Hysteroscopy Simplified by Masters

Sunita Tandulwadkar
Bhaskar Pal
Editors

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Springer

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This book is dedicated to all those who have passion for endoscopy and craving for updating oneself and to those who do not want to stop learning at any stage of professional life!

Foreword

As the Chair of Global Community of Hysteroscopy (GCH) I had the opportunity to meet Dr. Sunita Tandulwadkar years ago. During the last few years we have been collaborating in many scientific projects, collaboration that developed also into a friendship, and when she asked me to write a foreword for her book, I felt very honored.

Sunita is a prominent endoscopist with a focus on reproductive surgery. Her skills are known in her country, India, but also internationally. Her curiosity and interest for the uterine cavity and the effect on fertility is the fuel of her passion, a passion that we share together.

As president of the IAGE during 2019–2020 she gave hysteroscopy the place it deserves by creating important CME programs for the gynecologists in her country, helping to improve skills but at the same time focused on research. The seed she planted on this surgical procedure will flourish for years to come. It was only a matter of time for her to come with this idea as the culmination of her great work, a book.

This book is not just another book on hysteroscopy, but a step forward compared to other publications in the same field—a fact not only based on the excellent contributors she has chosen, both national and international, but based mainly on the topics included.

This book is focused on giving an answer to all those questions a surgeon of the uterine cavity may have, before the procedure, during the procedure, and even after it is finished. Topics are chosen in a very pragmatic way, directed to the most important issues related to hysteroscopy surgery, both for professionals that wish to start performing their first steps and for those who just would like to improve their skills.

I know that as a reflection of the personal success, this book quickly will become a reference in the hands of all the hysteron lovers.

Barcelona, Spain
Hadera, Israel
Haifa, Israel

Sergio Haimovich

Preface

The future belongs to those who believe in the beauty of their dreams

—Eleanor Roosevelt

Only those who practice perseverance achieve the dream! I saw an academic dream and probably have succeeded with the help of so many colleagues who believed in my dream! Being adventurous in nature, I had developed the habit of learning and introducing new advancements into my practice.

Hysteroscopy has been a part of routine gynecological practice and a main diagnostic tool for intrauterine pathology in the modern era. Being it "office" or in the operating room, hysteroscopy has the advantage of diagnostic as well as therapeutic knifeless day care procedure with minimal complications even in the most complex cases in one sitting by "see and treat" way.

The idea behind this comprehensive book on hysteroscopy is to share myriad clinical pearls by expert contributors to improve patient care and to minimize complications of hysteroscopy. This book can be a guide to gynecologists for case management efficiently on a daily basis. This book is also conceived with beginners in mind to help them become masters in hysteroscopy.

The book covers the most up-to-date and detailed possible though precise, consisting of 20 experts across the globe as contributors. It consists of more than 20 chapters, and illustrated by over 20 images to make it a kind of Hysteroscopic Atlas that you would love to have at your desk. We are more focused on practical aspects of each procedure along with common questions, tricks and tips to prevent complications.

I believe hysteroscopy is an art! To make beautiful cavity out of completely obliterated one in Asherman syndrome and to achieve successful implantation demands something more than just a skill! The excellent outcomes from operative hysteroscopic and minimally invasive surgical procedures keep us inspired!

We would like to thank all the contributors, our patients who entrusted us for their care, publisher, sponsor…

Finally, to our families and friends who supported us outside of our work place, we thank you!

Pune, Maharashtra, India — Sunita Tandulwadkar
Kolkata, India — Bhaskar Pal

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About the Editors

Sunita Tandulwadkar, MD, FICS, FICOG presently works as the Head of Department of Obstetrics & Gynaecology, Ruby Hall Clinic, Pune, India and Chief of Ruby Hall IVF and Endoscopy Center, Pune, India. She is also the Director of Solo Clinic, Centre of Excellence Infertility & Endoscopy and Founder & Medical Advisor of Solo Stem Cells, Stem Cells Research & Application Centre, Pune, India and Co-Founder of Solo Research Foundation (SPONSOR A BIRTH).

She is the president of the Indian Association of Gynecological Endoscopists (IAGE) (2019–2020); chairperson and founder secretary of Maharashtra State Chapter of the Indian Society for Assisted Reproduction (ISAR) (2019–2020); and 2nd Vice President of Indian Society of Assisted Reproductive Medicine; Founder Secretary of Maharashtra Chapter ISAR; Vice-President of West Zone FOGSI (2017). She was an elected board member of the International Society of Gynecologic Endoscopy (ISGE) (2013–2017). She was chairperson of the Infertility Committee of the Federation of Obstetrics and Gynecology of India (FOGSI) (2011–2013) and the west zone vice-president of FOGSI. She is also the Reviewer of Fertility and Sterility and Advisor & Reviewer of Journal of Human Reproductive Sciences. She has published several books and contributed many book chapters. She is an active member of various national and international societies and committees. Dr. Tandulwadkar also conducts workshops and trainings to help educate promising future doctors.

Bhaskar Pal, MD, DGO, DNBE, MRCOG, FICOG has been a Senior Consultant in Obstetrics and Gynaecology at Apollo Gleneagles Hospital, Kolkata, for the past 17 years. His area of interest is minimal access surgery. He has authored over 30 publications and book chapters and has co-edited four books.

Dr. Pal was vice-president of the Federation of Obstetric and Gynaecological Societies of India (FOGSI) in 2017. He is currently the general secretary of the Indian Association of Gynaecological Endoscopists (IAGE) and chair of the India East International Representative Committee of the Royal College of Obstetricians and Gynaecologists, London. He is the president elect of the Bengal Obstetric and Gynaecological Society and was the Biostatistician for the *Journal of Obstetrics and Gynaecology of India (2007–09)*. He was a member of the Governing Council of the Indian College of Obstetrics & Gynaecology (ICOG) (2015–17) and Chairperson of the Young Talent Promotion Committee of FOGSI (2011–13).

1 History and Evolution of Hysteroscopy

Sejal Naik and Sweta Patel

The telescope to view the uterine cavity, the hysteroscope, has evolved over the last two centuries. In 1805, a long-standing desire of physicians to see into the interior of body cavities was fulfilled. Hysteroscopy is a technique by which we can peep into the cavity of the uterus through the cervix. Before the advent of hysteroscope, the standard procedure of blind dilatation and curettage was used along with hysterosalpingography (HSG) for the evaluation of the uterus [1, 2].

Bozzini in 1805 first peered into the urethra of living subject and this was the beginning of endoscopy which has now advanced into a modern endoscopic surgery. Bozzini described the device and its use for the illumination of "inner cavities and interstices of the living animal body." In the preface of this article, he wrote, "Every invention owes its origin to a happy combination of various circumstances; it is always born like a child, and like a child keeps becoming nearly perfect in a step-wise fashion [1]." The device consisted of a tubular speculum. A candle was put into the square-windowed, hollow tube, while light was directed by a concave mirror through the tube into the cavity which was to be examined. The results, however, were unsatisfactory (Figs. 1.1 and 1.2).

Fig. 1.1 Philipp Bozzini

Fig. 1.2 First endoscope 1805–1807

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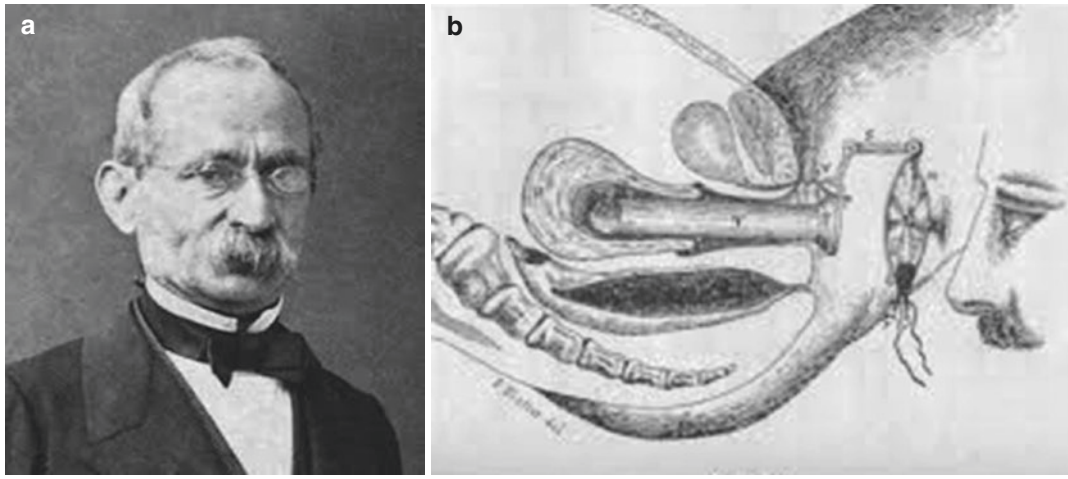

Fig. 1.3 (**a**) Pantaleoni (1810–1885) (**b**). Hysteroscopy as describe by S. Duplay and S. Clado, 1898

The credit of performing the first successful hysteroscopy goes to Pantaleoni in 1869. He evaluated a 60-year-old lady with therapy-resistant bleeding and detected a polypoid growth in the uterus on hysteroscopy, which was cauterized with silver nitrate [3] (Fig. 1.3).

Ernst Bumm [4] reported his first experiments and experiences with hysteroscopy in Vienna congress. He used endoscope that is commonly used for the male urethra. A head lamp with an incandescent light reflector served as an illuminator. This instrument enabled him to discover changes in the mucosa of the uterus, such as hyperaemia, granulation, uterus and polypoidal growth, but he also mentioned the disadvantages and difficulties such as bleeding which disturbed visualization.

Uterine cavity is not easy to explore, given the difficulty of distending its walls, in addition to its physiological fragility as well as tendency towards endometrial mucosal bleeding.

David [5] was first to use a workable hysteroscope in which the illuminating device modelled as Nitze's cystoscope was mounted near the viewing end and had a magnifying effect by way of a built-in lens. The viewing end of the inserted instrument was inserted into the fundus of the uterus. He demonstrated that endoscopy of the uterus was not only possible, but it considerably enriched gynaecologic diagnosis. In 1914 Heineberg [6] of Philadelphia described an endoscope equipped with a light source similar to Nitze's cystoscope but with an additional inner water sprinkler. The purpose of this was to rinse off the blood which covered the lens and hindered the view. In most cases, the result of the observation was satisfactory. His reason for endoscopic inspection of the uterine cavity was recognition of endometritis and exertainment of the presence of retained placenta after abortion (Fig. 1.4).

The uterus, a small cleft-shaped hollow cavity, is surrounded by tough, easily expanding muscle walls and its mucous membrane has the characteristic of bleeding even when slightly touched. Rubin [7] developed further methods to overcome this difficulty. His attempt to insufflate with carbon dioxide instead of water brought better result. He treated bleeding with an application of adrenaline. Out of 42 women, only 6 were disturbed by bleeding during his study. In some cases, patients were slightly affected by the insufflation. No infections were observed. Seymour [8] introduced a hysteroscope in 1926 which had a suction tube which drained away the mucus and blood.

After having carried out over 350 trouble-free examinations, Schroeder [9] felt that hysteroscopy was an excellent diagnostic tool for the recognition of certain intrauterine diseases. Exactly like these procedures, he could recognize the various cycles of the endometrium and patho-

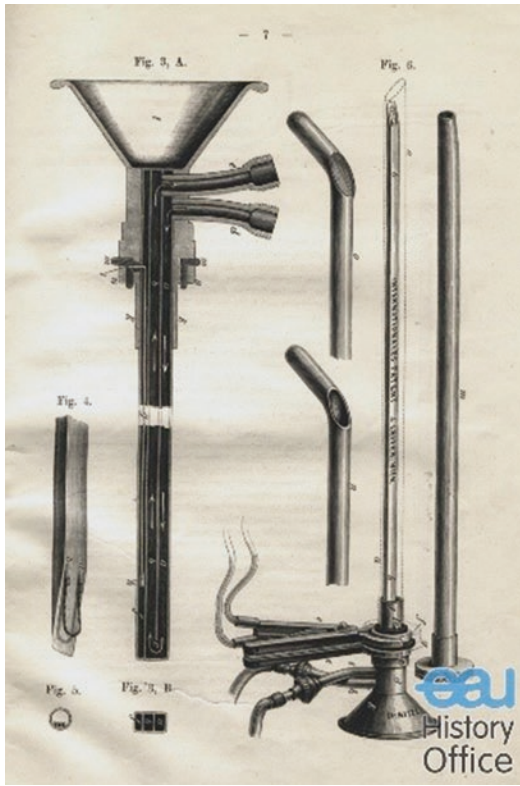

Fig. 1.4 Nitz's cystoscope

logic and anatomic changes, especially polyps and submucous fibroids. He emphasized the value of hysteroscopy for the radiologist who could located a corpus carcinoma and through this establish a targeted radium application. It was also possible to study the endometrium in vivo in the case of primary and secondary amenorrhoea. Von Midulicz, Radecka and Frand used saline as a rinsing system with separate channels for inlet and outlet [10].

Maleschki [11] published his observations on the blood circulation of the human endometrium according to the different cyclical phases and the colour of the mucous membrane changes. The fluctuations were unknown. Edstrom and Fernstrom [12] in 1970 used about 50–100 mL of a highly viscous 32% dextran-70 as a solution for the inspection of the uterus. The solution flows slowly under pressure through the tubes into the uterus. In order to keep the cavity at a constant level of expansion the cavity is constantly reflected from outside. Their hysteroscope was equipped with two separate canals. One is used to insert the dextran solution for expansion of the uterine cavity, whereas through the other one, a flexible biopsy forceps could be guided. Examination was done under barbiturate anaesthesia or paracervical block. They found dextran superior to other distension media because of its property of high viscosity and immiscibility with blood.

Various workers used a different distending medium to improve the visibility and ensure safety, especially in operative procedures. The credit of using 1.5% glycine instead of dextran for operative endoscopy goes to none other than Jagnes Hamon, a French surgeon. An ideal distension medium which is totally physiological and which will not cause fluid overload or electrolyte disturbances is yet to be found.

Lindemann [13] for 2 years practised hysteroscopy with a newly developed method, wherein the uterine cavity is filled with carbon dioxide gas. The best visibility was achieved when 80–100 mL/min of carbon dioxide gas with a pressure of about 200 mmHg is insufflated into the cavity and both tubes are penetrated with a viewing period of 5 min which is sufficient for the examination of the cavity. About 500 mL of carbon dioxide gas is insulated into the peritoneum. This gas quantity affects the patient only slightly if at all with diaphragmatic irritation and subsequent shoulder pain.

The improvement in optics, video system, safe and effective distension media and reduced telescope size has led to increased acceptance of hysteroscopy by both physicians and patients when symptoms require direct intrauterine examination.

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Instrumentation in Hysteroscopy

2

Sujata Kar and Kirty Nanda

2.1 Introduction

Hysteroscopy is derived from the two Greek words 'hystera' meaning uterus and 'skopeo' meaning to view. *Hysteroscopy* is the procedure of inspection of the uterine cavity by endoscopy through the cervix. It is used as a diagnostic tool for intrauterine pathology as well as a method for surgical intervention (operative hysteroscopy).

The diameter of the modern hysteroscope is generally small enough to conveniently pass the cervix directly. For a proportion of women, cervical dilation may need to be performed prior to insertion. Cervical dilation can be performed by pretreatment with misoprostol prior to the procedure or by serial dilation with the help of dilators.

2.1.1 History

It was first performed on a live human subject in 1869 by Diomede Pantaleone, who used a tube with external light source to detect 'polyp' within the uterine cavity in a 60-year-old female who was complaining of abnormal uterine bleeding. He successfully treated her with repeated cycle of silver nitrite. Later David performed hysteroscopic examination using a cystoscope with an internal light and lens system.

While Von Midulicz, Radecka and Freund used saline as a rinsing system, Edstrom and Ternstrom used 32% Dextran 70 as a distension medium and claimed it to be superior to other distension media because of its property of high viscosity and immiscibility with blood. Various workers used different distending media to improve the visibility and ensure safety, especially, in operative procedures. It was only in 1967 that Fritz Menken made a first step towards an atraumatic ambulatory approach using a paediatric cystoscope to perform a hysteroscopy. The distension of the uterine cavity was done with a high colloidal liquid, called luviscol, and an elastic cone was used to seal the cervical channel and prevent leakage of the liquid [1].

In the 1970s, Lindemann et al. [2, 3] published their experimental findings regarding the influence of CO_2 gas during hysteroscopy. Here, for the first time, not only the advantages of this new method but also the possible dangers and complications of gas insufflation were analysed. Cornier [4], and Lin et al. [5] tried to find a new way by using a flexible hysteroscope, a small flexible bored instrument with a channel for instrument application, through which, for example, laser wires could be applied. The use of the Nd-YAG laser for the destruction of the endometrium in patients with idiopathic uterine bleeding disorders, as published by Goldrath [6], was certainly

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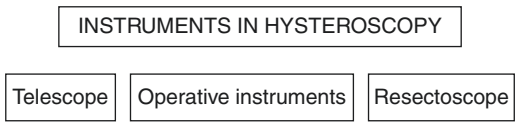
the start for renewed interest in this method by the public, mainly because the transcervical approach offered a safe and valid alternative with extremely high patient compliance in comparison to the transabdominal approaches [7]. At the end of the 1980s, CO_2 was replaced by watery or low-viscosity solutions as a distension medium and the introduction of a continuous flow system enabled the surgeon to restore view in nearly every situation. Hamou, in 1979, idealized the microhysteroscope with panoramic vision and of contact. The introduction of the atraumatic technique, the new mini-hysteroscopes and the technically superior video documentation now raises the chances that hysteroscopy, both diagnostic and operative, may become established as a routine procedure by every gynaecologist. The new generation of mini-endoscopes, both rigid and microfibre systems, have excellent to acceptable optical qualities with a large image diameter, sufficient brightness, good resolution and a field of view which allows panoramic sight. These instruments are suitable for both laparoscopy and hysteroscopy [8, 9].

In the last 150 years with the advancement of technology, developments in optics and fibre-optics, instruments and distension media help gynaecologist all over the world to diagnosis and treat many intrauterine pathologies.



2.1.2 Telescopes/Hysteroscopy

The telescopes have three parts:

1. The eyepieces: the end on the observer side which gets attached to the camera.
2. The barrel: containing the optical fibres and lens systems; light source is attached to it. It can be rigid or flexible, unicompartmental or multi-compartment.
3. The objective lens: it is the main optics of the scope placed at different angles for different viewing purposes.

In general, hysteroscopes are classified as rigid or flexible. It is designed for both diagnostic or operative use and possessing fixed or variable focussing. The key specification of a hysteroscope are telescope diameter, lens offset, sheath diameter and its ability to be used with a variety of distention media.

2.1.3 Rigid Telescope

There are most commonly used and most preferable for operative procedures. Usually they vary in size according to function and requirement. Size as small as 3 mm when coupled with endoscopic video system with zoom lenses are highly satisfactory for both office hysteroscopy as well as operative procedures. The 4 mm gives the sharpest and clearest image:

(a) 3 mm—rarely cervical dilation required
(b) >5 mm—specific surgical instrument through separate parts
(c) 8–10 mm—continuous flow of media.

Optics: The lens system is basically derived into three types:

(a) Classical optics.
(b) Hopkins.
(c) Graded index lens system (GRIN).

In Classical optics the width of the lens is far less than that of a telescope and also distance between lenses is large. On the other hand, in Hopkins the lens has a larger diameter with smaller separation between the lenses, thus providing a larger angle of view and brighter image. In the GRIN system, the entire telescope is occupied by a slender red of glass. This lens system is mostly used in contact hysteroscopy.

