 63.2 percent.

After 18 years of publishing his results in 1998, Garbin O et al (2006) believe that the enlarging hysteroscopic metroplasty should not be proposed as a first line treatment in patients having a dysmorphic uterus except in specific cases such as before enrollment in an Assisted Reproductive Technique Program, in order to decrease the possibility of implantation failure, or in the case of a nulligravida of advanced age.

Sequelae

In fact, the enlarging hysteroscopic metroplasty is not innocuous. Since it may create cervical fragilization (Garbin, 1998) apart from the cervical incompetence, thus, necessitating the insertion of a cervical cerclage in order to prevent 2nd trimester pregnancy loss. Moreover, the incision on the myometrium weakens the uterus and makes it more prone to uterine rupture. So, pregnancy in such a uterus must be considered a high-risk pregnancy.

Of course, complications are not limited to the enlarging hysteroscopic metroplasty alone, since the hysteroscopic septoplasty may be complicated by uterine perforation which occurs either during dilation of cervix, or during the resection of septum. There is also a risk of visceral burns if perforation is not detected. For this reason, some authors recommend a concomitant intraoperative sonography or laparoscopy.

Sentilhes L et al (2006) observed that the time interval between hysteroscopic septoplasty and a subsequent pregnancy varied from one month to 5 years with an average delay of 16 months. Uterine rupture occurred in pregnancies between 19 and 41 weeks of gestation, even in the absence of labor (in 12 out of the 18 cases reported) thus, exposing the maternal and fetal prognosis to high-risks. In his study, he denoted that the two most important factors that may increase the likelihood of uterine rupture are—the use of monopolar electrosurgery and perforating the uterus while resecting the septum. So, instead of using monopolar electrosurgery, he encourages the use of a coaxial bipolar electrode for a safer resection.

In addition to the mechanical complications already mentioned, post-hysteroscopic endometritis occurs in 1 to 5 percent of cases, thus justifying the systematic use of intraoperative prophylactic antibiotics. In order to avoid during hysteroscopy the intravascular passage of a significant quantity of irrigation fluid which can lead to hemodilution, adherence to the procedural protocol is essential with a meticulous monitoring of the inflow and outflow of fluids.

DISCUSSION

Hysteroscopic adhesiolysis is a safe and effective procedure for restoring the normal menstrual pattern and fertility.[25,26]

The initial severity of the adhesions appears to correlate best with the reproductive outcome. Adhesions after suturing the uterine cavity after open myomectomy or open surgery seem to cause maximum damage and yield poor results in both hysteroscopic correction and reproductive performance. The outcome of hysteroscopic adhesiolysis for Asherman's syndrome is significantly affected by recurrence of intrauterine adhesions. Further research in Asherman's syndrome should be directed toward reduction of adhesion reformation with a view to improving outcome. The extent of adhesion formation is critical. Mild-to-moderate adhesions can usually be treated with success. Extensive obliteration of the uterine cavity or fallopian tube openings (ostia) and deep endometrial or myometrial trauma may require several surgical interventions and/or hormone therapy or even be uncorrectable. Pregnancy and live birth rate has been reported to be related to the initial severity of the adhesions with 93, 78, and 57 percent pregnancies achieved after treatment of mild, moderate and severe adhesions, respectively and resulting in 81, 66, and 32 percent live birth rates, respectively.[7] The overall pregnancy rate after adhesiolysis was 60 percent and the live birth rate was 38.9 percent according to one study.[27]

Age is another factor contributing to fertility outcomes after treatment of Asherman's syndrome. For women under 35 years of age treated for severe adhesions, pregnancy rates were 66.6 percent compared to 23.5 percent in women older than 35.[21]

After successful lysis of intrauterine adhesions, normal menstruation resumes in 78 to 92 percent of women; another 8 to 9 percent may have menses relatively light or short in duration (hypomenorrhea).[27] The incidence of spontaneous abortion after lysis of intrauterine adhesions (15–43%) is generally lower than that reported before treatment (24–87%).[28,29] The incidence of preterm delivery (2%), placenta previa (1%), stillbirth (1%), postpartum hemorrhage or retained placenta (4%) is generally low.

Thus, innovative and borrowed techniques are enabling many other types of hysteroscopic interventions and new and improved hysteroscopic designs. Instruments are becoming narrower than before enabling additional in-office interventions.

Patient demands for safe and minimally invasive treatments will continue to drive research and development.

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CHAPTER 12

Hysteroscopy and Müllerian Septum

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INTRODUCTION

Intrauterine septum is one of the most common amongst Müllerian anomalies and also one of the correctable anomalies. But the question that always arises, is, whether these anomalies are to be corrected or not? With the advent of hysteroscopy there has been a revolution in the treatment of intrauterine septa.

Intrauterine septum is due to incomplete fusion of the two Mullerian ducts which usually, when completely fused will produce the uterus and the upper part of the vagina. Intrauterine septum varies in its extent from the fundus of the uterus to the middle of the vagina. There are different types of fusion abnormalities. The commonest one is an arcuate uterus or a subseptate uterus where it may be a bigger convexity of the fundus identified by the funneling of the ostia or it may be half-way in the uterine cavity. When this extends to the internal os it is called as complete septum. This may extend to the cervix to form a cervical septum or into the vagina to form a vaginal vertical septum. In all these cases, it is the uterine cavity that is divided and the rest of the tissue that is the myometrium and connective tissue of cervix is completely fused. If the division extends into the myometrium, it becomes a bicornuate or dydelphys, depending on the extend of the division. If the matter of the cervix is also divided, it becomes dicollis/bicollis which has to be differentiated from septate cervix by the hourglass appearance on speculum examination.

In case of a septum, there is always a misconception that there is a wall extending from the anterior wall of the uterus to the posterior wall and this has to be excised and removed. This visual impression is created by the hysteroscopic view, where the uterine cavity is distended. In a nondistended uterus, the cavity is collapsed in the anteroposterior dimension and this septum is just sticking to the anterior and posterior wall. Due to this, when the septum is cut in the middle, there is nothing hanging from the walls and it just merges into the walls. This wall phenomenon to a certain extent occurs in the vaginal septum too. Immediately after cutting, we find cut edges hanging from the anterior and posterior wall but will get merged with the anterior and posterior walls when it heals.

Most of the septa are in the midline vertical and does not produce any cryptomenorrhea. But at times we have come across certain septa which deviate from the midline and become oblique producing hematosalpinx, hematometra, hematocolpos and results in unilateral endometriosis. Whenever unilateral endometriosis is seen with absolutely normal opposite side, we should suspect these oblique septa. We have also seen some cases where it is more or less like a rudimentary horn with a functioning cavity but there is a complete myometrial fusion and it is only an inside septum producing cryptomenorrhea. In such cases when you open the cavity with a resectoscope, it becomes like a normal uterus.

DIAGNOSIS

Most of the times, these septa are asymptomatic. Uterine septa are detected accidentally while investigating for recurrent abortion or infertility. At the same time they may be detected during cesarean section for the first time. Vaginal septa may be detected earlier due to coital difficulty

A 3D ultrasound is the best method to diagnose septa. It also helps to differentiate it from bicornuate and didelphys uterus. In case of a septum, the fundus will be broad as against indentation in case of bicornuate or didelphys uterus. This can be confirmed on laparoscopy.

Hysterosalpingography and hysteroscopy can diagnose an internal defect but will not give any clue regarding a fundal defect which helps to differentiate it from bicornuate uterus.

On hysteroscopy, if you see one ostia and the opposite side is a blind wall it can be any anomally like unicornuate, septate, bicornuate or didelphys uterus. Coming down if you see another cavity it could be septate, or bicornuate which can be confirmed by laparoscopy. If no separate cavity is seen till the cervix, it can be a complete septum or a didelphys dicollis. This can be differentiated by a speculum examination by seeing the hour glass appearance. In some cases, the opposite cavity may not be seen as the septum can get flushed to the wall during dilatation of the cervix. In such cases a microhysteroscope can be used to get into the opposite cavity. Microhysteroscope is used without dilatation.

INDICATIONS FOR TREATMENT

Unless there is a clear indication, these Müllerian anomalies do not require any treatment. The most important indication is cryptomenorrhea . In these cases treatment should not be delayed as it will lead to damage to the tubes and endometriosis.

In cases of infertility, recurrent miscarriages, preterm labour, etc. the picture is not yet clear. But basically as the treatment is an extremely easy surgical one and as it involves only correction of the intrauterine environment it is usually done as the first step.

It is said that relatively avascular nature of the septa along with less number of estrogen receptors and restriction of space for the growing pregnancy results in recurrent pregnancy loss. Any way it is always important to correct the intrauterine environment in case of infertility and miscarriage as there are a lot of factors which are still not known to medical science. We usually correct these defects in all patients who are planning for pregnancy and do not wait for miscarriage.

In case of vaginal septa, difficulty in sexual contact becomes the most relevant indication. Of course as in uterine septum when a vaginal septum is seen in a patient with infertility we always correct it.

TREATMENT

Treatment is always surgical. Gone are the days when we used to do laparotomy, hysterotomy and then correction. Such a correction is always associated with risk of antepartum and intrapartum uterine rupture which makes cesarean section, a preferred route of delivery. Also it can lead to formation of intrauterine and extrauterine adhesions which can lead to infertility.

HYSTEROSCOPY

Hysteroscopic correction of septum is one of the simplest hysteroscopic surgeries. Different energy sources can be used for this purpose:
1. Hysteroscopic scissors
2. Versapoint
3. Needle unipolar electrode
4. Resectoscope.

Hysteroscopic Scissors

This stands the preferred energy sources in the order of preference. Hysteroscopic scissors has the advantage that it is simplest, can be used with saline (less electrolyte imbalance and glycine toxicity), can be used through the operating channel (less dilatation of cervix), least damage to the endometrium, and less chances of perforation as it does not cut in forward movement.

Hysteroscopic scissor is introduced through an operating channel and if it is in a microtelescope the dilatation required is extremely less. Usually in these kinds of anomalies, the cervix will be lax. Cutting is done mechanically.

Versapoint

This has all the advantages of scissors but has more endometrial damage compared to scissors and less damage compared to unipolar current. This is basically a bipolar energy and it can be used with saline or any electrolyte medium and all complications associated with fluids are avoided.

Unipolar Electrode

This has the advantage of a Versapoint that it can be used through the operating channel and does not need much dilatation. This will be the most cost effective method and it can be used in thick septa where scissor can fail. Both Versapoint and scissors are costly options. A proper current setting and correct usage reduces the endometrial damage to a large extent. The fluid used has to be glycine as it requires a nonelectrolyte medium. Glycine toxicity is almost never seen in case of septum as this is always a short procedure and large vessels are not opened up as in case of hysteroscopic resection of fibroid.

Resectoscope

This is a less preferred method but very easy to use. This requires over dilatation of an already lax cervix and needs glycine.

PROCEDURE

The cutting of the septum always starts from the lower most part which is always the thinnest part also. This has the advantage that both the cavities are under vision. The septum becomes thicker towards the fundal end. When the ostia are seen, stop cutting. The fundus is kept convex and we should avoid making it concave in the middle. We need to stay reasonably away from ostia as it may lead to damage to endometrium there.

Septum is normally avascular and when cut will easily merge into the anterior and posterior walls. We should cut the septum equidistant from anterior and posterior wall.

Laparoscopic guidance during this procedure does not add any safety further but it complicates the procedure. Laparoscopy is done only to differentiate it from a bicornuate uterus.

In cases where over dilatation is done, the septum can remain flushed to the cervix on one side. In such cases the telescope is kept at the level of cervix and pressure is set high. Even if you can find a small opening of the other cavity once the cutting starts it will open up well. Higher intrauterine pressures are used in septum as this is basically the anterior and posterior walls stuck to each other. But as the cutting proceeds you can see that the cavity opens up.

CERVICAL SEPTUM

There is always a controversy regarding whether a cervical septum has to be cut or not. We usually cut it and have not seen much of a difference and all these patients go for a cervical encirclage. Cutting of these septa is done usually with a normal thin, straight, long scissors. This does not bleed usually as this is avascular. Once this is cut up to the level of the internal os without dilatation, the resectoscope or the operating channel is kept in the cervical cannal and the external os is closed with a tenaculum. High pressure of 150 mm Hg is used here otherwise it is difficult to get adequate distension. Further cutting starts from the lower most part of the septum. In such cases, cutting with hysteroscopic scissors will be difficult inside the uterus as the septum will be very thick and the thickness keeps on increasing as it reaches the fundus.

VAGINAL SEPTUM

The most important part of cutting this septum is to stay equidistant from the anterior and posterior vaginal walls to avoid injury to the urinary bladder and rectum. Unipolar electrode is used for cutting as vaginal septa are vascular unlike intrauterine septa. The septum is kept stretched with fingers in the vagina on either side of the septum. Putting a urethral catheter does not help in all cases. Once the cervix is reached the cutting goes anterior and posterior to shape out the cervix. An electrocautery is never used to cut the cervical septum. In the case of a vaginal septum, there will be a redundant part hanging unlike in uterine septum but this need not be excised as it merges with vaginal wall soon.

POSTOPERATIVE CARE

The need of encirclage is one of the most important matter which has to be addressed. We feel that most of these cases have a lax cervix, especially those who have a cervical septum and all of them routinely need an encirclage during the next pregnancy. In cases of recurrent miscarriage we even prefer to do a laparoscopic encerclage during the time of surgery. The only problem with this is that the patient will have to go for an elective cesarean section. Laparoscopic encirclage has much better results in cases of proven cervical laxity.

We usually do not use estrogen after septal resection unlike intrauterine adhesions where there is damage to the endometrium. Adhesion formation is extremely less in septum resection.

Pregnancy is not recommended for the first two months and a diagnostic hysteroscopy is ideal before planning for the next pregnancy.

COMPLICATIONS

Other than the usual complications of hysteroscopic surgery there are no specific complications related to septum resection. Perforations are avoided by keeping the fundus convex as we have already discussed. Laparoscopic guidance to avoid perforation is never recommended and this helps only to complicate the procedure.

CHAPTER 13

Endometrial Ablation and Transcervical Resection of Endometrium

Rakesh Sinha, Meenakshi Sundaram

Menorrhagia is a common disorder that accounts for approximately 35 percent of all gynecological conditions.[1] Beyond the obvious problem of physical discomfort, increased levels of depression, anxiety and sexual problems are often reported in women with heavy menstrual bleeding. Menorrhagia has an enormous impact on many women's lives and, until the early 1990s; the only treatments widely available were relatively ineffective oral therapies and hysterectomy. However, for the last decade, women seeking treatment for menorrhagia have also been able to choose from a much wider range of therapies, including a potentially bewildering number of new surgical therapies that aim to permanently remove or destroy the endometrium. This review considers each currently available technology individually, assesses the role of endometrial ablation in the treatment of menorrhagia with focus on transcervical endometrial resection of endometrium.

FIRST GENERATION ENDOMETRIAL ABLATION TECHNIQUES

First generation or hysteroscopic methods of endometrial ablation introduced as early as 1980s, include endometrial laser ablation (ELA), transcervical resection of the endometrium (TCRE) and rollerball ablation (RBA). These techniques though effective are difficult to master. They require additional specialized training and surgical expertise, and involve a significant learning curve.[2]

Compared with hysterectomy, treatment is associated with lower morbidity, shorter hospitalization and faster recovery, and reduced treatment costs. As a result, the first generation ablation techniques are recognized as the "gold standard" ablation methods.

The aim of endometrial ablation is to remove or destroy the whole thickness of the endometrium, including the basal glands, a concept based on Ashermann's observation in 1950 that intrauterine adhesions and scarring with denudation of the endometrium is associated with oligo- or amenorrhea.[3]

Although the precise early history of hysteroscopic endometrial ablation is unclear, it was Robert Neuwirth who, in 1978, was the first to publish on the use of the urological resectoscope in order to excise submucous fibroids in cases of abnormal uterine bleeding.[4] Later publications by Neuwirth make it clear that at some time, he began to use the resectoscope to burn the endometrium as well.[5] The first formal description of endometrial ablation with the resectoscope was actually made by Alan DeCherney, who in 1983 and 1987 wrote about electrocoagulating the endometrium electrosurgically in women with intractable uterine hemorrhage who were unfit for hysterectomy.[6]

TRANSCERVICAL RESECTION OF THE ENDOMETRIUM

Successful treatment of abnormal uterine bleeding with endometrial ablation techniques requires complete resection of the endometrial glands that may extend deeply into the myometrium. The advantage of TCRE is that the procedure is under vision and depth of resection ideally includes 2.5 to 3 mm of myometrium in which the endometrial glandular elements are found though this requires greater operator skill to prevent uterine perforation.

Procedure

The use of the loop shaped electrode through a monopolar or more recently bipolar continuous flow resectoscope, produces efficient resection of the endometrium and underlying superficial myometrium and is the only technique which provides tissue for histological examination. The hysteroscopic resectoscope uses a continuous flow system with an inner and outer sheath. Most hysteroscopic resection use 4 mm telescopes with 30° angle. The more acute angled scopes are useful for resecting near the cornual area. The choice of viewing angle is largely dependant on personal preference. Most resectoscopes are 18 to 19 cm in length and 9 mm diameter (27 Fr). Smaller scopes are also available which may narrow the vision and increase operating time, but cervical dilatation required is less. While using the monopolar resectoscope, the irrigating fluid should be nonconducting. Various solutions are available but 1.5 percent glycine is commonly used for endometrial resection. It has to be carefully used with strict monitoring of fluid input and output as it is hypotonic and cause fluid overload and dilutional hyponatremia.[7]

Recently, bipolar resectoscope have been introduced which increases the safety of the procedure with respect to fluid overload as uterine distension with normal saline is associated with less electrolyte disturbance than is the case with electrolyte-free solutions.

The patient is placed in lithotomy position, parts painted and draped. Uterine sound is introduced to check the direction and length of the uterine cavity. The cervix is dilated enough to fit the resectoscope comfortably. The uterine cavity is visualized for the presence of any abnormalities and submucous fibroids. Resection is carried out from the fundus through the entire length of the cavity up to the internal os by activating the current (Figs 13.1 to 13.7). Resection of the cornual endometrium should also be ensured for good results.

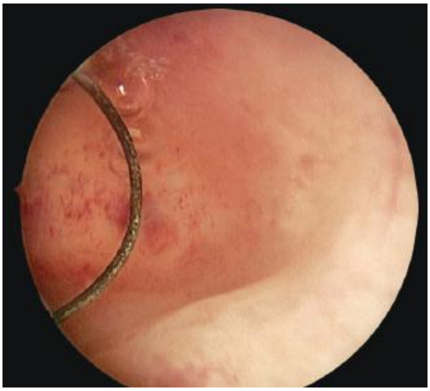


Fig. 13.1: Endometrial resection loop

Fig. 13.2: Resection of right cornual surface

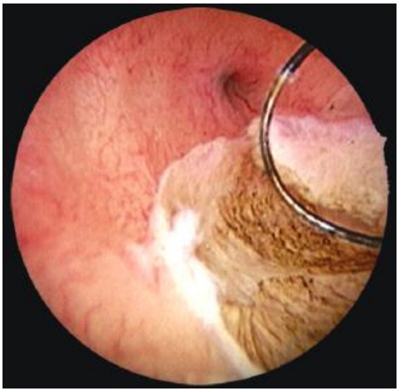
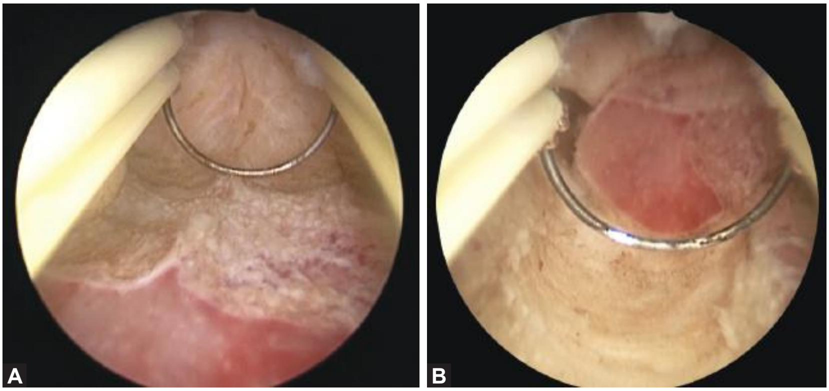


Fig. 13.3: Resection of left cornual surface



Figs 13.4A and B: Resection of posterior wall

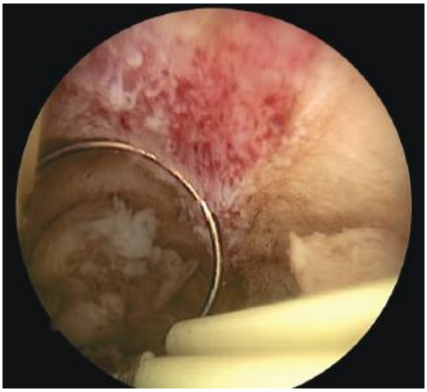


Fig. 13.5: Resection of anterior wall

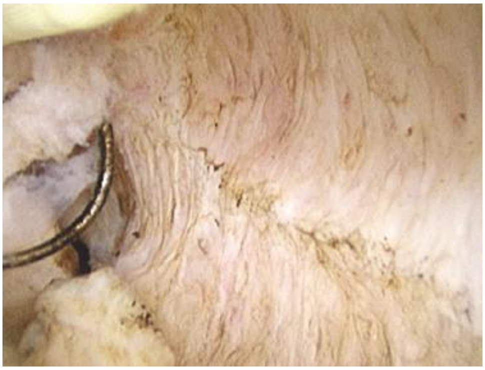


Fig. 13.6: Resection of lateral wall showing the base limit of resection

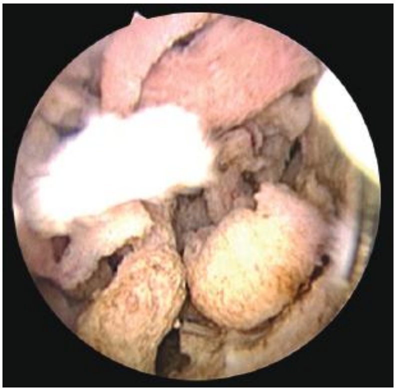


Fig. 13.7: Collected pieces in the uterine cavity

Transcervical resection of the endometrium (TCRE) is certainly a proven alternative to hysterectomy with high satisfaction rates ranging in various studies between 70 to 94 percent.[8]

Endometrial resection has the following advantages and disadvantages:

Advantages

a. Provides endometrial tissue for histology
b. Suitable if endometrium is thick
c. Submucous fibroids or polyps can be excised at the same time.

Disadvantages

a. The most skill dependent of the three techniques
b. Greatest risk of uterine perforation
c. Need to use electrolyte free distension media (with monopolar resectoscope).

First generation endometrial ablation techniques (FEAT) have been compared in randomized trials with recommended first-line medical treatments, and satisfaction rates, post-treatment hemoglobin concentrations, pain scores and quality of life measures are better after FEAT.[9] Randomized trials comparing endometrial resection with the levonorgestrel-releasing intrauterine device (LNG-IUS) show slightly higher amenorrhea rates and reduced blood loss following resection.[10] When compared with hysterectomy, operating time, hospital stay and direct costs are less after FEAT.[11]

Reported complications from FEAT include uterine perforation, hemorrhage, pelvic sepsis and fluid overload syndromes.[12] The UK-based MISTLETOE audit, which reported on 10,686 procedures, included two deaths and an overall complication rate ranging from 2.1 percent for laser ablation to 6.4 percent for loop resection.[12]

HYSTEROSCOPIC LASER ENDOMETRIAL ABLATION

The laser energy suitable for hysteroscopic surgery must not be absorbed by water and has to be transmissible through a fiber rather than mirrors. Carbon dioxide, for instance, fulfils neither of these two characteristics. In contrast, the neodymium-yttrium-aluminum-garnet laser (Nd-YAG laser) is ideal for intrauterine surgery as it is a fiber laser with a tissue penetration of 5 to 6 mm. The laser energy is delivered to the tissues via a 600 or 800 mm bare quartz fiber guided through an operating hysteroscope.[13] Power settings for the laser generator are usually between 40 to 80 W giving a power density of 4000 to 6000 W/cm^2.[14]

Laser endometrial ablation has the following advantages and disadvantages:

Advantages

a. Tissue coagulation to 5 to 6 mm
b. Perforation less likely than resection
c. Small fibroids or polyps can be vaporized.

Disadvantages

a. Expensive capital and running costs
b. Slowest of all the techniques
c. Greater risk of fluid overload than with electrosurgery
d. Need for special laser safety procedures and guidelines.

HYSTEROSCOPIC ROLLERBALL ENDOMETRIAL ABLATION

Soon after laser ablation, the introduction of rollerball became popular because of its relative simplicity and cost advantage compared with laser ablation.[15] It is a safe and effective technique, having also the advantage of being quicker to perform. The concept of rollerball ablation is similar to laser ablation, except the energy used is electrosurgical. Rollerball electrodes are usually available in two sizes—small and large, commonly 2.5 to 5 mm diameter respectively, which are used to electrocoagulate the endometrium.

Advantages

a. Easier to learn and perform than resection
b. Less risk of uterine perforation, fluid absorption and hemorrhage than endometrial resection
c. Shorter operating time than laser ablation.

Disadvantages

a. No endometrial specimen for histology
b. Cannot treat submucous fibroids (unless using rollerbar or barrel)
c. Use of monopolar energy which is less safe than bipolar
d. Need to use nonphysiologic distension media.

Long-term outcome data show that many women can avoid any further surgical intervention following treatment using a FEAT technique. However, a significant level of operator skill and training is required to produce reliable results safely. FEAT also require general anesthesia, expose the patient to the risk of fluid overload and can be time-consuming. The rapid development of a range of so called second generation (SEAT) or global ablation therapies that can be used by a gynecologist with no operative hysteroscopic skills make it likely that FEAT will, in future, be only infrequently used.

SECOND GENERATION ENDOMETRIAL ABLATION THERAPY

In the last decade, a number of second generation devices have been developed with the aim of making the efficacy and safety of endometrial ablation less operator-dependent and also to permit the use of this treatment in a clinic, rather than an operating theater setting.

Global endometrial ablation (GEA) procedures were introduced in the mid-1990s and quickly proved to be simple, effective, and safe therapies for menorrhagia, especially when compared with earlier hysteroscopic ablation procedures.[16] Thermal balloon ablation (TBA) was the first method of GEA approved by the US Food and Drug Administration, and by the end of the 1990s, it had become the most clinically used GEA procedure. Various modalities are available and each treatment modality is reviewed briefly below.

When considering clinical outcomes of the various global ablation technologies, the prime consideration should be improvement in the patient's quality of life rather than absolute amenorrhea rate.

Balloon Systems

These devices use an inflatable balloon on the end of a disposable probe, which is inserted into the uterine cavity and through which heated fluid is then circulated. Balloon inflation pressure ensures close contact between the heat source and endometrium and also produces a degree of endometrial ischemia, reducing the cooling effect of uterine blood flow. Some devices have a heating element and thermistor within the intrauterine balloon and no mechanism for circulating the fluid within the balloon (ThermaChoice, Gynecare).[17] Others heat saline or glycine within a separate unit and circulate it through the intrauterine balloon (CavaTerm, Menotreat)[18] or have an umpellar within the balloon to circulate fluid (ThermaChoice II, Gynecare). Treatment times are 8 min for Thermachoice, 11 min for Menotreat and 15 min for Cavaterm. The devices require dilation of the cervix to between 5 mm (Thermachoice) and 8 mm (Cavaterm).

ThermaChoice (Gynecare Division, Ethicon, Inc., Somerville, New Jersey) was approved by the FDA in 1999. The device consists of an 5.5 mm (outer diameter [OD]) balloon- tipped catheter containing a heating element that is positioned within the uterine cavity and slowly distended to 160 to 180 mm Hg by injecting a solution of dextrose and water. The microprocessor in the controller unit monitors the pressure in the balloon and heats, the fluid to approximately 87°C for 8 minutes, thus ablating the endometrium via a direct thermal effect. The third-generation balloon conforms somewhat to an irregular cavity, enabling greater contact with the endometrium. Because the device operates at high pressure within the uterus, most procedures have been performed either in a surgicenter or in the office using IV sedation and paracervical or deep intracervical block.

The *Thermablate* EA system (TEAS) is another endometrial ablation device to treat excessive uterine bleeding. It combines a short treatment time of 2 minutes and 8 seconds with automatic control of treatment parameters of high temperature (173°C) and pressure (180 mm Hg).[19] A 6.5 mm diameter catheter along with its portability and simplicity makes it ideal for outpatient use. It was shown to be effective and safe in a small group of patients where other therapies were contraindicated or difficult to perform.[20]

Intrauterine Laser Devices

A device using diffused laser energy from an intrauterine array of three 830 nm diode laser fibers has been developed (ELITT).[21] Two lateral fibers and a single central fiber on a disposable handset are introduced into the uterus and the cavity is illuminated for a treatment time of 7 min. Rates of amenorrhea of up to 70 percent at 12 months have been reported[22] but larger studies and randomized comparisons with other treatments are awaited.

Multielectrode Radiofrequency Ablation

The *Vestablate* (Valleylab)[23] system uses radiofrequency thermal energy applied globally within the uterine cavity to desiccate the endometrium. It consists of a polymer balloon covered with 12 monopolar electrodes inflated within the uterine cavity to bring the electrodes into contact with the endometrium for a treatment time of 4 to 7 minutes. Nonrandomized clinical studies suggest that similar amenorrhea and success rates to FEAT can be expected.

Bipolar Impedance Controlled Ablation

Novasure[24] uses bipolar electrosurgical energy to ablate the endometrium. The device consists of a conductive metallic wire mesh over a triangular frame that is expanded within the uterus. Prior to activation, intrauterine pressure is measured by the injection of carbon dioxide gas to check for cavity perforation and a vacuum is then produced to ensure close contact with the endometrium. Tissue impedance is measured during a treatment time of about 90s and the device is switched off when endometrial desiccation has occurred. Randomized trials have shown Novasure to be as effective as rollerball ablation at 12 months and associated with lower intraoperative pain, lower postoperative analgesia requirement[25] and a higher amenorrhea rate than balloon ablation systems.[26]

Hot Saline Instillation Systems

Fluid infused through the cervix at pressures below 70 mm Hg will not spill into the peritoneal cavity[27] and this principle is utilized by hydrothermal ablation devices.

In the *Hydrotherm Ablator* (BEI Medical systems),[28] 0.9 percent saline is infused through the inflow channel of a standard 3 mm hysteroscope covered by a 7.8 mmute disposable insulating sheath at a pressure of 50 mm Hg. Treatment time is 10 minute at an intrauterine temperature of 90°C.

It is the only procedure for global endometrial ablation that is performed under direct hysteroscopic control.