The picture through the hysteroscopy is affected by the angle of lenses to the central axis of the telescope. The telescope has a viewing angle of 0° straight on and 30° for oblique view. The advantage with 0° lenses is that it centred along the axis of the endoscope so that a 360° rotation of the telescope will not change the view. Again the 0° lens allows the operator

to see operative devices on a relatively distant panorama; on the other hand, with fore-oblique lens, when the telescope is rotated 360°, an expanded field of view is seen. The 180°, 0°, 15° and 25° angles may be more beneficial for the resectoscope. The depth of visual field of these telescopes is about 2 to 3 cm with 4× to 5× magnification with liquid distending medium. Most hysteroscopes posses an outer lens that will provide a 60° to 90° field of view depending on the distending medium. In gaseous medium, the view is wider compared to the aqueous media due to more optimal refractive index.

2.1.4 Sheath

There are basically two types of sheath: (a) diagnostic and (b) operative.

(a) *Diagnostic*: It is required to deliver the distending media into the uterine cavity. The sheath is 4–5 mm in diameter, depending upon the outer diameter of the telescope leaving 1 mm space in between to deliver the distending media. The telescope and the sheath are secured by a watertight seal that locks them in place and the medium instillation is controlled by an external stopcock.
(b) *Operative sheaths*: These have a layer diameter ranging from 7 to 10 mm with an average of 8 mm as these have space for instillation of the medium, for telescope and for operative devices. These are again of two types: one with single cavity for all three and the other with isolated cavity for each. The major disadvantage of single cavity is its inability to flush the uterine cavity with distending media and difficulty in manipulating the operating tools inside the cavity. The popular model of isolated channel sheath that consists of a double-flushing sheath permits media instillation by way of inner sheath and media reliever by outer perforated sheath. The constant flow of liquid medium in and out of the cavity creates a very clear operative field.

2.1.5 Flexible Telescope

The flexible telescope was initially described by Brueseke and Wilbanks in 1974. It also comes in various sizes ranging from outer diameter of 8.5–3.6 mm. A standard 4.8-mm-diameter fibre-optic hysteroscope with an operating channel of 2 mm consists of three sections:

(a) A soft flexible front section.
(b) A rigid-rotating middle section.
(c) A semirigid rear section.

The major advantage of these is they offer steerability and flexion inside the uterus for better viewing of the uterotubal openings, for aligning the catheter for tubal canalization and for viewing lateral aspects of the uterine wall. Nowadays, these are available as single-use sterile sheaths which eliminate the need to sterilize the equipment in between cases.

Drawbacks of flexible hysteroscopes include the fact that only a gaseous distending medium is recommended, diminution in the image and its resolution due to light transmission by fibres and its high cost.

2.2 Operative Instruments

The ancillary instrument for use through rigid hysteroscope are of three types: (a) flexible, (b) semirigid, and (c) rigid.

The flexible instruments like biopsy forceps, grasping forceps, and scissors are fragile and cumbersome and need frequent replacement. Development of the large isolated channel sheath has made the use of totally flexible 3 mm operative instrument feasible. Semirigid instruments provide easier manipulation and durability. They bent slightly but cannot be bent to 90° without breaking. The rigid instruments are fixed at the end of the operating bridge attached to the dorsal aspect of the distal end of the sleeve in such a way that the instrument tip is in full endoscope view. These are cumbersome to use, require the whole instrument to be moved towards targets reducing the viewing field. Again, the entire hysteroscope

has to be removed while changing the instrument. Great care should be taken to avoid perforation. Other operative devices include monopolar balls, needles, shaving loops, bipolar balls and cutting loops electrodes, bipolar scissor and needles.

2.2.1 Resectoscope

This is a specialized electrosurgical endoscope that consists of inner and outer sheaths for providing a continuous flow system. It includes straight forward 0° or 30° telescope with a 3.5–4 mm outer diameter; the outer sheath is 8–9 mm (29 F) in diameter. The double-armed electrode is fitted to a trigger device that pushes the electrode out beyond the sheath and then pulls it back within the sheath. By activating the spring mechanism, the electrode can be moved about 4 cm into the visual field, providing a clear unobstructed view of the uterine cavity. Other operating tools consist of four basic electrodes: a cutting loop, ball, button and angulated needle. Contemporary small-diameter resectoscopes use a 3 mm telescope and a 7–7.5 mm sheath.

2.2.2 Some Special Hysteroscopic Instruments

2.2.2.1 Versa Point

This is a type of bipolar instrument that can be used with normal saline solution as distension media. Thus it combines the two conventional output modalities of bipolar and monopolar electrosurgery in a specific system configuration. Unlike conventional bipolar electrodes, this system utilizes the fact that the irrigating solution is conductive to stagger the electrode arrangement at the tip so that the "return" electrode is mounted on the shaft of the instrument and thus remote from the tissue. Firstly, the proximity of the return electrode to the working tip and the fact that no tissue other than that contacting the active electrode is involved in the electrical circuit preserve the recognized safety features of bipolar electrosurgery. Secondly, this arrangement may avoid problems commonly encountered when using bipolar electrosurgery: orientation of the electrode to tissue visualization of the working tip, tissue sticking and limited power delivery.

2.2.2.2 Contact Hysteroscopy

This, mentioned earlier, rely on GRIN lens and do not require a distension media or fibre-optic light. Rather a light-collecting chamber is there located near the eyepiece. For viewing, the endoscope must touch the object. Because of rigid glass guide, there is no distortions from transmitted images. Also, it provides a magnification of 1.6 times without any lens. Greater magnification depends on the eyepiece. Its major advantage is excellent visualization even in the presence of bleeding. The major drawback is lack of panoramic view and inability to operate through the scope.

2.2.2.3 Microhysteroscopy

Hamon described it as instruments that can provide a panoramic view of the distended uterine cavity along with providing contact and 150x magnified views as well.

Key Points

1. Instruments used in hysteroscopy are divided as telescope and optics, operative instruments and resectoscope.
2. Telescope can be rigid or flexible.
3. Three types of lens systems are present: classical, Hopkins and GRIN.
4. Sheaths are of two types: diagnostic and operatives.
5. Special hysteroscope consists of resectoscope, Versapoint, microhysteroscopy and contact hysteroscopy.

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Energy Sources in Hysteroscopy

3

Omer Moore and Sergio Haimovich

The use of electricity is an integral part of hysteroscopy. Some of the hysteroscopic instruments being used routinely for diverse kinds of procedures demand different power setting. The surgeon has to be familiar with the electrosurgery physical principles, in order to use confidently the instruments, making the least possible accidents.

The hand instrument connected to an electric generator may bring to bear the electricity capabilities, giving it the operative ability in the uterus.

There are different types of energy in use, among them we may find bipolar and monopolar energy, both being used today as the main energy in the operative hysteroscopy. Laser energy which lately gains momentum in the operative hysteroscopy or microwave energy which is being used today in ablation therapy. In order to bring those energy types to usage, a hand instrument will transform them to heat.

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The versatility of procedures in the field of operative hysteroscopy is large. In a variety of ways, the surgeon may use one of the hysteroscopic hand instruments in order to solve the pathology or he may choose one of the other instruments in hand.

It is expected from any hysteroscopy surgeon to be deeply familiar with the pathology, knowing the different surgical technological options and the differences between the hand instruments and their usage.

It is important that the surgeon will be familiar with the electrosurgery physical principles, in order to use confidently the instruments, making the least possible accidents.

The ability of the electrosurgical instruments to achieve minimal blood loss and to reduce the operation time has a great medico-economic significance. With the hand instruments that we have in use now and the ones that we will have in the future, along with the surgeon's familiarity with the equipment, we will be able to face new pathologies in a better and safer way.

The electricity in endoscopy, whether it is hysteroscopy or laparoscopy, is based on the same principles.

Hundreds of years ago, heat was used to stop bleeding. The use of electrical devices, to heat tissue and control bleeding, was used as technology advanced. Modern-day electrosurgery is a result of these advancements (Table 3.1).

S. Tandulwadkar, B. Pal (eds.), *Hysteroscopy Simplified by Masters*,
https://doi.org/10.1007/978-981-15-2505-6_3

Table 3.1 shows the evolution of electricity used in surgery

Time of advancement	Researcher	Advancement
Early nineteenth century	Henri **Becquerel** (French physicist)	Heating a wire by passing a direct current (D.C.) through it, effectively cauterizing the tissue upon contact.
1881	Jacques-Arsène **d'Arsonval** (french biophysicist)	Was the first to use an alternating electrical current (A.C.) in a human body. *Proving that at a frequency of 200 kHz or higher alternating electrical current could pass through the human body without causing muscle stimulation, but instead generates heat in tissue.*
1890–1910	Karl Franz **Nagelschmidt** (German physician)	By understanding that cellular ions collide and release energy, he was able to develop a machine that is capable of producing the following therapeutic tissue effects: Fulguration, desiccation and cutting.
Late 1920's	William T. **Bovie** (American scientist) Harvey **Cushing** (American neurosurgeon)	Electrosurgical units we use today are a direct result of their research. Bovie used the knowledge to create his electrosurgical device and he first employed it in neurosurgical cases with Harvey Cushing. Dealing with bleeding.

3.1 Electrosurgery Principles and Types of Energy Used in Hysteroscopy

3.1.1 Electrosurgery Basic Principles

To better understand the mechanism of electrosurgery in hysteroscopy, one must know the basics of electricity.

- *Electrical current* flows when electrons from one atom move to an adjacent atom through a circuit.
- *Voltage* (V) is the necessary force that mediates or drives this electron movement. This power is measured by volts.
- *Current* (I) is the movement of electrons in the same direction, measured by amperes.
- *Resistance* (R) is the difficulty in driving the electrons through the tissue or other materials, measured by ohms.
- *Heat* is produced when electrons encounter resistance.

The flow of electricity in living tissue being governed by Ohm's law:

$$\text{Voltage}\ (V) = \text{Current}\ (i) * \text{Resistance}\ (R).$$

The circuit in the operating room consists of the patient, electrosurgical generator, and the active and return electrodes.

- *The circuit* has to be continuous in order for current to flow.
- *The electrosurgical unit* is the source of the voltage.
- *The active electrode* conducts electrons to the patient.
- *The patient's tissue* provides resistance to current flow, thereby producing heat and the resulting tissue effect.
- *The return electrode* is responsible of returning the current flow to the electrosurgical unit through either the conducting instrument itself or a patient return electrode.

All of this leads to basic *principles of electrosurgery*, found in Box 3.1.

The factors appearing in Box 3.2 have a major impact on tissue effect: current density, time, electrode size, tissue conductivity, current waveform, and manipulation of the electrode.

Box 3.1 Basic Principles to Remember

1. Alternating electric current enters the patient where it seeks the path of least resistance.
2. Electricity always needs to be grounded.
3. Electrical energy made by the flow of electrons will create heating of the tissue, yielding a range of different effects.
4. In order for electricity to work it has to have a complete circuit.

Notice!

- Electrosurgery—using alternating current (A.C.) including the patient in the circuit.
- Electrocautery—using direct current (D.C.) where only the heated wire comes in contact with the tissue. (This term cannot describe electrosurgery.)

Box 3.2 Electrosurgery Factors with Impact on Tissue Effect

1. *Current density*
   (a) The greater the current that passes through an area, the greater the effect will be on the tissue.
   (b) The greater the amount of heat that is produced by the current, the greater the thermal damage on tissue.
2. *Time*
   (a) The amount of time an active electrode is in use will determine the effect on the tissue. Too much time will produce wider and deeper tissue damage (thermal spread).
   (b) The speed with which an electrode is moved will result in either less or more coagulation and thermal spread.
3. *Tissue conductivity*
   - Electrical resistance is different with the various tissue types and this affects the rate of conductivity. The adipose tissue and bone are poor conductors of electricity, having high resistance, whereas muscle and skin are good conductors but have low resistance.
4. *Electrode size*
   (a) To achieve a higher current density one needs to use a smaller electrode, resulting in a concentrated heating effect at the site of tissue contact.
   (b) The return electrodes used in monopolar electrosurgery are large relative to the active electrode in order to disperse the current that is returning to the electrosurgical unit and minimize heat production at this return electrode site.
5. *Current (energy) waveforms*
   - There is a different tissue effect created by different current types. Electrosurgical generators produce three different waveforms—cut, blend, and coagulation. See below.
6. *Manipulation of the electrode*
   - This will determine whether vaporization or coagulation occurs. While sparking to the tissue from distance versus holding the electrode in direct contact with tissue.

3.1.1.1 Current (Energy) Waveforms

- *Cutting waveform* (higher current, lower voltage)
  - Local and intense heating effect that will vaporize tissue with minimal coagulation effect.
    - To be effective, a cutting current power setting needs to be between 50 and 80 W. Holding the electrode slightly away from the tissue, for achieving the best cutting results, will create a **spark gap** by which the current reaches the tissue. This spark gap results from heating up the atmosphere between the electrode and the tissue.
    - In comparing a cutting current to a coagulation current, the former produces less charring and tissue damage (Figs. 3.1 and 3.2a).
- *Coagulation waveform* (lower current, higher voltage)
  - Intermittent waveform, where the generator modifies the waveform so that the duty cycle is reduced to about 5% of time.
  - When the waveform spikes, the tissue is heated. The tissue cools between spikes, producing the coagulation effect. In order for the current to pass through the highly resistant and desiccated tissue, one needs to use higher voltage. It is possible to cut tissue using coagulation currents at high power; however, this will result in greater charring and tissue damage (Fig. 3.1).
  - When a discrete bleeder cannot be identified in the surgical field, it is common to use coagulation current in a fulguration way.
  - *Fulguration* is noncontact coagulation. **A spark gap** is used to mediate the tissue effect resulting in heating, necrosis, and a greater thermal spread (Fig. 3.2b).
  - *Desiccation* is another form of coagulation, where **direct contact** with the tissue is made, resulting in a total electrical energy conversion to heat within the tissue as opposed to both cutting and fulguration currents which lose a significant amount of electrical energy, when the spark gap is created (Fig. 3.2c).
- *Blend waveform*
  - A modification of the duty cycle. When changing the type of the wave from cutting to coagulation, the generator reduces the time of duty cycle ("on" time), producing less heat on the tissue. Blend waves are used less often in hysteroscopy (Fig. 3.1).

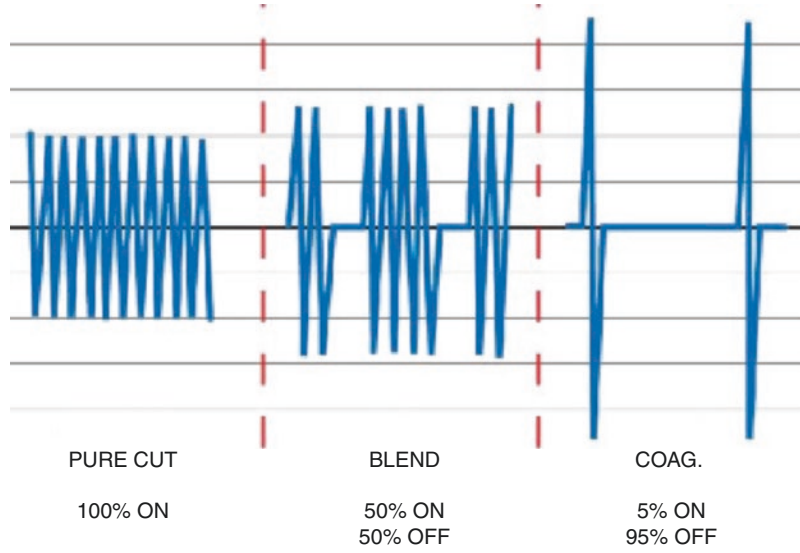


Fig. 3.1 Current waveforms

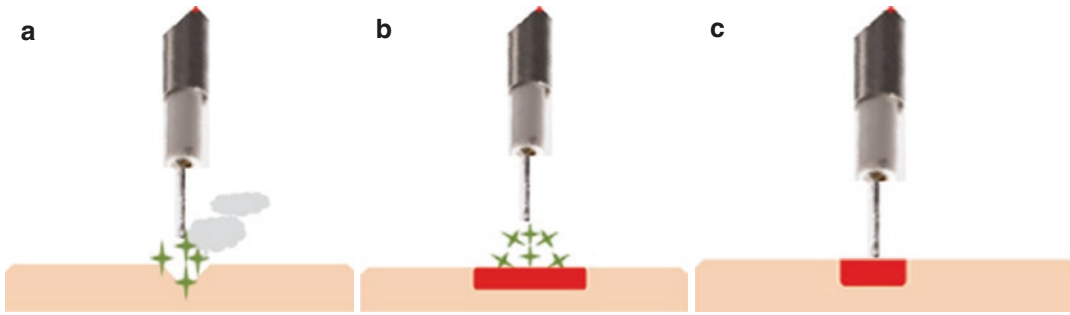


Fig. 3.2 (**a**) Cutting/Vaporization. (**b**) Fulguration. (**c**) Coagulation/desiccation are the main effects achieved by electrode manipulation. Watch the differences in the distance of the electrode from the tissue

3.1.2 Types of Energy Used in Hysteroscopy

3.1.2.1 Monopolar and Bipolar Electrosurgery

Historically the electrical current passed through the patient, completing the circuit either by the operating room floor via a grounded object or returning to a solid-state generator. As great concern arouse over accidental burns, the isolated generator system was developed in the 1970s, avoiding an alternating pathway to the ground.

Activation of the electrosurgical unit in both monopolar and bipolar is usually made by foot.

The *monopolar* device, being the most commonly used device in electrosurgery, becoming less frequently used in hysteroscopy, due to its need for a non-electrolytic solutions, such as glycine 1.5%, to distend the uterine cavity, with the potential of nonphysiological fluid absorption complications (such as hyponatremic encephalopathy, hypercapnia, and postoperative hyperammonemia).

The monopolar device conducts the current of electricity through the patient while using a return electrode on the patient's body, usually on the thigh (Fig. 3.3).

The patient's return electrode should contact a well-vascularized muscle tissue with a large-enough pad to prevent a high-density current producing an unintended burn.

The monopolar waveform can be modified into three clinical effects: cutting, fulguration, and desiccation.

Three main complications exist with the use of monopolar energy: direct coupling, insulation failure, and capacitive coupling. They will be discussed further on in the chapter.

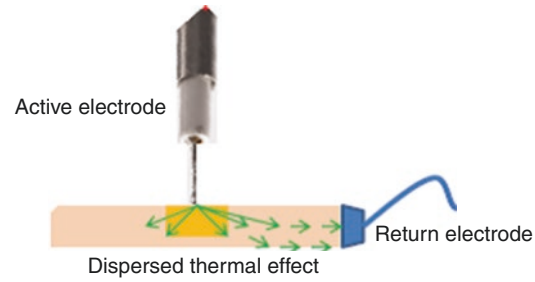


Fig. 3.3 Monopolar electrode

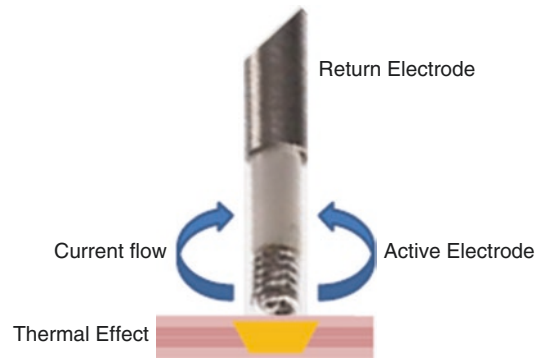


Fig. 3.4 Bipolar electrode. The tissue effect is taking place only between the active and the return electrodes. No dispersive electrode is needed

The *bipolar* device conducts the energy and returns it by the instrument itself, whether by the conducting (active) electrode tip or by the second blade of the hand instrument, without the requirement for a grounding pad (Fig. 3.4).