A multicenter randomized trial comparing the Hydrotherm ablator with rollerball ablation reported similar amenorrhea rates and improvements in quality of life scores at 12 months. Another device (EnAbl system, Innerdyne Medical)[29] has also been described that repeatedly instills and aspirates saline over 15 min at a pressure of 30 mm Hg through an intrauterine catheter with a heater, monitoring thermocouple and collapsible cage contained within its tip. Both devices switch off if fluid is lost from the uterine cavity.

Microwave Energy

Electromagnetic energy can be used to ablate the uterine cavity (Microwave endometrial ablation—MEA).[30] A 9 mm diameter reusable probe using a microwave frequency of 9.2 GHz produces heat penetration at its tip to a depth of 6 mm within the uterus. Temperature is indicated on a graphical display and the operator ensures that the probe tip remains within a therapeutic temperature band (75–85°C) as the probe is moved slowly across the uterine cavity and gradually withdrawn over a typical treatment time of 3 min. Uniquely for a SEAT device, the control unit records treatment profiles for all patients each probe is used for potentially facilitating the collection of audit data. Randomized trials comparing MEA with endometrial resection,[31] its use with local and general anesthesia[32] and long-term follow-up data on large enough numbers of patients to produce meaningful safety data[33] are available. Amenorrhea rate of 40 percent at 12 months and very similar retreatment rates at 3 years to FEAT devices have been reported.

Cryoablation Therapy

A number of gas mixtures and devices have been developed over the last 35 years for endometrial cryoablation,[34] but it has been difficult to find a gas mixture with a temperature–pressure relationship that permits the use of an applicator small enough to be inserted into the uterine cavity. Recently, an effective device has become commercially available.

Her-Choice Uterine Cryoablation Therapy

Her-Choice Uterine Cryoablation Therapy (Cryogen, San Diego, CA, USA) consists of a cryoprobe and 5 mm diameter disposable sheath with a tip surface temperature of –100°C that is inserted into the uterus for two freeze–thaw cycles over a total treatment time of about 10 minutes.[35] Transabdominal ultrasound is used to monitor the expansion of the hyperechoic edge of the "ice-ball" of treated tissue. A multicenter randomized trial has shown cryoablation to be similarly effective to rollerball ablation.[36]

Chemical Cautery of the Endometrium

Demonstrating that all medical treatments will be reinvented regularly, the Transcervical application of trichloroacetic acid (TCA) to the endometrium to chemically cauterize the endometrium has very been reported,[37] many years after the use of other chemical agents, such as formalin and quinacrine, were suggested. In this clinical study, 95 percent TCA was applied directly to the endometrium using a cotton-swab applicator on three occasions 1 week apart in 90 women. Over 80 percent reported a satisfactory reduction in menstrual loss at 6 months.

Photodynamic Therapy

The application of 5-aminolevulinic acid (ALA), a photosensitizing drug, to the endometrial surface and subsequent light activation via a transcervical catheter can be used to produce reactive oxygen intermediates that induce cellular necrosis.[38] Early clinical studies of a commercial prototype with a balloon catheter used to keep the ALA within the uterus for 4 to 6 hours prior to the insertion of a reflecting balloon light-diffuser has been reported.[39]

CHOICE OF SECOND GENERATION ABLATION TECHNIQUES

In most developed countries, gynecologists will have a choice of three or more SEAT devices, but many will work in a setting where they or their hospital can purchase only one type of SEAT. Some devices have only short-term follow-up data available, but most SEAT devices appear to produce similar results: 20 to 50 percent of women experience complete amenorrhea 12 months postoperatively and 80 to 90 percent report a reduction in menstrual loss. Individual small trials may show one SEAT to be more effective in producing amenorrhea than another, but patient satisfaction rates seem to be remarkably very similar for all devices. Versatility is another important consideration and the ability to treat women with a uterus distorted by fibroids is an important advantage that will allow some therapies, such as microwave ablation and hot-saline instillation to be used to treat a wider range of women than others. Treatment costs are an important consideration, although in an increasingly crowded market, costs per treatment are likely to become very similar for each device. Perhaps the most important consideration is patient safety. Most SEAT devices require the blind insertion of a potent energy source into the uterine cavity and have been developed with the aim of enabling gynecologists with limited hysteroscopic skills to offer ablation therapy. Serious complications associated with uterine perforation will inevitably happen and some devices have attempted to provide ways of recognizing this occurrence before SEAT activation. With appropriate training, individual clinicians should be able to expect a low risk of complications with all currently available devices, but larger follow-up studies and the continued meticulous reporting and analysis of serious complications are needed to rule out the possibility that some devices are less safe than others.

LONG-TERM COMPLICATIONS OF ENDOMETRIAL ABLATION

With any new technology, unique long-term complications may develop that, at first, may be difficult to recognize and treat. This is true for total endometrial ablation. The problem is that after this procedure, intrauterine scarring and contracture can occur. Any bleeding from persistent or regenerating endometrium behind the scar may be obstructed and cause problems such as central hematometra, cornual hematometra (CH), postablation tubal sterilization syndrome (PATSS), retrograde menstruation, and potential delay in the diagnosis of endometrial cancer.[40]

Endometrial ablation is an important addition to our armamentarium for the treatment of abnormal uterine bleeding. However, these unique long-term complications are now becoming recognized after this procedure. The actual incidence of these problems is not known. Future studies of the different ablation devices and techniques will be required to determine the long-term complication rates of these procedures.

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CHAPTER 14

Hysteroscopic Tubal Cannulation

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The incidence of infertility is on the rise in the last decade due to many factors. Tubal factor is responsible for 14 percent cases of infertility.[1] Proximal tubal blocks are seen in 10 to 20 percent of hysterosalpingograms done for infertility. Obstruction may be often due to spasm but may also be caused by amorphous debris, fibrosis, salpingitis isthimica nodosa or rarely polyps. In India, tuberculosis is a common cause of tubal blocks.

HIGH FALSE POSITIVE RATES WITH TUBAL PATENCY TESTS LIKE HYSTEROSALPINGOGRAPHY

Clearly checking tubal patency is the first line of investigation in infertility workup. The tests include hysterosalpingography (HSG), hysterosalpingo-contrast sonography (HyCoSy), fertiloscopy and laparoscopy. HSG is the first line of investigation to evaluate tubal patency. The technical quality of HSG is important to limit the factors leading to misinterpretation. Hysterosalpingography, if properly performed and interpreted, can be of great value in the diagnosis of patency, genital tuberculosis, intrauterine lesions like fibroid, polps, etc. The biggest drawback of HSG is that it cannot differentiate between a pathological block and a physiological block or a pseudo-occlusion at the cornu. Rubin and Deccharney introduced the concept of tubal occlusion and true pathological obstruction. The physiological block or a pseudo-occlusion is mainly due to ostial spasm, ostial occlusion by mucous plugs or debris. The pathological block is mainly due to chronic salpingitis following tuberculosis or PID, salpingitis isthmica nodosa (SIN), intratubal endometriosis, etc.[2] Pseudo-occlusion is seen in 50 percent of all cornual blocks. In one large meta-analysis tubal occlusion was present on laparoscopy only in 38 percent of HSG confirmed cases.[3] But when HSG confirms patency it is confirmed in almost all cases on laparoscopy, but it fails to identify peritubal adhesions.[4] In another study false positive HSG was present in 40 percent of women due to either spasm or mucous plug.[5] In a study by Tulandi et al showed that one-fourth of patients diagnosed with cornual block on HSG actually did not had any such block.[6] HyCoSy is another patency test[7] but does not give much information about tubal function and peritubal adhesions. Hence laparoscopy is the gold standard in diagnosis of true occlusion, peritubal adhesions and adnexal pathologies. It also helps in decision making for the optimum treatment strategy.

Treatment of tubal block:

1. Proximal tubal block (PTB): Tubal cannulation.
2. Bilateral terminal block with hydrosalpinx: IVF, laparoscopic or open neosalpingostomy.
3. Multiple bilateral tubal block, severe peritubal adhesions, frozen pelvis: IVF.
4. Mild-to-moderate peritubal adhesions: Laparoscopic adhesiolysis with restoration of tubo-ovarian anatomy and IUI.

TUBAL CANNULATION

Proximal tubal occlusion accounts for 15 to 25 percent of tubal pathologies. Before the advent of hysteroscopic cannulation, laparotomy and surgical repair was the only choice to overcome the proximal tubal occlusion. The term pregnancy rates with tubouterine implantation were very poor (10–15%).[8] Then came the era of microsurgical repair. In expert hands, it had a pregnancy rate up to 57 percent.[9] The problem with these traditional surgeries is that it requires laparotomy and hence is an amore morbid procedure, requires a prolonged recovery period and hospital stay. Only a few expert endoscopic surgeons are able to do these procedures laparoscopically. With the advent of operative hysteroscopy, tubal cannulation gained popularity. The main advantage with this procedure is that it is a less invasive daycare procedure and is simple, less morbid and effective. It also avoids need for IVF in non-affording patients. Tubal cannulation has emerged as an excellent minimally invasive alternative to microsurgery thus avoiding a laparotomy.[10] The candidates with distal tubal blockage are not good cases for cannulation.[11,12]

FALLOPIAN TUBE RECANALIZATION

It can be performed:

1. Hysteroscopically, with laparoscopic assistance
2. Falloscopic guidance
3. Sonographic guidance
4. Fluroscopic guidance
5. Tactile guidance.

Cannulation can be done with:

1. Flexible atraumatic guidewires:
   a. *Terumo guidewire:* Inexpensive
   b. Novy's/Cook's coaxial system
2. Catheters
3. Balloon systems.

Contraindications of Fallopian Tube Recanalization

1. Active pelvic infection
2. Active genital tuberculosis
3. Distal tubal block/Multiple tubal block
4. Hydrosalpinx/Severe tubal damage
5. Previous tubal surgery
6. Associated male or other factor for infertility.

Fallopian tube recanalization (FTR) is usually successful in:

1. Pseudo-occlusion
2. Muscular spasm
3. Mucous plug or debris obstruction
4. Flimsy adhesions due to mild infection
5. Stromal/Mucosal edema due to infection.

Fallopian tube recanalization (FTR) is usually not successful in:

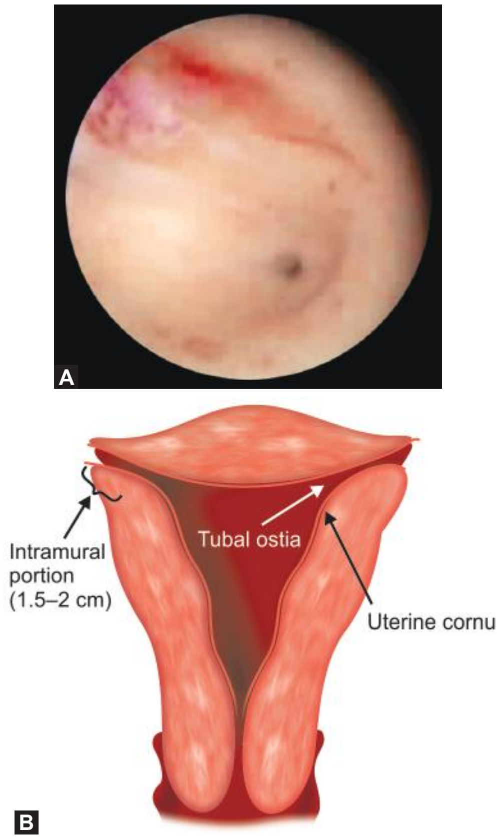
1. Tubercular salpingitis
2. Salpingitis isthmica nodosa
3. Tubal fibrosis
4. Peritubal adhesions causing tubal immobility
5. Multiple tubal blocks.

ANATOMY OF OSTIUM AND FALLOPIAN TUBES

In order to successfully cannulate the tubes we need to understand the anatomy of the intramural portion of the tube. The intramural portion of the tube is approximately 2.5 cm long, it is divided into a proximal segment of 1 cm and a distal segment of 1.5 cm (Figs 14.1A and B). The proximal portion is linear and straight and the distal segment is irregular and tortuous and opens into isthmic portion of tube. In 2/3rd of the patients the intramural course of the tube is tortuous. The thick muscular wall and tortuous course of intramural portion is a common site for blockade due to debris and mucous plugs and these are also the factors responsible for difficult cannulation. The ostium is approximately 1 mm in diameter and is situated at the apex of utero-tubal gutter. Hysteroscopically ostia are seen as a sharp membranous ring at the cornual depression. There is an intramural bulge or narrowing 1 to 1.5 cm beyond the ostia, hence coaxial system of cannulation is necessary to over-come it. The isthmus takes a 50° bend at its proximal portion. Laparoscopic assistance is helpful to negotiate this bend and avoids this common site from perforation.

TECHNIQUE OF HYSTEROSCOPIC TUBAL CANNULATION

The attempt to open the cornual block goes back to the year 1849 by Smith et al.[13] Since then the metal dilators and catheters, balloons, angioplasty guide- wire, ureteric cannulation set, embryo transfer catheters, stiff plastic catheters, infant feeding tube, epidural catheter, etc. all have been tried by



Figs 14.1A and B: Anatomy of uterine cornu—note the 1.5 cm intramural portion of tube is thick and narrow

clinicians in an attempt to open the cornual block. Technological advances have led to improvements in the design of coaxial cannulation set with virtually atraumatic soft guidewires.[14] Today all these cannulation system has been replaced by coaxial catheters and have been routinely used with consistent success.[15] The coaxial catheters have soft atraumatic guidewires, they help in proper alignment according to tubal anatomy hence the procedure of cannulation becomes very easy.[16]

The hysteroscopes used for cannulation are:[17]

1. *Standard hysteroscope:* It has external diameter of 4 mm hence requires cervical dilatation. The angle of vision is 30°.
2. *Bettocchi hysteroscope (Karl Stortz):* It has external diameter of 2.9 mm 30° angle of vision which helps to operate in the cornu with ease. The author uses this scope.
3. *Modified Bettocchi:* It has external diameter of 1.9 mm.
4. *Versascope system (Gynecare div of Johnson & Johnson):* It has external diameter of 1.8 mm and 0° angle of vision.
5. The flexible steerable hysteroscope.

Hysteroscopic tubal cannulation is used as a diagnostic as well as therapeutic measure for proximal tubal block.[18] The use of laparoscopy simultaneously helps to negotiate the block and to confirm the status of the distal end of the tubes, presence of hydrosalpinx, distortion of tubo-ovarian anatomy, peritubal adhesions and others factors responsible for infertility like endometriosis. It also helps in direct visualization of tubal patency following the procedure. Hysteroscopic tubal cannulation should be performed immediately postmenstrual when the endometrium is thin and visualization is better. In the advanced proliferative phase, due to thick mucosa it may be difficult to visualize the ostia.[19] Sometimes D and C is done prior to cannulation if the endometrium is polypoidal and visualization is difficult.

Procedure

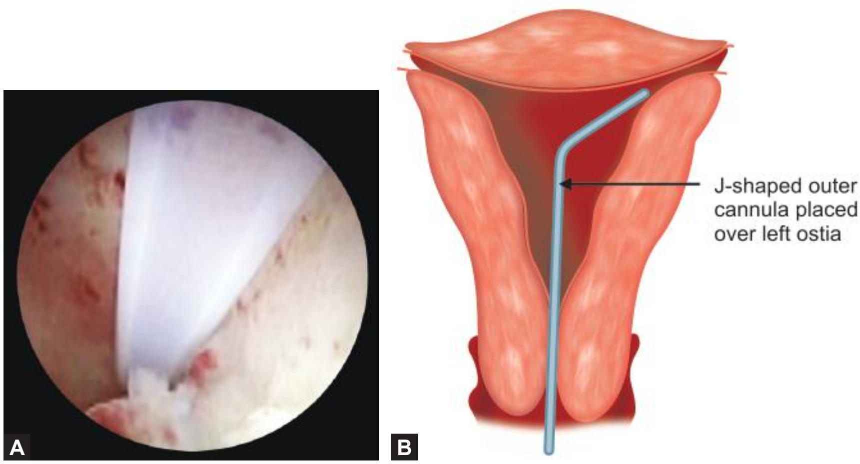
General anesthesia is given. First the laparoscope is introduced to confirm the status of the distal end of the tubes, presence of hydrosalpinx, distortion of tubo-ovarian anatomy, peritubal adhesions and others factors responsible for infertility like severe endometriosis. If these pathologies are encountered one must think of either abandoning the procedure or rectifying the pathologies at the same time. The Bettocchi hysteroscope (Karl Storz) with external diameter of 2.9 mm and 30° angle of vision is introduced and a detailed survey of the uterine cavity is done with continuous flow of normal saline to distend the cavity. Particularly the cornu and ostia are evaluated in detail. Sometimes mild adhesions and polyps are present at the cornu, which are then initially tackled.

CANNULATION USING TERUMO GUIDEWIRE/SIMPLE CANNULATION SET

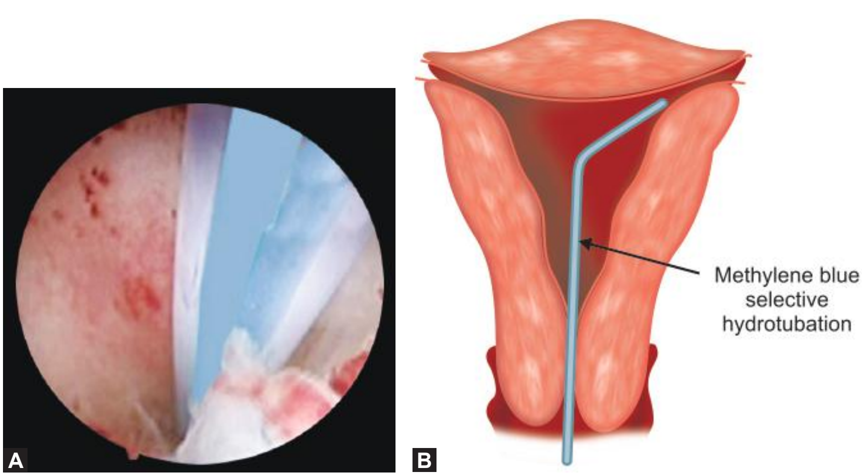
Cannulation using Terumo Guidewire (0.64–1 mm) and outer cannula (7 F) is more economical. The ostia are identified and the the outer catheter is introduced through the operating channel and aligned with ostia. The guidewire is then introduced through the outer catheter and negotiated into the ostia and interstitial part of the tube, for 1 to 1.5 cm (Figs 14.2A and B). The movements should be gentle, untoward force might damage tubal mucosa or cause perforation due to the stiff guidewire. The outer catheter and the hysteroscope should be held still for easy cannulation. Once the guidewire is negotiated to overcome the block, the wire is removed and the outer cannula is placed in close apposition with the ostia. The fallopian tube is now flushed with a syringe containing 20 ml of methylene blue diluted with saline (Figs 14.3 to 14.6). The easy flow of this solution through the fallopian tube, without backflow into the uterine cavity, confirms the successful recanalization of the fallopian tube. This can be further confirmed by the laparoscopic visualization of methylene blue pouring out of the fimbrial end of the fallopian tube. The similar procedure is repeated on the other side and dye injected through outer cannula to confirm the patency.

CANNULATION USING A COAXIAL TECHNIQUE

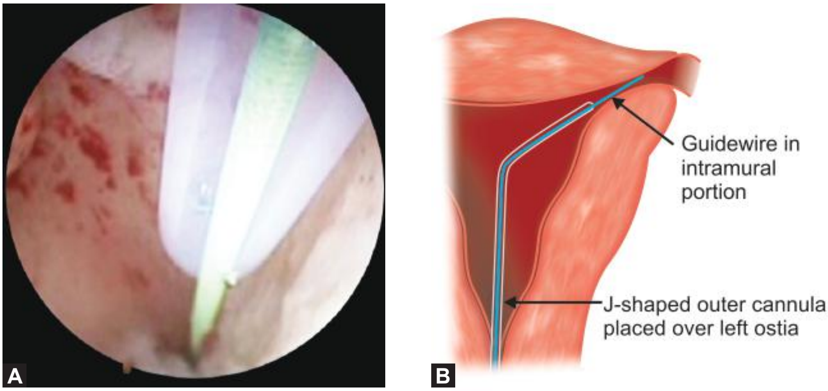
The authors commonly use Novy's (Cook) coaxial cannulation set. It has the advantage that the outer catheter (9 Fr) is transparent and has curved terminal portion (J-shaped) which is ideal for the anatomy of ostia and proximal tube. It is the ideal tubal cannulation set but it is expensive and delicate. The inner cannula (3 Fr) is flexible and graduated. The guidewire (0.6–0.8 mm) is soft and atraumatic and has a platinum tip for better visualization. The cannulation set is loaded before the introduction of hysteroscope. First the guidewire is loaded into inner cannula which in turn is loaded into outer canula. The Bettochi hysteroscope (Karl Stortz) with 30° angle of vision is introduced. The uterine cavity is distended with continuous flow of normal saline. The whole system is now loaded into the operating channel of hysteroscope. The catheter



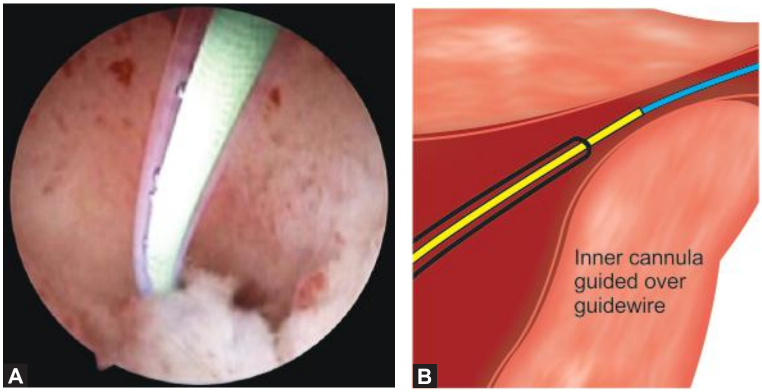
Figs 14.2A and B: J- shaped outer cannula placed over left tubal ostia



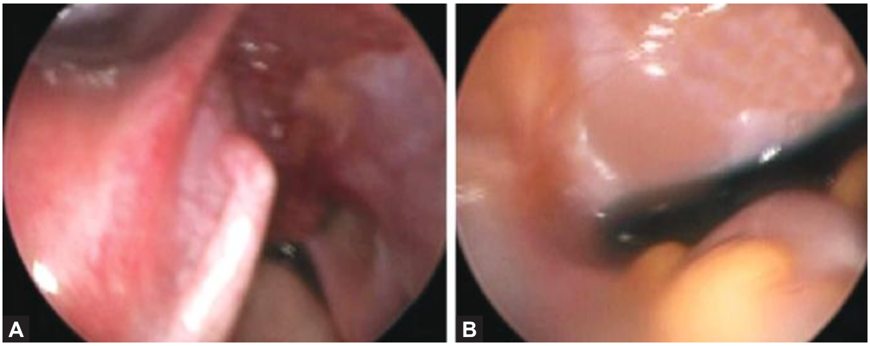
Figs 14.3A and B: Selective hydrotubation before cannulation



Figs 14.4A and B: Tubal cannulation with guidewire—note that the guidewire is introduced for only 2 to 3 cm into intramural portion



Figs 14.5A and B: Sliding inner cannula over guidewire



Figs 14.6A and B: Laparoscopic visualization and assistance and spillage of dye after cannulation

system and the scope should be held still and the outer end of guidewire is held by an assistant to avoid slipping out of guidewire.The ostia are identified and the outer cannula is aligned with the ostia. This alignment is easy due to the J-shaped outer catheter which fits the uterotubal angle at the ostia. The guidewire with inner cannula is gently pushed into ostia for 2 to 3 cm. The movements should be gentle, untoward force might damage tubal mucosa or cause perforation. If there is resistance to passage, the inner cannula is withdrawn and re-entry is made at different angle. The similar procedure is repeated on the other side and dye is injected through the outer catheter to confirm the patency via laparoscopy.

Difficulties Encountered during Cannulation

1. *Inability to cannulate the tubes due to resistance:* This is particularly true for very soft guidewires. In these cases a relatively more stiff wire may overcome the obstruction. In case the cannulation is not possible, it is wise to abandon the procedure.
2. Excessive glow as we are working in close proximity of the tissues.
3. Kinking/Damage to the catheter.
4. Prolonged procedure leads to mucosal edema and difficulty in visualization of ostia, prolonged procedure also has danger of fluid overload.

CLINICAL STUDIES

In a 1079 patients review by Thurmond et al,[20] the patency rate of 62 percent and the cumulative pregnancy rate by life time probability analysis of 28 percent, 59 percent, 73 percent at the end of 12, 18, 24 months respectively was observed.

In a study by Spiewankiewicz et al,[21] Zhu et al[22] and Burke et al[23] hysteroscopic tubal cannulation with laparoscopic assistance, with/without guidewire cannulation, the success rate of recanalization was 76 percent and intrauterine pregnancy rate up to 39 percent.

According to Zhu et al, laparo-hysteroscopic cannulation of the proximal tubal block is an effective method for diagnosis and treatment of cornual obstruction.[24]

Selective Salpingography

This can be either tactile, fluoroscopic or hysteroscopic. Commonly it is done under fluoroscopic guidance as an outpatient procedure. Here the catheterization of the tubal ostium is done and the patency is checked under fluoroscopic imaging after transcervical instillation of contrast media. Even tubal catheterization and guidewire cannulation, can be done if obstruction is observed.[25] In a study by Thurmond et al[26] and Schmitz-Rode et al,[27] fluoroscopic guidance is an outpatient, less invasive, cost effective alternative to microsurgery and IVF with success rate of recanalization of 71 to 92 percent and an average pregnancy rate of 30 percent.

Sonographically Guided Transcervical Tubal Catheterization

Sonographically guided transcervical tubal catheterization is a less commonly used technique. It is done with guidewire[28] or fluoroscopic assistance.[29]

Fujinon Fiberoptic Hysteroscope for Tubal Cannulation

These malleable hysteroscopes have an advantage over the routine rigid scopes as they can easily treat intrauterine and intratubal pathology and cannulate the tubes, without anesthesia, on an outpatient basis.[30,31]

Falloscopic (Falloposcopic) Tubal Recanalization

In this method the falloscope is guided smoothly through entire length of the tube with the help of a guidewire or linear everting catheter (like a balloon) to release cornual occlusion. It has a flexible optic cable which goes through the cannulation system into the ostia. During this procedure, mild-to-moderate intratubal adhesions of past infection that might be encountered, are also broken thus increasing the pregnancy rates.

In a study by Kou Sueoka et al[32] 50 infertility patients diagnosed to have bilateral proximal tubal occlusion by HSG and hysteroscopic selective hydrotubation had undergone falloscopy with a linear everting catheter. Eighty percent patency rate was observed by HSG 1 to 3 months following falloscopy. Pregnancy rate of 20 percent was observed over next 3 years.

COMPLICATIONS

Perforation

Perforation of fallopian tubes can occur in up to 6 percent cases. It occurs in fixed tubes with peritubal adhesions, due to undue force, wrong angulation. It is common with stiff guidewires. In case of perforation the procedure on that side is abandoned and it is left to heal on its own.

Bleeding

If perforation occurs on mesenteric border of tube, there are chances of bleeding and blood collection in broad ligament, which can be confirmed and treated laparoscopically if required.

Infection

Iatrogenic infection is rare if asepsis is maintained. Flare up of pelvic infection can occur if already active pelvic infection is present. Cannulation should not be performed in cases of known pelvic infection.

Ectopic Pregnancy

This is known long-term complication when patient becomes pregnant. All these patients should be warned about the possibility of ectopic pregnancy, and they should do early pregnancy scans immediately after missed periods.

The chances of ectopic with tubal cannulation are significantly less than that with microsurgery techniques.

In a study by Das et al,[33] the hysteroscopic cannulation and tubal microsurgery in patients with proximal tubal block showed an ectopic pregnancy rate of 0 percent and 29 percent respectively.

Dilemma: Tubal Cannulation or IVF?

In patients with proximal tubal obstruction the options for management are tubal cannulation, microsurgery and IVF. IVF is the treatment of choice when tubal cannulation and microsurgery fails. But the question remains, which is the first line of treatment? The proper evaluation of tubal damage, extent of tubal mucosal damage, severity of tuboperitoneal adhesions, presence of hydrosalpinx and bipolar tubal disease will decide the line of management. In properly selected cases, tubal cannulation has good success rates.[20,21,22,23] If the procedure fails due to true occlusion or if there is failure to achieve pregnancy then the patient can be referred for IVF.[34,35] In case of severe tubal mucosal damage, severe tuboperitoneal adhesions with distorted tubo-ovarian anatomy, presence of hydrosalpinx and bipolar tubal disease, IVF remains the first line of treatment. Dechaud et al reported no pregnancy after cannulation, in patients who had severe endotubal damage.[36] Also in one study there was no pregnancy reported following FTR in cases with bipolar disease.[37] In observations of Lee et al during falloscopy in cases of severe tubal damage, he reported that 67 percent of the cases had flattened tubal mucosa with adhesions, these cases were suitable for IVF and 27 percent cases had normal mucosa, they were suitable for microsurgery.[38] Hence, patients with both proximal and distal tubal disease should go for IVF treatment.

CONCLUSION

In properly selected cases, tubal cannulation has good success rates. The main advantage with this procedure is that it is less invasive, a daycare procedure, simple, less morbid and effective. It also avoids need for IVF in nonaffording patients. Tubal cannulation has emerged as an excellent minimally invasive alternative to microsurgery thus avoiding a laparotomy. If the procedure fails or if there is failure to achieve pregnancy then the patient can be referred for IVF. In cases of severe tubal mucosal damage, severe tuboperitoneal adhesions with distorted tubo-ovarian anatomy, presence of hydrosalpinx and bipolar tubal disease—IVF remains the first line of treatment.

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CHAPTER 15

Falloposcopy

Pravin Patel

INTRODUCTION

Falloposcopy is visualization of the fallopian tubes via a microendoscope. It involves the use of a falloscope, which is a flexible endoscope, through the uterine ends of the fallopian tubes. Technically, it can also be inserted at the time of laparoscopy through the distal fimbriated end.

INSTRUMENTATION

The first modern falloposcope that was described was the coaxial system by Kerin in 1970.[1] Subsequently, the linear-everting catheter (LEC) system was introduced by Bauer et al.[2]

The falloposcope is a flexible high-resolution microendoscope of 0.5 mm diameter and 1.73 m length that contains a bundle of 2000 optical fibers and 8 to 12 illuminating fibers. The falloposcope is capable of magnifying up to 50 times.

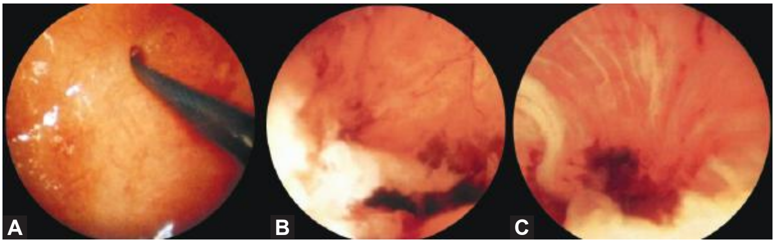
The coaxial system needs a hysteroscope for its uterine passage. In contrast, the LEC system consists of an external unfurling balloon catheter with an internal endoscope that is used transcervically without the need for a hysteroscope.

TIMING

The optimal timing for performing falloposcopy is during the mid-follicular phase of the menstrual cycle because the ostium can be visualized most easily in the absence of blood and a thick endometrial lining (Figs 15.1A to C).[1] Antibiotic prophylaxis has not been deemed necessary as the rate of post-procedure infection is negligible.[3]

The patient needs general anesthesia or conscious sedation for the duration of the procedure and is in a lithotomy position.

The duration of the procedure in the hands of a skilled operator is not more than 30 minutes.



Figs 15.1A to C: Visualization of tubal lumen

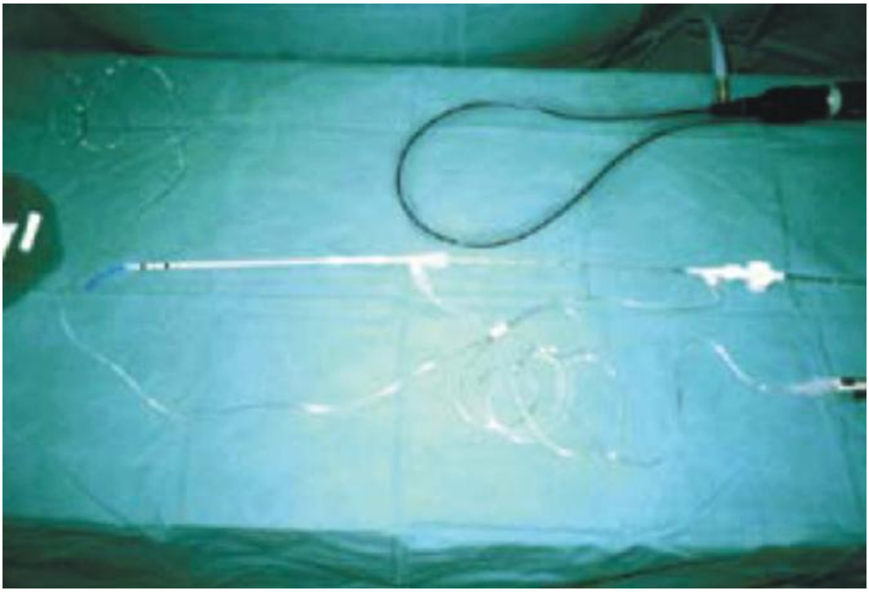


Fig. 15.2: The flexible coaxial falloposcope

COAXIAL TECHNIQUE

A flexible hysteroscope (Fig. 15.2) that has an outside diameter (OD) of 1.5 to 3.0 mm and that contains a single operating channel is introduced into the endometrial cavity; Ringer-lactate solution is used as a distention medium. Under video monitoring, the uterotubal ostium (UTO) is located and the tip of the hysteroscope is directed to within 3 mm of the UTO. A flexible, platinum tipped tapered guidewire of OD 0.3 to 0.8 mm is then introduced into the UTO through the second arm of the Y-connector and is advanced into the fallopian tube until a point of resistance, increase in patient discomfort, or a distance of 15 cm is reached. A Teflon coated catheter of OD 1.2 to 1.3 mm is introduced over the wire for a similar distance and the guidewire is withdrawn. A second Y-connector is attached to the proximal end of the catheter and the falloposcope is passed through the straight arm of the second Y-connector while Ringer-lactate solution is infused through the angled arm.

After the falloposcope has been connected to a xenon light source, camera chip, and a high-resolution video monitor, the tubal lumen is visualized in a retrograde manner (i.e. from the fimbrial end to the isthmic region as the catheter is withdrawn).[4]

LINEAR EVERTING CATHETER TECHNIQUE

The linear everting catheter (LEC) system (Figs 15.3A to C) is now emerging as the preferred method because it can be performed under sedation, as an office procedure, and does not require laparoscopy or hysteroscopy.

The LEC consists of inner and outer catheter bodies (of diameters 0.8 mm and 2.8 mm, respectively) that are joined circumferentially at their distal tips by a distensible polyethylene membrane. The pressure within the enclosed space (the balloon space) is controlled by a fluid-filled syringe. The falloposcope is advanced within the inner catheter and the membrane and introduced into the uterus. Once the ostium is identified, the outer catheter is held in position and pressure is applied to the membrane by using the fluid filled syringe; the inner catheter is pushed forward, resulting in the linear eversion of the balloon into the fallopian tube. As a result, the falloposcope is carried forward at twice the speed of the balloon. The balloon and falloposcope are advanced into the fallopian tube in small increments, up to a distance of 10 cm or until resistance is encountered. Imaging of the endotubal surface is then performed in a retrograde manner using the lens-fluid interface.[5,6]

Advantages of the LEC System over the Coaxial System[7]

The eversion balloon is unrolled into the fallopian tube without exerting any shearing force between the balloon and tubal epithelium. The balloon seeks the path of least resistance and can negotiate any tubal tortuosity. This greatly minimizes the risk of tubal injury that could be caused by the guidewire cannulation of the coaxial system.

The falloposcope advances automatically during balloon eversion and can be moved independently to gain optimal visualization.

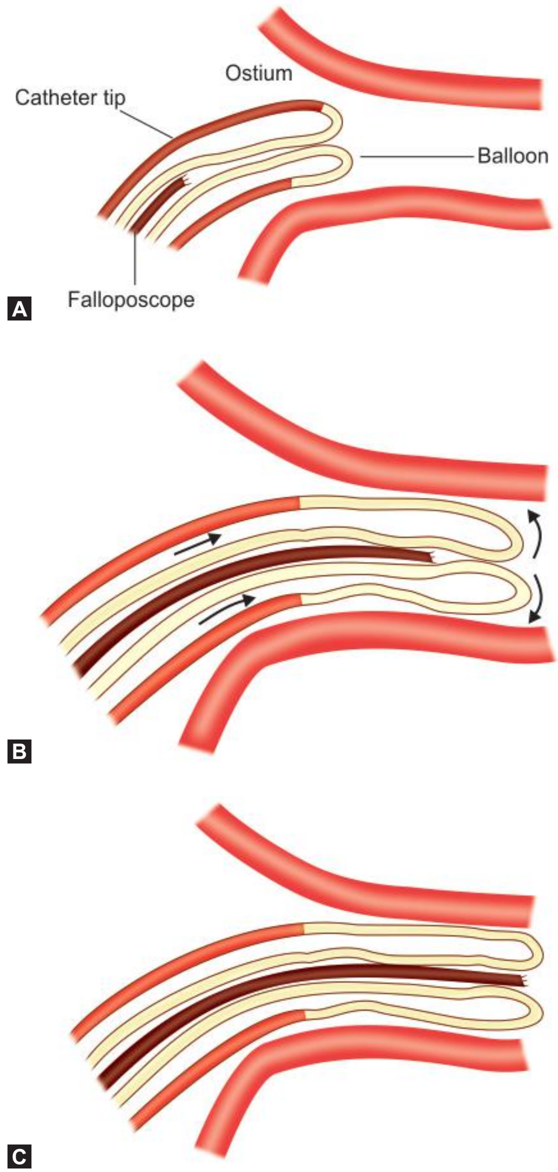
Hysteroscopy or cervical dilatation is not required, and can be performed under sedation or local anesthesia as an outpatient procedure.

The falloposcope is well-protected inside the balloon, minimizing damage, and remains aligned along the tubal lumen.

THERAPEUTIC APPLICATIONS

Although not considered as a part of the routine work-up for infertility management, it has been used primarily for the diagnosis and treatment of tubal infertility. It is considered as a more accurate alternative to hysterosalpingography and helps to overcome many of its false negative and false positive results.[7]

It allows direct visualization of the endosalpinx, thus aiding detection of nonobstructive tubal disease.



Figs 15.3A to C: The linear everting catheter—(A) Balloon is pressurized; (B) Inner body is advanced and balloon carries falloposcope forward; (C) Complete eversion—falloposcope reaches tip of balloon

Obstructions, adhesions within the tubal lumen, and debris can be identified.

It allows removal of debris or filmy adhesions from within the fallopian tube.

It can diagnose and correct pseudo-obstructions.

In selected patients who have tubal occlusion, pregnancies have been achieved after tubal recanalization using falloposcopic tuboplasty.[8]

The direct visualization and identification of each segment of the fallopian tube allows the nonincisional transfer of gametes or embryos into the ampulla region during assisted reproductive procedures.[9]

Direct instillation of methotrexate or an alternative medication during tubal pregnancy can be performed (potential application).[7]

The increased accuracy of the tubal assessment helps in the allocation of patients to the most appropriate treatment.

Complications

Perforation of a fallopian tube appears the only reported complication and is encountered in about 4 to 5 percent of inspected tubes.[7]

Six instances of minor tubal perforation among the 122 'diseased tubes' in 75 patients (i.e. a perforation frequency of 4.9% per tube and 8% per patient) have been detected by the coaxial system using guidewire cannulation.[4]

No other major complications have been reported.

Limitations

In 2001, Rimbach et al[10] reported in a large multicenter study involving 367 patients on the limitations of the procedure.

Problems were encountered in the ability to enter the tubes with a success rate of 93.9 percent. Access was obstructed due to malfunction of hysteroscope, marked uterine flexion, intracavitary pathology or thick endometrium obstructing the ostia.

Catheter navigation of the entire length of the tube or to the point of obstruction was successful in 89.4 percent cases. Failures were due to kinked catheters or bent guidewires, or excessive tubal tortuosity or spasm.

Light reflections by contact of the optic with the tubal wall (`white-out') disturbed the image in 7.4 percent cases.

Thus, the investigators were able to fully examine tubes in only 2 out of every 3 cases.

CONCLUSION

Overall, falloposcopy is considered a safe and atraumatic approach for the treatment of tubal infertility. However, it still has not gained widespread acceptance as a part of the routine work-up for infertility. With appropriate training and knowledge, the use of falloposcopy can be increased; pregnancy rates could thereby be improved and the cost and time spent on unnecessary surgical intervention or assisted reproductive procedures could be reduced.

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CHAPTER 16

Vaginoscopy in Gynecology

Chaitali Mahajan, Rakesh Sinha

Over the past several years, the number of office-based gynecologic surgical procedures has skyrocketed. Factors cited in this trend towards in-office surgery are better reimbursement, greater efficiency for both patient and physician as well as the ability to provide a familiar environment for the patient. Both diagnostic as well as operative hysteroscopy are two such procedures that easily can be converted to the office setting.

A common concern from the inception of in-office surgery is patient comfort. Patients appreciate the convenience of having hysteroscopic evaluations done more quickly and comfortably in an office with which they are familiar. The vaginoscopic technique for hysteroscopy—also referred to as a "no-touch approach"—avoids the use of a vaginal speculum and cervical tenaculum. It is an easier and quicker procedure for the surgeon, provides equally good visualization, and most importantly is even more tolerable for patients than the traditional approach that utilizes instrumentation.

Without placing a speculum in the vagina, grasping the cervix with a tenaculum, or injecting a paracervical block, there is a significant decrease in discomfort among patients. The use of premedication is minimized and rarely any local anesthetic is required. In addition to diagnosing and evaluating the uterine cavity, you can perform minor therapeutic and operative procedures such as removing polyps, lysing adhesions, obtaining biopsies and removing lost intrauterine devices.

REVIEW OF LITERATURE

Vaginoscopy has been described in the literature as far back as the 1950s and continues to be used for diagnosing vaginal endometriosis, pelvic floor mesh erosions, vaginal fistulas, and cervical pathology, for example, as well as excising vaginal lesions or longitudinal vaginal septums. It has also been utilized in the pediatric/adolescent population for visualizing and removing foreign bodies, and for evaluating pelvic trauma, abnormal bleeding, and infection.

Dr Stefano Bettocchi and Dr Luigi Selvaggi in Italy were the first, however, to describe the utilization of a vaginoscopic approach to office hysteroscopy for evaluating the endocervical canal and uterine cavity in addition to the vagina and external cervical os. In a paper published in 1997 in The Journal of the American Association of Gynecologic Laparoscopists (Feb 1997, 4: 255-8), they described various approaches they took to improve patient tolerance during the 1200 diagnostic hysteroscopies they performed between 1992 and 1996.

The first 49 procedures were done using the speculum and tenaculum but without local anesthesia. The investigators saw high rates of discomfort (53%), moderate pain (25%), and severe pain (20%), as well as two cases of serious vagal reactions.

They then began using local anesthetic (mepivacaine 2%) but found that, while it helped some of the women, many of them continued to have discomfort or pain. In the next 169 cases, 69 percent had discomfort or mild pain, 11 percent had moderate pain, and 8 percent had severe pain resulting in suspension of the procedure (again, including two women who had vagal reactions requiring medical assistance).

Dr Bettocchi and Dr Selvaggi[1] then decided to use the speculum to visualize the cervix but not place the tenaculum. They did not use any anesthesia with this group of 308 women. Their patients' pain levels started decreasing quite a bit, with 66 percent of these patients reporting no complaints. Cases of severe pain disappeared completely.

They then took it a step further to deal with the remaining causes of pain (32 percent had reported mild pain and 2 percent had reported moderate pain) and utilized the vaginoscopic approach. In these last 680 procedures—in unselected patients, both multiparas and nulliparas—the patients had a 96 percent no-discomfort rate. By not using the speculum and tenaculum to expose and grasp the cervix, the investigators nearly eliminated patient discomfort while still performing effective hysteroscopy.

Since this landmark report, several teams that have adopted a vaginoscopic approach to hysteroscopy have reported good results, and at least two teams among those I reviewed in the literature have conducted randomized prospective studies.

Dr M Sharma and his team[2] in London randomized 120 women to undergo either traditional hysteroscopy or vaginoscopic hysteroscopy (60 women in each group)—with a further breakdown into the use of a 2.9 mm and a 4 mm hysteroscope. The investigators reported an overall success rate of 99 percent. They used the need for local anesthesia as a primary outcome measure. Although they reported lower requirements with the vaginoscopic approach using the narrower hysteroscope, they found that overall; there was no significant difference in the use of local anesthesia among the groups. There also were no statistically significant differences in pain scores between the two techniques.

The main difference for this team lay in the length of the procedure. Hysteroscopy and biopsy times were significantly shorter (more than 25% faster) with the vaginoscopic technique—a difference that Dr Sharma and his colleagues said is important for patients who are anxious about the procedure.

In the other randomized study, in contrast, Dr O Garbin and his colleagues[3] in France found that patients had significantly less pain with the vaginoscopic approach. Their randomization of 200 patients to conventional and 200 patients to vaginoscopic hysteroscopy—with no use of either anesthesia or premedication in either group—showed no differences in the quality, success or duration of the exam but significant differences in patients' ratings of pain on a visual analog scale. Two cases of vasovagal syncope occurred in the group with traditional hysteroscopy.

Cervical passage was easier overall with vaginoscopic hysteroscopy, Dr Garbin and his team reported, though the differences were not significant. All of their procedures were performed using rigid single-flow hysteroscopes with an external sheath diameter of 3.5 mm.

The two randomized studies were quite different, and it is possible that Dr Sharma's[2] study lacked sufficient power. Certainly, it was more complicated with its use of two different hysteroscopes and the frequent use of anesthesia. Interestingly, Dr Garbin and his colleagues[3] addressed the issue of pelvic infection and pointed out that their procedures began with disinfection—something that was not mentioned in either Dr Bettocchi's or Dr Sharma's reports but is a practice that is done routinely.

Thus, the vaginoscopic approach to hysteroscopy is superior in terms of patient tolerance and can be quicker—without any impairment in cervical passage or visual quality.

PROCEDURE

The vagina and the cervix are prepared with a small-diameter swab dipped in Betadine (povidone-iodine), or an alternative if the patient has an allergy to iodine. Normal saline is used as distention medium. A 1 liter normal saline bag inserted in a pressure bag is hung on a tall IV pole with a TUR tubing.

A preprocedure counseling is done for all patients, that the use of saline and distention of the uterine walls usually causes some cramping but that ibuprofen or paracetamol can minimize this cramping. The diameter of the hysteroscope is shown, which often helps alleviate any anxiety. In rare cases, if a patient is very anxious and worried about her tolerance for the procedure, or if the procedure is expected to be unusually long, we prescribe an anti anxiety agent like Valium (diazepam). Usually, such patients are young and have never experienced any gynecologic procedure before. General anesthesia using propafol through the IV route can be considered as an option in such patients.[4]

Cervical priming is done preoperatively in nulliparous patients and postmenopausal patients with stenotic cervices. Cytotec (misoprostol) 400 µg orally or 200 µg vaginally, 9 to 12 hours prior to the surgery.[5]

A 3 mm single-flow rigid hysteroscope is used for diagnostic purposes and the operative sheath can be added to make the hysteroscope a 5 mm operative rigid hysteroscope to perform minor procedures. If we anticipate performing a procedure, we directly enter with the 5 mm hysteroscope. The Bettocchi hysteroscope system (Karl Storz Endoscopy-America Inc) is preferred because of its oblong shape that, when rotated horizontally with the light cord, easily slips into the slit-shaped external cervical os.

Rigid hysteroscopes have a camera lens angle of 0 to 30°. We use scopes with a 30° scoopes optimize visualization with minimal manipulation. With this angle, the hysteroscope can be brought to the midline of the uterine cavity and simply rotated about 90° to the left or right with the light cord without much movement of the hysteroscope to visualize the cornu.[6]

In contrast, visualizing the cornu with a 0° scope would require manipulation of the entire hysteroscope, potentially increasing patient discomfort. Vaginal and intrauterine pressures are maintained at a constant 30 to 40 mm Hg using an electronic pump for irrigation and aspiration (Endomat; Karl Storz GmbH & Co).

After placing the hysteroscope into the lower vagina, we guide it into the posterior fornix of the vagina to reach the end of the vaginal canal. Then, you slowly pull back while observing anteriorly and visualizing the external cervical os (Fig. 16.1). The hysteroscope is then introduced through the cervical os, based on an understanding of the anatomy and the scope's angled view into the endocervical canal and into the uterus. In cases where you can't get distension of the vaginal walls, you need to gently pinch the labia together to minimize fluid leakage or a piece of gauze can be used around the hysteroscope at the vaginal opening.[4]

Insertion of the hysteroscope without a tenaculum requires a great deal of dexterity and comfort with the instrument. The surgeon needs to understand the correlation between what is seen on the screen and the exact position of the hysteroscope so that the instrument does not rub against the cervix or the uterine tissue and cause trauma and pain.

With an angled hysteroscope, the image displayed on the screen reflects what is actually above the tip of the instrument. If the opening to the cervical os looks like it's straight ahead, for instance, it is actually above the direction in which the scope is being guided, and the scope must therefore be angled

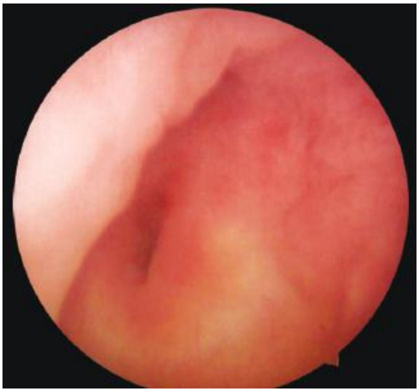

Fig. 16.1: Cervix is visualized and the hysteroscope is guided into the cervix

to enter the canal, (Fig. 16.2). For most gynecologic surgeons, the necessary skills and comfort levels fall into place after just a few vaginoscopic procedures.

Just as with traditional hysteroscopy, operative hysteroscopy is possible right after or even at the same time as a diagnostic hysteroscopy performed with a vaginoscopic approach, (Fig. 16.3). The gynecologic surgeon can remove polyps, (Fig. 16.4) that are visualized during a diagnostic procedure, for instance; perform adhesiolysis for Asherman's syndrome and tubular cannulation for blocked proximal tubal obstruction; and retrieve lost IUDs.

We do nothing differently when performing an operative hysteroscopy utilizing the vaginoscopic approach than we would use the traditional approach, except for not using the speculum and tenaculum (Fig. 16.5).

Fluid monitoring is recommended when performing operative hysteroscopy especially. A nurse should be allotted to check fluid levels and monitoring the deficit. Because diagnostic procedures are fairly short, the likelihood of fluid intravasation is low.

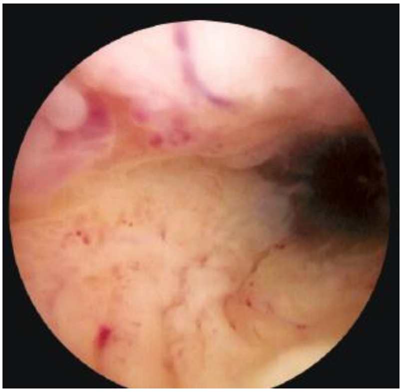

Fig. 16.2: Cervical canal is visualized as you enter the uterine cavity

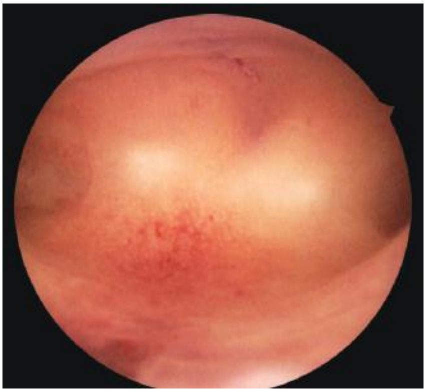

Fig. 16.3: Normal uterine cavity with bilateral ostia

Fig. 16.4: Cervical polyp seen in the vagina

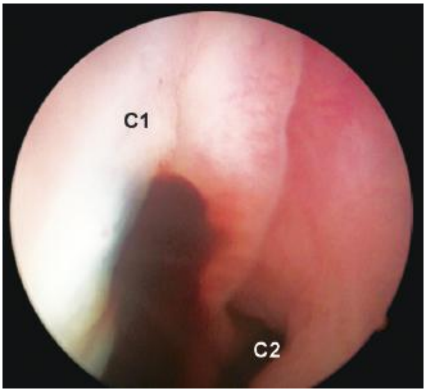

Fig. 16.5: Two cervices seen at the end of the vaginal septum

Vaginoscopy can be extremely helpful for evaluating patients who are morbidly obese and for whom standard office instruments are not adequately sized for visualization of the cervix.

POSTPROCEDURE MANAGEMENT

After the diagnostic and operative procedure, one should check patients' vital signs and ensure that they are feeling well and are ambulatory. Most of the time, patients leave the office within 15 minutes or so, happy to have had their procedure done in the office as opposed to the hospital.

DISCUSSION

Vaginoscopy also has been shown to be effective, fast, and easy for managing gynecologic problems in pediatric and adolescent patients. In a report published in 2000, Dr Abraham Golan and his colleagues[7] in Israel reported that they were able to complete the procedure successfully in 22 patients aged 3 to 16 years who were evaluated for vulvovaginitis, vaginal trauma, bleeding, or genital malformation. Gynecologic surgeons who build skills and experience with the vaginoscopic approach to hysteroscopy could also serve the pediatric/adolescent community well.

Resection of a longitudinal vaginal septum can be performed using the classic surgical procedure, consisting of excision by scissor. This traditional surgical method is successful in most patients, but it requires anesthesia and meticulous attention to dissection, suturing, and hemostasis to avoid injuries to bladder or rectum, subsequent bleeding, and scarring. Furthermore, traditional excision of the septum requires hymenotomy to be performed when an intact hymen is present.

In recent years, with the development of smaller-diameter scopes with working channels and continuous-flow systems and the advent of bipolar electrosurgical technology, it has been possible to treat several uterine and cervical pathologies, as well as those patients who might otherwise require general or local anesthesia (i.e. women with intact hymens, postmenopausal women), as outpatient procedures. This new philosophy (see-and-treat hysteroscopy) reduces the distinction between a diagnostic and an operative procedure with a substantial decrease in health and social costs.[6]

An electrosurgical instrument like VersaPoint Bipolar Electrosurgical System (Gynecare, Ethicon, Inc., Somerville, NJ), with a 5 F twizzle electrode, which provides a precise and controlled vaporization is ideal in such cases. The resection is performed by starting in the middle portion of the septum and proceeding progressively towards the vaginal apex.

Continuous flow vaginoscopy can be performed in infants, children and adolescents. Indications include persistent vulvovaginitis, blunt genital trauma with suspicion of intravaginal extension, unexplained vaginal bleeding, and mullerian malformation seen on ultrasonography. In these cases, vaginoscopy is performed under general anesthesia. Patients are positioned supine with thighs and knees flexed and thighs abducted. A lubricated hysteroscope is used which is inserted through the vaginal orifice with one hand while the other hand gently squeezes the vulvar tissues around the instrument to prevent fluid reflux.[7]

Hysteroscopy is also useful to do the follow-up of endometrial cancer patients after primary therapy. It allows evaluating uterine cavity and regression or progression of disease in patients who were submitted to conservative management. It also has the feasibility to diagnose recurrence in the vagina of surgically treated women.

Attilio Sardo, et al[8] diagnosed a case of vaginal endometriosis by vaginoscopy. A polypoid, pedunculated, brownish lesion is seen in the posterior vaginal formix. The lesion can be drained in same sitting using a bipolar forceps or scissors.

Currently, office hysteroscopy allows for an easy, precise, and cost-effective evaluation of the uterine cavity, cervical canal, and vagina. The absence of recovery time and an immediate return to normal activities completes the success of the procedure.

With the use of anesthetic agents, convalescence both in the office setting as well as at home may be extended. Furthermore, the cost of the procedure will be increased, thus affecting overall reimbursement. Finally, most gynecologists are uncomfortable providing even conscious sedation for their patient in the office. Thus, the key to successful transition to surgery in an office setting would be to modify the procedures to minimize the pain. Vaginoscopy allows such an approach to both diagnostic and operative hysteroscopy.

We can state that the best approach in terms of ease, reliability, acceptability, and safety for patients in whom intrauterine exploration is indicated should be simple diagnostic hysteroscopy using a small diameter, rod-lens hysteroscope with a single-flow diagnostic sheath, vaginoscopic approach, and fluid distention. In about 90 percent of patients, a correct diagnosis and if needed a proper choice for subsequent operative strategy can be obtained.[9]

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CHAPTER 17

Hysteroscopic Sterilization

Janesh Gupta, Rubab Munir

ABSTRACT

Sterilization is frequently chosen as a method of permanent contraception. Laparoscopic sterilization is considered as the traditional gold standard. Hysteroscopic sterilization has now been developed from the more invasive laparoscopic technique which requires entry into the abdominal cavity under general anesthesia, to a hysteroscopic procedure which can now be carried out with ease using local anesthesia in an outpatient setting. It has reduced complications and enables speedy recovery. Currently, there are two approved hysteroscopic sterilization techniques available, namely, Essure Permanent Birth Control System (Conceptus, Inc., Mountain View, CA) and Adiana Permanent Contraception System (Hologic, Inc., Bedford, MA). Hysteroscopic sterilization has proved to have similar efficacy and satisfaction rates as compared to other laparoscopic sterilization methods.

Keywords

Sterilization, hysteroscopic sterilization, Essure, Adiana.

INTRODUCTION

Sterilization is the most widely used method for permanent contraception. It has become increasingly popular since the late 1960s. It is estimated that one in 10 women under 50 years of age is sterilized in United Kingdom, whereas over 700,000 sterilizations are performed annually in the United States alone, making it the first method of birth control for women aged between 35 to 44 years (Fig. 17.1).[1]

HISTORY OF HYSTEROSCOPIC STERILIZATION

For decades gynecologists have used laparoscopic sterilization as a gold standard for sterilization. It has proven its safety and efficacy over time. However,

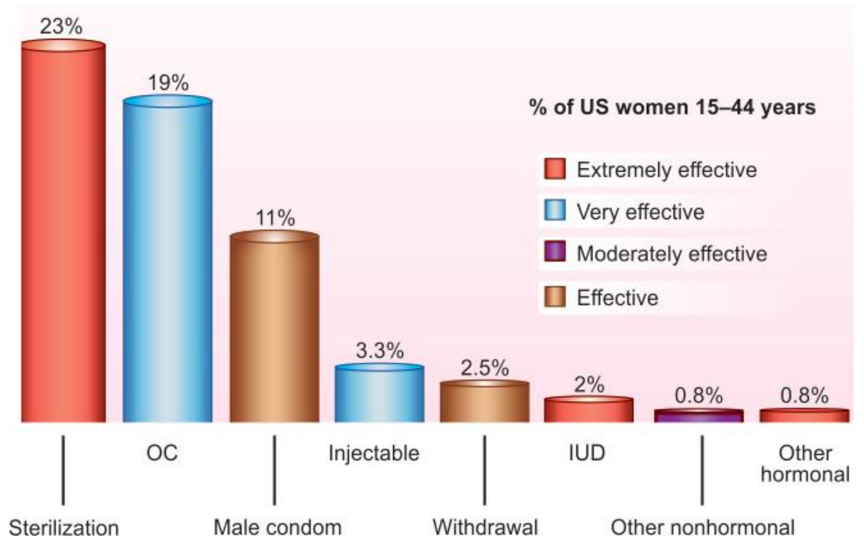


Fig. 17.1: Contraceptive use in women between 15 to 44 years (Chandra A et al, 2005)

the vast majority of these procedures require admission to hospital, general anesthesia and abdominal incisions and entry into the abdominal cavity. The most common quoted risks are those related to perforation or damage to small and large bowel and damage to major abdominal wall vessels.[2]

In 1878, Kocks attempted to occlude the uterotubal junctions blindly by a transcervically inserted electrode. Although the first hysteroscope was made by Pantaleoni; it was in 1934 when Schroeder performed intramural sterilization of the fallopian tubes by electrocoagulation under direct hysteroscopic visualization.[3] Hysteroscopy became popular in 1980s when technology offered more practical and usable instruments with use of distention medium.

The basic idea behind the hysteroscopic sterilization procedure is to have a more safe procedure with minimal side effects and an ability to perform in outpatient department using local anesthesia.[4]

DEVELOPMENT OF HYSTEROSCOPIC STERILIZATION TECHNIQUES

With the development of miniaturized hysteroscopes two main types of techniques have been introduced for sterilization: destructive techniques, in which the intramural portion of tube is destroyed by using electrocoagulation, laser or sclerosing agents chemicals such as quinacrine, or using occlusive techniques which involves a tampon or a device placed at level of tubal ostium to block the fallopian tubes (Table 17.1).