When compared to monopolar energy, while using a bipolar energy only the tissue held between the instrument's blades is included in the electrical circuit, becoming a tissue that is under effect, thereby reducing to minimum the damage on the surrounding tissue.

Using the bipolar device to focus the energy between the two electrodes along with lower voltage waveform results in a refined area of coagulation with less char formation.

Disadvantages for bipolar device:

1. Using a low power setting demands increased time for coagulation.
2. Incidental tearing of adjacent blood vessels since tissues can sometimes become adherent to the electrodes.

The proximity of the return electrode to the working tip manifest as a lack of versatility of tissue effects, as neither tissue vaporization nor fulguration is possible with bipolar electrosurgery.

One must remember that bipolar electrosurgery does not eliminate the risk of stray current injury from insulation failure (with or without direct coupling to other instruments) (Table 3.2 and Box 3.3).

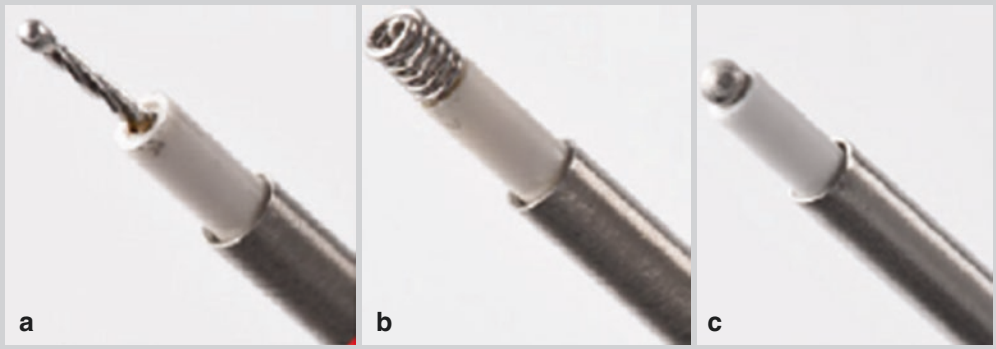
Table 3.2 Comparison of energy modalities

	Monopolar	Bipolar	Laser
Tissue effect	Cutting, coagulation	Cutting, coagulation	Cutting, coagulation
Power setting	50–80 W	30–50 W	15 W
Thermal spread	Not well assessed (multiple variables)	2–6 mm	<1 mm
Maximum temperature	>100 °C	>100 °C	>100 °C

Box 3.3 Bipolar Instruments

Bipolar instruments can be used with electrolyte solutions (normal saline solution 0.9%). Using a generator that works in combination with 3 main types of 5 Fr (1.6 mm) electrodes:

(a) *The Twizzle*, widely used for fine-regulated and precise tissue vaporization.
(b) *The Spring*, useful for the vaporization of larger portion of tissue.
(c) *The Ball*, extremely useful for coagulation.



3.1.2.2 Resectoscope

The modern resectoscope typically consists of a working element, two sheaths (inner and outer), and the loop (active or cold). The most used are of 22 Fr (~7.3 mm), 26 Fr (~8.7 mm), and 27 Fr (~9 mm) and can equip *unipolar or bipolar* energy.

The introduction of smaller devices ranging from 3 to 6 mm caliber such as the mini-resectoscope (Box 3.4) has allowed the possibility of displacing many indications from the operating room to office procedure settings, that is, on a "see and treat" basis.

When using a unipolar energy with a resectoscope, one can find cutting loops (angled or straight) with a great number of electrodes (pointed or Collins electrode, ball-end coagulating electrodes, spike electrode, roller electrode, and VaporCut).

The bipolar resectoscopic instruments may be cutting loop, ball-end coagulating, and pointed electrodes (Fig. 3.5).

Box 3.4 Mini Resectoscope

Bipolar/monopolar energy coupled with small-diameter hysteroscopes that have a continuous flow system

A mini-resectoscope was first demonstrated in 2009 when 26 patients underwent an office polypectomy and all lesions were resected. From then on, proving its advantages, the miniresectoscope Reducing medical costs, improving patient tolerability and reducing complications associated with traditional resectoscope. The miniresectoscope has its own promise in Hysteroscopy.

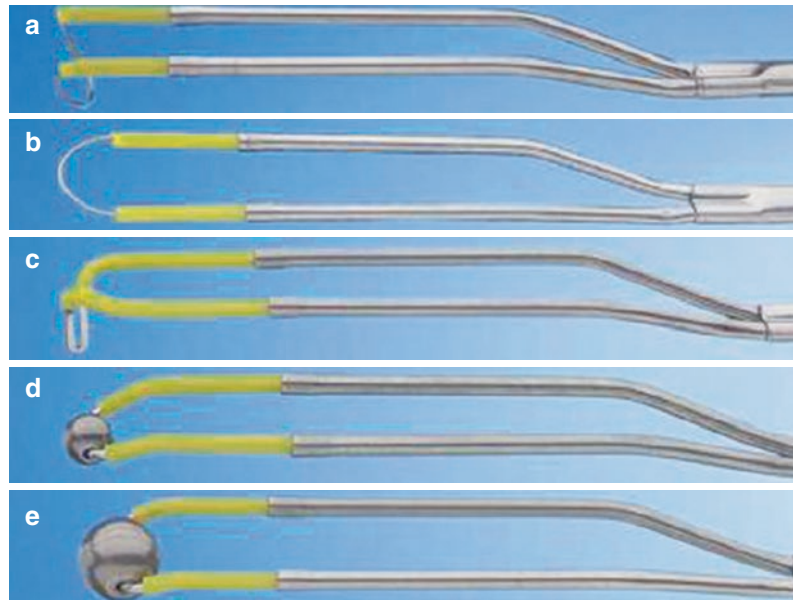
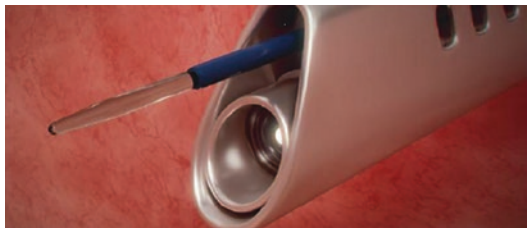


Fig. 3.5 Unipolar loops and electrodes. (**a**) Angled cutting loop; (**b**) Straight 5-mm cutting loop; (**c**) Collins pointed electrode; (**d**) 3-mm ball-end coagulating electrode; (**e**) 5-mm ball-end coagulating electrode

3.1.2.3 Laser



The diode laser was introduced to hysteroscopy in the 1970s and 1980s in the USA. The typical laser device is amplifying light to be reflected between parallel mirrors. The laser comes out as a parallel beam light, monochromatic and coherent with highly concentrated energy. Due to these features, the high-energy light beam is able to section tissue or even to vapor it. The beam might have high tissue penetration or low.

The main advantages using laser energy are avoidance of most of pain, low relapse rate, and high patient satisfaction compared with the electrical bipolar procedure. The results do not seem to be related to size or number of pathologies, and a 12-month follow-up shows both the lowest recurrence and complications rates (Fig. 3.6 and Box 3.5).

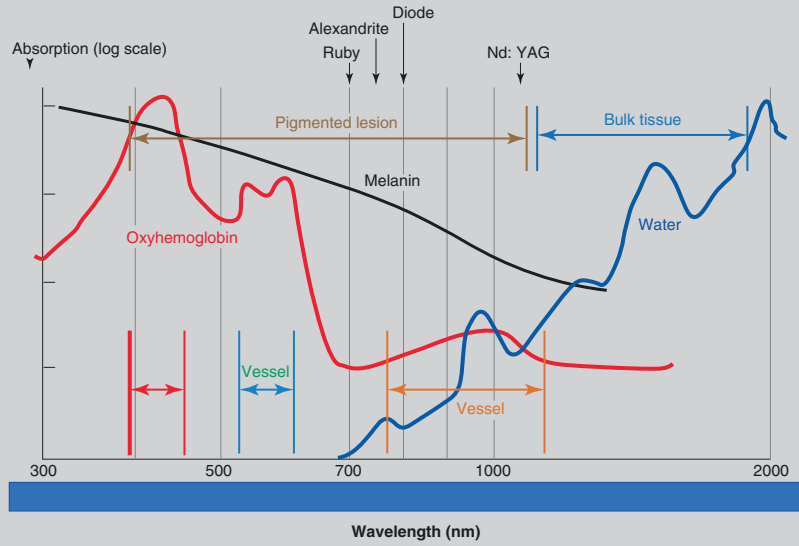
3.1.2.4 Ablation

Endometrial ablation is done mainly to manage abnormal uterine bleeding.

The basic method of endometrial ablation is to place an electrode over the target tissue to transmit high-frequency alternating current to the tissue in the range of 350 to 500 kHz. It can increase the temperature of the target tissue to greater than 100 ° C and cause protein denaturation, desiccation, and coagulation necrosis; it has a built-in sensor for automatically terminating transmission of the current at a particular set point to prevent overheating and unwanted collateral damage (Box 3.6).

Box 3.5 Parameters for Laser Surgery

1. Power in watts (Watt): relatively low energy (15 W) may be used for tissue sectioning, While energy over 100 W is needed to vapor tissue.
2. Wavelength: depending on the wavelength, the energy emitted will behave different. A 980 nm wave will be absorbed by hemoglobin having a coagulation effect, while the 1470 nm wave being absorbed by water will have a vaporization effect.



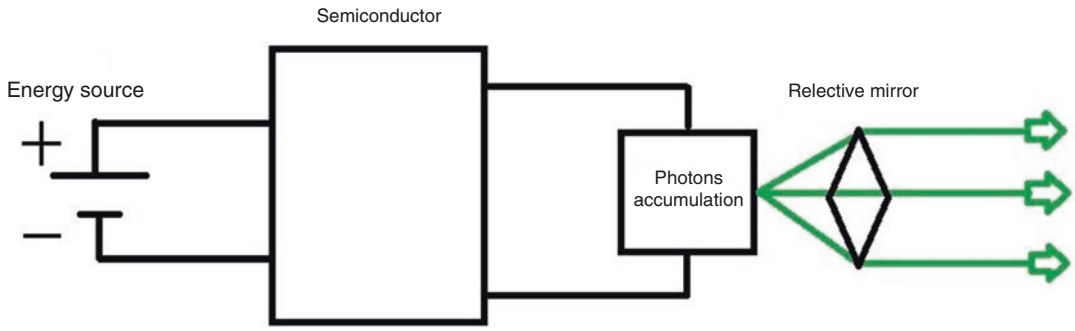


Fig. 3.6 Laser technology Scheme. (1) Energy source. (2) Semiconductor. (3) Photon accumulation. (4) Reflective mirror

Box 3.6 Options for Endometrial Ablation
Options for endometrial ablation include:

- *Electrosurgery*. Heating of the endometrium.
- *Cryoablation*. Extreme cold is used to create two or three ice balls that freeze and destroy the endometrium.
- *Free-flowing hot fluid*. Heated saline fluid is circulated within the uterus.
- *Heated balloon*. A balloon device is inserted through the cervix and then inflated with heated fluid.
- *Microwave*. A slender wand is inserted through the cervix. The wand emits microwaves, which heat the endometrium.
- *Radiofrequency*. A special instrument unfurls a flexible ablation device inside the uterus. The device transmits radiofrequency energy that vaporizes the endometrium (Fig. 3.7).

3.1.3 Electrosurgical Hysteroscopic Hazards

Operating room fires might be the result of inappropriate use of electrosurgical devices. Where in laparoscopic procedures it is mainly due to limited surgeon's field of view, in hysteroscopy, though very rare, it is due to inappropriate use of the equipment.

Some of the most frequently encountered complications related mainly to monopolar device are direct coupling, insulation failure, and capacitive coupling.

$$\text{Burn} = \frac{\text{Current} \times \text{Time}}{\text{Area}}$$

(a) Direct coupling—When the active electrode is near another metal instrument during electrical activity. The energy will seek a different route to the return electrode.
(b) Insulation failure—Happens mainly during coagulation, using high voltage energy. Where the energy "leaks" via a break in the active electrode device, seeking a different route to the return electrode.
(c) Capacitive coupling—When energy from an active electrode is transferred across the insulator surrounding it to another conductor.
(d) Dangerous return electrode contact—If the surface area of the return electrode is reduced or if the impedance of the contact is increased, a burn might ensue.

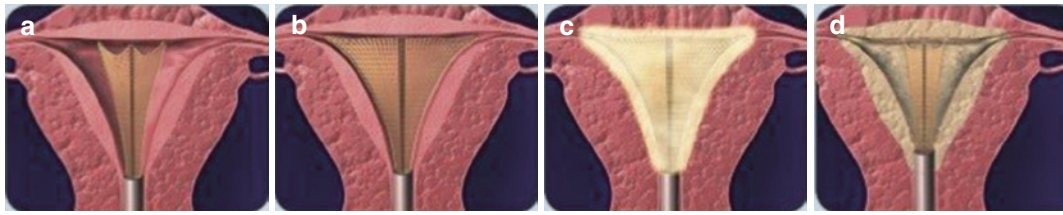


Fig. 3.7 Radiofrequency (Novasure) ablation: (**a**) Triangular mesh device is extended in the uterus. (**b**) Fitting to the size of the uterus. (**c**) RF energy is delivered through the mesh. (**d**) The mesh device is pulled back

4 Distension Media and Fluid Management in Hysteroscopy

Aswath Kumar and Megha Jayaprakash

Since the uterine walls are closely apposed to each other, hysteroscopic visualization of any intrauterine pathology requires adequate distension of uterine cavity by overcoming the myometrial resistance. Knowledge of the characteristics of each distension medium, its interactions with energy sources and its potential complications is an essential prerequisite for all gynaecologists.

4.1 History

Selection and use of distension media has evolved over the years. Lindermann introduced CO_2 as a distending medium through automatic pressure insufflator in 1972 [1]. This was followed by the usage of dextrose (5% and 10%) as well as high-molecular-weight dextran (32%) in the 1980s, both of which have become unpopular due to adverse effects and difficulties associated with use.

Currently low-molecular-weight liquid media which includes electrolyte solutions like normal saline and non-electrolyte solutions like sorbitol and glycine are mostly in use.

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4.2 Classification of Distension Media

1. Based on physical state into
   (a) Gaseous—CO_2.
   (b) Liquid—Normal saline, mannitol, sorbitol, glycine, dextran.
2. Based on molecular weight and viscosity into
   (a) High viscosity, high molecular weight—32% Dextran 70 (Hyskon).
   (b) Low viscosity, low molecular weight
   - Electrolyte-rich
     - Normal saline (0.9%)
     - Ringer lactate
   - Electrolyte-free
     - 5% Mannitol
     - 3% Sorbitol
     - 1.5% Glycine
     - 3% Sorbitol + 0.5% mannitol (Purisol)

An ideal distending medium should allow clear visualization and at the same time be inexpensive, a nonconductor, nonallergenic, isoosmolar, nontoxic, nonhaemolytic and rapidly cleared from the body. Such a perfect medium is yet to be discovered!

The choice of medium will depend mainly on the type of procedure (diagnostic/operative) and the choice of the energy source used by the surgeon.

Let us examine each commonly used medium in detail.

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https://doi.org/10.1007/978-981-15-2505-6_4

4.2.1 Gaseous Media

4.2.1.1 Carbon Dioxide

It is the only gaseous medium used in hysteroscopy now. Since it has a refractive index of 1, it allows maximal angle of view and clear viewing. As it is highly soluble and diffusible in blood, it is easily eliminated through the lungs. But if there is intrauterine bleeding, it can form gas bubbles and impair vision.

A specialized hysteroscopic insufflator is needed to calibrate gas flow rate and intrauterine pressure when using CO_2 and a laparoscopic insufflator should never be used as it can cause gas embolism. This is because the flow rates in laparoscopic insufflator are very high in the range of 1 L/min when compared to 100 mL/min or less with hysteroscopic insufflator to achieve intrauterine pressures of around 100 mmHg. Gas embolism can also occur if very high intrauterine pressures are used for a long time.

Other problems with CO_2 include shoulder pain due to diaphragmatic irritation by CO_2. This usually resolves by itself without treatment.

CO_2 is used only for simple diagnostic procedures if at all. As randomized trials have shown that pain scores and operating times are lesser and visualization and satisfaction scores are better with normal saline, it is preferred over CO_2 for diagnostic procedures too [2]. BSGE/ESGE Guidelines advise not to use CO_2 for operative hysteroscopy.

4.2.2 Electrolyte-Rich, Low-Viscosity Media

4.2.2.1 Normal Saline

It is a freely available, inexpensive, isoosmolar (285 mEq/L) and metabolically inert electrolyte-rich fluid of low viscosity containing Na^+ (153 mEq/L) and Cl^- ions in physiological concentration. Being isotonic, it does not disturb the osmolar balance between intracellular and extracellular fluid compartments.

Hyponatraemia is also not a problem with this fluid and it is the preferred medium for diagnostic hysteroscopy. It is also used in operative procedures using bipolar electrosurgery, laser and microwave energy as well as mechanical tissue morcellation and removal.

It is contraindicated with monopolar resectoscopic surgery as the electrolytes conduct and disperse the electric current and impede the electrosurgical effect.

In cases of intravasation of excessive amounts of normal saline (in excess of 2.5 L), the patient can develop fluid overload with pulmonary oedema and congestive heart failure. Guidelines from AAGL, BSGE and ESGE recommend using automated fluid pumps and fluid-monitoring systems to strictly monitor input and deficit.

When automated monitors are not available, a designated person should manually monitor both input and deficit. Longer operating times and use of higher pressures to distend the uterus are associated with higher risk of intravasation.

A cutoff of 2500 mL is suggested as criterion to terminate the procedure for electrolyte-containing media like normal saline in healthy women. This cutoff is kept at 1500 mL for women with comorbidities. These cutoffs are arbitrary and good practice points [2, 3].

Gas embolism can also occur with fluid media through production of gas bubbles during electrosurgery or with entry of air through an open cervix or during removal and reinsertion of instruments. Dyspnoea with fall in end tidal CO_2 should alert the monitoring personnel on the possibility of gas embolism. Fluid deficit more than 1000 mL, high intrauterine pressures above 150 mmHg and longer operating times are also found to increase the risk of gas embolism.

4.2.2.2 Ringer Lactate Solution

It is an isoosmolar(279 mEq/L) electrolyte-rich fluid containing water and sodium chloride, potassium, lactate and calcium. So electrolyte

imbalance is not a problem but excessive fluid intravasation leading to volume overload and heart failure is a distinct possibility, warranting the use of automated fluid infusion pumps and automated deficit monitoring systems. The deficit cutoff recommended is 2500 mL which is the same as for normal saline.

It can be used for diagnostic hysteroscopy as well as operative procedures using bipolar and laser energy as well as for mechanical morcellation and removal.

4.2.3 Nonelectrolyte Low-Viscosity Media

4.2.3.1 Sorbitol 3%

It is an inexpensive, electrolyte-poor 6-carbon sugar (reduced form of glucose) solution which is metabolized in the liver into fructose, glucose, CO_2 and water in the body. It has an elimination half-life of approximately 33 min. It is a hypoosmolar solution (165 mosmol/L) and can cause fluid overload with hypoosmolar hyponatraemia, hyperglycaemia, hypocalcaemia, cerebral oedema, skeletal muscle and nerve dysfunction if large volumes are absorbed.