Table 17.1: Hysteroscopic sterilization techniques

Destructive methods

- Electrocoagulation
- Cryo-coagulation
- Other thermal methods
- Bipolar radiofrequency ablation (RFA) (Adiana) and laser
- Quinacrine

Occulisive methods

Formed-in-place intratubal device
- Silicone (Ovabloc™)
- Hydrogelic + nylon device

Premolded intratubal devices
- Nylon + elastic loops
- The tubal screw
- Mechanical implant (Altased™)/Alphascience
- Nitinol + PTF (Essure™)

DESTRUCTIVE METHODS

Most of the destructive methods for hysteroscopic sterilization were abandoned either due to their limited efficacy or due to adverse effects. At present only quinacrine insertion is been practiced in some third world countries in spite of concerns regarding its safety.

Quinacrine Pellet Sterilization

The intrauterine installation of quinacrine represents a simple, inexpensive, effective, and seemingly safe method of nonsurgical female sterilization. This destructive method of female sterilization was developed in 1973, in which seven pellets of quinacrine are inserted one month apart and anti-inflammatory ibuprofen in the proliferative phase 6th to 14th of the menstrual cycle. The chemical composition of quinacrine is shown in Figure 17.2.

Procedure

Patient is placed in a lithotomy position and Quinacrine tablets are inserted by using a simple Copper T intrauterine device like inserter as shown in Figure 17.3.

Mechanism of Action

Although the exact mechanism of action is unknown it is believed that quinacrine acts by chelating DNA, by formation of quinacrine-DNA complexes. This action is believed to result in fibrosis of the endothelial lining of the proximal areas of the fallopian tube. It gained popularity in 1990s.[5]

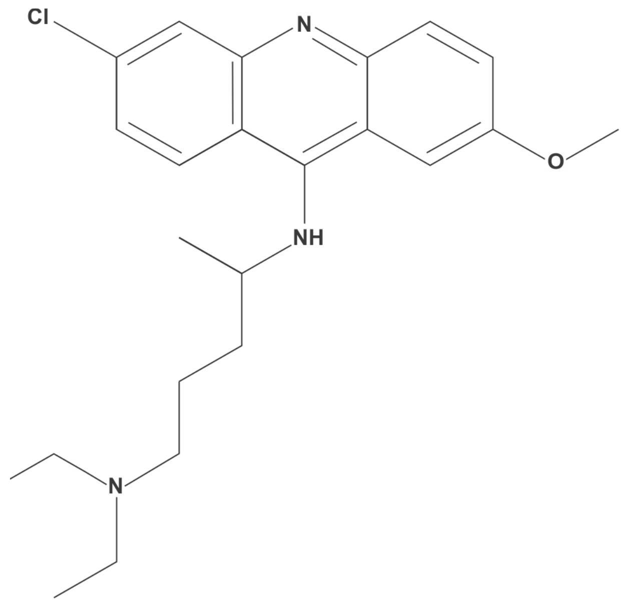


Fig. 17.2: 6-chloro-9-{(4-(diethylamino)-1-methylbutyl) amino}- 2-methoxyacridine dihydrochloride

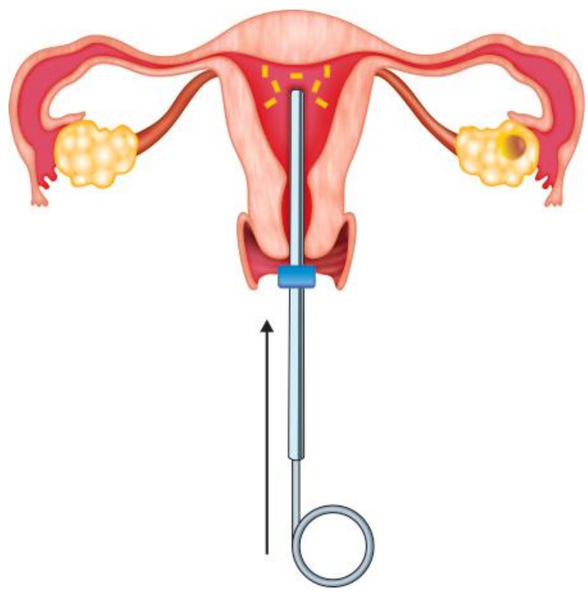


Fig. 17.3: Insertion of quinacrine tablets

Adjuvant Therapy

As adjuvant therapy, oral contraceptives are prescribed from the first insertion cycle and continued for three cycles with anti-prostaglandins such as ibuprofen taken orally on the day of the first and second insertions.

Efficacy

When compared with surgical methods of sterilization which has failure rates of less than 0.5 percent, the quinacrine pellet method originally considered of having a lifetime failure rate of 5 to 6 percent. However, recent 10-year data from Vietnam has questioned these data with reported pregnancy rates of 12.1 percent (Fig. 17.4). Although pregnancy rates of 4.3 to 4.6 percent do not seem excessive, they compare reasonably with the 3.6 percent failure rates of laparoscopically applied Hulka clips, which were considered too high for permanent methods of sterilization and therefore, discontinued. Nonetheless, pregnancy rates over 10 percent are excessive, even by developing world standards. Given the complexity of assessing effectiveness data due to variations in techniques and follow-up methodology, the final words on the effectiveness of quinacrine sterilization cannot be fully evaluated until better larger trial results are available.[6]

Cost

The most attractive feature of quinacrine sterilization from a world health perspective is cost. When quinacrine was manufactured by SIPHARM (Sisseln, Switzerland), the cost in Asia for the inserter and quinacrine pellets was less than $1 per sterilization. Compared with the cost of tubal ligation, the cost difference is significant.[7]

Safety

Although no serious side effects were reported in initial trials and the method became quite popular between 1980 and 1990s, in 1994, a World Health Organization (WHO) sponsored conference stated that adequate animal

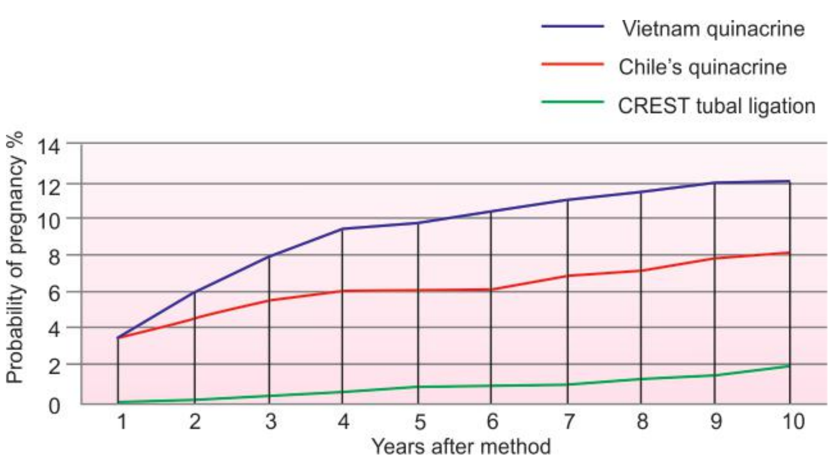


Fig. 17.4: Vietnamese quinacrine cumulative probability of pregnancy and estimates from Chile (quinacrine) and US Collaborative Review of Sterilization (CREST) study (tubal ligation). (Reprinted from Sokal DC, et al. Contraceptive effectiveness of two insertions of quinacrine: results from 10-year follow-up in Vietnam. Contraception, 2008;78:61–5, with permission from Elsevier)

toxicology studies had not yet been performed and the long-term safety concerns had not been addressed. Safety concerns included the possibility of increased risk for reproductive tract cancers, development of abnormal uterine lesions, ectopic pregnancy, and fetal exposure to quinacrine. Later studies confirmed that quinacrine is mutagenic *in vitro* and a potential risk to human health due to its exposure after intrauterine exposure.[8] This leads to the issue of an interim statement by the Department of Reproductive Health and Research (WHO), stating the quinacrine to be genotoxic.[9]

Electrocautry

Blind attempts at electrocautery of uterotubal junction were reported as early as 1878. With this technique, an electrode is passed into intramural portion of tube under hysteroscopic guidance, and a coagulating current is passed for several seconds.

In addition to poor efficacy with tubal patency rates around 26 percent it had many safety concerns with many studies reporting uterine perforation and thermal injury to bowel.[10]

Neodymium:Yttrium-Aluminum-Garnet Laser

The Nd:YAG laser is delivered through a long, flexible, quartz fiber and applies consistent thermal energy to tissues to a depth of 5 mm. Brumsted and colleagues attempted using the Nd:YAG laser for tubal occlusion in a carefully designed clinical trial in 1991. Despite high hopes, the trial was terminated after enrolling only 17 subjects due to patency rates of 74 percent. This method was abandoned due to poor efficacy although there were no safety concerns.[11]

OCCLUSIVE METHODS

Ovabloc

In 1978, a new method of hysteroscopic sterilization called Ovabloc (Fame Medical Products, Nijmegun, The Netherlands) was introduced. It is a hysteroscopic method of tubal occlusion in which liquid silicone is injected into tubes which forms plugs and occludes the ostia and fallopian tubes. Its phase II and phase III trials were carried out in the 1970s and 1980s in USA and Belgium. It is CE marketed but not FDA approved. This system is only available in a few centers of Belgium and Netherlands.[12]

Ovabloc System

Ovabloc procedure is carried out shortly after the menstruation in an office setting using local anesthesia via the Ovabloc system, which includes the following parts:[13]

- A mechanical fluid flow actuator (Fig. 17.5).
- A mixing dish.
- Microsyringe to inject the silicone catalyst.
- Insulating cup to hold the syringe during mixing.

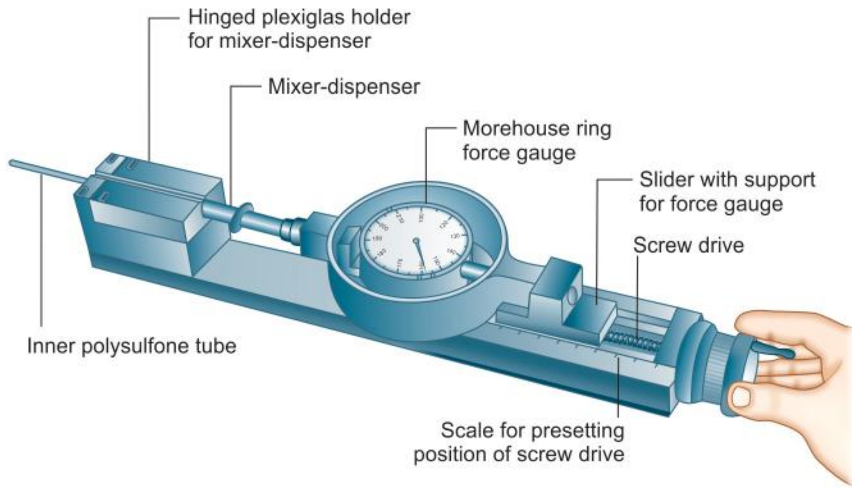


Fig. 17.5: Fluid flow actuator system (Advanced Medical Grade Silicones BV, The Netherlands) used to drive the activated and hardening silicone out of the syringe and down the coaxial catheter and into the fallopian tubes. (Reproduced by permission of Siegler AM, Lindemann JH (Eds). Hysteroscopy: Principles and Practice. Philadelphia: JB Lippincott, 1984)

- A frozen mixer-dispenser syringe containing raw silicone (Fig. 17.6).
- A vial of catalyst to activate the silicone.
- Sterile coaxial catheters with soft tips (Fig. 17.7).

Patient Selection

Careful patient selection is important when using the Ovabloc system since tubal occlusion is not achievable in all patients. The manufacturer of the Ovabloc system lists the following exclusion criteria:

- Acute or chronic cervicitis or vaginal infection
- A recent history of pelvic inflammatory disease.
- Undiagnosed genital tract bleeding or the presence of a bleeding disorder.
- Congenital malformation of the genital tract or previous tubal surgery.
- Known or suspected genital tract malignancy.
- Occlusion is more difficult in patients with a posterior uterus, especially if retroflexed, since the tubal ostia are not readily approached at an angle where silicone can be instilled.

Procedure

Procedure is done in outpatient department with patient in dorsal lithotomy position. As the cervical canal must be dilated to Hegar dilator size 8 to pass 7 Fr operative hysteroscope, a local paracervical block is given.

An Ovabloc catheter is inserted into the uterine cavity via the working channel of an operational hysteroscope. The tubal ostium of the tube is engaged. The assistant is asked to inject a methylene blue dye solution through the coaxial catheter into the fallopian tube to demonstrate tubal

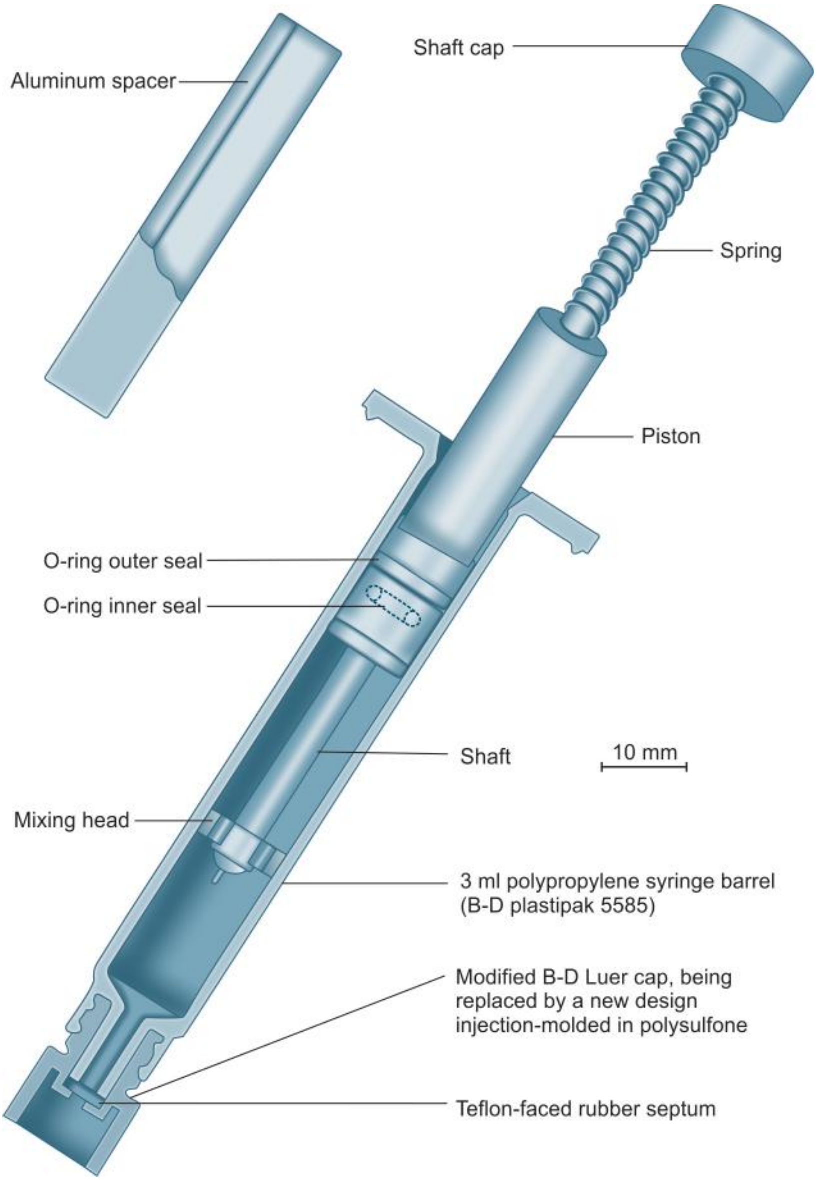


Fig. 17.6: The mixer-dispenser syringe (Advanced Medical Grade Silicones BV, The Netherlands) allows the catalyst to be injected with the silicone and mixed. A spacer converts it into an injection syringe, which is connected to the coaxial catheter and placed in the fluid flow actuator. (Reproduced by permission of Siegler AM, Lindemann HJ (Eds). Hysteroscopy: Principles and Practice. Philadelphia: JB Lippincott, 1984)

patency and proper alignment of the catheter tip. The hysteroscopist holds the catheter in place without movement while the assistant removes the silicone syringe from the freezer and places it in the insulated holder. A predetermined amount of catalyst is then injected into the silicone syringe and the

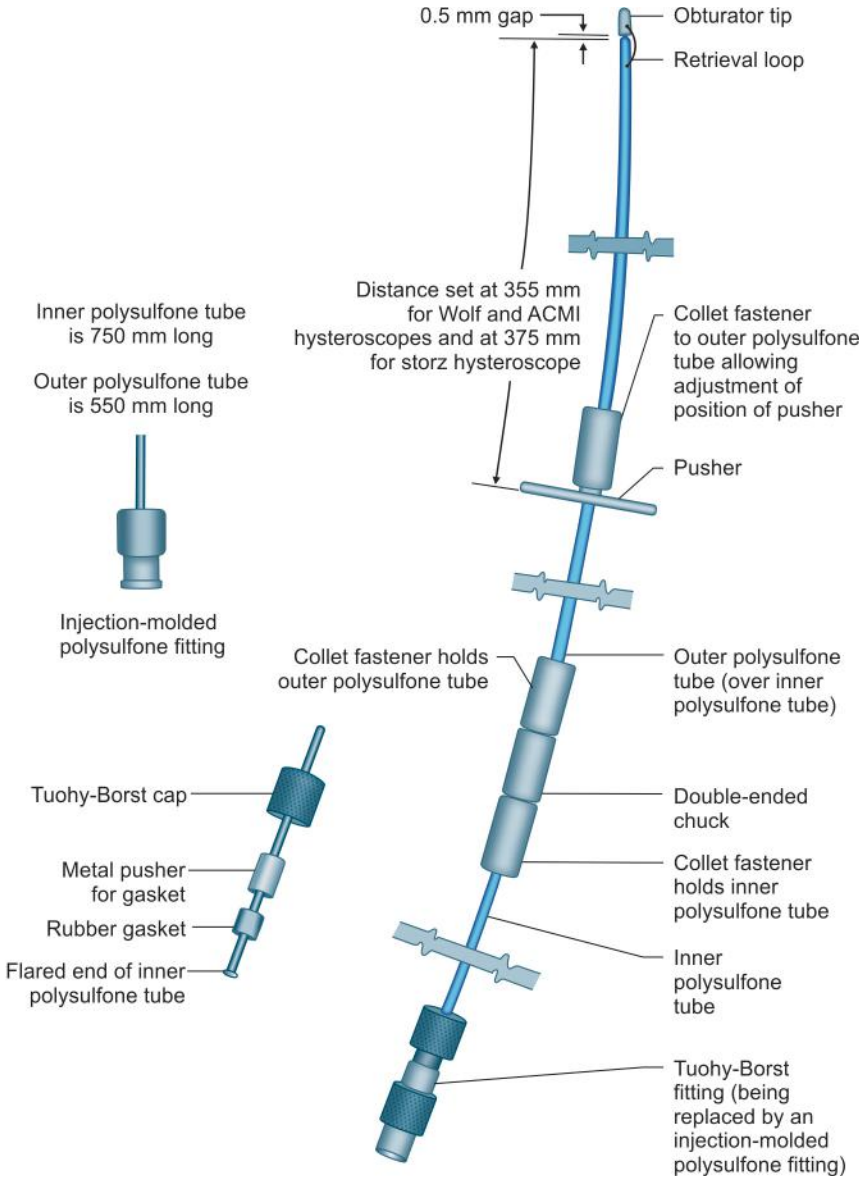


Fig. 17.7: Coaxial catheter with preformed soft obturator tip (Advanced Medical Grade Silicones BV, The Netherlands). (Reproduced by permission of Siegler AM, Lindemann HJ (Eds). Hysteroscopy*:* Principles and Practice. Philadelphia: JB Lippincott, 1984)

mixer syringe handle is then pumped to mix the silicone and catalyst. Once a predetermined number of mixing strokes have been performed, a spacer converts the mixing syringe into a dispensing syringe. This liquid silicone is then inserted into the tubal orifice as shown in Figure 17.8.

Within five minutes, the Ovabloc material is polymerized into a soft rubber. The catheter and its tip adheres to the material and remains behind which can be seen by a hysteroscope as shown in Figure 17.9.[14]

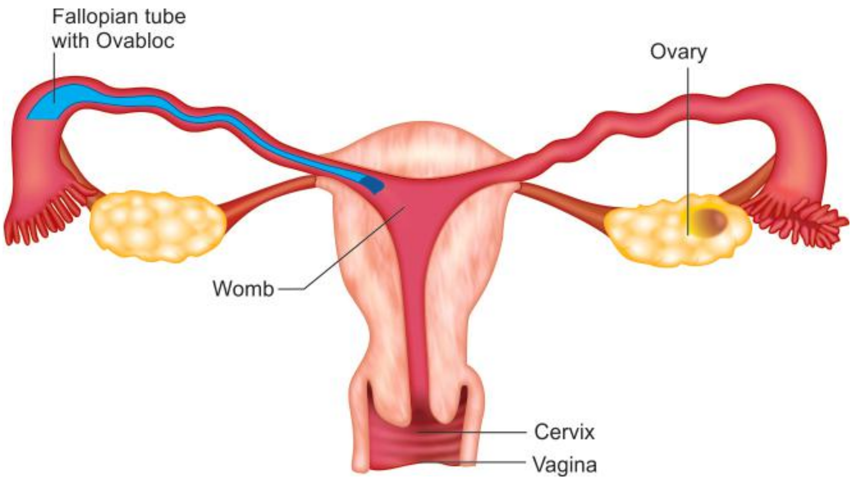


Fig. 17.8: Silicone injection into the fallopian tube
(http://www.ovabloc.nl/ovabloc/the_treatment)

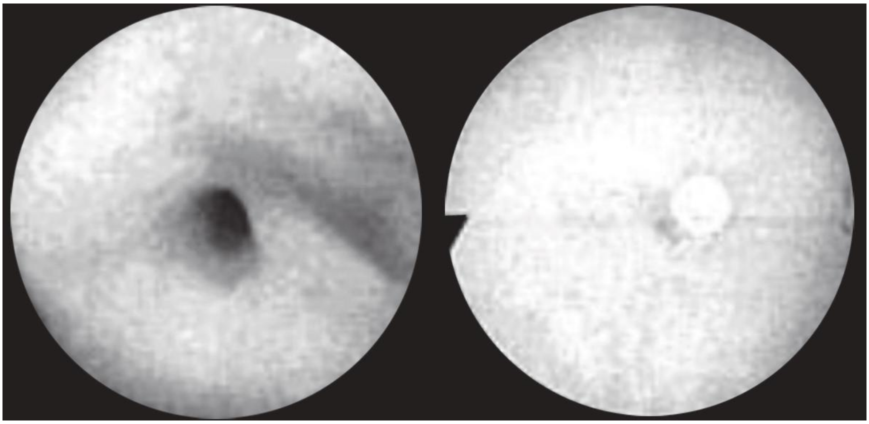


Fig. 17.9: Ostium before and after the Ovabloc procedure
(http://www.ovabloc.nl/ovabloc/ovabloc)

The silicone contains radiopaque silver powder which can be easily visualized by X-ray as shown in Figure 17.10. X-ray should be done after procedure to confirm the proper placement of plugs and the X-ray repeated in 3 months. The patient should be advised to continue taking contraceptives for at least 3 months.

COMPLICATIONS

Apart from difficult delivery apparatus, some of complications include reflux of silicone back into the uterine cavity, migration of plug into the peritoneal

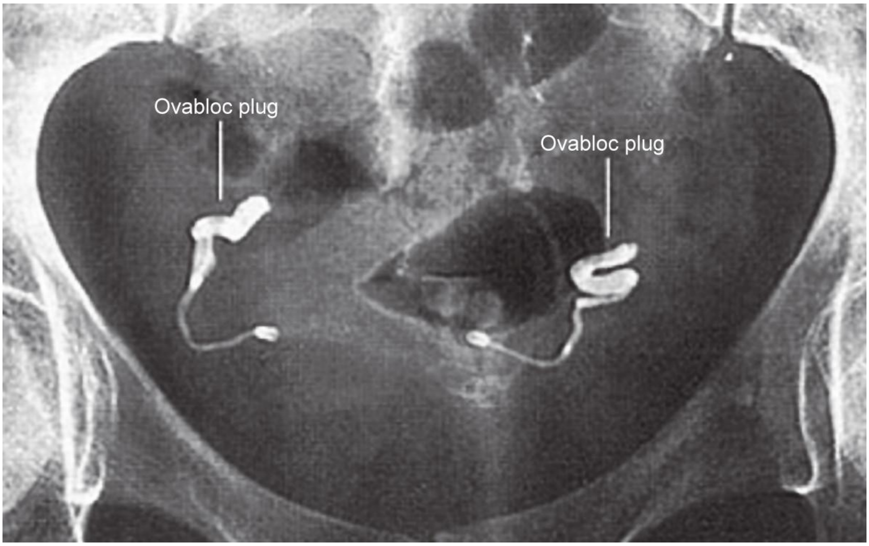


Fig. 17.10: X-ray film showing an appropriate placement of Ovabloc (http://www.ovabloc.nl/ovabloc/the_treatment)

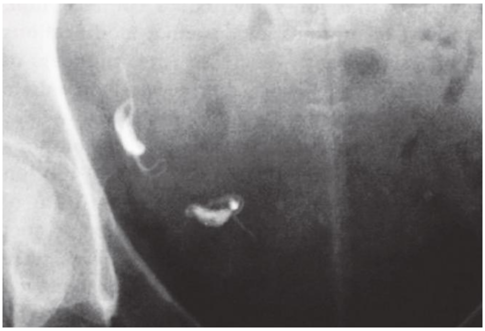


Fig. 17.11: Displaced silicone plug into peritoneal cavity

cavity if the tip was not appropriately bound as shown in Figure 17.11, resulting in an expulsion of silicon plugs.

Efficacy

There were 2501 patients entered into the Food and Drug Administration (FDA) clinical study by all investigators. The method failures were 3/1000 women in 12 months and 8/1000 women in 36 months. The follow-up should be extended to 12 months. Due to high failure rate, difficulty of procedure and operating system, FDA stopped the trials. The reversibility of the method remains questionable.[15]

ESSURE

Currently in the United States, Essure® (Conceptus, Inc., Mountain View, CA) is the only available approved method of transcervical sterilization. It was approved by the European Union in 2001 and received US Food and Drug Administration (FDA) approval in November 2002. In this nonincisional method of sterilization, a metal microinsert is placed under hysteroscopic guidance into the interstitial portion of each fallopian tube. A complete Essure device is shown in Figure 17.12.

Structure of Micro-Insert

The micro-insert itself is an expandable spring which is made of 98 percent titanium alloy and 2 percent nickel. The spring is 4 centimeters long, and has a diameter of 0.8 mm when folded or 2 mm when unfolded. Its function is to anchor itself inside the tube. Inside the spring, there are polyethylene terephthalate (PET or Dacron) fibers which are attached to central steel shaft as shown in Figures 17.13 and 17.14.

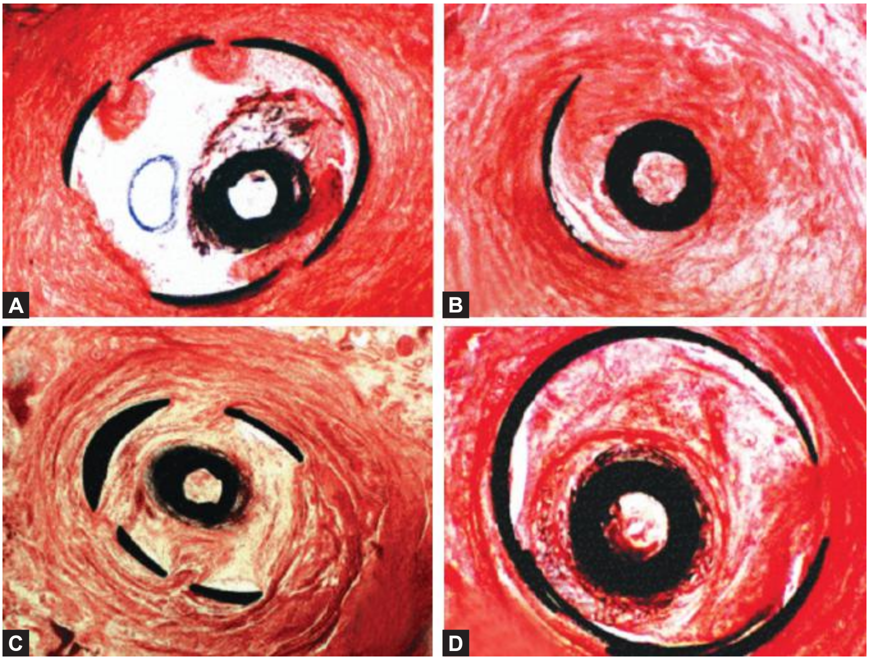
Mechanism of Action

The objective of the device is to obstruct the inside of fallopian tube by fibrosis. The PET fibers induce a benign tissue response characterized by macrophages, fibroblasts and collagen, which invade the device, creating a second and definite anchorage which can be seen histologically (Figs 17.15A to D).[16]

Fig. 17.12: Essure device
(*Courtesy:* Conceptus, Inc.)

Fig. 17.13: Pet fibers inside the titanium nickel micro-insert
(*Courtesy:* Conceptus, Inc.)

Fig. 17.14: Close up of spring and fiber insert
(*Courtesy:* Conceptus, Inc.)



Figs 17.15A to D: Microscopic view of cross section of tube containing the Essure device. (A) One week—fibrosis and acute inflammation cells migrating into device; (B) Four weeks—fibrosis replacing tube, acute and chronic inflammatory cells present; (C) Eight weeks—dense fibrosis filling the tube. Epithelium destroyed. Tubal lumen occluded; (D) Thirty weeks—dense fibrosis replacing tubal lumen; scant acute inflammatory cells present. (Reproduced with permission from Elsevier, Valle. Tissue response to STOP microcoil. Fertil Steril 2001)[16]

Procedure

This quick, simple and safe procedure is carried out in an outpatient department. Total procedure time is 15 to 35 minutes.[17] A continues flow hysteroscope with external caliber of 4 to 5. 5 mm and a 5 Fr working channel is used with normal saline as distention medium. A good source of light, camera and television monitor is essential.

Patient Selection

As Essure is a permanent method of sterilization and therefore irreversible, patients should be thoroughly counseled preoperatively. Proper selection is also important as procedure cannot be carried out in following conditions:

Absolute Contraindications

- Patient's doubts
- Current pregnancy
- Recent or active pelvic inflammatory disease
- Gynecological cancer.

Relative Contraindications

Known nickel allergy.

Preparation of Patient

Any present or past, medical/surgical, gynecological history with complete examination should be done. A transvaginal ultrasound should be performed if patient has clinical symptoms or clinical examination suggesting any gynecological pathology. An informed consent should be taken.

Although insertion can be done on any day of menstrual cycle the follicular phase is an ideal time. During the luteal/proliferative phase, the endometrium becomes hypertrophic, thus making it difficult to visualize the ostia.

If patient has an IUCD it should be removed and ideally after birth or abortion one should wait for at least 6 weeks before using Essure.