Hence, strict monitoring of fluid deficit is essential. It is preferred for all procedures using monopolar electrocautery.

4.2.3.2 Glycine 1.5%

It is an amino acid solution that is metabolized into serine, ammonia and free water in the liver and has an elimination half-life of more than 40 min but the half-life is dose dependent as glycine is absorbed intracellularly and metabolized.

It is a hypoosmolar solution (200 mosmol/L), and intravasation of large volumes can cause volume overload, hypoosmolar dilutional hyponatraemia, hyperammonaemia, neurological symptoms like seizures, temporary blindness and coma due to cerebral oedema. Hence, strict monitoring of fluid deficit is essential.

There is good evidence recommending the use of intracervical injection of dilute vasopressin (1 unit in 20 mL normal saline at two sites around the cervix) at the start of the procedure to minimize intravasation of electrolyte-poor distending media. It is preferred for operative procedures using monopolar electrosurgical instruments.

Traditionally a fluid deficit of >1000 mL is considered a cutoff for stopping the procedure when using all nonelectrolyte solutions. This is because a drop in serum sodium level by 10 mEq/L corresponds to an absorbed volume of 1000 mL. In elderly patients with comorbidities, it is advisable to stop the procedure at a fluid deficit of around 750 mL [2, 3].

4.2.3.3 Mannitol 5%

It is a 6-carbon sugar alcohol (polyol) and is an isoosmolar solution (275 mosmol/L). It is an osmotic diuretic with only minimal amounts being metabolized. Its elimination half-life is more than 100 min. It can produce hyponatraemia due to increased sodium excretion. Volume overload can also occur and strict monitoring is required. It is used for operative procedures using monopolar electrosurgery.

4.2.4 High-Viscosity Fluids

4.2.4.1 32% Dextran 70 (Hyskon)

It is a high-molecular-weight substance (70,000 kDa) in dextrose solution. Being highly viscous, only a small quantity is needed. Being immiscible with blood and with a high refractive index, it gives clear views even in the presence of bleeding.

But it has fallen into disrepute because of serious side effects like anaphylaxis, electrolyte imbalances, coagulopathies and disseminated intravascular coagulation. It is also known to cause crusting on instruments, making it very difficult to clean and reducing the lifespan of these expensive instruments. Hence it is no longer used [3].

4.2.4.2 Methods for Fluid Inflow

Gravity

The fluid bag is suspended at a height of about 80–100 cm from the perineum and the fluid is allowed to flow by gravity to get an irrigation pressure of about 70–80 mmHg. It can only be used in diagnostic and simple office hysteroscopic procedures that can be completed in a short time.

Pressure Cuffs

These cuffs are applied over the fluid bag and inflated manually by an assistant to get a pressure of around 80 mmHg. The pressure needs adjustment with the emptying of the bag. Precise calibration of pressures may not be possible, leading to increased fluid absorption.

This is useful only in diagnostic and short office procedures.

Electronic Fluid Infusion Pumps

These automated systems allow control of flow rate, setting of a desired pressure cutoff and titration of intrauterine pressure. Ideally, titration of pressure within the uterus rather than a constant pressure throughout the procedure is required.

Some advanced systems also allow precise calculation of fluid deficit and these are invaluable in operative hysteroscopy involving deep resection, opening up vascular channels and needing longer operating times.

When using manual methods to infuse fluid and to measure fluid deficit, it is advisable to have drapes with reservoir bags [3].

4.3 Major Complications Associated with Distension Media

4.3.1 Gas/Air Embolism

It can occur not only with CO_2 but also with fluid media. With the use of dedicated hysteroinsufflator which controls the flow rate and pressure, the incidence of gas embolism with CO_2 has decreased. It is more common in lengthy operative procedures undertaken using large volumes of fluid distension media at high intrauterine pressure with multiple reinsertion of the scope, air getting in through open cervix or by the presence of air bubbles in the tubings. Gas embolism significant enough to cause cardiovascular collapse is rare but can be fatal.

Symptoms of gas embolism include dyspnoea (most common), gasping, "sucking sound" of air entering vessels, substernal chest pain, dizziness and blurring of vision. These can only be appreciated with regional anaesthesia.

Signs include tachypnoea, tachycardia, hypotension, wheeze, rales, Mill-wheel murmur, elevated JVP with signs of right heart failure, sharp fall in end tidal CO_2 and respiratory failure. There may be altered mentation with focal neurological deficits. If it is, a massive air embolism crepitus may be elicited over superficial vessels and livedo reticularis on skin.

Once there is a suspicion of air embolism, the procedure should be stopped and the uterus deflated. Supportive resuscitation is the main mode of management and includes ventilation, volume expansion and vasopressors.

Preventive measures include:

- Ensuring there are no gas bubbles in all tubings.
- Clamping the open cervix around the hysteroscope.
- Limiting removal and reinsertion of hysteroscope.
- Titration of intrauterine pressure to keep it not too high compared to mean arterial pressure (not more than 125–150 mmHg).
- Limiting fluid deficit to less than 1000 mL.
- Use of hysteroinsufflators for CO_2.
- Using flat or reverse Trendelenburg position.
- Avoiding nitrous oxide for anaesthesia.

4.3.2 Excess Fluid Intravasation with Electrolyte Imbalance

This is more common in hysteroscopy than TURP procedure in urology as the distension pressures used are much higher than the mean arterial pressure in hysteroscopy. The incidence is less than 0.5% and is dependent on the patient's

age, comorbidities, type of distension medium used, length and complexity of procedure, size and intramyometrial depth of lesion to be excised.

4.4 Factors Influencing Fluid Absorption

- The higher the intrauterine pressure is above the mean arterial pressure, the more the chance of intravasation into the blood. Pressures above 75 mmHg drives fluid through the tubal ostia into the peritoneal cavity. Fluid absorption is also higher in elderly and in those with cardiovascular conditions with low mean arterial pressure.
- In procedures like myomectomy, endometrial resection and metroplasty where there is deep dissection that opens up larger diameter blood vessels, there is danger of rapid intravasation of fluid under high pressure.
- In larger uteri with greater surface area, the chance of absorption is more.
- It is also higher with longer operating times.
- Complications from fluid overload tend to be more severe and occur at lower fluid deficits in women with cardiovascular and renal diseases.
- Neurological complications are higher in premenopausal women as oestrogen suppresses the ATPase pump that regulates the flow of electrolytes across the blood-brain barrier [3].
- Though it is a threat with all types of fluid media, hypoosmolar electrolyte-poor media are more likely to cause fluid overload with electrolyte and metabolic abnormalities at relatively lesser fluid deficits when compared to electrolyte-rich media.

It can manifest as headache, dyspnoea, chest pain, facial oedema (parotid area sign), bradycardia, acute pulmonary oedema, hyponatraemia, visual disturbances, seizures and coma.

Measures to decrease fluid absorption include:

- Avoiding excess preloading with intravenous fluids.
- Injecting intracervical diluted vasopressin at the start of the procedure.
- Using isoosmolar, electrolyte-rich media whenever possible.
- Using regional anaesthesia to limit intraoperative fluids.
- Opting for regional anaesthesia to elicit symptoms in the awake patient.
- Using automated systems that control flow rate, titrate intrauterine pressure and monitor fluid deficit accurately with safety alerts and alarms for high pressure and fluid deficit.
- Limiting removal and reintroduction of hysteroscope [4] and surgical time to less than an hour if possible.
- Limiting fluid deficit to less than 1000 mL for electrolyte-poor media and to less than 2500 mL for electrolyte-rich media.
- There is conflicting evidence regarding the use of preoperative GnRHa in reducing fluid absorption [2, 3]. Its use can be considered in premenopausal women [3].

It is advisable to measure fluid deficit at 10-min intervals [3] and to reassess the cardiovascular, mental and respiratory status of the patient after a deficit of 500 mL with evaluation of laboratory parameters and to terminate the procedure if the cutoffs for fluid deficit or blood levels are attained. Evaluation of haematocrit, platelets, blood urea nitrogen, creatinine, sodium, potassium, chloride, bicarbonates, glucose, ammonia and plasma osmolality are done depending on the medium used. It is important to know that some patients may not show any symptoms but since fluid and electrolyte shifts continue for several hours, it is mandatory to continue monitoring them postoperatively.

Management should be multidisciplinary in an intensive care setting and includes terminating the procedure with the use of intrauterine balloon tamponade if there is excessive bleeding, fluid restriction, diuresis with intravenous frusemide, correction of hyponatraemia with hypertonic saline and if required positive pressure ventilation and haemodialysis.

Too rapid and too late correction of hyponatraemia both can produce central pontine myelinolysis. Hypertonic saline (1 L = 513 mEq/L) is usually reserved for severe cases with correction at the rate of 1–2 mEq/L per 2 h until serum level

of 120 mEq/L is attained, followed by less concentrated saline until the goal of 135 mEq/L is reached [1].

Other complications associated with distension media include vasovagal syncope due to pain during distension and theoretical risk of spilling neoplastic cells into peritoneal cavity [1].

Key Points

1. Use electrolyte solutions or CO_2 for distension in simple diagnostic procedures.
2. Use monopolar electrosurgery only with electrolyte-poor fluid media like glycine and sorbitol.
3. Use electrolyte-rich media with other energy sources as well as for mechanical morcellation.
4. Use automated fluid infusion and monitoring systems for operative hysteroscopy.
5. Use intracervical dilute vasopressin before cervical dilatation to minimize fluid absorption.
6. Terminate the procedure at a fluid deficit of 1000 mL for electrolyte-poor media and at 2500 mL for electrolyte-rich media. Use lesser level cutoffs for patients with advanced age and comorbidities.
7. Use dedicated hysteroscopic insufflators while using carbon dioxide.
8. Maintain the lowest intrauterine pressures that provide adequate visualization.
9. Ensure operating team has efficient management plans in place to prevent, recognize and treat complications associated with distension media.

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How to Set up High-Tech Hysteroscopy Unit

5

Rahul Manchanda and Richa Sharma

Hysteroscopy allows direct visualisation of the uterine cavity with the opportunity for targeted biopsy, safe removal of endometrial polyps, submucous fibroids, treatment of intrauterine septum and adhesions [1]. Since the last few years, there has been a drastic improvement in hysteroscopic diagnostic and operative procedures. Various new innovations, integrated technological developments and continuous research to improve the techniques have enabled us to offer the best approach to our patients.

5.1 High-Tech Hysteroscopy Unit Components

1. Operation theatre (prefabricated modular OT/integrated operation room).
2. Efficient team.
3. Basic and advanced instruments.
4. Safe patient positioning.
5. Mandatory use of BSGE/ESGE 2016 safety checklist proforma for monitoring fluid management during operative hysteroscopy.

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5.2 Operation Theatre

A well-equipped and organized OT is the basic requirement of high-tech hysteroscopy unit, to perform diagnostic and advanced operative procedures [2]. Prefabricated modular operation theatre and an integrated OR (Karl Storz OR 1 fusion™) provides excellent opportunity for OT set-up.

Prefabricated Modular Operation Theatre (Fig. 5.1)—Flexible prefabricated modular wall system for OTs installation has a modular grid construction.

5.3 Features

- **Laminar air flow system:** Creates a positive pressure in the OT especially giving out fresh air on the operating area. The air is quickly and continuously circulated through the exhaust system and purified through the HEPA filters.
- **Control panel:** Control panel consists of 6–9 tiles displaying time of days clock, lapsed time clock, temperature display/control, humidity display/lighting control/control dimming, medical gas alarm systems, hands-free telephone, HEPA filter status indicator, OT pressure indicator and music control.
- **X-ray viewer:** Ergonomically designed X-ray/HSG view base.

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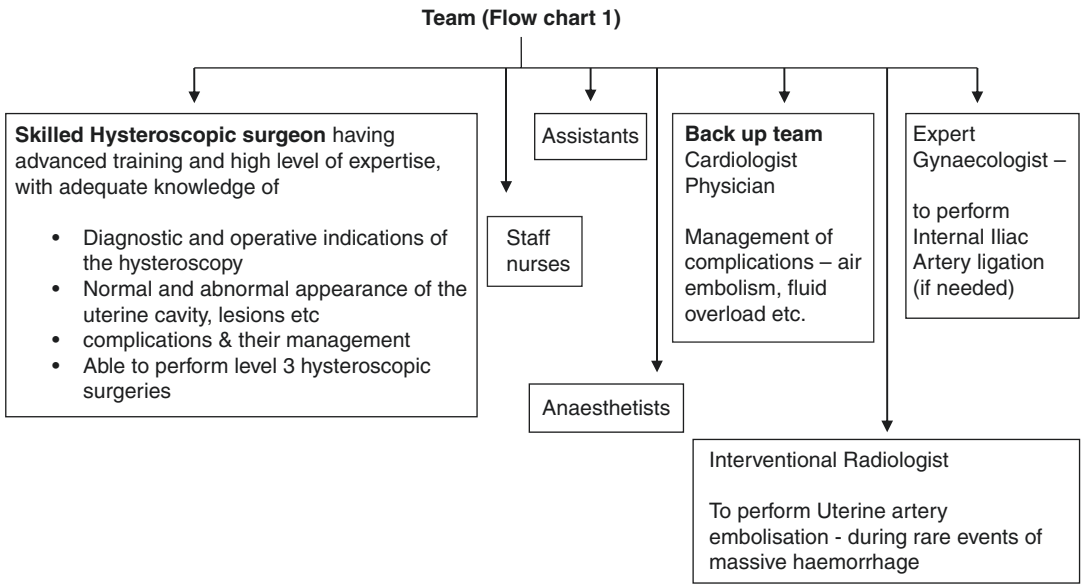
https://doi.org/10.1007/978-981-15-2505-6_5

Fig. 5.1 Equipped modular operation theatre

- **Magnetic writing board:** Made of ceramic having magnetic properties and is flushed to the wall of the operating room.
- **Storage unit:** Zintex panels transformed to integrated storage unit with antibacterial paint, covered with clear glass and magnetic catcher.
- **Pendant system:** Ceiling pendant with closed powder-coated aluminium alloy beam that contributes to improved hygiene and maximizes the working area with a hassle-free and wire-free floor space.
- **Scrub station:** Modular splash-proof sensor-controlled scrub sink fully made of stainless steel, high finish, 304-grade sensor can sense the slightest of movements and is preprogrammed with 1, 3, 6 and 10 min scrub setting and knee-press action during unavailability of power.
- **Automatic hermetic slide door.** These are specially designed sliding doors that are complete and airtight.
- **Anti-static conductive vinyl flooring:** This special flooring is non conductive to free radicals and run off current hence helpful in operating rooms using cautery.
- **Peripheral lights:** Energy-efficient lamp with special blasts, which can offer 1500 lux consistent light throughout the OT. Additional set of recess mounted lights with on/off and dinner in built into the ceiling to increase/decrease the light to surgeon's requirement.
- **Hatch/pass box:** To remove waste materials from the operation theatre to the dirty linen area just adjacent to operation.
- **Pressure relief damper:** They are placed so as to maintain the pressure in the OT.
- **Attached modular ICU:** Specifically designed, staffed, furnished, equipped and dedicated to management of complications of hysteroscopy like air embolism, fluid overload, etc.
- **Bettocchi set-up trolley** [3]**:** Equipped with Tele Pack X LED, Telecam one-chip camera, Hysteromat EASI SCB, BIOH compact hysteroscope, 5 mm Bettocchi outer sheath and 4.3 mm inner sheath, Hopkins forward oblique telescope, biopsy and grasping double jaw 5Fr, scissors and accessories (Fig. 5.13).

5.4 Integrated Operation Room

Digital operating room platform allows complete integration of all video and data devices in the OR, optimizing surgical workflow and eliminating cable clutter. The digital operating theatre Karl Storz OR1 Fusion™ is the advanced platform that helps the clinical team expand beyond the traditional OR walls and can be able to more effectively collaborate with experts throughout the world.



5.5 Categories of Hysteroscopic Surgeries (RCOG 2011) [1]

5.5.1 Level 1

- Diagnostic hysteroscopy with target biopsy.
- Removal of simple polyps.
- Removal of intrauterine contraceptive device.

5.5.2 Level 2

- Proximal fallopian tube cannulation.
- Minor Asherman's syndrome.
- Removal of pedunculated fibroid (type 0) or large polyp.

5.5.3 Level 3

- Division/resection of uterine septum.
- Major Asherman's syndrome.
- Endometrial resection or ablation.
- Resection of submucous fibroid (type 1 or type 2).
- Repeat endometrial ablation or resection.

5.5.4 Instruments [4, 5]

- **Image management system:** camera, light source, medical grade monitors.
- **Hysteroscopes:** telescope, outer and inner sheath of working channel.
- **Resectoscopes.**
- **Electrodes:** bipolar and unipolar.
- **Ancillary instruments.**
- **Fluid delivery system:** Hysteromat.
- **Generator.**

5.5.5 Camera

Karl Storz and Strykers are the pioneers in the field of endoscopic imaging. FULL HD endoscope camera is modular in design and are optimally adapted to suit various requirements. With 1920 x 1080 resolution and progressive scan, the camera control unit (CCU) guarantees a lag-free image (Figs. 5.2 and 5.3).

IMAGE1S™-Technologies enable surgeons to modify the endoscopic image through homogeneous illumination or by increasing the dynamic contrast. In addition, colour hue shifting makes it easier to differentiate between tissue types. It

Fig. 5.2 Karl Storz HD camera

Fig. 5.3 Stryker HD camera

Fig. 5.4 Karl Storz 3D camera

gives sharp and excellent image brightness and tissue differentiation and homogenous illumination.

Image 1 S™ 3D provides excellent depth perception (Fig. 5.4).

Fig. 5.5 Light source—power LED

5.6 Light Source

LED laser hybrid technology ensures excellent bright light at homogenous colour temperature of 6000 k throughout the entire operating life. These are high-performance LED cold light source with service life 60 times more than xenon light, so frequent replacement of lamps is not required (Fig. 5.5).

Medical grade LCD display monitors—with facilities of 3D and 2D modes, maximum depth perception with detailed imaging with high-resolution pixels 1920 x 1080 (HD 1080) (Fig. 5.6).

5.7 Tele Pack X LED

Compact combination of powerful LED light system, monitor, camera control unit and integrated data management system (Fig. 5.7). It allows comprehensive recording of procedures; multiple USB ports and SD/SDHC card recorder are available for storing data; and patient images or videos can be transmitted to the hospital or practice network through export options. Keyboard and printer connected; patients data can be directly entered and printed.

Hysteroscopes: Two types are available—flexible and rigid; rigid hysteroscopes are frequently used.