Pharmacological Preparation

Most of the patients do not require any premedication but using diclofenac 100 mg 1 to 1.5 hours prior to procedure reduces the cramping uterine pain.[18]

Insertion of Device

Patient should be placed in lithotomy position with thighs well flexed and fully abducted. Abdominal and bimanual vaginal examination should be carried out to assess the size and position of the uterus and any adenxal pathology. A speculum should be introduced and cervix cleansed. The anterior lip of the cervix can be held with a volsellum or a vaginoscopic approach can be used.

Although the procedure can be done without any kind of anesthesia, if the cervix is stenosed then it may need dilatation. A direct cervical infiltration of local anesthesia may be preferable.[18] The patient should be informed that she will feel wet and experience some cramping lower abdomen pain. The 30^{o} hysteroscope should then be introduced and tubal ostia visualized by rotating the hysteroscope by 45°. Once the cavity and ostia are visualized an introducer guide is placed in the working channel. This will protect the device as it advances in working channel.

The orientation of hysteroscope should be kept in a way that the tubal ostium is in the center view. The device should be inserted firmly into the tubal ostia to the black mark on the device. The thumbwheel of handle is rotated anticlockwise until it reaches its limit and the gold band can be seen (Fig. 17.16). With this action the protective catheter is retracted and after pressing the button on the device the filament uncoils inside the fallopian tube.

Once uncoiled a further anticlockwise rotation of the thumbwheel detaches the coil from the device. Three to eight coils should be visible inside uterine cavity as shown in Figure 17.17.

Similar steps are repeated on the contralateral fallopian tube.

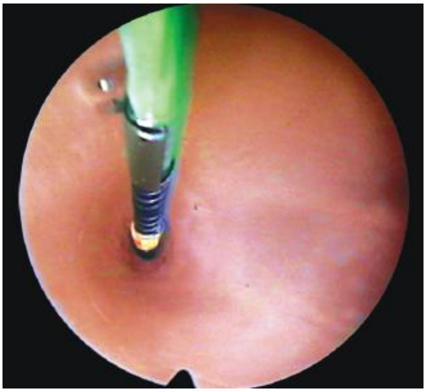


Fig. 17.16: Correct placement of Essure filament
(*Courtesy:* Conceptus, Inc.)

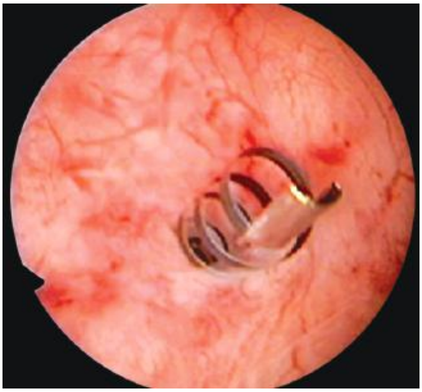


Fig. 17.17: Three to eight coils showing outside the ostia
(*Courtesy:* Conceptus, Inc.)

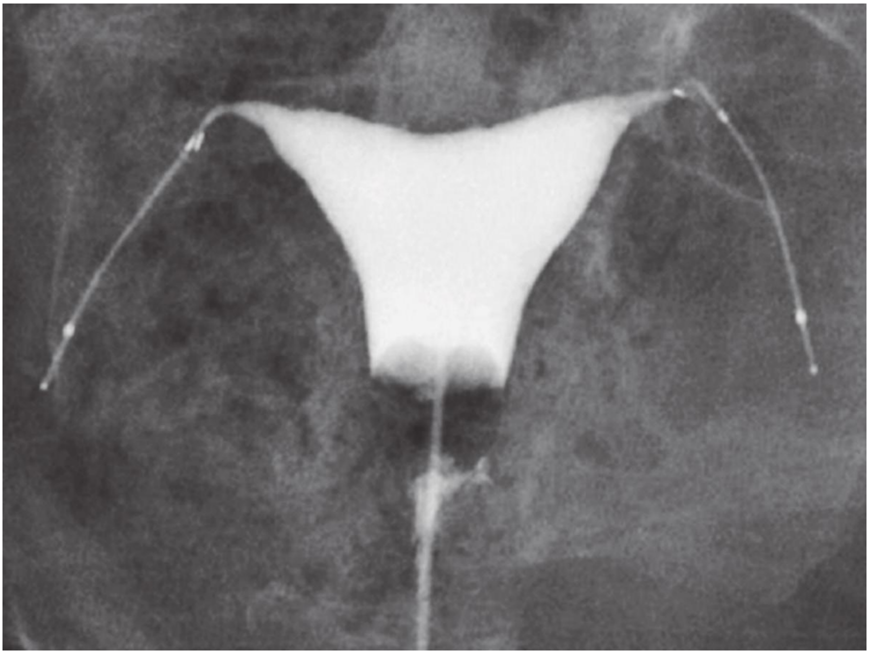


Fig. 17.18: Hysterosalpingogram showing bilateral tubal occlussion (*Courtesy:* Conceptus, Inc.)

Postprocedure

Postprocedure most the patients do not require any medication except additional nonsteroidal anti-inflammatory drugs. The recovery time and time taken to get back to normal life activities is also markedly quicker than laparoscopic sterilization methods with more than 90 percent returning to everyday life within 24 hours of Essure insertion.[19]

Postprocedure Counseling

Patient should be informed that she will need to use her current contraceptive method for next 3 months. A hysterosalpingogram or ultrasound scan to confirm tubal blockage or device placement should be carried out in 3 months period as shown in the Figure 17.18.

Effectiveness

Essure is highly effective method with effectiveness rate of 99.8 percent in 4 years. According to the phase II multicenter trial of effectiveness, no pregnancies were reported in 6015 woman-months of exposure to intercourse following documented bilateral tubal occlusion. A more recent review analyzed 64 pregnancies that were reported to the device manufacturer as of December 2005.[20] A breakdown of these pregnancies is detailed in Table 17.2.

Table 17.2: Breakdown of pregnancies

Reason pregnancy occurred	*Total number*	*% of total*
Patient or physician noncompliance	30	47
Misread radiograph or HSG	18	28
Pregnant at time of placement	8	12.5
Prior device design	1	1.5
Other	7	11
Total	64	

(Reprinted from Levy B, et al. A summary of reported pregnancies after hysteroscopic sterilization. Journal of Minimally Invasive Gynecology. 2007;14:271-4, with permission from Elsevier).[20]

Most pregnancies occurred in patients without appropriate follow-up. Other causes included misread hysterosalpingograms, undetected pre- procedure pregnancies, and failure to follow product-labeling guideline.[21] Applying these data from the CREST study,[22] transcervical tubal occlusion is second only to unipolar tubal ligation in terms of effectiveness and equivalent to the Filshie clip laparoscopic method of sterilization (Table 17.3).[22,23]

Table 17.3: Comparison of cumulative risk of pregnancy in CREST study versus Essure sterilization

Method	*Five years of follow-up*
Bipolar	16.5 (10.6–22.4)
Unipolar	2.3 (0.0–4.8)
Silicone band	10.0 (6.4–13.5)
Spring clip	31.7 (22.6–40.7)
Interval salpingectomy	15.1 (3.1–27.1)
Postpartum salpingectomy	6.3 (2.2–10.3)
All CREST average	13.1 (10.8–15.4)
Essure, posterior mean	2.6 (0.0–7.9)*
Filshie clip[23]	2.7

*Cumulative number of pregnancies/1000 procedures and 95 percent confidence intervals.
Represents 75 phase II clinical trial patients who have completed 5-year follow-up. No patients in the pivotal study have reached the 5-year follow-up visit. CREST, US Collaborative Review of Sterilization.[22]
(Reprinted from Levy B, et al. A summary of reported pregnancies after hysteroscopic sterilization. Journal of Minimally Invasive Gynecology. 2007;14:271-4, with permission from Elsevier).[20]

Safety

Essure is a safe procedure. Most common side effects during or immediately after the procedure include mild-to-moderate lower abdomen cramping pain, nausea/vomiting, dizziness/light-headedness, and bleeding/spotting but most of them settle within couple of hours.

There were no major adverse events reported in the phase II and Pivotal trial carried out in 745 women undergoing placement of Essure between 1998 and 2001, although uterine perforation was noted in 2 of the patients (Essure, Mountain View, CA: Conceptus, Inc.) Similarly a review carried out by FDA from the introduction of Essure in 2002 did not reveal any major adverse events, but there were 2 reports of uterine perforations (MAUDE: US Food and Drug Administration Center for Devices and Radiological Health).[24] Finally, for women with significant medical problems (such as severe cardiac disease) who require permanent contraception but might otherwise carry considerable surgical risks, Essure has been shown to be a safe alternative to tubal ligation.[25]

Discomfort and Pain

Essure procedure is performed in the outpatient setting using local anesthesia. It avoids the risks of general anesthesia giving favorable pain profiles and better patient satisfaction rates. When procedure is performed with only local anesthesia and oral ibuprofen 86.5 percent reported to have excellent pain relief with about 10 percent had menses like pain and only 3.1 percent having moderate pain more than in normal menses.[26,27]

Cost

Essure being an outpatient transcervical procedure of female sterilization is highly cost effective as compared with standard laparoscopic techniques, despite the high cost of the device itself. A 5 year prospective study carried out in USA showed that Essure saves 33 percent of laparoscopic tubal ligation costs.[28] Even when compared with laparoscopic tubal ligation with electrocautery it was shown to save $180 per patient.[29]

ADIANA

After Essure, FDA approved another new system in 2007, called The Adiana® (Hologic, Inc., Bedford, MA) which uses bipolar radiofrequency energy within the fallopian tubes, followed by insertion of a nonabsorbable biocompatible silicone elastomer polymer matrix to promote scarring. The whole Adiana apparatus is shown in Figure 17.19.

Procedure

The procedure is performed in outpatient department with patient in lithotomy position with local anesthesia with occasional intravenous sedation. Under hysteroscopic guidance, a delivery catheter as shown in Figure 17.20 is introduced into the tubal os.

Once placement inside the intramural section of the fallopian tube is confirmed, the distal tip of the catheter delivers bipolar radiofrequency (RF) energy, causing a lesion within the fallopian tube.

Following thermal injury, the silicone matrix is deployed in the region of the tube where the lesion was formed and the catheter and hysteroscope are removed as shown in Figures 17.21A to C.

Over the following few weeks, occlusion is achieved by fibroblast in growth into the matrix, which serves as permanent scaffolding and allows for

Fig. 17.19: Adiana permanent contraception system (http://www.medgadget.com/archives/img/f34f34ghu6.jpg)

"space-filling.[31] The mean procedure time (scope in, scope out) is about 12 minutes. Patients require local anesthesia. Occlusion of tubes is assessed by hysterosalpinogram at 3 months after device placement.

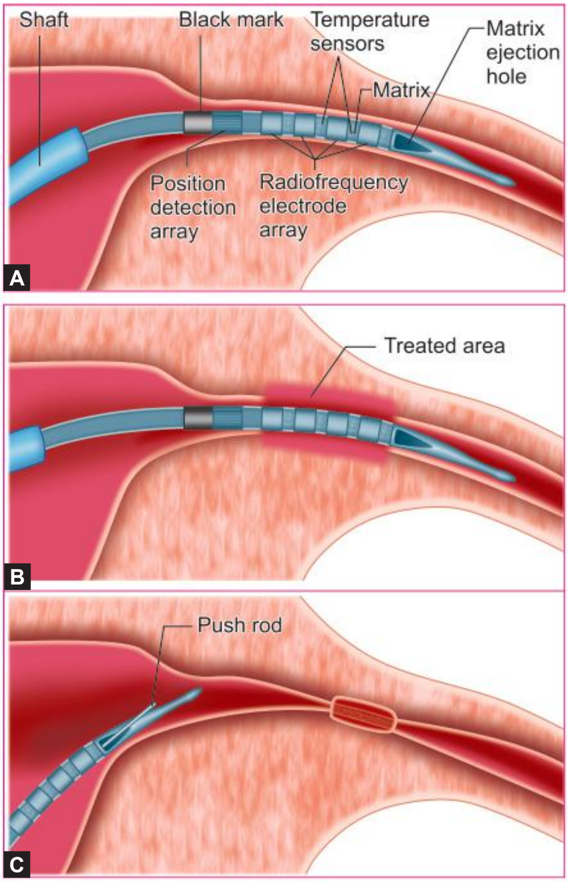
Effectiveness

Compared to the Essure procedure, no portion of the device is left within the uterine cavity. Initial failure rates seem higher than Essure at 4.9 percent, but more clinical studies are needed to confirm this. Data from the pivotal study called the evaluation of the Adiana system for sterilization using electrothermal energy (EASE) trial was presented to the Obstetrics and Gynecology Devices Panel of the Medical Devices Advisory Committee for the FDA in December 2007. In this study, the primary endpoint was to demonstrate the effectiveness of the Adiana system. In this trial 570 women had documented tubal occlusion by HSG. During the first year of follow-up, 6 pregnancies were reported, with half attributed to true method failure and the remainder from physician error (misinterpretation of HSG results). The second year yielded 3 additional pregnancies believed to be the result of method failure. There were no pregnancies reported in the third year and 1 additional pregnancy reported in a patient at 42 months postplacement. The cumulative failure rates were 1.08 percent at 1 year and 1.82 percent at 2 years.[30,32] These effectiveness data are within the range of all sterilization methods evaluated by the CREST study at similar time intervals; however, the Adiana failure rate is higher than all methods evaluated in the study, except for the spring clip application.[33] Adiana may also be an alternative to Essure, especially in patients in whom tubal stricture or spasm prevents Essure placement.[34]

Safety

Adiana seems to be a relatively safe procedure.[35] Of the 653 procedures performed in the study, the only notable significant complication was a case

Fig. 17.20: Andiana delivery catheter
(http://www.medgadget.com/archives/img/35433cyt2.jpg)



Figs 17.21A to C: Steps of Adiana insertion
(Reproduced from Vancaillie et al, 2008)[30]

of hyponatremia that was may be due excessive absorption of glycine, which is needed as a distention media given the use of the RF energy.

Technology Overview

A review of Essure and Adiana is given in Table 17.4:

Table 17.4: Review of Essure and Adiana

	Essure	*Adiana*[30]
Potential occlusion length	20 mm	3.5 mm
Distention media	Saline	Glycine, sorbitol or mannitol
Generator required	No	Yes—1 min RF application in each tube
Pregnancies in women relying on devices during clinical trial	0	12
Confirmation test	HSG confirms both occlusion and placement	HSG to show occlusion Ultrasound to show placement
Visible on X-ray/HSG	Yes	No
Estimated number of procedures performed	290,000+	< 1000
6 month HSG patency rate	0%	5.6%
Visual confirmation of correct placement	Yes—coils verify placement	No

CONCLUSION

After over 150 years of seeking a safe and effective method for female sterilization that avoids entry into the abdomen, transcervical sterilization is today a reality. In addition to safety and effectiveness, transcervical tubal occlusion offers the benefits of an outpatient, local anesthetic procedure that includes potentially lower total costs and better resource utilization. Currently there are two approved by FDA, namely—Essure® and Adiana®. More research on implantable devices and chemical technologies should broaden the options for this area of women's health.

SUMMARY

Laparoscopic tubal ligation was considered the gold standard against which other methods for permanent female sterilization were judged. But it is invasive and usually requires general anesthesia.

Female sterilization via the transcervical route is an outpatient procedure. It is performed with local anesthesia or even without anesthesia. Its complication rate is low. It should be preferred to the abdominal procedures provided the equipment and the experience required are available.

Careful selection of patient and counseling of patient is important to ensure the success and decrease complication rates. The ten-year cumulative pregnancy rate of sterilization techniques ranges from 0.1 to 3.6 per 1000 procedures. The life-time risk of failure is around 1:200.

Earlier destructive hysteroscopic procedures like electrocautery, laser were abandoned due to their poor efficacy, low safety profile and high complication rates.

Quinacrine pellet sterilization is a frequently used method in poorer nations where access to expensive medical technology is limited. Because of its role as a mutagen, it has been implicated as a potential carcinogen. The most attractive feature of quinacrine sterilization from a world health perspective is cost, about $1 per sterilization.

Ovabloc is a hysteroscopic method of tubal occlusion by injecting silicone which forms a plug in the fallopian tubes. This system is only available in a few centers of Belgium and Netherlands. It is CE marketed. Due to high failure rates, difficulty of procedure and operating system, the FDA stopped its introduction more widely.

Transcervical sterilization using Essure® has proved effective and safe. According to phase II multicenter trial results, no pregnancies were reported in 6015 woman-months of exposure to intercourse following documented bilateral tubal occlusion. No major adverse events were reported. It is currently the hysteroscopic method of choice for sterilization.

The Adiana® sterilization method is a combination of controlled thermal damage to the lining of the fallopian tube followed by insertion of a non-absorbable silicone elastomer matrix within the tubal lumen. Failure rates are less than 2 percent after 2 years, and the procedure seems to be safe and well tolerated. Longer term studies are required to show if these success rates are sustained.

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C H A P T E R 18

Hysteroscopy in Endometrial Cancer

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BACKGROUND

Endometrial cancer is the sixth most common cancer in females.[1] The reported incidence is highest in Europe and North America and lowest in Asia and the Far East.[2] The lifetime risk of developing the disease is approximately 2.7 percent. Most patients are postmenopausal with a median age of 63 years at diagnosis. The overall 5-year survival for all stages is 86 percent, with uterus-confined tumors having a 97 percent 5-year survival.[2]

Prolonged unopposed exposure of the endometrium to estrogen is the most significant risk factor. Simple or complex hyperplasia with no cytological atypia are associated with a much lower risk of progression to carcinoma as compared to complex hyperplasia showing evidence of atypical cytological features which are associated with a 23 percent risk of progression over 10 years. Other risk factors for endometrial carcinoma include obesity, early menarche, late menopause, nulliparity, anovulation, estrogen producing ovarian tumors, polycystic ovary disease, tamoxifen use, Lynch syndrome, diabetes mellitus, gallbladder disease, hypertension and prior pelvic radiotherapy.

Tamoxifen, a synthetic antiestrogen which is structurally similar to diethylstilbestrol has a partial agonistic action on estrogenic tissues like endometrium. This can give rise to pathological changes in endometrium from simple endometrial proliferation to hyperplasia, polyp formation, cystic atrophy and invasive endometrioid endometrial carcinoma (Fig. 18.1). The most common hysteroscopic finding in tamoxifen-exposed women is the presence of bleb-like vesicles disseminated throughout the uterine cavity probably due to underlying stromal edema with atrophy of the overlying endometrium.[3] The overall incidence of carcinoma in tamoxifen-exposed subjects is estimated at 2-3/1000.[4]

The vast majority of women with endometrial pathology, including endometrial carcinoma present with abnormal uterine bleeding (AUB). In recent years, diagnostic hysteroscopy has emerged as the "gold standard" for the objective evaluation of women with AUB. Recent technological advances in micro-hysteroscopic instrumentation have facilitated the development of

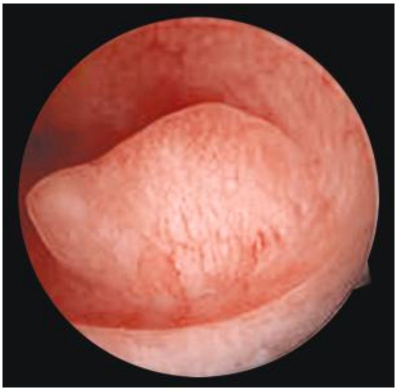

Fig. 18.1: Tamoxifen induced endometrial polyp

"office hysteroscopy" as an outpatient procedure requiring no anesthesia, producing minimal discomfort and allowing for an excellent objective evaluation and photo-documentation of the endometrial cavity.

There is, however, some controversy concerning its use in endometrial cancer, i.e. possibility of iatrogenic dissemination of tumor cells into the peritoneal cavity during the procedure and the significance of this positive peritoneal cytology.

DIAGNOSTIC STRATEGIES FOR ABNORMAL UTERINE BLEEDING

Establishing or excluding the presence of an endometrial carcinoma is of paramount importance in the evaluation of patients with AUB, both in the peri- and postmenopausal woman. The principal diagnostic tools used for endometrial evaluation include outpatient endometrial biopsy/sampling, dilatation and curettage (D and C), transvaginal ultrasonography (TVS) and hysteroscopy.

Outpatient Endometrial Biopsy

Endometrial biopsy is a simple, albeit "blind" outpatient technique employed for obtaining a sample of endometrial tissue for histological evaluation. A meta-analysis of 39 studies compared the accuracy of the different endometrial sampling devices in the detection of endometrial cancer and atypical hyperplasia. The detection rates for endometrial cancer using the Pipelle in post- and premenopausal women were 99.6 and 91 percent, respectively while the Vabra aspirator had a sensitivity of 97.1 and 80 percent respectively. The Pipelle device was also significantly more sensitive for the detection of atypical hyperplasia as compared to the Vabra device. The authors concluded that Pipelle endometrial biopsy is superior to the other available devices and that its accuracy is higher in postmenopausal women,[5] while conceding that its efficacy may be limited due to sampling errors. Endometrial sampling might produce an insufficient tissue sample for diagnosis. Up to 20 percent of cases where such samples are reported as inadequate will be found to have uterine pathology on further investigation, including on occasion, endometrial carcinoma.[6]

The accuracy estimates of the endometrial biopsy are better in symptomatic (bleeding) and postmenopausal women and for the diagnosis of endometrial cancer as opposed to atypical endometrial hyperplasia. Hysteroscopy is invaluable in those cases where insufficient tissue is obtained by blind endometrial biopsy.

Dilatation and Curettage

Dilatation and Curettage (D and C) was considered to be the principal diagnostic tool before introduction of hysteroscopy. However, the procedure is blind like endometrial biopsy, and also requires general anesthesia. There is a risk that focal endometrial pathology in the region of the uterine cornua may be missed besides the procedure-related risks of uterine perforation and bleeding. Epstein et al in their study of 105 patients found that D and C missed 58 percent of polyps, 60 percent of atypical hyperplasia and 11 percent of endometrial carcinomas (Fig. 18.2).[7]

Ultrasonography

It is an easy, fast and cheap technique that has become widely used to evaluate the endometrium in postmenopausal women with abnormal uterine bleeding.[8] It is less invasive, well-tolerated, and generally painless, without complications and it can diagnose intrauterine, intramyometrial as well as other pelvic lesions. Other advantages include its use in patients with cervical stenosis where office endometrial biopsy may be unsuccessful. Identification of a regular endometrial echo and the use of a 5 mm threshold to define abnormal endometrial thickening effectively excluded abnormalities in postmenopausal patients.[9,10] However, the cut-off value for premenopausal women is still a controversy. Also the diagnostic accuracy varies depending on the expertise of the investigator.

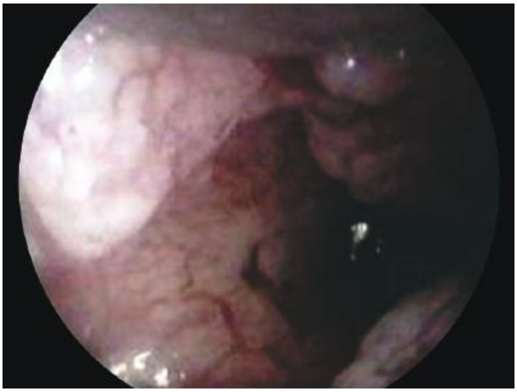

Fig. 18.2: Hysteroscopic view of endometrial carcinoma

Hysteroscopy

The first hysteroscope was designed by Desormeaux in 1865, but the first hysteroscopy was performed by Pantaleoni in 1869 by visualizing the uterine cavity and treating a uterine polyp.[11] Over the next century several innovations and refinements have led to the introduction of the modern hystero-resectoscope. Hysteroscopy is now considered the "gold standard" for evaluation of endometrial pathology. An additional advantage is that it can also be used to treat minor focal endometrial lesions, i.e. polyps, septa, submucous fibroids in the same sitting. Office hysteroscopy using the new generation of microhysteroscopes allows a satisfactory view of the endometrial cavity in more than 90 percent of cases.[12] There does not appear to be any loss in diagnostic sensitivity for endometrial lesions when compared to inpatient examination nor any reduction in the percentage of endometrial biopsies obtained during the outpatient procedure that are suitable for histological analysis.[12]

Carbon dioxide is the ideal media for diagnostic office hysteroscopy. The maximum permissible flow rate is 100 ml/min and maximum permissible intrauterine pressure is 150 mm Hg. CO_2 as a distention medium is excellent for diagnostic evaluation, is convenient to use and does not cause spillage as does liquid media. However, there is a small but real risk of gas embolism and it is unsuitable if bleeding is present. CO_2 is also not suitable for operative work as it cannot be used to flush the cavity of debris and blood.

Hysteroscopic surgery needs a liquid medium for the conductance of electrical energy and provision of better views. Nonelectrolyte media are used for procedures involving cutting/coagulation as they do not conduct electricity, whereas electrolyte media are used for diagnostic procedures. Using isonatremic (NaCl) medium has advantages over hyponatremic solutions (Glycine, Sorbitol) as it can avoid complications, i.e. fluid overload leading to electrolyte imbalance and consequent cerebral/pulmonary edema and cardiac arrhythmias.

HYSTEROSCOPIC VIEW OF ENDOMETRIAL PATHOLOGIES

The hysteroscopic appearance of endometrial carcinoma is quite typical. The visual diagnosis is generally based on the presence of a gross distortion of endometrial cavity, because of focal or extensive nodular, polypoid, papillary, or mixed patterns of neoplastic growth. Focal necrosis, friable consistency, and atypical vessels are other features almost invariably associated with endometrial cancer and easily detected by hysteroscopic inspection.[13] Hysteroscopic classification of endometrial carcinoma was first proposed by Sugimoto in his study of 53 patients, specifying the four types of tumor growth: (a) Polypoid, (b) Nodular, (c) Papillary, (d) Ulcerated type.[14] He also described the polypoid, nodular, and papillary types as exophytic and circumscribed disease, but the ulcerated type as endophytic and diffuse.

Regarding the morphologic appearance of focal endometrial lesions, the papillary type is significantly more frequent in malignant tumors. The presence of a warty aspect, with many tentacle-like projections, suggests a pattern of fast, aggressive, and disorganized growing. The polypoid-type lesions are mostly benign, but eventually, lesions with malignant behavior grow so fast into the uterine cavity that they mimic benign polypoid lesions. So, the mere presence of a polypoid growth is not enough evidence of its benign nature. Nodular lesions with a smooth surface presenting as large protrusions into the endometrial cavity are usually associated with benign histology.[14]

Tumor size may on occasion correlate with myometrial invasion and dissemination in endometrial cancer.[15] Size estimation may however be limited since hysteroscopic assessment is subjective and it is difficult to measure structures because of distortion and magnification.[16] Irregular and ulcerated surfaces, with areas of necrosis are usually associated with malignant lesions. Lesions with velvety surfaces are usually associated with thick normal endometrium but might also be present in endometrial hyperplasia or well-differentiated malignant tumors.[16]

The endometrial color is related with the vascular pattern. Pale colors suggest insufficient blood supply as in atrophic endometrium and are usually associated with benign lesions. Heterogeneity of color, i.e. deep red intermixed with paler areas represents areas with increased vascularization and necrosis, and is associated with malignancy. The reddish color is associated with increased vascularity and could be related to normal, inflammatory, or malignant endometrial tumors. Lesions with increased vascularization on the entire surface are more likely to be malignant, and when the increase of the vessels occurs only in some areas the lesions are usually benign. This pattern of neovascularization represents formation of new blood vessels.[17] Reticular formation is typical of capillary nets between arteries and veins and occurs in benign lesions. On the other hand, loss of reticular distribution, presence of vessels without dichotomous branching and other bizarre vascular patterns is suggestive of rapid neoangiogenesis and is a hallmark of malignant tumors. There is also a relationship between the main vascular axis and the direction of the lesion growth. Benign lesions progress slowly together with the progress of their vascularization and in these cases we can see a perfect agreement between the main vascular axis and the direction of the lesion growth. Malignant tumors, probably because of their irregular growth and disorganized angiogenesis, lose that visual characteristic.[16]

To conclude, the hysteroscopy features usually associated with malignancy are: papillary appearance, large size, irregular and ulcerated surface, heterogeneous colour, diffuse vascularization with anarchical or bizarre vascular branching patterns, discordance between the main vascular axis and the direction of the lesion growth.[16]

Hysteroscopy however fails to evaluate the degree of myometrial invasion. MRI is a highly sensitive and specific test for the detection of myometrial invasion and hysteroscopic features are a useful adjunct to it. This combination of hysteroscopy and MRI is essential in young patients when considering nonsurgical conservative management in the interest of fertility preservation. In a study of Kanazawa et al, the preoperative hysteroscopy appearance of 97 patients with well-differentiated endometrioid adenocarcinoma was correlated with the histologic findings of the hysterectomy specimen. According to this study, hysteroscopy findings helped in the correct selection of patients with disease confined to the endometrium, with a sensitivity and negative predictive value (NPV) more than 90 percent, while the specificity and positive predictive value (PPV) were less than 65 percent when calculated independently according to the growth pattern of the tumor with or without ulceration. However, when these parameters were calculated combining the tumor growth pattern and the presence of ulceration, the specificity rose to 75 percent and the PPV to 72 percent, with no significant change in sensitivity and NPV.[18]

DIAGNOSTIC ACCURACY OF HYSTEROSCOPY

Inspite of the limited data available on accuracy of diagnostic hysteroscopy, it is being widely used as a reference method in majority of studies. In a meta-analysis of 65 studies, Clark et al stated that the overall sensitivity of hysteroscopy was 86.4 percent and specificity was 99.2 percent for endometrial cancer. The likelihood ratio for a positive test was high indicating that hysteroscopy is highly accurate and thereby clinically useful in diagnosing endometrial cancer in women with abnormal uterine bleeding. However, its high accuracy relates to diagnosing cancer rather than excluding it.[19]

Does Hysteroscopy Disseminate Endometrial Cancer Cells?