5.8 New-Generation Atraumatic Hysteroscopes [6]

With facilities of two working channels that allow semirigid 5Fr operating instruments and bipolar electrodes:

Fig. 5.6 Medical grade LCD 2D and 3D monitors

Fig. 5.7 Tele pack X LED

Fig. 5.8 BIOH

1. **Bettocchi integrated office hysteroscope** (**BIOH**)—2 mm rod lens, 30° telescope and small 4 mm diameter. Allows single-handed operation and control of inflow and outflow (Fig. 5.8).
2. **CAMPO trophyscope**—2 mm rod lens, 2.9 mm outer sheath good image quality and have intra-op change over from single flow to continuous flow and/or operating sheath. Continuous flow operating sheath size of 4.4 mm and 24 cm length.
3. **Bettocchi 5 mm hysteroscope**—with 2.9 mm rod lens 30° telescope. Inner sheath size of 4.3 mm with working channel, outer sheath size of 5 mm and 30 cm length.
4. **Bettocchi 5 mm elongated hysteroscope**—36 cm.
   - **Telescope:** Forward oblique 30° and 12° telescope with diameters 2 mm, 2.9 mm, and 4 mm (Fig. 5.9). 30° telescope provides panoramic view best suited for diagnostic procedures, 25–30° are helpful for cannulation of tubes and the placement of sterilization devices and 12–15° are useful for ablation, resection and diagnostic procedures.
   - **Hysteroscope sheath:** Inner and outer sheaths are used according to the size of the telescope: for 2 mm telescope, 3.6 mm inner and 4.2 mm outer sheath; for 2.9 mm telescope, 4.3 mm inner and 5 mm outer sheath; for 4 mm telescope, 5.4 mm inner and 6 mm outer sheath (Fig. 5.10).

5.9 Electrodes (Unipolar and Bipolar)

For Coagulation of minor bleeding, adhesiolysis, polypectomy, myomectomy and metroplasty

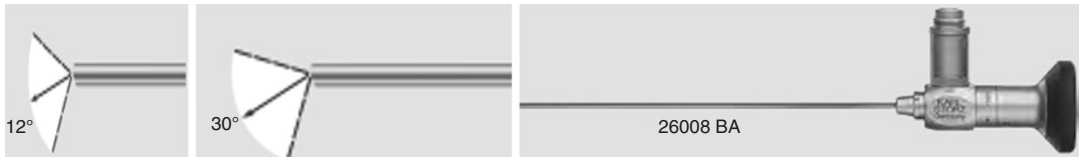


Fig. 5.9 Hopkins telescope

Fig. 5.10 Bettocchi sheath with working channel

Fig. 5.11 Bipolar electrodes

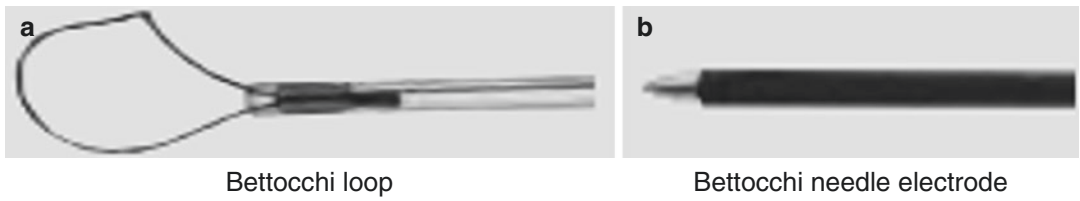


Fig. 5.12 Unipolar electrodes

- Bipolar electrodes (Fig. 5.11).
- Unipolar electrodes (Fig. 5.12).

Semi rigid Ancillary instruments: for mechanical operative hysteroscopy (Fig. 5.13).

5.10 Resectoscope [7, 8]

In addition to bipolar resectoscopes with diameters of 22 and 26 Fr., KARL STORZ introduced 15 Fr. Resectoscope that can perform resection outside the OR. Infertility patients or those suffering from abnormal bleeding can thus be treated in the clinical outpatient setting, even without anaesthesia. Together with the AUTOCON® III 400 HF generator, effective resection, coagulation or vaporization is achieved. It can also be used as a diagnostic hysteroscope in conjunction with semirigid 5 Fr. instruments (optional) and is real bipolar system with current not returned via the sheath (Figs. 5.14 and 5.15).

Double-flow bipolar resectoscope had been the gold standard technique to perform hysteroscopical myomectomy. But the disadvantages are:

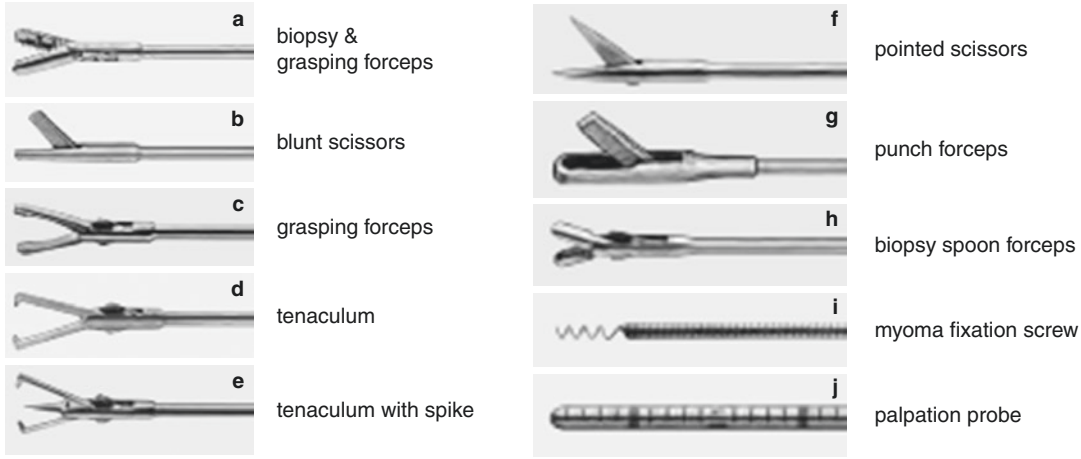


Fig. 5.13 Ancillary instruments

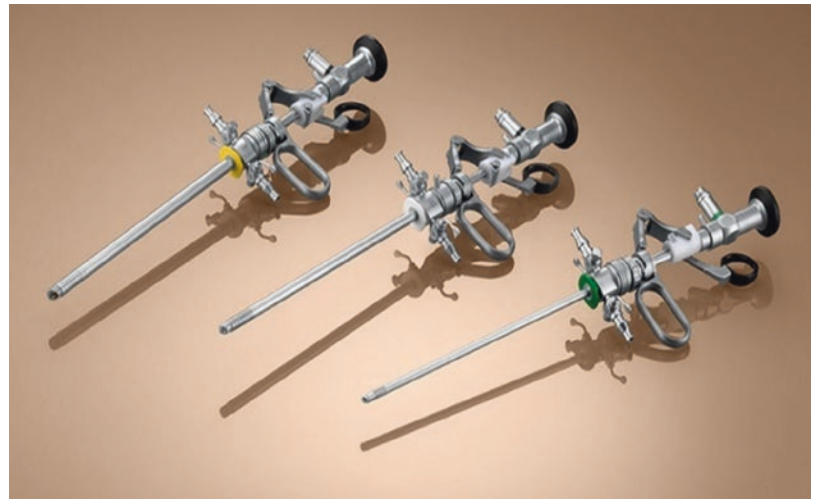


Fig. 5.14 15 Fr, 22 Fr and 26 Fr resectoscope

- Risk of fluid overload syndrome and water intoxication, even with normal saline and also massive absorption of normal saline solution can result in severe hyperchloremic metabolic acidosis and dilution coagulopathy that must be resolved with diuretic therapy.
- Use of high-frequency current during resection may lead to uterine perforation with bowel injury and internal and external burns caused by the uncontrolled leakage of current.
- During resection of large myomas, the tissue chips that remain inside the uterine cavity impair the surgeon's visual field and tissue pieces must be removed from the uterine cavity in order to complete the procedure under visual control, which increases operating time, intravasation of fluid and cervical laceration.

5.11 New-Generation 19 Fr. Intrauterine BIGATTI Shaver [IBS] [9]—(Fig. 5.16)

Removes the tissue chips at the same time as their resection and electrical current-free resection of myomas, could significantly reduce the postoperative adhesions formation and should be pre-

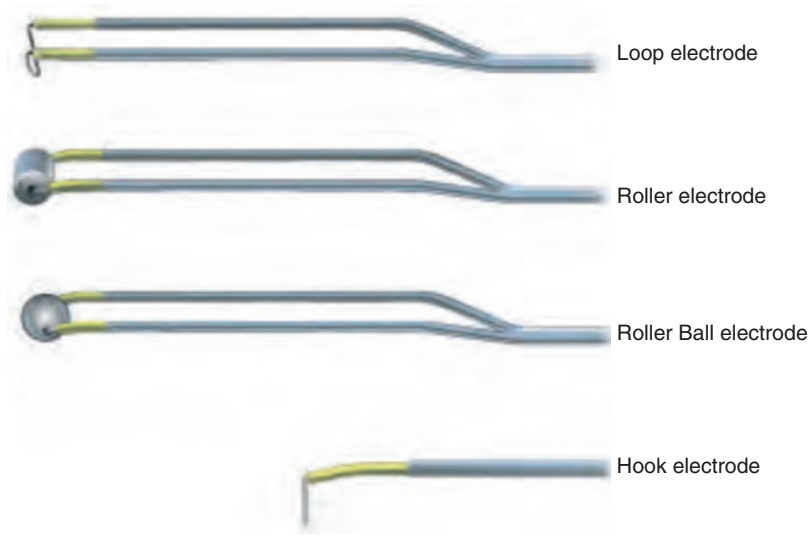


Fig. 5.15 Resectoscope—electrosurgical electrodes

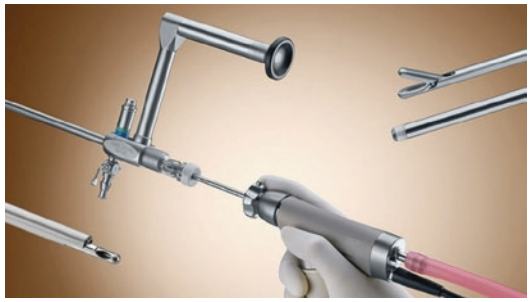


Fig. 5.16 Storz—19 Fr. Intrauterine BIGATTI shaver

ferred in young women. It has the property to enucleate the myoma without injuring the adjoining normal myometrium (Fig. 5.17a,b).

5.12 Laser

Fibre optic lasers have the advantage that it can be transmitted through the fibre inserted into the operating channel and these lasers are not blocked by fluids and can be easily directed to any area of the uterine cavity. The neodymium:yttrium-aluminium-garnet (Nd:YAG) laser is most commonly used, particularly for endometrial ablation, because it is attracted by the purplish tissue and because it destroys tissue protein by coagulation with its frontal, back and lateral scattering. The depth of penetration of 4–5 mm makes it suitable for endometrial ablation. This laser is in the infrared portion of the spectrum, with a 1064 nm wavelength, and is specifically absorbed by tissue protein. These are useful for endometrial ablation, adhesiolysis and division of a uterine septum.

5.13 Hysteromat

Hysteromat with features of automatic constant monitoring of intrauterine pressure due to controlled suction and irrigation function along with display of fluid deficit. It should be used in diagnostic as well as operative hysteroscopy, resection and shaver.

Storz endoscopic automatic system for irrigation (EASI) has optimized safety by display of intrauterine pressure and safety alerts in case of change of preset parameters. Optimal view is maintained all the time, as the cavity is sufficiently dilated and continuously rinsed [6].

IDLE mode enables liquid consumption to be reduced to minimum when changing instruments or removing tissues, also it ensures patient safety as the instrument mode is automatically deactivated on activation of IDLE mode (Fig. 5.18).

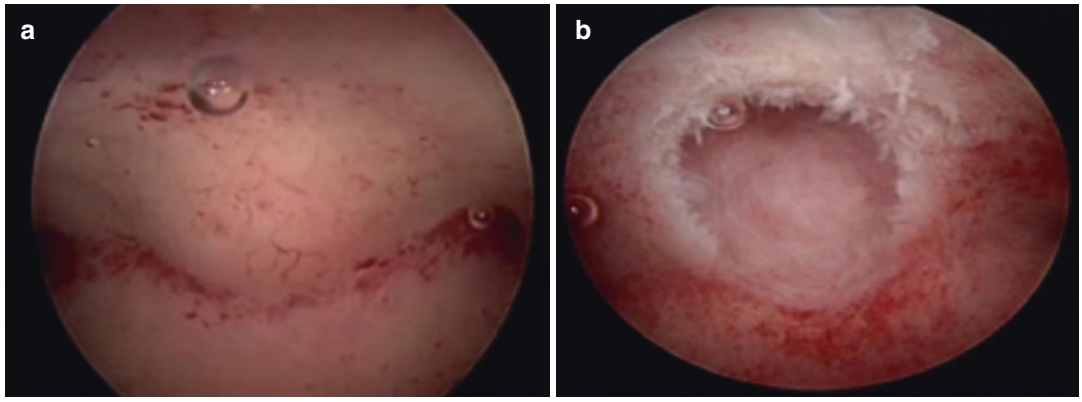


Fig. 5.17 (**a**) grade II—1.5 cm myoma. (**b**) myoma enucleated with IBS

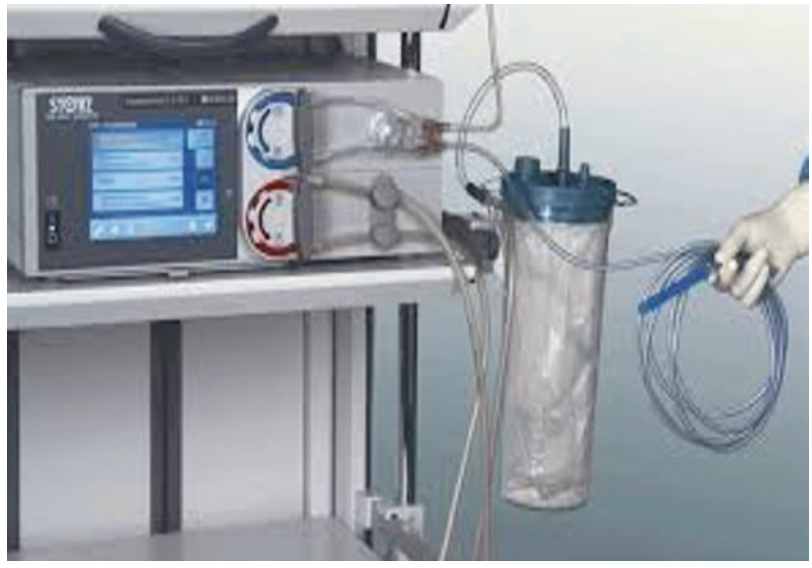


Fig. 5.18 Karl Storz Hysteromat—EASI

5.14 Generator

AUTOCON® III 300: With a maximum output of unipolar 400 Watt and bipolar 200 Watt, separate sockets for unipolar and bipolar electrodes for electrosurgical cutting and coagulation. It includes the features of early warning system that detects leakage current or incorrectly positioned neutral electrode. This system can deactivate power output and hence improves patient safety (Fig. 5.19).

5.15 Safe Patient Positioning

Modified lithotomy position is the most ideal position—moderate hip flexion, limited abduction and external rotation. Use padded supports at the pressure points like neck, hip and calf. Usage of Allen stirrups or candy cane stirrups avoids majority of trauma to the nerves, joints and soft tissues (Fig. 5.20).

Fig. 5.19 AUTOCON® III 300

Fig. 5.20 Modified lithotomy position with Allen stirrups

Key Points

- High-tech hysteroscopy unit is a self-sufficient unit that is able to carry out diagnostic and up to level 3 advanced hysteroscopic surgeries.
- Level 3 surgeries include division/resection of uterine septum, major Asherman's adhesiolysis, endometrial resection or ablation, resection of submucous fibroid (type 1 or type 2) and repeat endometrial ablation or resection.
- Prefabricated and integrated operation theatres are preferred.
- Tele Pack X LED is the compact combination of powerful LED light system, monitor, camera control unit and integrated data management system.
- New-generation 19 Fr. Intrauterine BIGATTI Shaver (IBS) removes the tissue chips at the same time as their resection.
- Modified lithotomy position is the most ideal position and pressure area should be well supported.

BSGE/ESGE 2016 Safety Checklist Proforma for Monitoring Fluid Management During Operative Hysteroscopy [10]**.**

Name…….
Date …….
Operation …….
Surgeon ……
Anaesthetist……
Energy of resectoscopy……
Energy medium used ……
Method of limiting intrauterine pressure:
Gravity height above patient meters
Pressure bag maxim pressure used mmHg
Automated system brand _____
Method of monitoring distension fluid in theatre.
Sole person identified to monitor fluid deficit, measured every 10 min yes ☐
Drape used with fluid reservoir yes ☐ no ☐
Closed system, i.e. fluid collection with suction yes ☐ no ☐

Operation start time	Fluid input	Fluid output	Fluid balance
+10 min			
+20 min			
+30 min			
Review—If not likely to complete procedure in under 60 min, consider stopping			
+40 min			
+50 min			
Review—Consider stopping procedure at 60 min			
Length of procedure min	Final	Final	Final
Stop procedure if fluid deficit reaches 1000 mL hypotonic solution (750 mL if elderly or with co-morbidities) or 2500 mL isotonic solution (1500 mL if elderly or with comorbidities)			

Management of significant fluid deficit
Catheterize with strict fluid balance
Diuretics: furosemide 40 mg IV
Check serum electrolytes, urea and creatinine
Consider chest X-ray if respiratory signs or symptoms
Involve ITU or senior anaesthetic staff
If Na <120 mmol/L, consider hypertonic saline in a critical care setting.

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6 Sterilization and Maintenance of Hysteroscopy Instruments

S. Krishnakumar, Rachana Kaveri, and Aditi Joshi

6.1 Introduction

Endoscopy instruments are delicate, expensive and must be handled carefully at all times. Besides the operating doctor, the assistant surgeons, nursing personnel and other assistants must be aware of the functioning of all instruments, accessory devices and their proper dismantling, cleaning and maintenance to ensure longevity of the instruments. As these instruments are complexly built, they are more vulnerable to lodging of bioburden within their crevices. Improper sterilization of reusable instruments can predispose the patient to genital infections and in severe cases even pelvic inflammatory disease.

Sterilization is defined as any process that kills, eliminates or deactivates micro-organisms like bacteria, fungi, viruses and spores. Earl Spaulding classified the instruments and devices depending upon the risk of infection and nature of contact into:

- Critical.
- Semi-critical.
- Non-critical.

Most of the endoscopic hand instruments are categorized as critical and must be sterilized, whereas endoscopes being semi-critical devices do not necessarily need sterilization, but a high-level disinfection is mandatory.

Sterilization of instruments is a major prerequisite to surgery. Prior to commencement of the process of sterilization, there are other important precursor steps [1]. These include:

1. Cleaning of the instruments: Manual cleaning of all surfaces of the instruments is important. The telescope must be disassembled from the inner and outer sheath. The instruments can be cleaned with the help of a brush or jet spray. Mild detergent solutions may be used for cleaning; however, corrosive solutions should be avoided.
2. Rinsing: All hollow instruments need to be flushed with water to ensure there is no blockage due to blood clots or other debris.
3. Drying: Once rinsed, the instruments can be disinfected with alcohol and dried before storage. This step is important to prevent recontamination with micro-organism that may be present in the rinse water.
4. Sterilization: This includes autoclaving, gas sterilization or use of high-level disinfectant solutions.

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https://doi.org/10.1007/978-981-15-2505-6_6

6.2 Cleaning and Maintenance of Instruments [1, 2]

6.2.1 Telescopes

These have to be handled with utmost care to avoid scratch marks or dents. Never stack or pile other instruments over the telescope while cleaning as this may damage the lens optics. Liquid soap is often used for cleaning the surface. The use of ultrasonic cleaner should be avoided in the case of telescopes. The mini-telescopes used in hysteroscopy are extremely delicate and have a diameter of 2 mm. These telescopes should never be held only in the centre, as it may lead to bending or slipping. One must always hold the telescope at the head end (camera head) to avoid damage to the telescopes (Fig. 6.1).