Several retrospective studies have postulated that the increase in the intrauterine pressure during distension media insufflation leads to dissemination of cancer cells through the fallopian tubes. Polyzos NP et al conducted a meta-analysis including nine trials in which one thousand fifteen patients with histologically proven endometrial carcinoma were allocated to hysteroscopy or no hysteroscopy before surgery. Hysteroscopy resulted in a significantly higher rate of malignant peritoneal cytology (odds ratio [OR], 1.78; 95% confidence interval [CI], 1.13-2.79; $P = 0.013$) and significantly higher disease upstaging owing solely to the presence of malignant cells in the peritoneal cavity (OR, 2.61; 95% CI, 1.47-4.63; $P = 0.001$) compared with no hysteroscopy. They concluded that hysteroscopy in patients with endometrial cancer increases the risk for cancer cell dissemination within the peritoneal cavity.[20]

There are conflicting results about the use of various distension media in dissemination of cancer cells. Lo et al suggested that endometrial malignant cells were introduced into the peritoneal cavity during hysteroscopy and that positive peritoneal cytology was significantly more common among patients having hysteroscopy using normal saline (NS) rather than CO_2 (14.0% versus 1.4%, OR 11.2, 95% CI, P 0.009). There was no statistically significant difference between the two groups of patients undergoing hysteroscopy using either CO_2 or NS with regard to other prognostic factors (age, pathologic stage, International Federation of Gynecology and Obstetrics (FIGO) grading, myometrial invasion, tumor size, cervical involvement, nodal involvement, and 2-year disease-free survival.[21] However, another prospective randomized self-controlled study by Nagele et al revealed no significant difference in the spreading of endometrial cells after hysteroscopy using CO_2 or NS hysteroscopy. Transtubal dissemination occurred in about one quarter of patients, irrespective CO_2 or NS was used for uterine distention.[22]

The mean intrauterine pressure responsible for dissemination of cancer cells has further been a controversial issue. Usually 100 mm Hg of mean pressure is required during hysteroscopy for adequate visualization of uterine cavity. It has been stated that pressures less than 70 mm Hg do not increase intraperitoneal dissemination of cells. Cicinelli et al in their randomized controlled study of 140 patients evaluated the 5-year incidence of pelvic recurrences in women affected by early-stage endometrial carcinoma (Stages IA or IB) who did or did not undergo preoperative hysteroscopy with low pressure (<70 mm Hg) saline uterine distention. They concluded that pre-operative low-pressure fluid microhysteroscopy does not increase the risk of intraperitoneal transport of endometrial carcinoma cells during the examination or the risk of pelvic recurrences at 5-year follow-up. It does not seem to modify the recurrence rate, disease-free survival, and overall survival, although multicenter randomized trials and long-term follow-up are required to evaluate the overall oncologic outcomes of this procedure.[23]

Finally, according to the data of a recent study, diagnostic hysteroscopy significantly increases the risk of positive peritoneal cytology, but not the risk of adnexal, abdominal, or retroperitoneal lymph node metastases in patients with endometrial cancer.[24]

Are These Disseminated Cells Viable?

The viability of cancer cells disseminated intraperitoneal during hysteroscopy is another controversial issue. There is enough evidence demonstrating the significance of peritoneal immune mechanisms in the control of metastatic spread.[25] In the study of Hirai et al, 50 patients with clinical Stages I–II endometrial cancer and positive peritoneal cytology smears were studied. A tube for the cytological analysis of peritoneal washings was positioned into the peritoneal cavity when closing the abdomen at the end of surgery. This study suggested that endometrial cancer cells found in the peritoneal cavity usually disappear within a short-time and seem to have a low malignant potential.[26] Arikan et al in their *in vitro* model of hysteroscopy in uteri containing endometrial carcinoma, reported a 42 percent of trans-tubal dissemination of functionally viable tumor cells, as defined by cell adhesion to a matrix. Viable tumor cells may survive longer periods of time within the peritoneal cavity and could explain the same rate of positive peritoneal cytology observed, if the hysteroscopy is performed immediately before surgery or days or weeks later.[27]

SIGNIFICANCE OF POSITIVE PERITONEAL CYTOLOGY

Positive peritoneal cytology was considered an important determinant in the staging of endometrial cancer and the presence of positive peritoneal cytology would upstage the tumor to Stage IIIA in otherwise early-stage disease. The current revision of the FIGO Staging System (2009)[28] however, excludes positive peritoneal cytology as an independent variable in assigning the final FIGO Stage, though it states that positivity must be separately mentioned. Wethington et al[29] in their review of 50 studies from the literature concluded that peritoneal cytology was found to be positive in approximately 11 percent of patients. It was associated with an increased incidence of extrauterine disease, but it only rarely altered the clinical management of these patients.

Positive peritoneal cytology is not consistently linked to other high-risk factors as seen in multiple, large contemporary studies. This lack of connection supports the importance of complete surgical staging including peritoneal cytology and lymph node dissection. Lastly, there is no definitive consensus on the prognostic significance of positive peritoneal cytology when disease is otherwise confined to the uterus. The recurrence risk in these patients is estimated to be 4.1 percent. The clinical benefit of adjuvant treatment in patients with such a low-risk of recurrence remains unproven as the magnitude of effect adjuvant therapy has on outcome is undefined.

CONCLUSION

To conclude hysteroscopy plays an important role in diagnosing endometrial cancer. It is a highly accurate and clinically useful tool in the diagnostic work-up of patients with abnormal uterine bleeding. Though there is a small risk of intraperitoneal dissemination of cancer cells posthysteroscopy in patients with endometrial cancer, the viability of these cells is questionable. Moreover positive peritoneal cytology independently has only minor implications on the management of patients with early-stage endometrial cancer.

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CHAPTER 19

Hysteroscopic Management of Cervical Ectopic Pregnancy

Nozer Sheriar, Prajakta Gokhale

Cervical ectopic pregnancies are an obstetric rarity. They account for between 1 in 2500 to 18000 of all ectopic pregnancies (Parent et al, 1983). Their location and local growth and invasion make them potentially life threatening with severe difficult to control hemorrhage from the cervix. Traditionally, the severe bleeding associated with a disturbed cervical ectopic gestation was managed by hysterectomy. Contemporary developments in biochemical and imaging techniques now permit an early suspicion and detection of this uncommon type of cervical ectopic pregnancy thereby permitting conservative medical therapy with or without local compression thereby avoiding hysterectomy and to maintaining future fertility.

Hysteroscopy is today the gold standard in the diagnosis and management of intrauterine pathologies, including the resection of polyps and myomas and with control of local bleeding. Recent case reports in literature describing a role for hysteroscopy in managing cervical pregnancy. Not only does it only allow direct visualization but also allows control of hemorrhage and complete resection of ectopic and thus avoids prolonged follow-up (Ash and Farrel, 1996). This presentation is an overview of conservative management of cervical ectopic pregnancies with the first author's experience of managing these by hysteroscopic surgery.

HISTORICAL ANTECEDENTS

The clinical entity was first described in 1817 and first named cervical pregnancy in 1860. In a 1911 case report, Rubin proposed the diagnostic criteria for cervical pregnancy. These included close attachment of placenta to the cervix, cervical glands present opposite the implantation site, placental location below uterine vessel insertion or below anterior and posterior reflections of the visceral peritoneum of the uterus and no fetal elements in the uterine corpus (Rubin, 1911).

PREDISPOSING FACTORS

The likelihood of development of cervical pregnancy is increased with previous instrumentation of the endocervical canal, myomas, scarring and adhesions, intrauterine diethylstilbestrol exposure, intrauterine device use and *in vitro* fertilization (Ginsburg, 1983 and Weyerman, 1989).

DIAGNOSIS OF CERVICAL ECTOPIC PREGNANCY

On clinical examination, the cervix is soft, barrel shaped and disproportionately enlarged compared with the uterus. The external os may be closed or partially open and on occasion may have profuse hemorrhage particularly on manipulation of the cervix. None of these clinical signs are diagnostic of cervical pregnancy and if there is suspicion of cervical pregnancy, ultrasound evaluation is mandatory.

Ultrasound diagnosis is essential for the early detection of a cervical pregnancy.

Raskin suggested that diagnosis by ultrasound examination of cervical ectopic pregnancy should fulfill four criteria—cervical enlargement, uterine enlargement, diffuse amorphous intrauterine echoes and absence of an intrauterine pregnancy (Raskin, 1978). In 1993, Timor- Tritsch et al proposed more stringent criteria—the placenta and entire chorionic sac containing live pregnancy must be below the internal os and the cervical canal must be dilated and barrel shaped (Timor-Tritsch et al, 1994)

Cervical pregnancies may be confused with products of conception in transit through the cervical canal during a miscarriage and must hence be distinguished from a cervical abortion. The use of Doppler studies helps in distinguishing abortions in progress from those with vascular implantation in the cervix. (Benson and Doubilet, 1996; Jurkovic et al, 1996).

MANAGEMENT MODALITIES

Prior to 1980s the diagnosis of cervical ectopic pregnancies was often made when curettage for presumed incomplete spontaneous abortion resulted in severe often uncontrollable hemorrhage. Most women then required hysterectomy and massive blood transfusion.

Since then the advent of readily available sensitive biochemical assays and transvaginal ultrasound has made an early diagnosis of cervical pregnancy possible and the acceptance of medical management of ectopic pregnancies has provided an opportunity for conservative treatment of this condition.

Conservative management of cervical ectopic pregnancies includes the following options:

- Methotrexate therapy by systemic administration or local injection
- Cervical evacuation by curettage or hysteroscopic resection
- Local tamponade with inflatable balloon or catheter
- Cervical encirclage

- Uterine or internal iliac artery ligation by laparotomy or laparoscopy
- Cervical artery ligation through vaginal access
- Uterine artery embolization.

A primary hysterectomy may still be appropriate in case of intractable hemorrhage, late trimester diagnosis of cervical pregnancy and occasionally to avoid transfusion or emergency surgery in a woman who does not desire fertility (Dall, 1994).

Currently, there are no specific recommendations for the preferred treatment for a cervical ectopic. The rarity of this condition makes it impractical to perform prospective, randomized, controlled studies to evaluate the efficacy of different treatment options.

Methotrexate administered systemically or locally has been effective. Systemic methotrexate treatment may be now considered the first line of therapy. Primary methotrexate treatment is associated with high failure rates in patients with serum hCG levels over 10000 IU/ml and with presence of cardiac activity with age and parity having no effect on the efficacy of treatment (Hung et al, 1998 and Bai et al, 2002). Methotrexate therapy seems to be most effective before 9 weeks of gestation particularly in absence of cardiac activity. The suggested dose as in the medical management of ectopic gestations is 1mg/kg maternal body weight.

Direct methotrexate injection under ultrasound guidance is reported to have a higher success rate than systemic methotrexate particularly in case of multifetal cervical pregnancies (Jeong et al). Following local injection of methotrexate, serum beta hCG levels are monitored till complete absorption and significant reduction of levels. Direct injection under ultrasound guidance is considered to decrease side effects of systemic therapy.

Although there is no standard protocol of methotrexate used systemic methotrexate administration is believed to be effective in around 90 percent of cases. Many cases may require concomitant or subsequent surgical debulking in combination with methotrexate therapy.

Hemostatic measures may be used in preparation for chemotherapy or surgical evacuation to reduce hemorrhage. Laparoscopic internal iliac ligation or uterine artery ligation in combination with methotrexate injection appears to be effective in preventing unexpected massive bleeding. Angiographic embolization of uterine arteries has recently been used as rescue therapy when profuse bleeding ensues following conservative management.

Vaginal ligation of cervical arteries, cervical cerclage (Shirodkars or Macdonald) or local infiltration with vasopressin are other hemostatic measures that have been applied (Sherer et al, 2003 and Lin et al). Cervical cerclage may be only suitable therapy in cases of heterotopic pregnancies (Mashiah et al, 2002).

Cervical evacuation with curettage has an increased risk of bleeding when used alone. During curettage for removal of products of conceptions by dilatation and evacuation, profuse bleeding often ensues from the placental site. As cervix is nonretractile, it is difficult to arrest hemorrhage. Profuse hemorrhage may ensue following spontaneous expulsion of cervical pregnancy treated with methotrexate (Emersson et al, 2005).

Tamponade is often used after other conservative techniques. A Foley catheter placed gently past the external os followed by inflation of balloon has proven to be more effective in achieving hemostasis than packing. The intracervical tamponade may be buttressed by a cerclage to achieve effective compression.

HYSTEROSCOPIC MANAGEMENT

Hysteroscopy can be used for diagnosis or treatment of cervical pregnancies. It may also be performed after successful conservative treatment for visualization of normalcy of cervix. Complete resection of cervical pregnancy under direct visualization helps in preventing hemorrhage, prompt resolution and avoiding prolonged follow-up.

Hysteroscopic resection of a cervical pregnancy was first reported by Ashe and Farrel). Successful treatment of a cervical pregnancy by uterine resectoscope was described with operative hysteroscopy permitting direct visualization and complete resection. This was followed by other case reports of successful hysteroscopic treatment (Hardy TJ, 2002).

A new single-step combination endoscopic operation is an effective uterus-preserving alternative with laparoscopy-assisted uterine artery ligation followed by hysteroscopic local endocervical resection to remove the ectopic pregnancy was reported by Kung et al. Cervical pregnancy was diagnosed in six patients and they were all successfully treated without the need for adjuvant therapy. The mean operating time was 119 minutes and the mean blood loss was 125 ml. Menstruation began a mean of 63 days after the treatment (Kung et al, 2004).

Resection of cervical heterotopic pregnancy by hysteroscopy has been reported with a successful pregnancy resulting in a term baby (Jozwiak et al, 2003).

Personal Experience

Presented herewith is a series of three cases of cervical pregnancy managed hysteroscopically:

Case 1: Hysteroscopic Management of Chronic Cervical Ectopic Gestation

Mrs SJA, 23 years old gravida 3 with 3 abortions had persistent and heavy bleeding per vaginum since one and a half months having undergone D and C two months ago for what was thought to be a missed abortion. Bimanual examination revealed a normal sized, firm uterus with a bulky cervix. Ultrasonography revealed a normal uterine cavity with a 3.5 cm mass in the posterior cervical wall protruding into the cervical canal suggestive of a cervical fibroid.

Diagnostic hysteroscopy confirmed a normal uterine cavity. The cervical canal revealed a growth protruding into the uterine cavity well below the internal os. It was friable, vascular with a fluffy surface suggestive of chorionic villi. The mass with distinctive consistency and coloration was excised using the resectoscopic loop with 1.5 percent glycine for distention. The hemostasis was achieved within the resultant crater by coagulation of bleeding vessels with a rollerball. The bleeding was immediately controlled and the cervical canal found to be normal at postoperative ultrasound. Histopathology confirmed degenerated chorionic vill and reported products of conception.

Case 2: Hysteroscopic Management of Failure of Medical Therapy

Mrs SR, 27 years old gravida 2, para 1, ectopic had a cervical ectopic diagnosed at 8 weeks gestation for which she was treated with systemic methotrexate. A week later she presented with heavy bleeding per vaginum at which time the methotrexate was repeated. The bleeding continued and she was referred for further management.

Bimanual examination revealed a normal sized, firm uterus with a bulky cervix with the external os open and bleeding present. Ultrasonography revealed an irregular 3 cm mass in the cervical canal.

Operative hysteroscopy using the resectoscopic loop with 1.5 percent glycine for distention excised the ectopic gestation mass and the rollerball was used to then coagulate the vessels at the base. The bleeding was controlled immediately. The cervical canal found to be normal and closed at postoperative ultrasound. Histopathology confirmed the diagnosis of a cervical ectopic gestation.

Case 3: Hysteroscopic Confirmation of Complete Evacuation

Mrs SB, 24 years old primigravida presented at 10 weeks gestation with acute urinary retention. On examination, the uterus was acutely retroverted with an enlarged barrel shaped cervix. Ultrasound diagnosed a 4.5 cm mass suggestive of a cervical fibroid.

Examination under anesthesia permitted correction of the uterine retroversion. The cervical canal was dilated and the mass easily enucleated by digitally sweeping a plane of cleavage and removed. At this time the internal os remained closed. Immediate operative hysteroscopy using the rollerball with 1.5 percent glycine for distention achieved complete hemostasis. Histopathology confirmed a cervical ectopic gestation. A repeat hysteroscopy after three days confirmed a normal uterine cavity and cervical canal.

Mrs SB went on to conceive spontaneously and delivered a full-term pregnancy vaginally 18 months later.

Fertility after Cervical Ectopic Pregnancy

Due to the low incidence of cervical pregnancy, pregnancies after treatments are relatively unknown. It is also unclear if there is an increased risk of recurrence. Early ultrasound examination in a subsequent pregnancy may be advisable to rule out a recurrent ectopic pregnancy. Clinicians would be prudent to watch carefully for a possible increased risk of preterm labor or incompetent cervix, while reassuring patients that most pregnancies after a cervical ectopic will lead to term deliveries.

CONCLUSION

It is now both possible and desirable to diagnose the extremely rare cervical pregnancies with a high index of suspicion in cases where there is unexplained cervical distention/enlargement with or without a history of amenorrhea. In a majority of cases medical management with option of complementary local devascularization or tamponade is adequate treatment.

There are reports of hysteroscopic management cervical ectopic pregnancies in literature. To these we add our experience of hysteroscopic management of cervical ectopic pregnancies in three cases. Hysteroscopy offers a visual modality to not just visualize the endocervical mass but do a targeted resection and coagulation of bleeding vessels. The patients managed hysteroscopically had a complete excision, immediate control of bleeding were discharged within 24 hours completely recovered giving clinicians yet another option for managing ectopic pregnancies.

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CHAPTER 20

Hysteroscopic Embryo Transfer

Parul Kotdawala, Sonal Kotdawala,
Runoo Ghosh, Zaid Shirazi

The IVF technology has revolutionized the fertility treatment and a testimony to that is current award of Nobel Prize to the pioneer of IVF. Although the technology is a boon to the desiring couples, there is a flip side to it. The treatment is not only very expensive and entails many side effects, but the limited success rates are also a great source of disappointment to both; the couples undergoing the treatment and also the caregivers. By now we seem to have mastered the 'ovulation'. We have been able to achieve good fertilization and now with ICSI, we can take care of oligospermia. But the biggest roadblock to the IVF success story has been poor implantation rates. Scientists have tried to improve the implantation success by altering and manipulating the embryo transfer techniques. The gamete intrafallopian transfer (GIFT) procedure, the USG guided ET, hatching of the embryo and ploughing of the endometrium, have all been tried with a hope that this will enhance the implantation rates.

One thought was that the high failures of implantation following ET in IVF/ICSI, is due to some faults in the embryo. It was hypothesized that perhaps the egg or the sperm which was selected on the basis of physical well being (as decided by looking at them through the microscope) may carry some genetic defects. In an endeavor to weed out the defective embryos, scientists have started delaying the ET and obtaining a cell or two from the blastocyst for genetic testing. The technology of preimplantation genetic diagnosis (PGD) is the result and this has improved the pregnancy rates.

Clinically pregnancy rates are more in day 3 versus day 2 transfers. The pooled odds ratio from 10 studies for clinical pregnancy was 1.26, 95 percent CI 1.06 to 1.51. Blastocyst (day 5 embryo) transfer has been suggested to improve implantation rate without affecting pregnancy rate.[1]

The advantage of transfer of day 5 embryo in IVF is that it facilitates selection of the best quality embryo (fittest to survive 5 days *in vitro*) for uterine transfers and embryo quality is an important factor for pregnancy outcome. In a natural pregnancy the embryo reaches the uterus in about 80 hours after ovulation. Embryo implantation process begins after blastocyst formation and the hatching out of the embryonic shell have occurred. When blastocyst are transferred on 5th day in IVF, the uterine lining is more receptive to the arriving embryo, as this is a more natural time for the embryo to be in the uterus and this may circumvent the problems associated with the maternal receptivity aspect of the so-called 'window of implantation.'[2]

The disadvantage of blastocyst transfer is that under standard IVF culture conditions only about 25 to 60 percent of human embryos progress to the blastocyst stage after 5 days of culture, and if the culture environment is suboptimal, a delayed embryo development and even embryonic arrest will occur in some cases.[3] Therefore, if the culture system and laboratory quality control are inconsistent, good results will not be obtained with extended culture to day 5. Such programs will do better with day 3 transfers—putting back embryos earlier, before they are stressed excessively in a weak culture environment. Another disadvantage is the high costs of keeping the embryo in the lab condition till day 5 transfer.

In an endeavor to increase the implantation rates further a new concept of 'hysteroscopic subendometrial embryo transfer' has been promoted. Kamrava and colleagues have published a large series of cases where hysteroscopy guided subendometrial seeding of the blastocyst was used for ET and their success rates are noteworthy. Hysteroscopy assistance was used initially in the difficult cases where there was cervical stenosis or where previous ET was unsuccessful. Now this technique is being promoted for all ET. One major benefit of this technique is that it eliminates the possibility of ectopic pregnancy which has been a major nemesis of IVF success.

The first report of a case series was published in 1997 where a direct intra-endometrial transfer (DIET) of human embryos was performed in 14 women.[4] Day 2 embryos were injected into the endometrial stroma using a CO_2-pulsed flexible hysteroscope in this study. They achieved 2 pregnancies by this technique. The authors concluded that a low implantation rate after DIET of day 2 embryos, suggest that the endometrial stroma does not provide an optimal environment for early embryonic development. They presumed that perhaps the acidifying effect of CO_2 used for insufflation may be the reason for the low pregnancy rate after DIET and summarized that it is possible to achieve pregnancy by DIET in humans, but presently this procedure can be considered only in cases where the implantation site needs to be precisely determined.

A systematic review of the use of hysteroscopic embryo implantation and meta-analysis of prospective controlled trials comparing hysteroscopic embryo implantation with abdominal ultrasound-guided embryo transfer was conducted by a computerized search using all literature since 1980s. The review authors concluded that 'there is no strong evidence that hysteroscopic embryo or blastocyst transfer is more beneficial than either routine clinical touch or ultrasound-guided embryo transfer.[5]

The ultrasound guided ET uses a blind technique of catheter introduction into the uterus. The malleability of the ET catheters have also a limitation. The soft catheters in comparison to firm catheters may result in lesser trauma to the endometrium, but their introduction into the cavity becomes difficult. It is estimated that about 30 percent of all IVF failures are due to poor embryo transfer techniques.[6] We now have data to support the assumption that quasi-blind ET catheter introduction by ultrasound guidance also results in significant trauma by the catheter tip to the endometrium.[7]

Hysteroscopic transfer of embryo is under vision and the tip is guided in atraumatic manner into the cavity and we can deposit the embryo at a specific location to avoid the ectopic pregnancy. Transfer of one or two blastocyst reduces the possibility of multiple pregnancies without reducing the pregnancy rates, which may happen in a blind technique where we transfer more embryos (3 or more) to cover the embryos which may occasionally get lost!

TECHNIQUE OF HYSTEROSCOPIC EMBRYO TRANSFER

Initially the hysteroscope was used in difficult cases of ET or where there were repeated failures in spite of good embryos. Anecdotal cases with successful pregnancies are reported in literature.[8] In majority of such cases the hysteroscope was introduced only in the cervical canal and then the ET catheter was guided into the internal os under hysteroscopic vision and the embryos were discharged in the endometrial cavity (Fig. 20.1).

There are reports of depositing the zygote into the fallopian tubes through hysteroscopic cornual catheter in a bid to mimic GIFT type of procedure. Special catheters with tapering tips were designed for this. However, these methods have long been abandoned in routine practice.[9]

Michael Kamrava and his colleagues[10] at West Coast IVF clinic, USA, have reported a large series of cases where they have employed the hysteroscopic embryo transfer technique, for a subendometrial seeding of the late age embryo (day 5). In their technique a light weight flexible minihysteroscope is used for visualization of the endometrial cavity. The thin, flexible, and movable tip endoscope ensures direct entry and visualization of the uterine cavity with minimum trauma. The 3 mm office hysteroscope incorporates a flexible distal end and a straight operating channel through which the ET catheter is navigated. They have used nitrogen gas instead of CO_2 for uterine distention. Nitrogen gas is inert and is being used in the mixture of nitrogen,

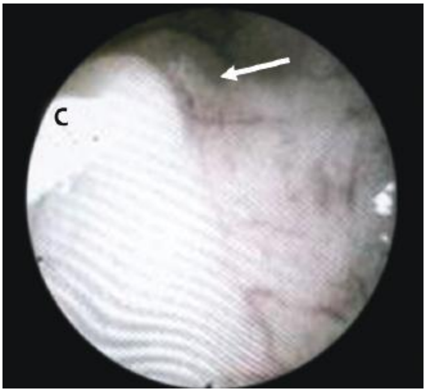


Fig. 20.1: Catheter tip 'c' buried in endometrium (*Courtesy:* Kamrava M)

oxygen and carbon dioxide for embryo culture in IVF laboratory and is not known to be toxic to the embryo. Gas pressure is set at 70 mm Hg and the vaginoscopic method of hysteroscope insertion is used. An average of 50 cc of gas is used during the procedure. The uterine cavity is distended during the introduction of the hysteroscope into the uterus by slow passage through the endocervical canal. This allows the hysteroscope to move in a gaseous phase and not in direct contact with the endometrium as is the case with the blind procedure. The ET catheter is polycarbonate based semirigid one, with a tapered tip (500 μ) bevelled to 45^0 to 60^0. The advantage of using a semirigid catheter is to prevent kinking as it passes through the endoscope, and still it retains enough flexibility to bend with the endoscope. This also allows bending and kinking to prevent inadvertent entry into the myometrium. The catheter is inserted to for distance of 0.5 cm horizontally and to a depth of approximately 1 mm into the endometrium. The day 5 embryo is deposited under direct hysteroscopic visualization. For the advanced blastocyst embryos, the implantation technique assures placement into the endometrium (similar to ICSI for placement of sperm into the oocyte). For the early embryo replacements, visually directed placement using minimum volume of transfer media, i.e. 5 μL, will minimize embryo migration and assure a reliable and correct placement onto the endometrium.

The technique is described as Subendometrial embryo delivery (SEED) or hysteroscopic endometrial embryo delivery (HEED) (Fig. 20.2). The procedure is performed without giving any anesthesia. The most common site for embryo delivery is the fundus of the uterine cavity. The methods provide for a more precise and reliable method of embryo transfer, in contrast to the current "blind" transfer techniques with and without the use of ultrasound. Once inside, the optimum position for embryo placement can then be visually determined. Under vision procedure makes the procedure replicable, more reliable and with more consistent or improved results.

The ultrasound guided ET requires simultaneous coordination of two professionals, the physician performing the transfer and the ultrasonographer. In addition, all transcervical and transmyometrial techniques involve "blind" introduction of the embryo(s) via transfer catheters (with limited

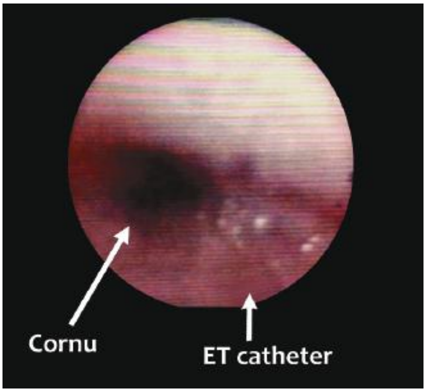


Fig. 20.2: Hysteroscopic view to the Figure 20.1 (*Courtesy:* Kamrava M)

flexibility of the tip) and subsequent release of embryo(s) onto the surface of the endometrium. In many cases the embryo fails to adhere or implant into the endometrium due to some luteal phase defect or due to some, as yet unclear, 'implantation window' problem. There is a significant risk that the embryo might be washed out of the cervix or may enter and get lodged in the fallopian tubes. Physicians tend to adopt the practice of transferring higher numbers of embryos back to the uterus to compensate for this potential conceptus loss.[11]

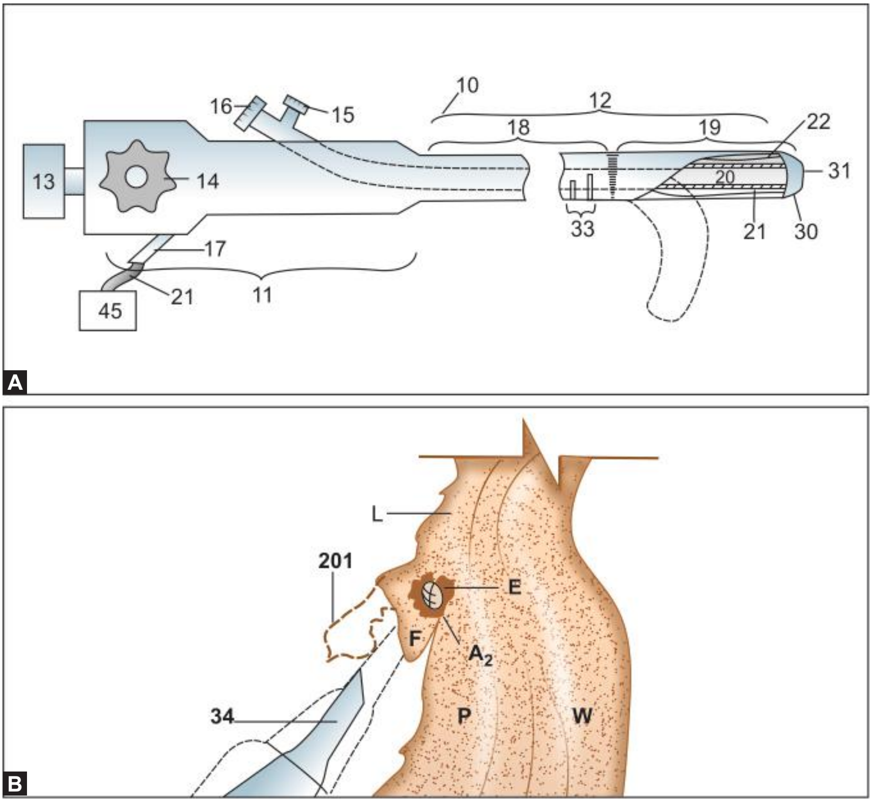
A possible drawback with the transcervical hysteroscopic embryo implantation (SEED) is the possibility of damaging and scratching the endometrium during the procedure. In this situation, the physician can choose a nonscratched portion of the endometrium for implantation even if there is an inadvertent trauma to the endometrium.[13] The endometrial damage is a much greater potential hazard of "blind" procedures.[14] The risk of disruption of the uterine lining is less in hysteroscopy technique than "blind" and ultrasound guided transfers due to the advantage of direct visualization of the uterine lining and not requiring movement of the catheter to facilitate identification during ultrasound.

In the study conducted by Michael Kamrava et al, 15 IVF cycles in 13 patients were completed. There were 8 hCG+ reports of > 5IU/ml eleven days after embryo implantation. There were 5 clinical pregnancies confirmed by the presence of a gestational sac at 5 weeks of gestation and heart beat at 6 weeks of gestation by ultrasound examination. A total of 3 first trimester spontaneous abortions occurred at 7 to 8 weeks of gestation. Healthy term babies were delivered by 2 patients of whom one patient had a spontaneous abortion in a previous implantation. No ectopic pregnancies were seen.[10] At a later study Kamrava et al showed that the technique of hysteroscopic endometrial embryo delivery (HEED) is very effective with both, the cleavage stage embryos and blastocyst transfer, including day 2 embryos (Figs 20.3A and B).[11]

In a recent interview at the ASRM meeting Dr Kamrava has further reported their experience with 150+ SEED procedures where their center achieved a 70 percent higher pregnancy rate in comparison with the blind procedure which was the norm earlier. The average pregnancy rate was 18 to 20 percent from all patients (all ages and all causes of infertility), which increased with SEED to 34 to 35 percent. Interestingly the ectopic pregnancy rate was 0.[12]

SUMMARY

Hysteroscopic embryo implantation on day 5 seems to be a promising procedure to increase the pregnancy rates and pregnancy outcomes in ART. Transferring day 5 embryos ensures the quality of embryos and also mimics the natural cycle in respect to implantation, thus preventing loss of embryos and ectopic pregnancies. Hysteroscopic transfer decreases the chances of disrupting the endometrial lining and visualization allows one to place the embryo at a different location if trauma ensues. Increased cost is definitely



Figs 20.3A and B: (A) Hysteroscope with flexible tip; (B) Subendometrial implantation of embryo (Kamrava M, et al)

a drawback, but utilizing a hysteroscope with an objective and replicable procedure that improves results will decrease the overall costs from multiple failed IVF-ET attempts and improve patient satisfaction.