6.2.2 Light Cables

These contain delicate fibre optic glass channels. Hence the cable should never be bent in an inadvertent manner while attaching or detaching them from the light source. The cables can be washed in water but should not be immersed immediately post-procedure since the cable is heated, which may lead to damage. Often, alcohol is also utilized to clean and disinfect the cables.

6.2.3 Camera System

This encompasses the camera head, zoom and focus rings and the camera cables. The lens of the camera can be wiped with water, while the remaining apparatus can be disinfected with alcohol. The camera system must be connected to a voltage regulator to prevent damage due to fluctuations in electricity voltage.

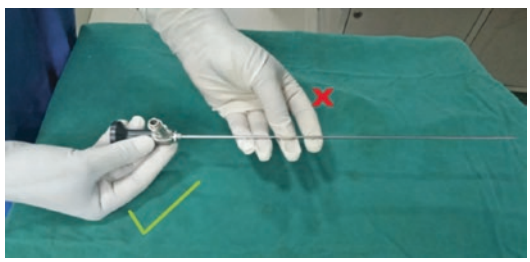

Fig. 6.1 Correct method of holding the telescope

6.2.4 Irrigation Pumps

The irrigation pumps should ideally be placed at a level above the patient. There should be no leakage of the irrigation solution near the dome of the tubing, since it may damage the sensors. Once the operative procedure is complete, both the irrigation and suction tubing must be cleaned thoroughly with water and air-dried with a gun.

6.2.5 Hand Instruments (Fig. 6.2)

These are more challenging to clean owing to the length and small calibre. Many instruments cannot be disassembled, hence are difficult to clean. Any available stopcock (Fig. 6.3) and crevices (Fig. 6.3) must be opened and water can be flushed through them at high speed. Additionally, the jaws and small crevices must be cleaned thoroughly with the help of a brush.

It is preferable to soak the instruments in enzymatic solutions to decontaminate them immediately post-surgery.

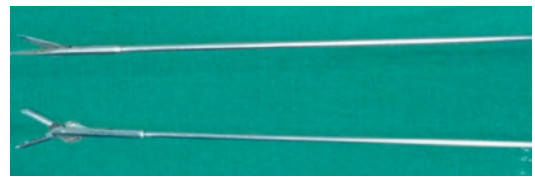

Fig. 6.2 Hand Instruments with Small Crevices

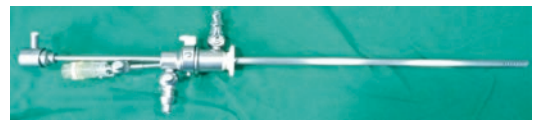

Fig. 6.3 Stop-cock helps to flush the channels

6.3 Methods of Sterilization

6.3.1 Autoclaving

This is the method of choice for sterilizing all metallic instruments. It is generally performed at a temperature of 121 °C for 15 min. Even telescopes, cords and silicon tubings can be autoclaved, however, with caution. Cords and tubings must be doubly covered in a cloth to avoid direct contact with the hot metallic surface. Telescopes are sterilized with vacuum or flash autoclave method. Flash autoclave constitutes sterilization at 135 °C for 1 hour at 30 Pa pressure. Post-sterilization, a 45-minute cooling period is given before drying. Automatic autoclaving machines these days come with inbuilt drying option (Fig. 6.4).

6.3.2 Gas Sterilization

Ethylene oxide (ETO) is the gas commonly employed for gas sterilization. This can be done in either cold or hot gas. The temperature is set at 85 °C for cold gas and instruments kept for 4 hours and 30 minutes. Aeration for 12 hours is mandatory after the previous step. Hot sterilization occurs at 145 °C for 2 hours and 30 minutes, followed by 8 hours aeration. Ethylene oxide offers advantages like non-corrosive nature and permeability through porous materials, and hence plastic packaging of instruments can be done before the process; this will help in storage of these instruments [3]. However, factors such as cost, toxicity, long duration of procedure and need for aeration are major drawbacks (Figs. 6.5 and 6.6).

Fig. 6.4 Autoclaving machine

Fig. 6.5 Ethylene oxide sterilizer

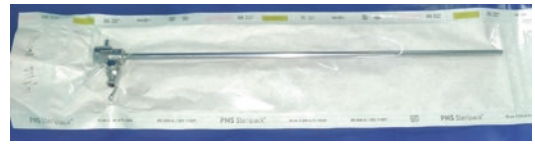

Fig. 6.6 Packaging of instruments for ETO

6.3.3 STERRAD [4] (Johnson & Johnson)

It is the modality of sterilization available especially for hospitals with a rapid turnover of cases. It combines the use of hydrogen peroxide vapour and low-temperature gas plasma to sterilize and leaves no toxic residue. The duration required is 75 minutes for wrapped and dried instruments. Aqueous peroxide (59%) is vaporized into the chamber after creating vacuum. Once the diffusion of the gaseous peroxide with the instrument load is begun, chamber pressure is reduced, allowing the generation of low-temperature gas plasma via radiofrequency energy. This leads to generation of reactive molecules which recombine to form water vapour and oxygen, along with other nontoxic by-products. Once the procedure is complete, instruments are dry and available for immediate use or sterile storage. Sterile storage minimizes the risk of contamination and also helps preserve the instruments in the event of a particular procedure being delayed or cancelled. This system requires minimal space and no venting or water hook-up. The only utility requirement is electrical supply.

6.4 Disinfectants [5]

Disinfectants are chemicals applied to the surface of inanimate objects in order to destroy micro-organisms or their vegetative forms. Endoscopes require a minimum of high-level disinfectant for sterilization. ETO is not preferred due to the prolonged time required for sterilization and the occupational hazard of the gas to the staff. The Centers for Disease Control and Prevention (CDC) categorizes disinfection into three levels:

(a) High level—kills vegetative micro-organisms and inactivates viruses, but not high numbers of bacterial spores.
(b) Intermediate level—kills vegetative micro-organisms, including *Mycobacterium tuberculosis*, and all fungi and inactivates most viruses.
(c) Low-level—most vegetative bacteria and some fungi are killed, also inactivates some viruses. Mycobacteria remain undestroyed.

The FDA has currently approved the following solutions for high-level disinfection: ≥2.4% glutaraldehyde, 0.55% *ortho*-phthalaldehyde (OPA), 0.95% glutaraldehyde with 1.64% phenol, 7.35% hydrogen peroxide with 0.23% per-acetic acid, 1.0% hydrogen peroxide with 0.08% per-acetic acid and 7.5% hydrogen peroxide. However, the last two agents amongst these are not commonly employed since some have reported functional damage to the endoscopes with them. Glutaraldehyde and ortho-phthalaldehyde are the most common agents employed for disinfection in day-to-day practice.

6.4.1 Glutaraldehyde

It is the most common disinfectant used. It requires activation and is utilized at a dilution of 2% with a buffer solution. It needs a temperature of 25 °C and exposure time of a minimum of 20 minutes; in the case of mycobacterium, exposure time required is 45 minutes and for sporicidal action, it may be as long as 6–10 hours. Its major limitations are irritability caused to the nasal mucosa as well as the eyes and clogging of the telescopes due to protein coagulation in the presence of blood or debris. The shelf life of the prepared solution is 14 days.

6.4.2 *Ortho*-Phthalaldehyde (OPA)

This is an aldehyde disinfectant. It does not require any activation, thus offering a major advantage over glutaraldehyde. The contact time required is also much less (5 minutes). Being less toxic, it is safer for handling by staff. The shelf life is 14 days. However, its disadvantages include high cost and the possibility of permanently staining the skin or clothing (Fig. 6.7).

The disinfectant solutions ought to be tested daily with the manufacturer's test strip. Always adhere to the manufacturer's instructions regarding proper storage temperature and expiration date. In the event that the solution turns cloudy, it must be discarded and new solution should be prepared.

6.4.3 Formalin Chamber

Once employed commonly as a means of sterilization, formaldehyde has been found to be extremely irritating to the skin, eyes, nose and respiratory tract. There have been reports of it being potentially cancer-causing [6]. Furthermore, its efficacy is yet inconclusive. Hence, routine utilization of formaldehyde for sterilizing instruments and other items is not recommended.

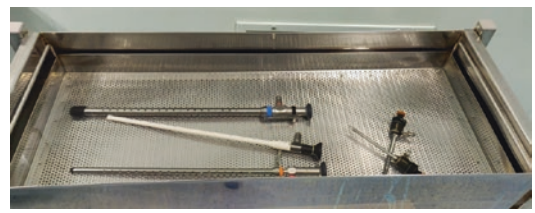

Fig. 6.7 Sterilization chamber filled with disinfectant solution

Key Notes

- Always clean the instruments immediately post-procedure, to avoid drying of blood stains and other debris. Any enzymatic solution used should be according to the instructions as per manufacturer.
- Most instruments have to be cleaned manually. The use of mechanical or automated devices may damage the instruments; hence it must be used with caution.
- Only individuals with proper knowledge regarding the correct handling and sterilization of instruments should handle them.
- Avoid stacking instruments on one another.
- Never bend or drop the instruments.
- Storage of sterilized instruments must be done in a manner to avoid recontamination and to keep them dry.
- Always coil all cable wires loosely.
- Avoid reuse or reprocessing of instruments manufactured for single use.

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Office Hysteroscopy

7

Bhavana Girish and Vidya V. Bhat

Hysteroscopy is a powerful tool to diagnose and treat pathologies within the uterine cavity. Indications of diagnostic hysteroscopy have been enumerated in Table 7.1 [1]. The trend has shown that the diagnostic hysteroscopy, as well as some selective minor operative procedures, could be performed in the office setting on conscious patients instead of in the operating room without anaesthesia. Office hysteroscopy has several advantages as there is no risk of anaesthesia, reduced hospital stay and low cost and also has good correlation of findings compared with inpatient hysteroscopy. Office hysteroscopy in its present form avoids most traumatic uterine manoeuvres, leading to a less painful and better-tolerated procedure [2].

Table 7.1 Indications of diagnostic hysteroscopy

1. Suspicion of intracavitary mass
• Endometrial mass: e.g. endometrial polyp
• Myometrial mass: e.g. leiomyoma
• Retained gestational tissue
• Foreign body: e.g. retained intrauterine device
2. Abnormal uterine bleeding (other than the cervical aetiology)
• Reproductive-aged women
• Perimenopausal and/or postmenopausal bleeding
• Abnormal endometrial thickening
• Suspicion of endometrial hyperplasia or malignancy
3. Infertility or implantation problems
• Recurrent implantation failure
• Recurrent pregnancy loss
• Survey for uterine factor
4. Suspicion of congenital anomaly
• Uterine septum: complete or incomplete
• Unicornuate/bicornuate uterus/uterus didelphys
5. Suspicion of intrauterine adhesion, or Asherman's syndrome
6. Post-treatment (medical or surgical) follow-up
7. Patients of breast cancer with tamoxifen treatment
8. Second-look for surgeries involving endometrial cavity

7.1 Technique

The 'no-touch' or vaginoscopic approach is referred to the insertion of the scope to the vagina, cervical canal and uterine cavity without

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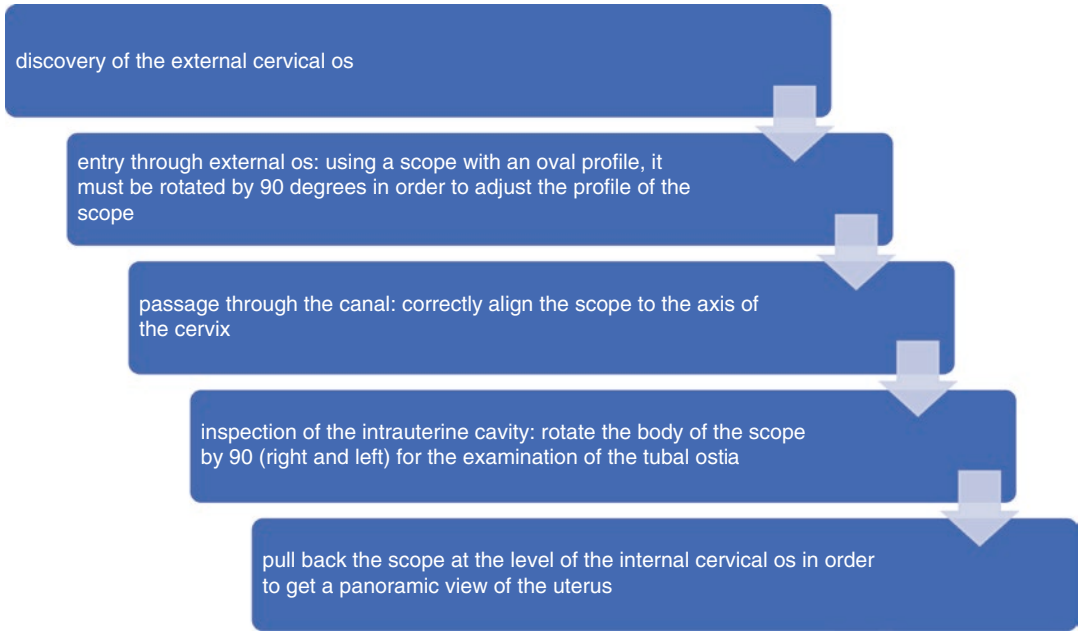
Fig. 7.1 Rigid office hysteroscope

using the speculum, tenaculum, analgesia or anaesthesia (Fig. 7.1). This approach is significantly faster to perform than the conventional one, with similar values in pain scores [3]; the former is sometimes better tolerated. The awake patient's discomfort and anaesthetic requirements are very low or even zero. In addition, it can be offered to patients who otherwise would require general anaesthesia, such as virgins or older women with stenotic vaginas [4].

The pioneers and developers of the 'no-touch' technique made a further logical step: to integrate the operative into the diagnostic part. The new-generation hysteroscopes carry the advantages of a 5-Fr operative channel, which enables the simultaneous diagnosis and treatment of endo-uterine pathologies [5]. Apart from the classic mechanical instruments, bipolar electrosurgical equipment (Versapoint System) has been introduced, so that larger benign intrauterine pathologies can be treated [1]. Benefits include savings in time (comparable to that of transvaginal sonography), anaesthetic and analgesic drugs, personnel, surgery room and hospital costs.

7.2 Steps [6]



7.3 Instrumentation

The basic hysteroscopy setup in an outpatient gynaecology clinic has been shown in Fig. 7.2.

The range of instrumentation available for hysteroscopy is vast, but the essential instruments have been enumerated below.

Mandatory	Highly recommended	Optional
• Hysteroscope—Flexible/rigid	• Video printer	• Digital still printer
• Camera	• Mobile card	• Digital video recorder (or) MP3 recorder
• Light source and light cord		• Automated documentation system
• Monitor		• Disinfection station

7.4 Minihysteroscopes

Instrument final diameter is considered the main factor influencing pain, together with the operative time spent [2]. Patient parity, menopausal status, diameter of the lesions and surgeons' experience remain conflicting factors [7]. The office continuous flow operative hysteroscope (Karl Storz, Tuttlingen, Germany) 'size 4', is one of the newest, worldwide used office hysteroscopes based on a 2.0 mm rod-lens system with 30° fore oblique view with an outer diameter of 4.0 mm. This instrument has two sheaths (one for irrigation and another for suction) and an operative 5-Fr canal (approximately 1.6 mm) (Fig. 7.3).

7.4.1 Advantages

- A 1–2 mm reduction in the telescope diameter and consequently in the total hysteroscope size reduces the area of the instrument by about 50–75%, making its introduction easier and less painful compared with conventional ones.
- The oval profile of the hysteroscope together with the possibility of introducing grasping forceps or scissors through the working channel now allows overpassing most of the anatomical impediments.

Mandatory	Highly Recommended	Optional
• Hysteroscope – Flexible/rigid • Camera • Light source and light cord • Monitor	• Video printer • Mobile card	• Digital still printer • Digital video recorder (or) MP3 recorder • Automated documentation system • Disinfection station

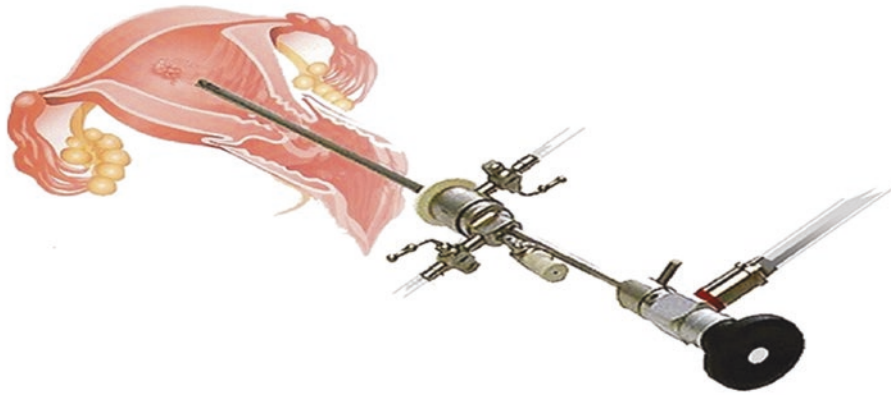


Fig. 7.2 Office hysteroscopy OT setup

Fig. 7.3 Minihysteroscope

7.5 Flexible Hysteroscopes

Flexible hysteroscopes (Fig. 7.4) with a smaller diameter have demonstrated some advantages over the rigid ones.

7.5.1 Advantages

- No need for cervical dilation.
- No need to use a tenaculum even if the uterus is acutely anteflexed.
- Less pain.

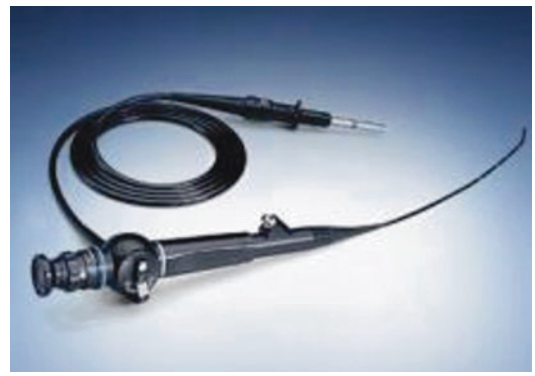


Fig. 7.4 Flexible hysteroscope

7.5.2 Disadvantages [7]:

- Higher costs for purchase and maintenance.
- Increased efforts for cleaning disinfection and sterilization.
- Reduced image size on the monitor screen compared with full-size standard hysteroscope.
- Greater fragility of equipment.

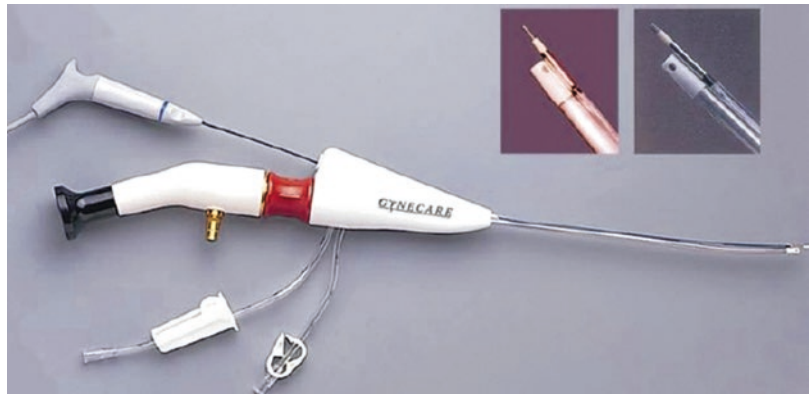


Fig. 7.5 Versascope

7.5.3 Versascope (Gynecare, Ethicon)

This is a semirigid 3.2 mm fibre optic minihysteroscope which consists of a 1.8 mm telescope with a 0° angle of vision and single disposable outer sheath (Fig. 7.5). The sheath has an additional expanding plastic collapsible outer sheath that permits insufflations of carbon dioxide gas or low-viscosity fluids under a continuous flow system for uterine distension.