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CHAPTER 21

Complications of Hysteroscopic Surgery

Rajesh Modi, Geeta Bhusari

In hysteroscopy, as in any other surgical techniques, there is a risk of complications. These complications have reduced significantly over the years due to improved equipment, better understanding of the risk factors, proper training and better experience of the operating surgeons.

These complications can be described as follows:
1. *Distention media related:* Saline/glycine
2. *Mechanical:* Cervical/endometrial/uterine perforation/bleeding
3. Electrocautery complications.
4. Anesthesia complications.
5. Late complications.

COMPLICATIONS OF DISTENDING MEDIA

Distention of the endometrial cavity is necessary to create a viewing space for visual diagnosis and for the performance of surgical procedures. Presently, the media used for distention are saline and 1.5 percent glycine. The media choices at one time included CO_2 gas, high-viscosity 32 percent dextran 70, and several low-viscosity fluids, including nonelectrolytic solutions of sorbitol, mannitol and dextrose in water, and electrolyte-containing isotonic solutions such as normal saline.

For diagnostic and simple procedures, this is rarely a concern but, during many operative procedures, glycine or saline can gain access to the systemic circulation if the integrity of the uterine vasculature is breached. In the extreme, fluid overload may occur, and electrolyte disturbances typically result. Large volumes of distending media can quickly enter the systemic circulation, particularly when myometrial dissection results in the transection of larger veins.

The so-called low-viscosity media, i.e. 1.5 percent glycine, and some others not commonly in use, can be used when electrosurgery is to be performed using monopolar instruments, because they are nonionic, and, therefore, do not disperse current. However, these hypo-osmolar, electrolyte-free media can create fluid and electrolyte disturbances if absorbed in excess. Patients can develop hypervolemia, severe hyponatremia (Table 21.1), and decreased osmolarity. This manifests in right heart failure, and pulmonary and cerebral edema with resulting death.

Aqueous intoxication is seen in 0.2 to 6 percent of cases. It involves rapid intravascular absorption of glycine through exposed venous sinuses, causing dilutional hyponatremia, acute fluid overload, high blood pressure and reflex bradycardia. This is followed by hypotension, nausea, vomiting, headache, visual disturbance, agitation, confusion and lethargy. It can present intra or postoperatively. The severity depends on amount of fluid absorbed which in turn is related to the number of vascular apertures, duration of procedure and the flow pressure being used. After about 85 minutes the glycine moves to the interstitial space and causes hypo-osmolar hyponatremia. The free water then moves to the interstitial space and then to the intercellular space in order to achieve a balance. This can cause pulmonary edema and cerebral edema which might be life-threatening.

Gylcine is metabolized into glyoxylic acid and ammonia. Higher concentration of ammonia in the brain decreases the visual acuity. Glyoxylic acid forms oxalate, hence glycine use is contraindicated in patients with renal failure.

Preoperative Prevention

The volume of systemically absorbed distention media may be reduced with the preoperative use of GnRH analogs. Another approach that can be used immediately before cervical dilation is the preoperative administration of dilute vasopressin 8 ml (0.1U/ml) injected deeply about 4 and 8 o'clock in the cervix.

Intraoperative Fluid Media Management

Before undertaking a procedure using the resectoscope, baseline serum electrolyte levels should be measured. Women with cardiopulmonary disease should be evaluated carefully for shifts in fluid volume. Absorbed volumes tolerated by healthy women may be catastrophic in the context of compromised cardiac function.

The extent of systemic intravasation can be reduced by operating at the lowest effective intrauterine pressure (50–80 mm Hg), always trying to keep this at less than the mean arterial pressure, and completing the procedure as quickly as possible.

There is also evidence that use of bulk vaporizing electrodes is associated with reduced systemic absorption compared with the resection loops, apparently because of the greater degree of electrocoagulation (and resultant collateral vessel sealing) associated with bulk vaporization.

Detection of impending excess systemic absorption can prevent fluid overload.

Measurement of fluid inflow and outflow should take place in a closed system to allow as precise a calculation as possible of the absorbed volume.

If an automated system is not available, the volume should be measured and the deficit calculated every 5 to 10 minutes. If the deficit reaches a predetermined limit (which, depending on the patient's baseline status, could be 750–1500 ml), serum electrolytes are measured and furosemide is given intravenously, in a dose of 10 to 40 mg, depending on renal function. Should the serum sodium decrease to < 125 mEq/L, or should the deficit reach 1500 to 2000 ml, the procedure is expeditiously terminated.

Table 21.1: Hyponatremia

Serum Na^+ level	*Symptoms*	*Treatment*
135–145	Normal	Nil
120–135	Restlessness	Oxygen Inj. Furosemide 40–60 mg IV 0.9% normal saline
110–120	Nausea, headache, confusion, cardiac irregularities	Ventilator support if pulmonary edema Inj. Furosemide 1 mg/kg 4–6 hourly 3% hypertonic saline
< 110	Arrhythmia, convulsions, severe hypotension, coma and death	

Postoperative management of clinically significant fluid and electrolyte disturbances should involve the support of a critical care unit. Patients may manifest with one or a combination of cerebral edema, pulmonary edema, and right heart failure and could require ventilator support, the use of diuretics and inotropic agents, and the judicious administration of hypertonic saline solutions.

MECHANICAL COMPLICATIONS

The most commonly encountered complications are cervical laceration and perforation of the uterus, the latter resulting in premature termination of the procedure. They occur in diagnostic hysteroscopy as well as operative hysteroscopy.

Cervical Lacerations

Occurs due to excessive traction on cervix by tenaculum or clamp or when cervix is forcefully dilated. Nulliparity, menopause and cervical hypoplasia are some of the predisposing factors. Dilatation itself can also cause bleeding from the cervix. Diagnosis is usually easy and immediate. If the bleeding is less, treatment is expectant. Sutures can be placed if necessary.

In difficult cases like stenosed cervix, the preoperative preparation of cervix with prostaglandin gel or vaginal misoprostol (200 microgms) kept 2 hours prior to surgery is extremely helpful. Misoprostol may be ineffective as a cervical ripening agent in postmenopausal women, but the addition of systemic estrogen for two weeks before the procedure may provide results similar to those reported for premenopausal patients.

If cervical stenosis is encountered, and misoprostol have not been used or were ineffective, deep intracervical injection of dilute vasopressin (0.05 U/ml to 0.1U/ml, 4 ml at 4 and 8 o'clock on the cervix) also substantially reduces the force required for cervical dilation. Care must be taken to prevent systemic injection as it can result in severe cardiorespiratory complications.

In cases of previous access failure, adhesions or synechiae in the canal frequently exist. In such instances, the use of mechanical scissors passed through the operating channel can be used to divide the adhesions under direct vision.

Endometrial Lesions and False Passage

This occurs during dilatation of the cervix, without actually perforating the uterus. Menopause, stenosed cervix, acute retroflexion are the predisposing factors. The use of a smaller diameter office hysteroscope is extremely helpful in diagnosing the problem on table and preventing a perforation. Difficult dilatation and bleeding from the cervix are the warning signs. Avulsion of the endometrium is usually of no consequence and can be left alone (Figs 21.1 to 21.7).

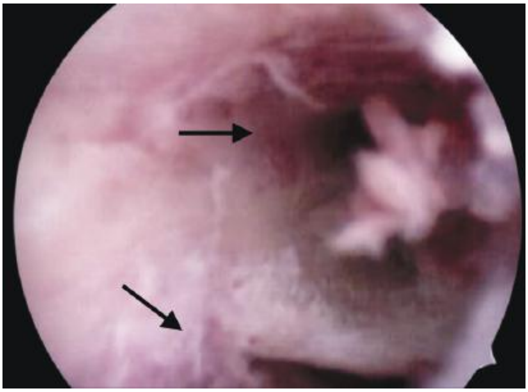


Fig. 21.1: False passage 1

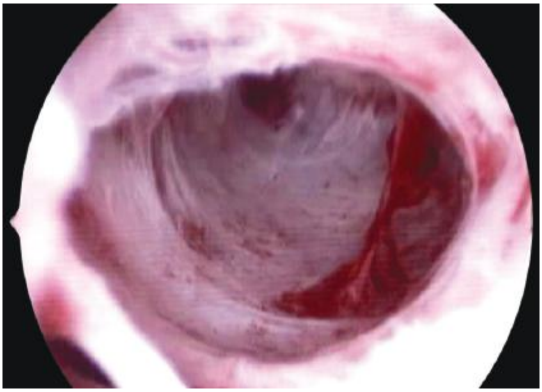


Fig. 21.2: False passage 2

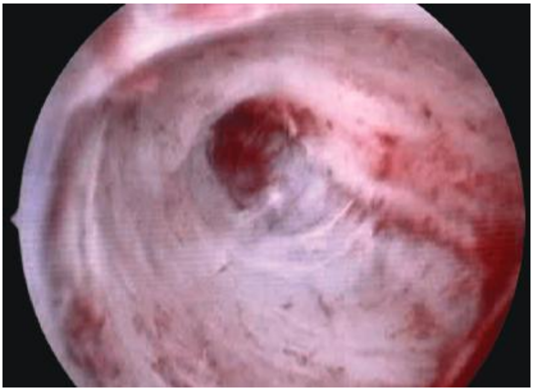


Fig. 21.3: False passage 3

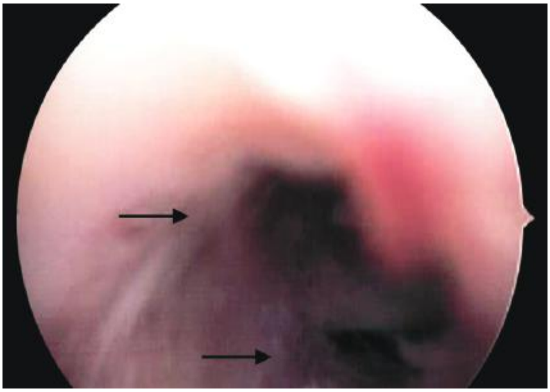


Fig. 21.4: Normal cervical canal

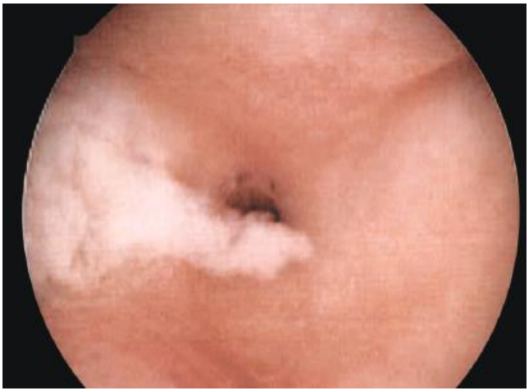


Fig. 21.5: Normal cavity

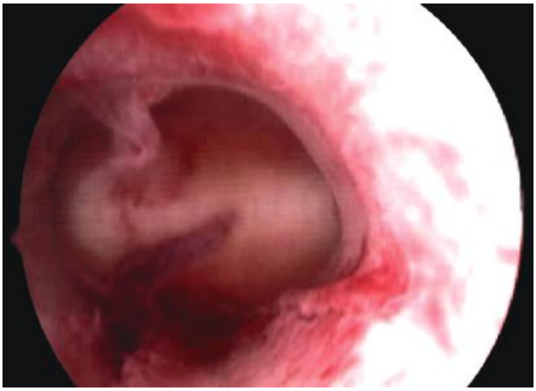


Fig. 21.6: Dilator trauma to anterior wall endometrium

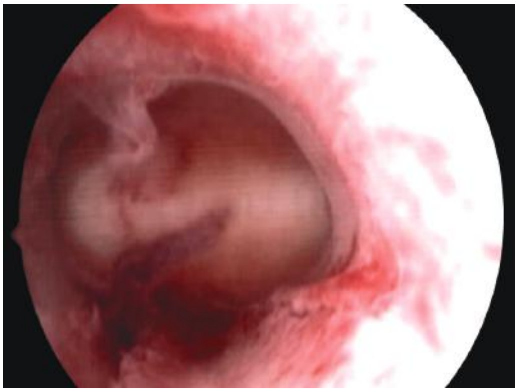


Fig. 21.7: Dilator trauma to posterior wall endometrium

Uterine Perforation

Perforation can occur during dilatation of cervix and inserting hysteroscope. The predisposing factors are acute ante or retroversion of uterus, cervical stenosis, uterine synechia, endometrial malignancy, uterine malformation. It is suspected when there is sudden loss of distension despite proper distention medium pressure and flow or when intestinal loops or omentum is seen. The procedure should be stopped immediately. If perforation is of small caliber and is not caused by cutting or electric current the management is expectant. The patient should be observed for signs of hemorrhage. Tachycardia and hypotension indicates ongoing hemorrhage. In such cases laparoscopy should be done and bleeding stopped by endocoagulation or sutures. Broad spectrum antibiotics should be given and hysteroscopy can be repeated after 6 weeks (Figs 21.8 to 21.12).

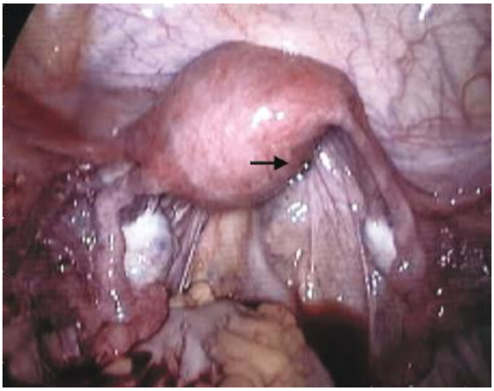


Fig. 21.8: Perforation by dilator

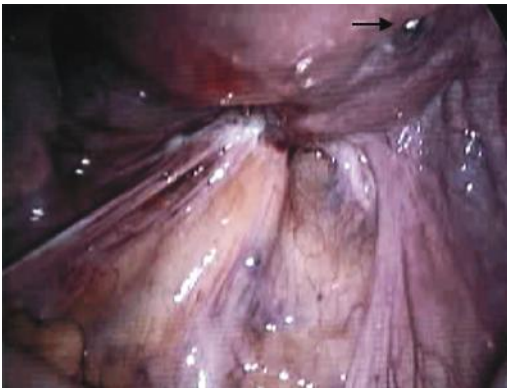


Fig. 21.9: Perforation assessed

Fig. 21.10: Perforation

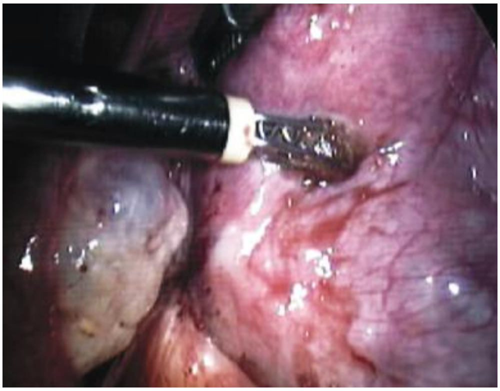


Fig. 21.11: Perforation coagulated

Fig. 21.12: Perforation hemostasis confirmed

Bleeding

Bleeding is infrequent in hysteroscopy. It may still be reduced by preoperative GnRH analogs or the intraoperative (just before cervical dilation) injection of diluted vasopressin into the cervical stroma. Intraoperative bleeding can be reduced by temporary increase of the intrauterine pressure, which may reduce the blood flow sufficiently to improve visualization and allow using ball electrode for coagulation. Intractable bleeding may respond to the injection of diluted vasopressin. Postoperative bleeding usually stops by itself. If needed, a Foley catheter is inserted into the uterine cavity and the balloon inflated to 30–50 mL. This is then removed after 6 hours.

ELECTROCAUTERY COMPLICATIONS

Thermal injury can occur to intraperitoneal structures, especially bowel, if an activated electrode perforates the myometrium and serosal surface. This injury could also occur without perforation if bowel was adherent to the serosal surface and deep myometrial resection is used specially in the region of uterine cornua. Injury may also occur at the site of placement of the patient plate if it is improperly placed or dislodged. Rarely, with monopolar instrumentation, current diversion may occur, causing injury to cervix, vagina, or vulva through the speculum or the tenaculum.

Overzealous use of resectoscope and current may cause irreversible damage to endometrium, resulting in inadequate growth of the endometrium in subsequent cycles, adhesion formation with fibrosis.

Secondary bleeding from the uterus may happen due to excessive coagulation of the tissues resulting in the dead tissue getting infected and sloughing off (Figs 21.13 and 21.14).

Prevention

The following principles serve to reduce the risk of electrosurgical injuries.

First and foremost, the footswitch should not be placed in a location which may result in accidental activation of the current.

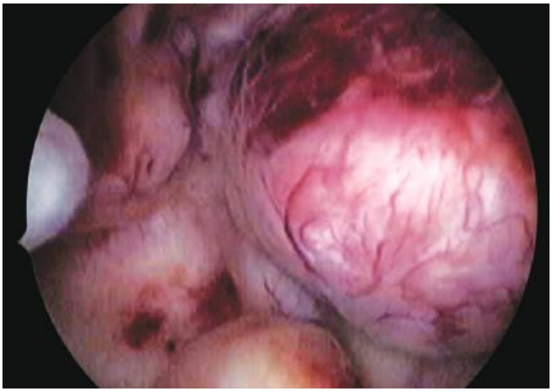


Fig. 21.13: Submucous fibroids

Fig. 21.14: Submucous fibroids removed excessive coagulation

Operate using a bipolar resectoscope, because with these instruments there is no opportunity for current diversion.

The patient plate (monopolar resectoscopes only) should be securely affixed to the patient.

It is safer to use low-voltage (cutting) current, minimizing the use of high-voltage (coagulation) current, because such waveforms facilitate these complications.

One sign of current diversion is the absence or reduction of the electrosurgical effect. Following determination that power to the ESU and connections in the circuit are intact, the temptation is often to increase the generator output. Care should be taken to ensure that potentially traumatic current diversion is not taking place. Any metallic object, such as a vaginal speculum or a cervical tenaculum, also can, following contact with the external sheath, serve to conduct current to locations in the vagina and vulva. Care should be taken to avoid contact of these instruments with the resectoscope.

ANESTHESIA COMPLICATIONS

Local Anesthesia

Common problems that are associated with the use of local anesthesia for hysteroscopic surgery are anxiety, vasovagal reaction and pain. To alleviate anxiety it is important to create a relaxed setting and good communication between surgeon and patient.

Traction and dilatation of cervix may trigger a vasovagal reaction. Patient feels unwell and there is hypotension and bradycardia. These can be prevented by giving atropine 0.6 mg IM approximately 30 minutes before the procedure.

Pain results from dilatation of cervix beyond Hegar 5 to 6 and also from over distention of uterine cavity. This can be diminished by preoperative administration of analgesic rectal suppository and using local anesthetic for paracervical block.

Local anesthetic agents rarely cause adverse drug reactions. If there is a rapid absorption from the injection site or accidental intravascular injection has taken place, the cardiac effect is manifested as bradycardia, cardiac arrest, shock or convulsions. Treatment is IV atropine 0.5 mg and adrenaline with cardiac resuscitation.

General Anesthesia

It should always be administered with continuous positive pressure respiration and endotracheal tube or a laryngeal mask.

LATE COMPLICATIONS

Infection

Infection of the endometrium or myometrium following hysteroscopic procedures is rarely encountered. It occurs more commonly in women with history of PID. Endometritis may present in before the hysteroscopic procedure. Patient usually presents with pain, odorous discharge, fever, and tenderness on manual examination of the uterus. Treatment is oral antibiotic cover for 14 days with vaginal pessary.

Hematometra

This occurs if there is obstruction of the internal os secondary to intrauterine adhesions due to hysteroscopic surgery. To prevent this, isthmus region and cervical canal should be avoided during resection.

Intrauterine Adhesion

Due to excessive resection. Prevention is by using cyclical hormonal tablets to facilitate the growth of the endometrium. Intrauterine devices can also be placed to prevent adhesion formation.

Uterine Rupture and Placenta Accreta

May occur in pregnancy postablation.

Complications Related to Patient Positioning

Acute Compartment Syndrome

Use of the dorsal lithotomy position has been associated with the development of a postoperative compartment syndrome in the lower legs. Compartment syndrome occurs when the pressure in the muscle of an osteofascial compartment is increased to an extent that compromises local vascular perfusion. This period of ischemia is followed by reperfusion, capillary leakage from the ischemic tissue, and a further increase in tissue edema in an ongoing cycle that ultimately results in neuromuscular compromise that can cause rhabdomyolysis and serious sequelae including permanent disability.

Neurologic Injury

The principal motor nerves arising from the lumbosacral plexus (T12 to S4) are the femoral, the obturator, and the sciatic nerves. Injury to one or more of these nerves can occur in association with hysteroscopic surgery as it is performed in the lithotomy position, the risk of neurologic injury increases with prolonged operative time.

Femoral neuropathy occurs secondary to one or a combination of excessive hip flexion, abduction, and external hip rotation that contribute to extreme angulation (>80) of the femoral nerve beneath the inguinal ligament and resulting nerve compression.

The sciatic and peroneal nerves are fixed at the sciatic notch and neck of the fibula respectively, making them susceptible to stretch injury. Two orientations create maximal stretch at these points: flexion of the hip with a straight knee, which essentially positions the entire leg vertically; and extreme external rotation of the thighs at the hip. The sciatic nerve can also be traumatized with excessive hip flexion. The common peroneal nerve is injured if there is excessive pressure over the head of the fibula from, for example, a stirrup, neural injury results in foot drop and lateral lower extremity paresthesia.

Dissemination of Tumor Cells

There is no evidence that hysteroscopic surgery displaces fragments of endometrium into the peritoneal cavity and cause endometriosis or causes metastasis of endometrial carcinoma cells. However, hysteroscopy is contraindicated in proven cases of cervical or endometrial malignancy.

CHAPTER 22

Newer Developments in Hysteroscopy

Piyush S Goyal

Visual examination of the uterine cavity and contextual operative facilities have provided the gynecologist with the perfect 'diagnostic' tool, making it possible to examine the cavity and biopsy suspected areas under direct visualization.

NEW DEVELOPMENTS IN AMBULATORY HYSTEROSCOPIC SURGERY

In the last decade, advancements have been made in hysteroscopic techniques, instrumentation and indications. Vaginoscopic hysteroscopy is performed without medication, cervical dilation and use of vaginal speculum or cervical tenaculum. To prevent complications during uterine access, both misoprostol and laminaria are equally effective for cervical priming. The use of normal saline to distend the uterus prevents hyponatremia, but hypervolemia may still be a major problem. Irrigant fluid deficit is best monitored by automated devices. Bipolar electrosurgical systems do not require dispersive return electrodes and do not generate stray currents, thus minimizing the risk of electrical burns. Tissue debulking and extraction are facilitated by vaporizing electrodes or morcellators. Hysteroscopic indications have expanded to include diagnosis and treatment of missed abortion, and cervical and interstitial pregnancies. The most important advancement of hysteroscopy has been proximal tubal access for sterilization.

Office Hysteroscopy and Compliance: Mini-Hysteroscopy versus Traditional Hysteroscopy

The technological advances made in recent years—for example the introduction of small-diameter hysteroscopes—have brought about remarkable progresses in the field of office hysteroscopy, even though large-diameter instruments are still widely used. It has been a constant endeavor to diminish the level of pelvic pain or discomfort felt by the patient during office hysteroscopy in order to make this procedure acceptable, well tolerated and 'pain-free'.

The use of mini-hysteroscopes (3.3 mm) (Fig. 22.1) has brought about a small revolution in hysteroscopy by lowering the level of pelvic pain the patients feel. It has been halved compared with traditional caliber hysteroscopes; hence the invasiveness of the examination is also reduced.

The image quality provided by the mini-endoscope with a lens system (2.7 mm) is almost as high as that of the traditional hysteroscopic optics (4 mm) in terms of luminosity, outline definition and width of the visual field.

However, the use of mini-optics does not allow a good observation of the uterine cavity. Actually the diameter of the instrument is too small for the specific anatomic conditions of the uterus: a wide open cervical canal, a notably thickened endometrium, and the presence of blood inside the uterine cavity. In these cases, a greater optical lens (5 mm) should be used to satisfactorily bring the examination to an end.

The advantage of using mini-optics is self-evident if we consider the patient's compliance—in most examinations only a slight pain or simply a feeling of discomfort during or at the end of the examination is felt by the patient which is comparable to the level of pain felt during transvaginal ultrasound. Sometimes the worst discomfort is linked only to the introduction or withdrawal of the speculum. The use of mini-optics entails a suitable pre-training with traditional hysteroscopic optics, which is certainly more indicated to acquire the necessary operative skills and the correct spatial orientation. Another limitation to the use of mini-optics is its high costs—even though the initial costs do not differ very much, mini-endoscopes are more delicate and wear out more easily than large-caliber instruments, thus requiring more frequent substitutions.

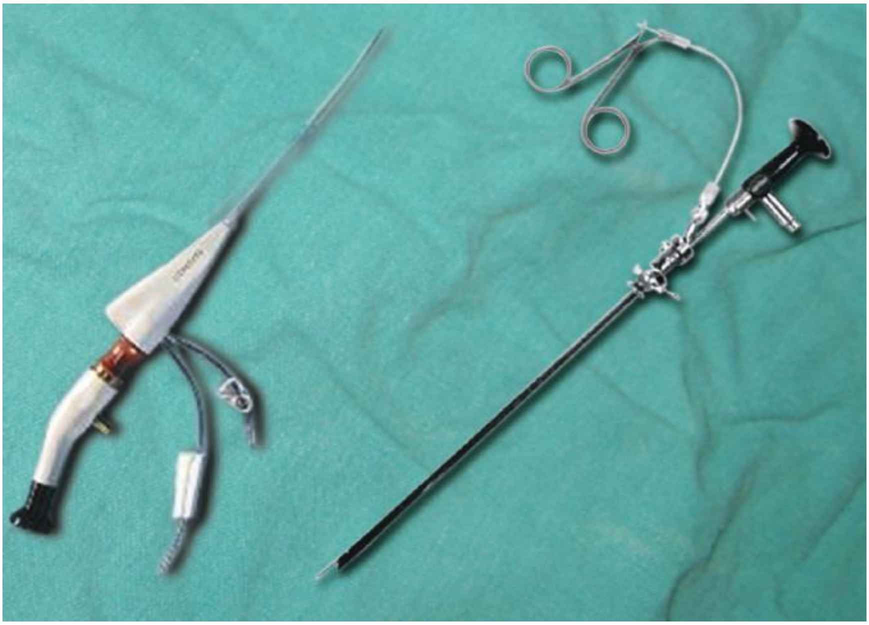


Fig. 22.1: Versascope and Bettocchi office hysteroscopes

Flexible Mini-Hysteroscope with a Controlled 90° Bendable Tip for Vision-guided Endometrium Biopsy

Evaluation of the uterine cavity is limited with rigid 5 mm hysteroscopes because of the need for cervical dilatation, reduced movements inside the uterus, and no option for vision-guided biopsy. After defining requirements, a novel, thinner, and more flexible mini-hysteroscope, 18 cm long with a 2.67 mm outer diameter, was developed with straight 0° scope, 70° vision field, and 6000-pixel resolution. Two working channels, 1.2 mm and 0.55 mm, allow suction-irrigation and introduction of a 1.0 mm biopsy forceps or cytology brush. The tip of the instrument is 90° stageless bendable to both sides.

This new flexible mini-hysteroscope is less invasive compared with standard rigid hysteroscopy, which supports performance of ambulatory hysteroscopy and makes increased movements and vision-guided biopsy inside the uterine cavity possible.

Operative Office Hysteroscopy

For the past three decades, gynecologists have been utilizing the hysteroscope in the office to diagnose a variety of conditions that can be responsible for symptoms such as abnormal uterine bleeding, recurrent miscarriage, infertility, and postmenopausal bleeding. The most common lesions found during diagnostic office hysteroscopy include cervical and uterine polyps, submucous myomata, uterine septae, intrauterine adhesions, endometrial hyperplasia and endometrial cancer.

Office hysterosocpic procedures that can be performed with a "mini" continuous flow hysteroscope (< 5.5 mm)—polypectomy, myomectomy, adhesiolysis, metroplasty, biopsy under direct visualization and tubal sterilization.

TECHNIQUE

Uterine Distention

When performing operative hysteroscopic procedures, it is best if a nonviscous, physiologic solution is used, i.e. saline or lactated Ringers as opposed to CO_2 gas.

Adequate distention pressures (50–70 mm Hg) can be achieved in the office by the use of gravity or a pressure bags. Most office based procedures are of short duration and no more than 2 liters of solution should be utilized.

UTERINE ACCESS

Standard Approach

The standard access approach to the cervix involves placing a speculum within the vagina (preferably side opening), placing single tenaculum on the anterior lip of the cervix, injecting the cervix with local anesthesia (if necessary), and placing the rigid continuous flow hysteroscope within the cervical canal. In most patients, including nulliparous and postmenopausal patients, it is not necessary to dilate the cervix prior to insertion.

Vaginoscopic Approach

The vaginoscopic approach involves placement of the hysteroscope into the vagina without using a speculum. The scope is guided into the posterior fornix of the vagina while the fluid is on in order to create vaginal distention. The hysteroscope is slowly withdrawn until the cervix is identified. The hysteroscope is visually guided into the cervical canal without the use of a tenaculum. When using an oval shaped hysteroscope system such as the Karl Storz-Bettocchi system, it is often advantageous to rotate the scope 90° to assist with insertion into the uterine cavity. Utilizing the vaginoscopic approach, it is typically not necessary to place a paracervical anesthetic block.

Techniques

Hysteroscopic polypectomy: Either using the standard approach or the vaginoscopic approach, the rigid hysteroscope is inserted into the cervical canal or the fluid distention flow is begun. Under direct visualization, the hysteroscope is advanced into the uterine cavity using an atraumatic approach (Figs 22.2A to E).