7.6 Indications of Diagnostic Hysteroscopy

7.6.1 Evaluation of Abnormal Uterine Bleeding

- Premenopausal ovulatory bleeding.
- Premenopausal anovulatory bleeding that fails medical therapy.
- Postmenopausal bleeding off HRT.
- Postmenopausal bleeding on HRT with failed hormonal manipulation.

7.6.2 Infertility Evaluation

- Routine infertility.
- Pre-IVF evaluation.
- Abnormal hysterosalpingography.
- Recurrent miscarriage.
- Asherman's syndrome.

7.6.3 Location of Intrauterine Device and Foreign Bodies

7.6.4 Preoperative Evaluation

- Grade 'O, I, II' submucous myoma.
- Asherman's syndrome.
- Septate uterus.

7.6.5 Evaluation of Endometrial Hyperplasia and Carcinoma

7.6.6 AUB

In premenopausal ovulatory women with AUB, hysteroscopy will detect an anatomical structural lesion in 65–80% of patients. About 28% of asymptomatic postmenopausal women with an endometrium >4 mm had intrauterine pathology detected by office hysteroscopy and 76% of symptomatic postmenopausal women had endometrial pathology detected by office hysteroscopy.

7.6.7 Evaluation of Infertility Patient

Intra-cavity abnormalities that affect embryo implantation like intrauterine scar tissue, submucous myoma, endometrial polyps and uterine septa are found in 10–62% of infertile patients.

7.6.8 Preoperative Surgical Planning

Grade II submucous myomas which have less than 50% of their volume within the endometrial cavity and in patients with multiple submucous myomas, a preoperative evaluation will help the patient to decide about alternative treatment (lap myomectomy, UAE or hysterectomy) and allow the clinician to counsel the patients regarding two sittings to complete myomectomy.

7.6.9 Staging Endometrial Carcinoma

Hysteroscopy can clearly display the appearance of endometrial cancer and its involvement in the lower uterine segment and cervix. The concern, of course, is whether the intrauterine distension medium will carry cells into the peritoneal cavity and worsen the prognosis. Hysteroscopy is useful in hysteroscopic treatment and follow-up if hyperplasia or cancer is focal or contained within an endometrial polyp.

7.7 Contraindications

- Pelvic inflammatory disease.
- Active herpes infection.
- Vaginal bleeding.
- Known intrauterine pregnancy.
- Cervical cancer.
- Severe cervical stenosis.

7.8 Office Operative Hysteroscopy

Rigid rod lenses are the most commonly used design in office hysteroscopy and come with several different options for viewing angles. Typically, the single-flow sheath of the rigid hysteroscope is used in combination with a 4–5 mm outer sheath to create a continuous flow system and permit the passage of semirigid instruments such as scissors, graspers or biopsy forceps. Small 5 Fr monopolar or bipolar vaporizing electrodes, roller balls or barrels can be used for resection of small submucous myomas, endometrial polyps, intrauterine adhesions and uterine septa. Procedures performed in an office setting include the following:

1. Hysteroscopic Polypectomy: Polypectomy performed in the outpatient setting under local or no anaesthesia has been found to be non-inferior to inpatient polypectomy under general anaesthesia in the outcomes of improvement of bleeding as well as feasibility and acceptability of the procedure [8]. Outpatient polypectomy has also been found to be more cost-effective than inpatient polypectomy when followed up at 6 and 12 months post-procedure. For these reasons, outpatient hysteroscopic resection with direct visualization represents the optimal treatment modality for endometrial polypectomy.
2. Hysteroscopic Adhesiolysis: Office-based adhesiolysis with the use of hysteroscopic scissors can be offered in majority of women with Asherman's syndrome, with nearly 90% of cases using preoperative NSAID alone for analgesia. Avoiding the use of electrosurgery is preferred, as there is a cumulative negative effect on pregnancy outcomes when compared to adhesiolysis without application of energy (16% vs. 29% pregnancy rates, respectively, for patients with two or more previous procedures) [9]. Additionally, patients with moderate to severe Asherman's are at an inherently higher risk of perforation during adhesiolysis, with rates of 3–5% per adhesiolysis procedure. Avoiding electrosurgery averts the risk of thermal injury to surrounding pelvic structures should perforation occur.
3. Hysteroscopic Resection of Septum: The procedure is simple, effective and safe with a <2% complication rate. It is unclear whether there are different reproductive outcome results when comparing hysteroscopic 5 Fr scissors versus electrosurgery with the laser or the resectoscope. The literature suggests that the use of electrosurgery may increase the risk of uterine rupture during subsequent pregnancy when compared to hysteroscopic scissors [10].

4. Hysteroscopic Myomectomy: Small type 0 submucous myomas <1 cm can easily be removed in the office with no anaesthesia. In our clinic, office-based transcervical resection is performed using 5 Fr hysteroscopic scissors using the vaginoscopic technique (no speculum, tenaculum or local anaesthetic). The 5 Fr scissors are used to detach the myoma from the myometrium by hugging the fibroid and cutting the myometrial fibre attachments. The detached myoma is then removed through the cervical canal using a 5 Fr tenaculum. The entire procedure typically takes less than 10 min and is well tolerated by the patient. Hysteroscopic tissue shavers may also be used to complete the procedure.

7.9 Complications

- Vasovagal reaction.
- Local anaesthetic toxicity.
- False passage.
- Haemorrhage.
- Perforation of uterus.

7.10 Conclusion

An office hysteroscopy usually takes 10–15 min from the time the patient is in the examination room until the room is turned over for the next patient. In short, four office hysteroscopes can be performed in the office in the same time that it takes to do one hysteroscopy in the operating room. From a patient's perspective, there is far greater patient satisfaction when a patient can see the pathology and participate in the decision-making process when deciding on appropriate therapies.

Key Learning Points

- Office hysteroscopy is a safe and effective technique for the assessment of uterine cavitary lesions with image quality equivalent to that of conventional hysteroscopy.
- Office hysteroscopy offers the advantages of no anaesthetic risk, reduced operative time, low cost and better patient satisfaction compared to conventional hysteroscopy.
- Office hysteroscopy is suitable to perform minor operative procedures including polypectomy, septal resection, myomectomy and adhesiolysis.
- The use of flexible hysteroscopes and minihysteroscopes may offer additional benefit of reduced pain but has associated poor image quality.
- Vaginoscopy or 'no touch' technique is the gold standard of office hysteroscopy, and practitioners of gynaecologic endoscopy must be trained in this technique.

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8 Histology and Hysteroscopic View of Normal Endometrium

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Exploration of human body cavities was a mystery and it has constantly attracted mankind since ages. Since early 1980, the hysteroscopic research to search and treat the uterine cavity has started in real sense. The renaissance to hysteroscopy in all directions has opened up new challenges and revolutionised this field. And hysteroscopy has become the gold standard in the evaluation of uterine cavity and cervical canal.

The uterus and endometrium are dynamic entities markedly changing from birth to puberty to menopause. At birth the uterus is small, measuring only one half the size of the cervix with the entire cervix and uterus being only 3–4 cm in length (Fig. 8.1).

At menarche, the uterus and cervix respond to increase in circulating oestrogen. At age 13, the cervix and uterus each measure same in length. As the adulthood is reached, the uterine/cervical ratio approaches 2:1.

8.1 Endometrium

The mucosa covering the uterine cavity or the lining over myometrium is the endometrium. Endometrium is a specialised form of mucous membrane.

In the seventh prenatal month, the uterine epithelium, i.e. endometrium, is formed. But it is in dormant state till puberty. Endometrium is derived from the mucosal lining of the fused Mullerian ducts. The neonatal endometrium at birth may undergo changes from in utero exposure to maternal steroids. In one study, proliferative endometrium was seen in 16% of patients, secretory changes in 27%, and menstrual endometrium in 5%, consistent with the fact that menstrual-type bleeding may be seen in non-pathologically in the female newborn. After birth, the endometrium returns to a resting low cuboidal epithelium unless stimulated by exogenous steroids.

8.2 Evaluation of Endometrium

The endometrium plays a major role in menstrual cycle as well as in reproduction. Also in most of the gynaecological disorders like abnormal uterine bleeding (AUB) and infections, the endometrium is commonly affected. Considering the importance of endometrium in reproduction as well as its response to various gynaecological

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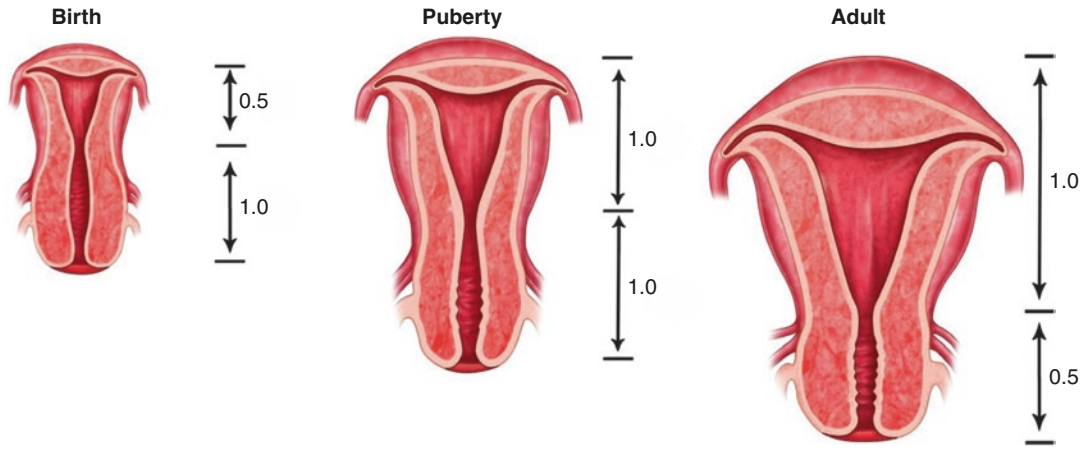

Fig. 8.1 Schematic representation of the change in uterine length and cervix/corpus ratios at birth, puberty and adulthood

conditions, it has become necessary to evaluate the endometrium. There are two important modalities to evaluate the endometrium: the user-friendly colour Doppler ultrasound and hysteroscopy. We also need to have knowledge on the histology.

8.2.1 Histology of Endometrium [1–7]

After puberty and in reproductive years, it varies in thickness, depending upon the phase of the menstrual cycle and ranges between 1 and 8 mm, frequently is thickest in the fundus. It is covered by a single layer of cuboidal or low columnar epithelium. It is divided into a deep basal layer (stratum basalis) and superficial functional layer (stratum functionalis) [Fig. 8.2]. The functional layer is composed of the superficial compact layer (stratum compactum) and deeper spongy (stratum spongiosum) layer. The basal layer or stratum basalis constitutes the 'reserve cell layer' of the endometrium, lined by simple to pseudostratified epithelium in dark, compact stroma. The epithelium shows no evidence of secretory activity or mitotic activity in either glands or stroma. It changes little during the menstrual cycle and left intact during menstruation. This is the layer that is important to the hysteroscopist during endometrial ablation. If not completely destroyed, further endometrial regeneration will

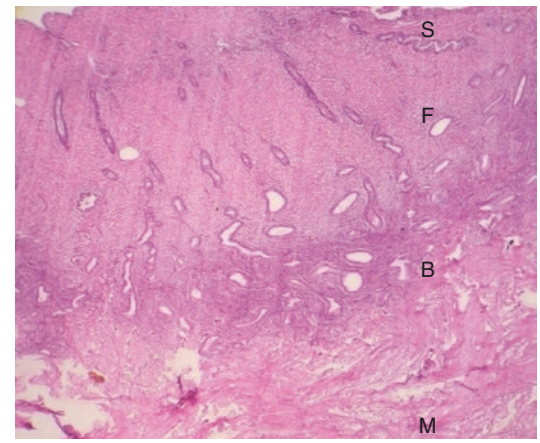

Fig. 8.2 Section showing the myometrium (M); basal endometrial layer-stratum basalis (B); superficial functional layer, stratum functionalis (F); and endometrial luminal surface (S) (H&E, 5×)

ensue. Also in treating an infertile woman with intrauterine adhesions, if the basal layer is involved, then regeneration of the endometrium is very difficult. This point is to be considered while doing curettage of reproductive-age-group women having a miscarriage.

The stratum functionalis (stratum compactum and stratum spongiosum) responds to ovarian steroids and is shed at the time of menstruation. Histologically it comprises glands and stroma with interspersed blood vessels, scattered stromal granulocytes and foamy cells and a surface epithelial lining that is cuboidal to columnar.

This endometrium is always changing in response to the cyclic patterns of oestrogen and progesterone of the ovarian menstrual cycle and to a complex interplay among its own autocrine and paracrine factors. The regular cyclical morphologic changes progress through three distinct phases, i.e. proliferation, secretory differentiation and shedding during menstruation.

8.2.1.1 Menstrual Endometrium

This is the phase of shedding of the superficial endometrial layer (stratum functionalis). It is characterised by haemorrhage and glandular and stromal breakdown along with stromal fibrin thrombi, thrombosed spiral arterioles, necrotic debris and infiltration by neutrophils. The glandular epithelium is clumped, and stromal cells form compact balls. Over day 2–4 of the menstrual cycle, the degenerated stratum functionalis progressively detaches from the stratum basalis and is discharged while early changes of proliferation set in.

8.2.1.2 Proliferative Endometrium

The proliferative phase can be subdivided into three phases: early (day 4–7 of the menstrual cycle), mid (day 8–10 of the menstrual cycle) and late (day 11–14 of the menstrual cycle). However, the overlapping changes during proliferation make dating of the cycle in this phase imprecise. And moreover, as it has no clinical utility, it is also unnecessary, and identification of the endometrium as proliferative is sufficient.

The proliferative endometrium is initially thin and comprises short narrow straight glands that are non-branching, non-budding and regularly spaced. On cut section, they appear as 'blue doughnuts' lined by columnar cells with basally located nuclei with mild pseudostratification (Fig. 8.3). During the mid and late phases, the glands gradually become longer and tortuous/coiled, and pseudostratification of nuclei increases (Fig. 8.4). The stroma is compact in the early and late phases and loose oedematous in the mid phase. Initially mitoses are few in both the epithelium and stroma and become numerous in late proliferative endometrium.

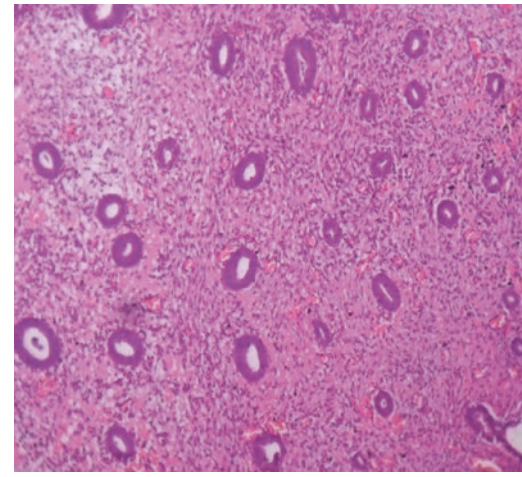

Fig. 8.3 Early proliferative endometrium comprising narrow straight glands that are regularly spaced in compact endometrium (H&E, 10×)

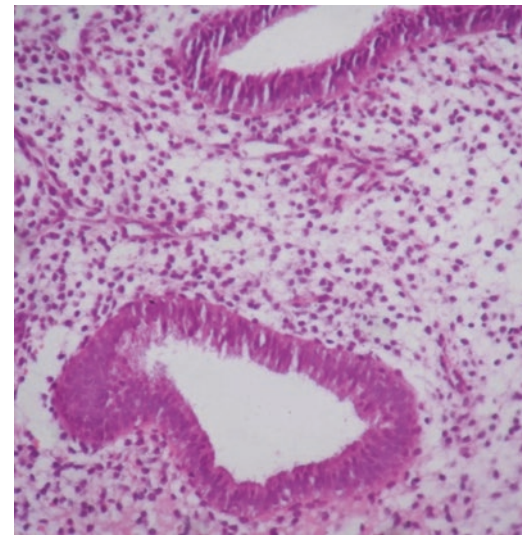

Fig. 8.4 Mid-proliferative endometrium shows slightly tortuous glands lined by columnar cells with pseudostratification of nuclei and loose oedematous stroma (H&E, 40×)

8.2.1.3 Interval Endometrium

It refers to the endometrium during the first 36 to 48 h post-ovulation (Fig. 8.5). Subnuclear vacuoles are seen in <50% of glandular epithelium and are non-uniform. This is suggestive, but not a definite indicator, of ovulation as it may be seen even in anovulatory cycles.

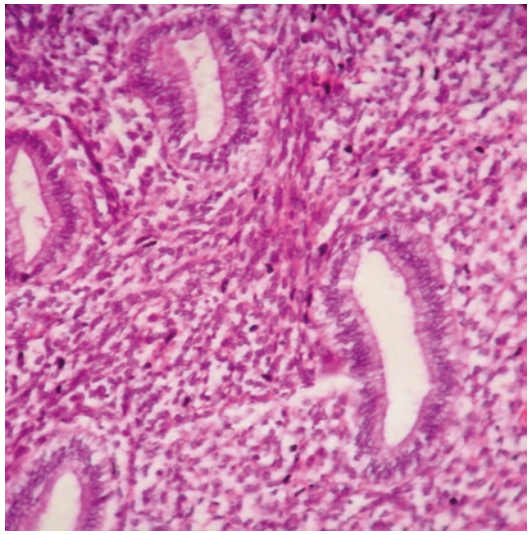

Fig. 8.5 Interval endometrium showing slightly tortuous late proliferative glands showing non-uniform subnuclear vacuoles (H&E, 40×)

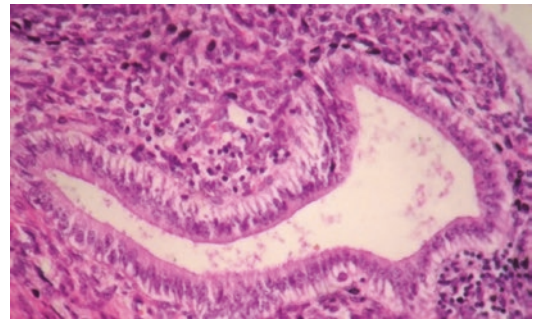

Fig. 8.6 Early secretory endometrium: partly coiled gland with prominent subnuclear vacuoles (H&E, 40×)

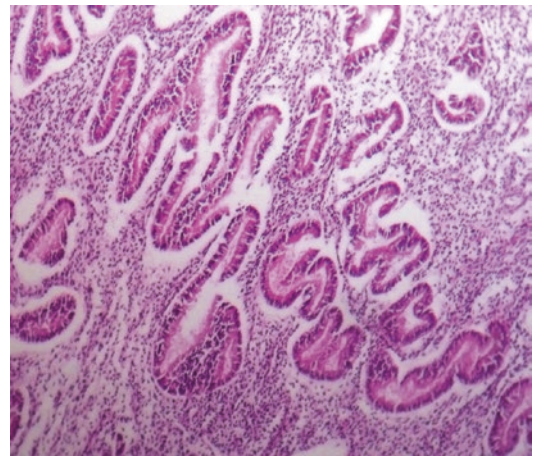

Fig. 8.7 Mid secretory endometrium: coiled glands with intraluminal secretions and stromal oedema (H&E, 10×)

8.2.1.4 Secretory Endometrium

Following ovulation, morphologic changes in the secretory phase are relatively constant, specific and highly predictive, and hence accurate dating is possible in this phase. This phase can be broadly divided into three stages, i.e. early, mid and late.