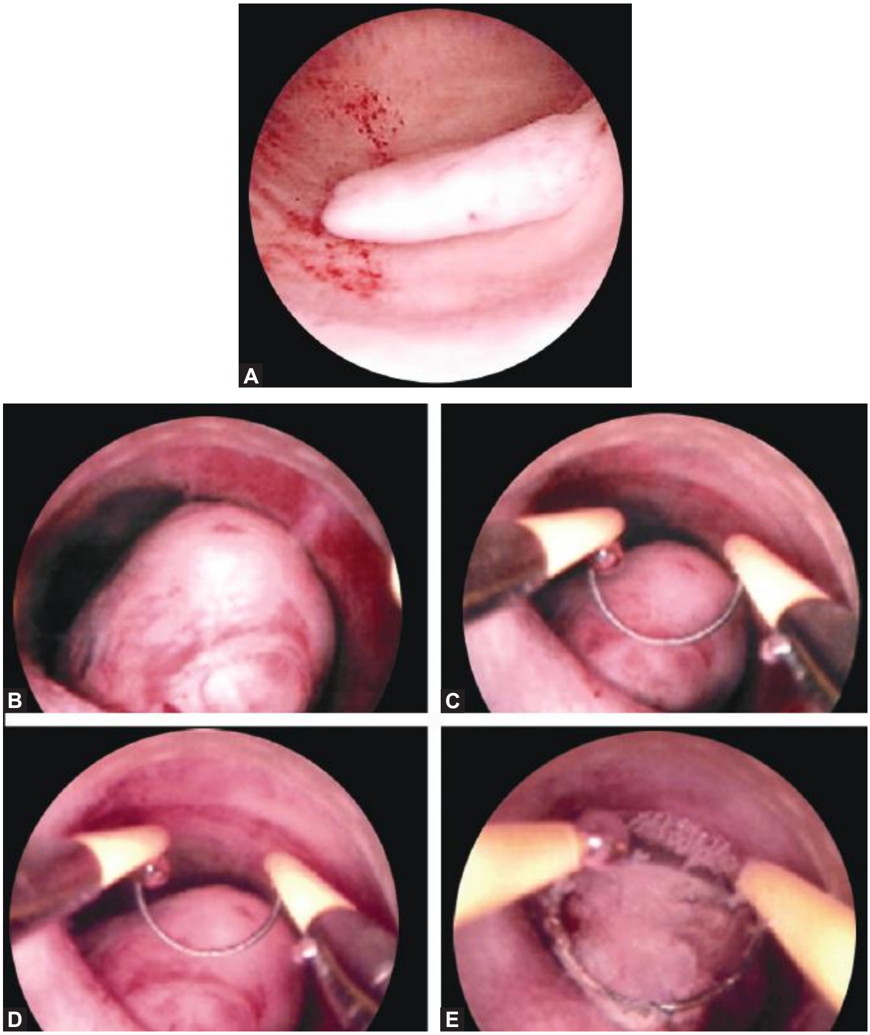
A complete survey of the cavity should include visualization of both tubal ostium and a panoramic view from the cervix in order to locate all pathology.

Polyps with a narrow base are the most ideal to remove with the mini-hysteroscopes. While it is tempting to grasp the base of the poly with the grasping forceps, it is often more difficult to twist off at the base than anticipated. It is easier to cut the base of the polyp with scissors and grasp the polyps with the grasping forceps. The polyp cannot be removed through the narrow 5 to 7 Fr working channel so the entire hysteroscope system should be removed while pulling the polyp through the cervical canal.

Hysteroscopic myomectomy: Because of the consistency of most fibroids, they are not easy to remove through an undilated cervix even if they are detached from the endometrium or myometrium (Figs 22.2A to E).

Vaporizing small myomata with a bipolar electrode (Versapoint). This technique does not require fibroid chip removal. This is a 5 Fr instrument that can be placed through a mini-hysteroscope. As well, physiologic distention media is utilized because of the bipolar RF energy used to vaporize the myoma.

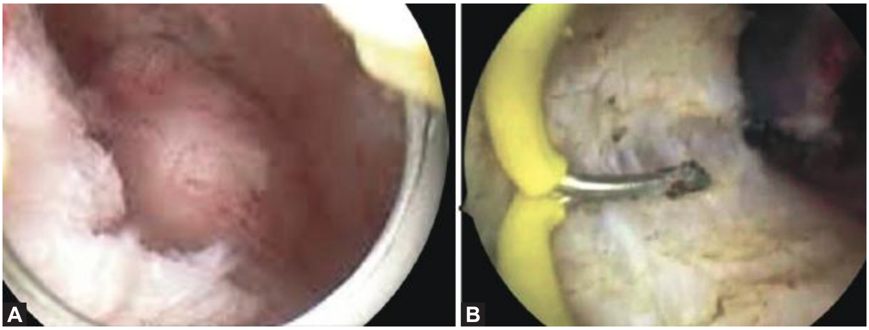
Hysteroscopic adhesiolysis: Because intrauterine adhesions are not innervated, it is painless to the patient when lysing intrauterine adhesions. The patient does complain of discomfort when the normal endometrium or myometrium are injured. Many surgeons prefer to use a monopolar or bipolar needle to cut intrauterine scar tissue. Because Asherman's syndrome patients are at high risk for uterine perforation and the fact that laparoscopy is not utilized in the office setting, only blunt tip or sharp tip scissors should be used to cut intrauterine scar tissue.



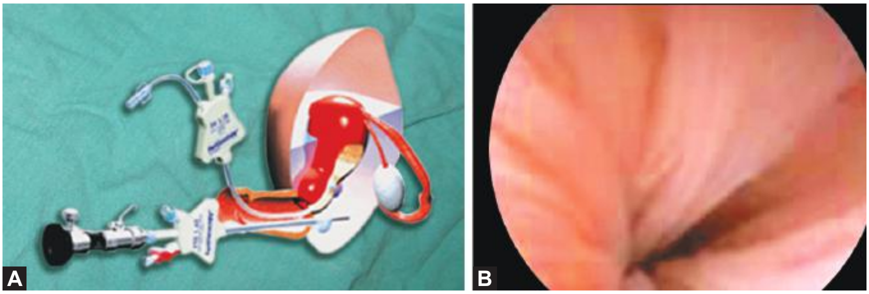
Figs 22.2A to E: Hysteroscopic polypectomy and myomectomy

The goal of the adhesiolysis procedure is to identify both tubal ostium and restore the uterine cavity to a normal shape and volume. Should a small perforation occur—loss of uterine distention will occur and the procedure should be discontinued.

Uterine metroplasty: Cutting a uterine septum with blunt or sharp tipped scissors is very similar to lysing intrauterine adhesions (Figs 22.3A and B). Prior to cutting the septum, both uterine horns should be explored and the tubal ostia identified. The scissors are used to cut the septum midway between the anterior and posterior uterine walls. The septum is cut until the fundus is reached or there appears to be normal vasculature within the septal tissue. No follow-up hysteroscopy is needed in these patients as it is rare to have scar tissue development in these patients.



Figs 22.3A and B: Hysteroscopic adhesiolysis and uterine metroplasty



Figs 22.4A and B: Fertiloscopy and salpingoscopy

ADVANCES IN THE ASSESSMENT OF THE UTERUS AND FALLOPIAN TUBE FUNCTION

Hysterosalpingo-contrast is a well-tolerated outpatient technique that provides a significant amount of information of relevance to the infertile woman that is not obtainable at hysterosalpingogram (HSG) whilst avoiding exposure to X-ray irradiation. When performed by experienced operators, it serves as a valuable, first-line screening test for the more invasive procedures of laparoscopy and dye chromopertubation and hysteroscopy. If detailed diagnostic information is required in women in whom there is no clinical or ultrasound evidence of pelvic pathology, the surgical technique of fertiloscopy can be considered to be appropriate. This technique permits confirmation that the ovum pick-up mechanism is normal, the tubes are patent and the uterine cavity is normal, while salpingoscopy and microsalpingoscopy permit the assessment of the tubal lumen (Figs 22.4A and B).

NIGO DEVICE: A NEW TECHNIQUE TO OBTAIN ENDOMETRIAL DIRECTED BIOPSY DURING SONOHYSTEROGRAPHY

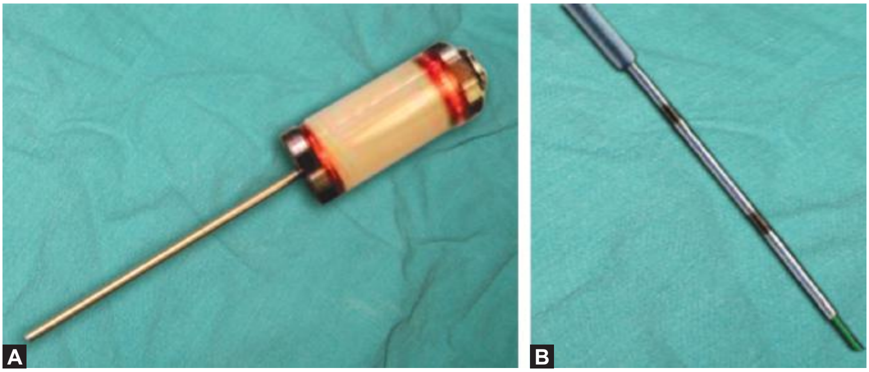
The primary goal of the clinical evaluation of abnormal uterine bleeding is to establish a specific diagnosis in the most efficient and least invasive manner possible. Hysteroscopy (HS) allows physicians to obtain directed biopsy in addition to direct visualization of the uterine cavity and lesions, but often requires ambulatory surgery centers and some anesthesia, or can potentially result in significant patient discomfort. Sonohysterography (SHG) is less invasive than HS but does not allow a histologic sample. A new technique, called the Nicoletti-Gorlero (NiGo) device, was developed and evaluated to obtain histologic results during SHG. The NiGo device technique allows the physician to obtain sonographic-guided biopsies of the entire endometrium during SHG. The technique is less invasive compared with hysteroscopy.

ROLE OF CONTACT HYSTEROSCOPY

Contact hysteroscopy has been replaced by a new technique based on the use of a special hysteroscope. The instrument was designed to study the squamo-columnar junction and the lesions of the portio. A new technique, endometrial dating, uses the Hamou hysteroscope to study endometrial physiology. In endometrial dating, a new pattern, the pseudofunctional dysvascular endometrium (PFDE), has been discovered which seems to pertain to uterine bleeding. PFDE syndrome occurs in the presence of dysfunctional uterine bleeding. Contact microhysteroscopy is a reliable diagnostic procedure, and should be considered part of diagnostic hysteroscopy, not an independent technique (Figs 22.5A and B).

NEW METHODS FOR TRANSCERVICAL CANNULATION OF THE FALLOPIAN TUBE

Technological advances have led to major improvements in the design and application of fallopian tube cannulation devices using the transcervical approach. Presently such cannulation systems are being used to overcome infertility disorders. These transcervical access systems are now able to displace debris that may block the tube, break down intraluminal adhesions or place egg, sperm or embryos in the tube to facilitate conception. Conversely, these same or modified devices could be used to place sclerosing agents or occlusive devices within the fallopian tubes using similar transcervical access



Figs 22.5A and B: Contact hysteroscope and cornual cannulation catheter

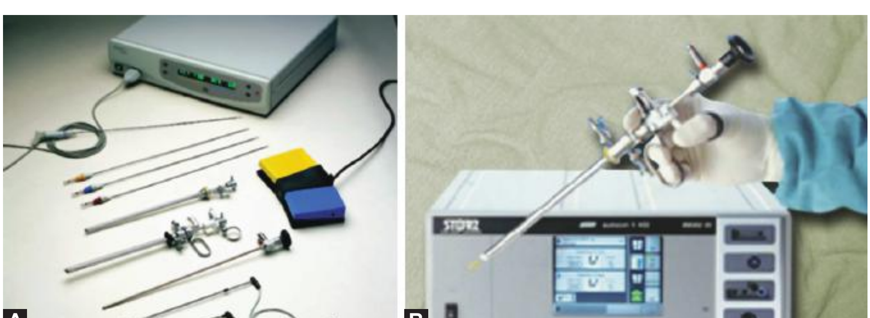
technology. Transcervical delivery systems incorporating a very fine endoscopic fiber have also been developed to visibly assess the inside lumen of the Fallopian tube using a transcervical approach. Such a system could be used to accurately identify specific sites in the tube for placement of such devices. The potential for placing permanent or temporary devices in the tube and the option of reversible sterilization may become a possibility in the future. One of the biggest obstacles against a wide distribution of these devices, particularly in third world countries, will be cost and the relative technical complexity in using them. These factors will need to be addressed more carefully in assessing the overall strategy of population control. The pressure on governments and international agencies to place more resources into population control may facilitate the accelerated development, application and cost containment of these new devices and delivery systems.

RECENT ADVANCES IN ELECTROSURGERY—VERSAPOINT TECHNOLOGY

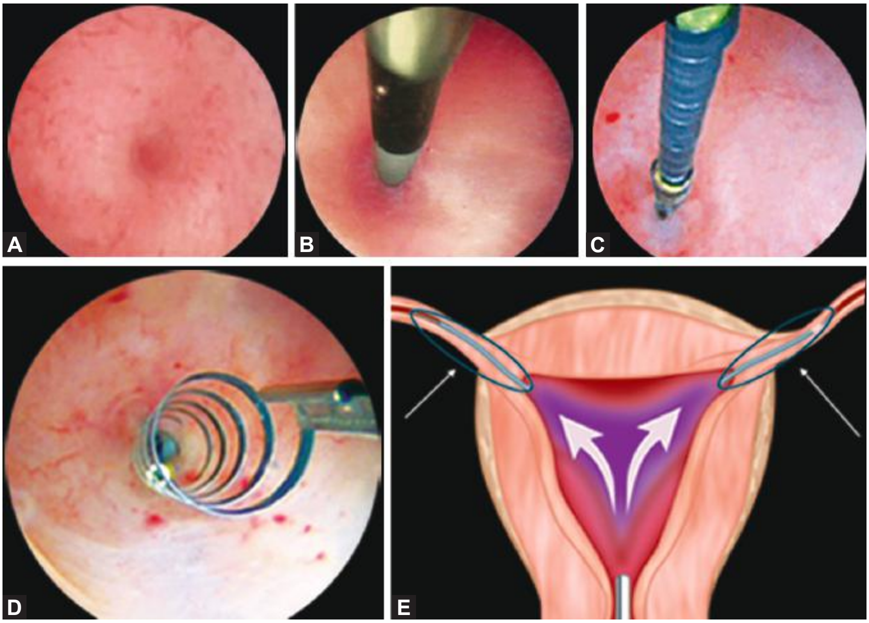
Electrosurgery is the generation and delivery of an alternating current between an active and a return electrode in order to raise the tissue temperature for the purposes of desiccation and cutting. The tissue effect achieved is dependent on a number of factors, which include peak voltage, the frequency of the alternating current, modulation, type of tissue, shape of the electrode and the time energy is applied for. In operative hysteroscopy, the energy source and the distention medium used are closely linked. The use of a cheaper and more versatile electrosurgery generator instead of laser energy has been offset by the risk of serious complications resulting from the use of nonionic distention media. Versapoint bipolar technology has combined Electrosurgery with a safer distention medium, saline (Figs 22.6A and B).

ADVANCES IN HYSTEROSCOPIC STERILIZATION

Hysteroscopic sterilization performed in the outpatient setting avoids the risks and discomfort associated with the laparoscopic procedure. A variety of techniques has been assessed and discarded, mainly because of poor



Figs 22.6A and B: Bipolar resectoscope systems



Figs 22.7A to E: Hysteroscopic tubal occlusion device—(A) Ostia visualized; (B) Delivery catheter postioned; (C) Release catheter gold band; (D) Micro-insert positioned; (E) Micro-inserts in place during HSG

efficacy. More recently, the Essure® procedure has been shown to be easy to perform, acceptable to women and highly effective at five-year follow-up. However, concerns remain about the absolute irreversibility of this method of sterilization. Other devices in development may prove to be equally effective but reversible (Figs 22.7A to E).

OFFICE HYSTEROSCOPIC TUBAL OCCLUSION WITH SILOXANE INTRATUBAL DEVICES (OVABLOC® METHOD)

The Ovabloc® method for female sterilization can be used in an outpatient setting. This method should be offered to women with (relative) contraindications for laparoscopic sterilization such as severe obesity, extensive pelvic adhesions or anesthetic risks.

NEW GUIDELINES FOR DISTENTION MEDIA

To reduce complications due to fluid overload, I recommend that surgeons:

- Draw preoperative serum electrolytes for a baseline in all patients.
- Place a fluid-collection drape or a larger, plastic cover with the bottom cut-off under the patient's buttocks so that fluid drains into a "kick" bucket. Also adjust the resectoscope's outflow tubing to drain into the collection bag.

Figs 22.8A and B: Fluid management system—suction irrigation tubings with endomat

- Continuously record inflow and outflow using the electronic monitor with the deficit alarm set to 500 mL.
- Keep distention fluid at room temperature and monitor the patient's core temperature continuously. Significant fluid intravasation will lower the patient's temperature, and this may be the first sign of fluid overload.
- Perform operative hysteroscopy under spinal or epidural anesthesia so the anesthesiologist can continually assess the patient's sensorium. Confusion and irritability are early signs of dilutional hyponatremia.
- If the fluid deficit reaches 750 mL, immediately give 20 to 40 mg of intravenous furosemide and draw a serum sodium. Do not wait for the result of the sodium level before treatment, since a 5 to 20 minute delay can be catastrophic.
- Interrupt the procedure for 5 to 10 minutes to allow the uterus to contract and to seal off small blood vessels.
- Discontinue the procedure if the fluid deficit reaches 1,500 mL or if the serum sodium level is below 125 mEq/L (Figs 22.8A and B).

HYSTEROSCOPIC MORCELLATOR

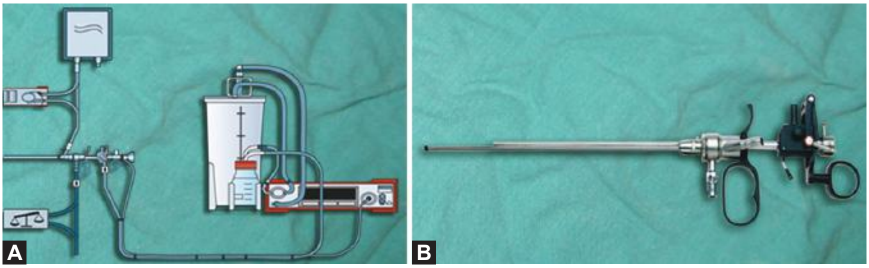
The new hysteroscopic morcellator (HM) (Fig. 22.9) has a 4 mm blade, consisting of a rigid inner tube which rotates within an outer tube. The blade is inserted into an electrically powered control unit which connects to a handheld motor drive unit. A foot pedal activates the blade and regulates the direction of rotation of the internal blade tube. The direction can be oscillating or continuous, with the optimal number of rotations per minute being 750 or1, 100, respectively. The rotary morcellator is recommended for polypectomy and the reciprocating blade for myomectomy.

The hysteroscopic morcellator is a fast technique for removal of smaller type 0 and 1 myomas, as well as larger polyps. The HM beholds some advantages over monopolar resectoscopy. The use of saline solution prevents hyponatremia, although meticulous measurement is indicated to prevent excessive absorption and fluid overload.

Disadvantages of the Hysteroscopic Morcellator

First, the inability to coagulate bleeding vessels encountered during surgery might be disadvantage.

Fig. 22.9: Hysteroscopic morcellator



Figs 22.10A and B: Resection Master with automatic chip aspiration

RESECTION MASTER WITH AUTOMATIC CHIP ASPIRATION

The resectoscope is considered worldwide to be the “gold standard” in the therapy of intracavitary myomas. In a myoma resection the chips float in the dilatation medium and this makes it more difficult to maintain control, since the chips have to be removed frequently. Every time the resectoscope is reintroduced, coagulated blood must firstly be rinsed out and the hydrometra re-established until a good view of the operating site is obtained, then the resection can continue. There is an increased risk of perforation due to these manipulations. There is an increased risk of the dreaded TUR syndrome, especially with longer surgery times.

With the Resection Master (Figs 22.10A and B), chips are aspirated immediately they are produced and removed from the cavity of the uterus without the hydrometra being impaired. Repeated interruptions of the resection are no longer the case, it is not necessary to time and again remove and reintroduce the resectoscope.

There is continuous control during the entire myoma resection because of the automatic chip aspiration. As a result, the surgery time is significantly shortened. This results in a clear reduction of complications compared with using the conventional resectoscope, and the surgeon can resect the myoma completely and with much less difficulty.

CONCLUSION

The approach used to insert the scope, together with the diameter of the hysteroscope and the distention of the uterine cavity, are of extreme importance in reducing patient discomfort to a minimum during an outpatient examination. The vaginoscopic approach (without speculum or tenaculum) has definitively eliminated patient discomfort related to the traditional approach to the uterus. One of the major problems for endoscopists is passing through the internal cervical os; the new generation of hysteroscopes, with an oval profile and a total diameter between 4 and 5 mm, are strictly correlated to the anatomy of the cervical canal. Miniaturized instruments have enabled the physician not only to perform targeted hysteroscopic biopsies, but also to treat benign intrauterine pathologies, such as polyps and synechiae, without any premedication or anesthesia. This has been defined as a 'see and treat' procedure—there is no longer a distinction between the diagnostic and operative procedures, but a single procedure in which the operative part is perfectly integrated in the diagnostic work-up.

Diagnostic hysteroscopy has long paid the price of being a purely visual method of investigation. Today, thanks to recent advances in instrumentation and to modified techniques related to the simultaneous use of the scope and of instruments, hysteroscopy is finally achieving the full accuracy that has been awaited for the last 30 years.

CHAPTER 23

Hysteroscopy in Evaluation of Endometrial Tuberculosis

Madhu Loomba, Kirti Bendre,
Ameya C Purandare

INTRODUCTION

Tuberculosis remains a global health problem, primarily in developing countries with inadequate health services. A significant portion of tuberculosis in these settings is extrapulmonary, including genitourinary tract. Female genital tract tuberculosis is rare in developed countries but more may be seen in future resulting from high incidence of drug resistant *M. tuberculosis* and immunocompromised states due to HIV.[1] It is estimated that 1 percent of infertile females in United States versus 18 percent in India suffer from genital tuberculosis.[2,3]

ETIOPATHOGENESIS

Genital tuberculosis is virtually always secondary to pulmonary tuberculosis. About 3/4th of women with genital tuberculosis have endometrial involvement. The fallopian tubes are almost always involved (95–100%)[2] and endometrium affected secondarily (50–60%)[2] by passage of bacteria down from the tubes to the endometrial cavity.

While tuberculosis damages the fallopian tubes irrepairably, it also damages endometrium. In women if the diagnosis is made early and treated, the uterus heals well, partly because the old uterine linning is shed every month in menstrual period and new regenerates. However, in severe cases the endometrium does not heal and leads to scarring, fibrosis and adhesions. These patients usually have scanty menses or amenorrhea.

CLINICAL PRESENTATION

The patients with genital tuberculosis are young adults and diagnosed during work-up of infertility. The disease may be present without any gynecological symptoms or may be associated with irregular bleeding or amenorrhea. Intrauterine adhesions are usually suspected when patient complaints of oligomenorrhea, hypomenorrhea or amenorrhea.[4] Genital tuberculosis is rare in postmenopausal women and responsible for only one percent of cases for postmenopausal bleeding.[5,6] The low incidence in this age group is difficult to explain, it is believed that an atrophic endometrium offers a poor milieu for the growth of mycobacteria.

DIAGNOSIS

Early tuberculosis: Hysteroscopy may show a normal cervical canal, normal uterine cavity and thin, smooth endometrium.[7] Presence of superficial localized ulcer in endometrium may cause suspicion of genital tuberculosis. Some cases may show tubercles on thickened endometrium and pale shaggy cavity with caseation (Fig. 23.1).

Advanced disease: Following hysteroscopy findings are seen:[8,9]

1. Tubercles, microcaseation, distorted ostium, normal cavity with obliterated tubal ostium (Figs 23.2 and 23.3).
2. Intracavity adhesions, more commonly dense fibrous or fibromuscular.
3. Fibrosed tubular cavity with complete absence of endometrial proliferation.
4. Complete obliteration of the endometrial cavity.

A targeted tissue sampling, followed by histopathology or newer molecular methods like polymerase chain reaction (PCR) or transcription mediated amplification (TMA) for tuberculosis may further confirm the diagnosis.[10,11]

Intrauterine adhesions: The various diagnostic modalities used are ultrasound, sonohysterography, hysterosalpingography (HSG) and MRI but these are not very reliable for diagnosis of intrauterine adhesions. The gold standard for diagnosis of intrauterine adhesions is hysteroscopy.[9,12-14] The procedure also helps to evaluate the condition of endometrium and tubal ostia. It also helps in detecting suitability for *in vitro* fertilization and embryo transfer. Hysteroscopy is superior with the negative predictive value of more than 97 percent when no structural abnormality is disclosed in a completely visualized uterine cavity.

Various classification systems are proposed for intrauterine adhesions. All these classifications are based on location and appearance of adhesions.

Marsh et al Classification, 1978[13]

Grade	*Findings*
Severe	More than 3/4 of uterine cavity involved Agglutination of walls or thick bands Ostial areas or upper cavity occluded
Moderate	Between 1/4–3/4 of the uterine cavity involved No agglutination of walls, adhesions only Ostial areas and upper cavity only partially occluded
Minimal	Less than 1/4 of uterine cavity involved—thin or flimsy adhesions Fundus, ostial areas are clear

Valle and Sciarra Classification, 1988

Mild Adhesions

Flimsy adhesions composed of basal endometrium producing partial or complete uterine cavity occlusion (Fig. 23.4).

Moderate Adhesions

Fibromuscular adhesions that are characteristically thick, still covered by endometrium that may bleed on division, partially or totally occluding the uterine cavity (Fig. 23.5).

Severe Adhesions

Composed of connective tissue with no endometrial lining and likely to bleed upon division, partially or totally occluding the uterine cavity (Fig. 23.6).

American Fertility Society Classification, 1988

Extent of cavity involved	< 1/3	1/3–2/3	> 2/3
	1	2	4
Type of adhesions	Flimsy	Flimsy and dense	Dense
	1	2	4
Menstrual pattern	Normal	Hypomenorrhea	Amenorrhea
	0	2	4

Stage I (mild) 1–4
Stage II (moderate) 5–8
Stage III (severe) 9–12

European Society Classification, 1989

Grade	*Extent of intrauterine adhesions*
I	Thin or flimsy adhesions Easily ruptured by hysteroscope sheath alone Cornual areas normal
II	Singular firm adhesions Connecting separate parts of the uterine cavity Visualization of both tubal ostia possible Cannot be ruptured by hysteroscope sheath alone
IIa	Occluding adhesions only in the region of the internal cervical os Upper uterine cavity normal
III	Multiple firm adhesions Connecting separate parts of the uterine cavity Unilateral obliteration of ostial areas of the tubes
IIIa	Extensive scarring of the uterine cavity wall with amenorrhea or hypomenorrhea
IIIb	Combination of III and IIIa
IV	Extensive firm adhesions with agglutination of uterine walls At least both tubal ostial areas occluded

Donnez and Nisolle Classification, 1994

Degree	*Location*
I	Central adhesions • Thin flimsy adhesions (Endometrial adhesions) • Myofibrous (Connective adhesions)

Contd...

Contd...

Degree	Location
II	Marginal adhesions (Always myofibrous or connective) • Wedge like projection • Obliteration of one horn
III	Uterine cavity absent on HSG • Occlusion of the internal os (Upper cavity normal) • Extensive coaptation of the uterine walls (Absence of the uterine cavity) (True Asherman's syndrome)

TREATMENT

Antitubercular treatment followed by hysteroscopic lysis of adhesions with scissors, laser, electrosurgery can restore the size and shape of uterine cavity.

Postoperative mechanical distention of uterine cavity and hormonal treatment to facilitate endometrial regrowth appear to decrease the recurrence of adhesions.

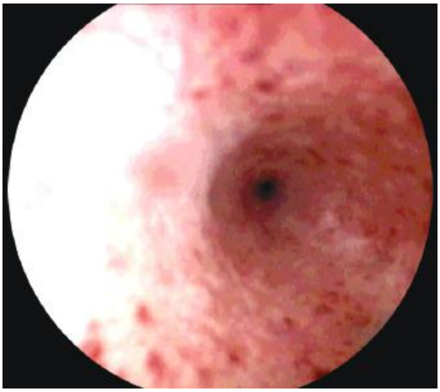


Fig. 23.1: Ostia in tuberculosis endometritis

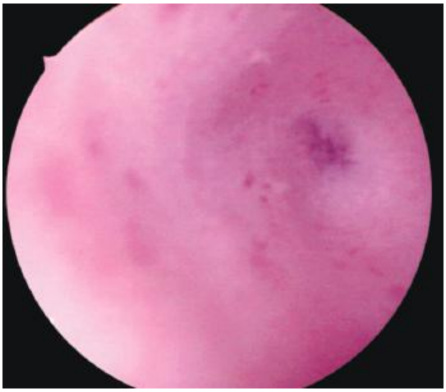


Fig. 23.2: Ostia obliterated

Fig. 23.3: Ostia obliterated and endometrium shows less vascularity

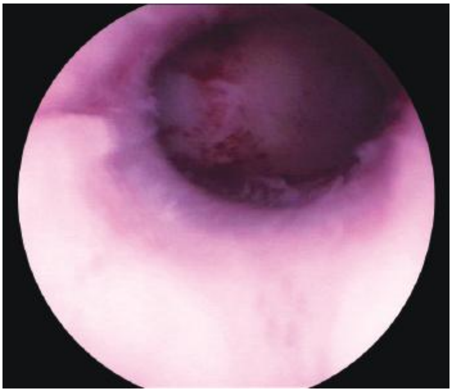


Fig. 23.4: Uterine cavity cicatrized

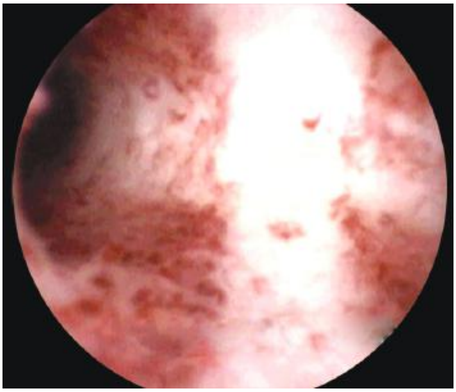


Fig. 23.5: Fundal area obliterated

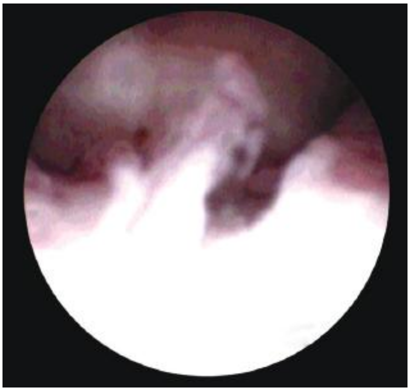


Fig. 23.6: Intrauterine adhesions

Endometrial development can remain stunted due to scanty amount of residual functioning endometrium and fibrosis. Potential pregnancy complications especially placenta accreta after treatment of adhesiolysis should be kept in mind.[12-14]

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