1. **Early Secretory Endometrium** (POD [post-ovulatory day] 2–5; day 16–19 of MC [menstrual cycle]): the unequivocal indicator of ovulation is the presence of large uniform subnuclear vacuoles in >50% of endometrial glands that are slightly tortuous. Pseudostratification of nuclei and mitoses are also seen. The subnuclear vacuoles become uniformly aligned and then move to the luminal side (Fig. 8.6). The vacuoles are infrequent on POD5 and the nuclei are basal without any pseudostratification. There are no mitoses and intraluminal secretions that appear.
2. **Mid secretory endometrium** (POD 6–8; day 20–22 of MC): Glands are more coiled with papillary infoldings. Intraluminal secretions are prominent on POD6 and later become inspissated (Fig. 8.7). Stromal oedema begins on POD7 and peaks on POD8.
3. **Late secretory endometrium** (POD 9–14; day 23–28 of MC): The spiral arterioles become more prominent on POD9 due to periarteriolar stromal condensation (Fig. 8.8). This is followed by conspicuous predecidual (stromal cells with more eosinophilic cytoplasm) cuffing around the spiral arterioles (Fig. 8.8) that further coalesce to form sheets. Predecidua is also seen under the surface epithelium (stratum compactum). By POD10 the glands are markedly tortuous, with infoldings/tufting of the lining tall columnar epithelium that have ragged luminal margins (saw-tooth appearance) (Fig. 8.9). Stromal oedema decreases and mitoses are seen. Infiltration by neutrophils occurs on POD12 that progressively becomes more prominent. Additionally, fibrin thrombi in stroma and small blood vessels, foci of haemorrhage, and necrosis appear on POD14.

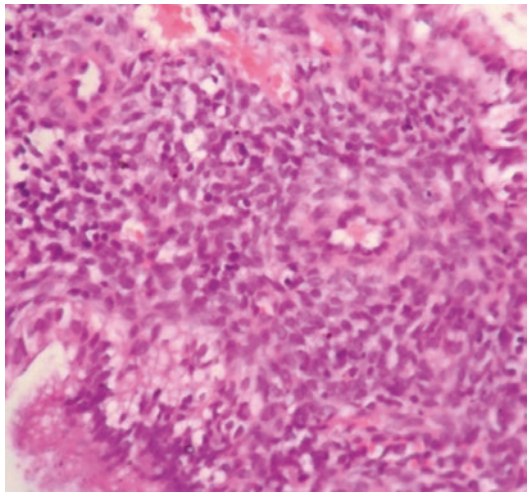

Fig. 8.8 Late secretory endometrium with predecidual cuffing around prominent spiral arterioles (H&E, 40×)

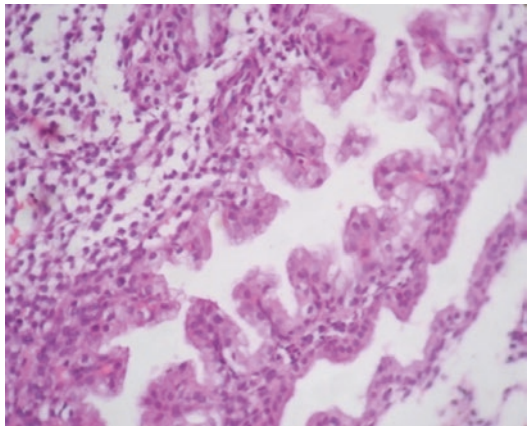

Fig. 8.9 Late secretory endometrium with saw-tooth appearance of glands and exhausted secretions (H&E, 40×)

Endometrial Dating: Based on the careful evaluation of the glandular and stromal histologic features, the morphologic date of the endometrium that is constantly undergoing regular cyclical morphologic and physiologic changes in the form of proliferation, secretory differentiation, shedding during menstruation and regeneration can be assessed. The findings can then be summarised in terms of post-ovulatory days (POD) or menstrual cycle (MC) days or phases. Endometrial dating should preferably be reported as a range of 2 days because of varying follicular and luteal phases among women and also because of poor interobserver reproducibility (Table 8.1).

8.2.1.5 Atrophic Endometrium

During menopause, atrophic changes set in. The endometrium becomes thinned and comprises only of stratum basalis. The glands are sparse and inactive and are lined by cuboidal to low columnar epithelium. Often the glands undergo cystic dilatation and are then lined by flattened epithelium. Stroma is less cellular and more collagenised. There are no mitoses or secretory activity (Fig. 8.10).

8.2.2 Hysteroscopy and Endometrium

Endometrium development through hysteroscopy was first described by experts in the early 1990s when CO_2 hysteroscopy was used and correlates reliably with the anatomical description by Netter. To view the 'hystera' through hysteroscopy is like learning the philosophy of hystera, i.e. uterus. The hysteroscope is also designed in a delicate way to adjust the curves of the uterus and occupy space in the uterus without disturbing its anatomy and physiology. That is why today most of the hysteroscopic procedures do not need anaesthesia. Hence one can evaluate the endometrium without dilating the cervix and without disturbing the cervicouterine path. Endometrium evaluation is part of the standard workup in infertility. Usually the first exam is done by transvaginal ultrasound (TVUS), which allows the evaluation of the endometrium in a noninvasive way along the menstrual cycle.

8.2.2.1 Hysteroscopic Assessment of the Uterine Cavity Should Include the Following Parameters

Uterocervical cavity features: Endocervical canal, uterine axis, uterine fluid, endometrial assessment and its application according to the phase of menstrual cycle, thorough evaluation of all the walls of uterine cavity, uterine focal lesions or foreign bodies and tubal ostia.

Table 8.1 Histologic features for dating endometrium

Phase/(day of MC)	Important histologic features
Early proliferative (day 4–7)	Glands: straight, tubular; regularly spaced; C/S: 'little blue doughnuts' Stroma: compact; Mitoses: + in glands and stroma
Mid proliferative (day 8–10)	Glands: slightly tortuous Stroma: loose, edematous; Mitoses: +++ in glands and stroma
Late proliferative (day 11–14)	Glands: more tortuous/ coiled Stroma: moderately dense; Mitoses: +++ in glands and stroma
Interval POD1(day 15)	Subnuclear vacuoles in <50% glands (Glands, Stroma, Mitoses: similar to proliferative)
POD2 (day 16)	Subnuclear vacuoles in >50% glands (Ovulation confirmed)
POD3 (day 17)	Subnuclear vacuoles; Nuclei uniformly aligned Few mitoses
POD4 (day 18)	Vacuoles: supra- and subnuclear (on both sides of nuclei of glands) Mitoses rare after this
POD5 (day 19)	Vacuoles are infrequent and above nuclei of glands; Nuclei: basal Intra-luminal secretions appear
POD6 (day 20)	Marked intra-luminal secretions
POD7 (day 21)	Stromal oedema begins
POD8 (day 22)	Peak stromal oedema
POD9 (day 23)	Prominent spiral arterioles Papillary infoldings & tufting of glands; Secretions++
POD10 (day 24)	Pre-decidual cuffs around spiral arterioles Papillary infoldings and tufting of glands; ragged luminal edges (saw-tooth appearance); secretions++
POD11(day 25)	Pre-decidua under surface epithelium (in Stratum compactum) Glands same as above
POD12 (day 26)	Pre-decidua coalesce to form solid sheets; polymorphs appear Glands same as above
POD13 (day 27)	Maximum pre-decidual confluence Stromal granulocytes and infiltrating polymorphs prominent Secretory exhaustion; Necrosis and haemorrhage begin to appear
POD14 (day 28)	Necrosis and haemorrhage prominent
Menstruation (day 1–3)	Glandular, stromal breakdown

[MC, menstrual cycle; POD, post-ovulatory day]

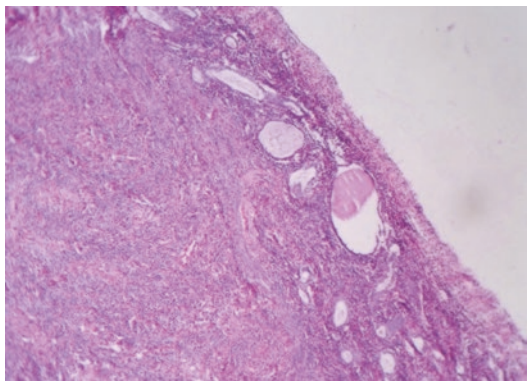

Fig. 8.10 Atrophic endometrium comprising thinned endometrium with few cystically dilated glands and sparsely cellular stroma. Myometrium is also seen (H&E, 5×)

Endometrial parameters: Endometrial thickness, endometrial surface, endometrial colour, vasculature, and glandular openings (only appreciated if using high magnification).

8.2.2.2 Various Phases of Menstrual Cycle and Types of Endometrium

During the menstrual cycle and as a response to hormonal changes, there is a continuum of morphological modifications. In the normo-ovulatory patient, the normal endometrium has two phases: the follicular phase, which can be highly variable in length, and the secretory phase, which is more or less constant for around 14 days [8].

These microscopic changes lead to different endometrial hysteroscopic patterns [9] (Table 8.2).

Proliferative Phase

During the follicular phase, oestradiol stimulates the growth of glands, stroma and vessels. The endometrium grows from around 0.5 mm to around 6 mm, and at the end of this phase, the glands elongate and become tortuous.

Hysteroscopically in proliferative phase the endometrium is pink with a smooth surface (Fig. 8.11). One should also appreciate the immediate postmenstrual phase (Fig. 8.12). The endometrial surface becomes reddish with scattered whitish pointed dots (early proliferative phase). As time goes by, it gets thicker and it is possible to see small uniform round dots (Fig. 8.13), representing the gland opening. Thin vessels can be identified (Fig. 8.14). At this moment, if the hysteroscopist makes a gentle notch on the mucosa, little bleeding would come to the endometrial surface (Fig. 8.15).

Secretory Phase

During the secretory phase, both oestrogen and progesterone stimulate glandular and stromal changes. These begin around 36–48 h after ovulation (Fig. 8.16).

Hysteroscopically in the secretory phase, the endometrium is thicker and pale pink. The surface becomes irregular and wavy as time goes by. There is a growing oedema that no longer allows to indi-

Table 8.2 Endometrial features during menstrual cycle-hysteroscopy

	Menstrual	Proliferative	Early luteal	Late luteal
Days	1–4	5–14	15–21	22–28
Colour	Red	Pink	White	White
Surface	Irregular	Smooth	Wavy	Spongy
Thickness	0–1 mm	2–5 mm	>6 mm	>7 mm
Glands	Absent	White dots	Prominent	Absent
Notch	No	Haemorrhagic	Serous	Serous
Vessels	No	Thin vessels	Absent	Absent

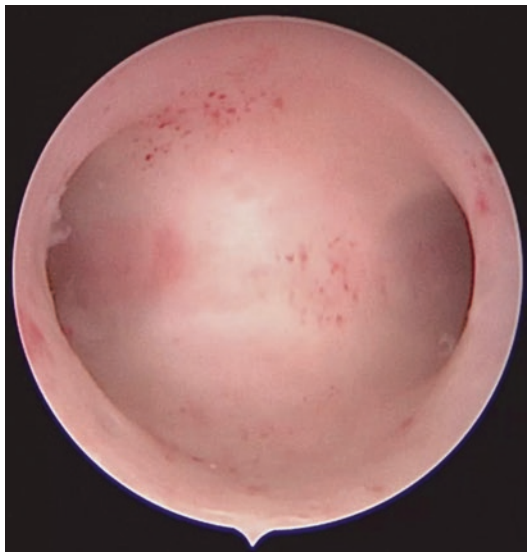

Fig. 8.11 Early proliferative phase—panoramic view from internal os

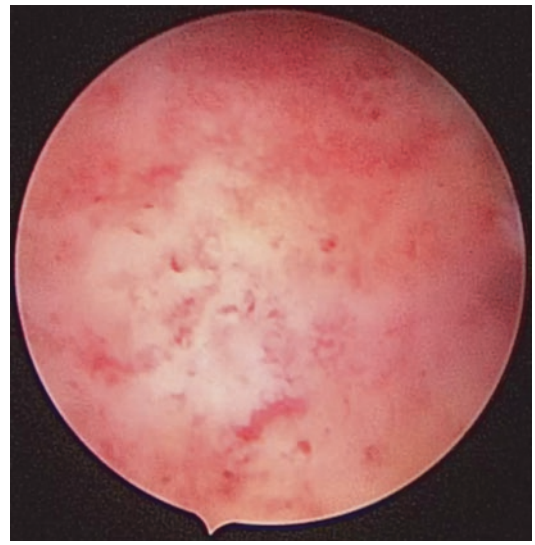

Fig. 8.12 Immediate postmenstrual endometrium

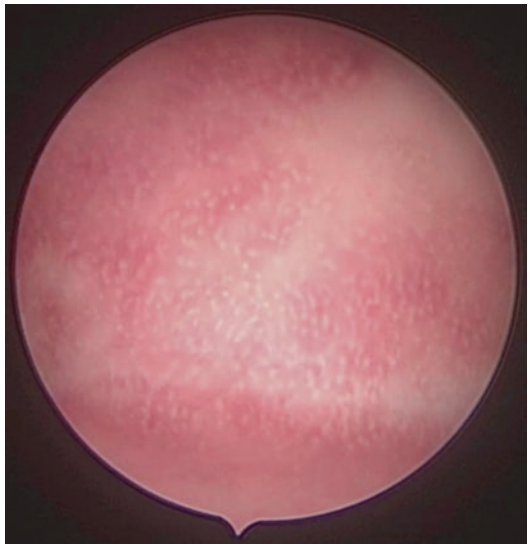

Fig. 8.13 Proliferative phase

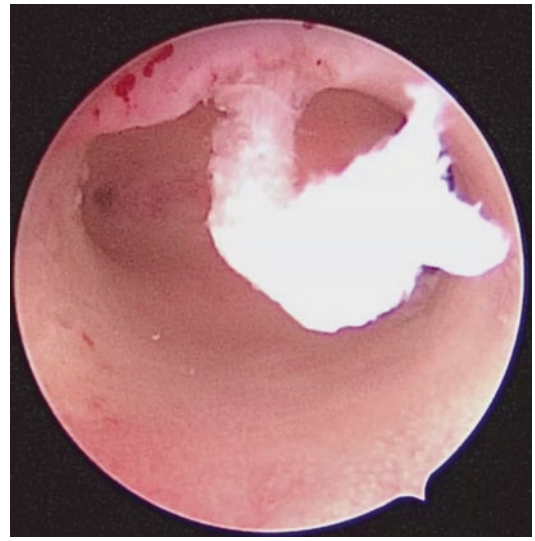

Fig. 8.15 Proliferative phase—notch on the mucosa, little bleeding would come to the endometrial surface

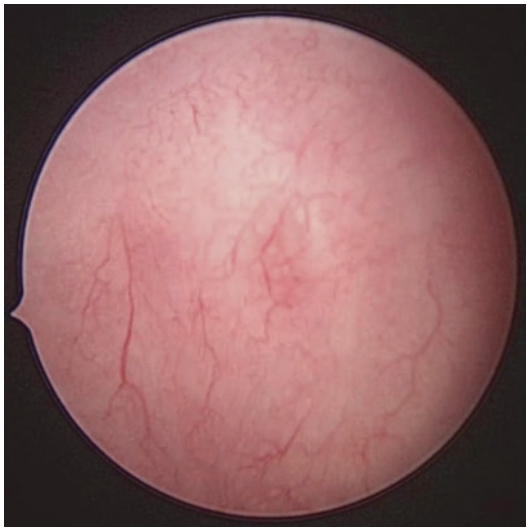

Fig. 8.14 Late proliferative (small blood vessels)

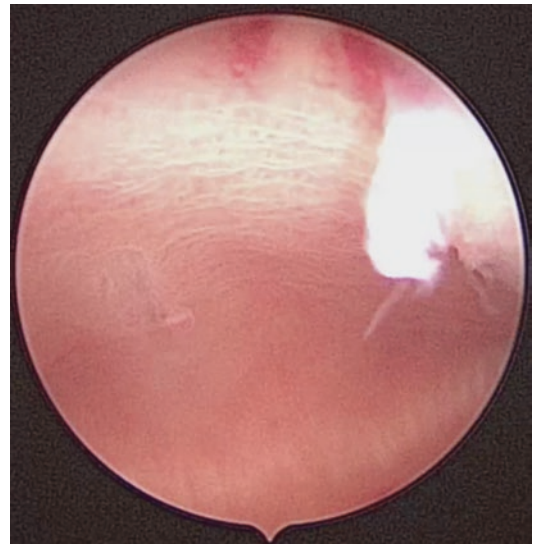

Fig. 8.16 Early secretory

vidualise vessels. Touching the endometrium with the hysteroscope produces a smooth valley (Fig. 8.17). In the early secretory phase, still some gland openings can be seen, though they appear somehow bulged. Conversely, in the late secretory phase, the whole mucosa is homogeneous and shiny (Fig. 8.18). In both phases, the hysteroscopy notch shows a clear secretion, lacking of any bleeding.

At the latest days, the ischemic period starts. Blood vessels are appearing in the endometrial surface, allowing the hysteroscopist the view of particular images which are rarely seen but which undoubtedly mean the end of the endometrial life. The superficial mucosa shrinks and starts to detach from the basal layer due to decrease of blood supply.

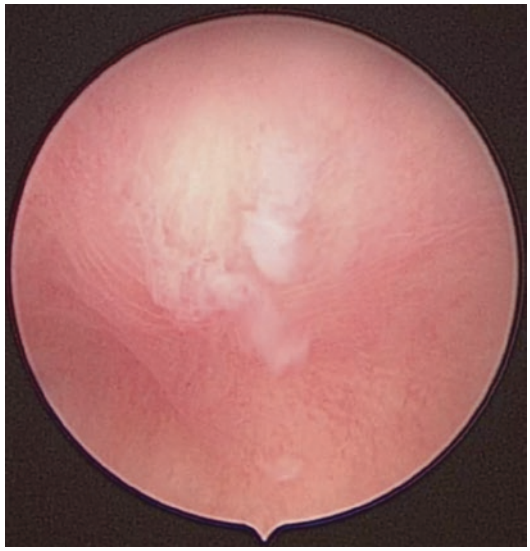

Fig. 8.17 Mid-secretory—touching the endometrium with the hysteroscope produces a smooth valley

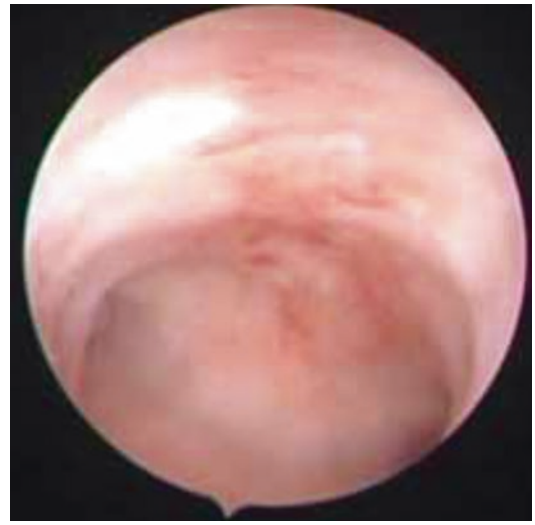

Fig. 8.19 Atrophic endometrium—anterior wall

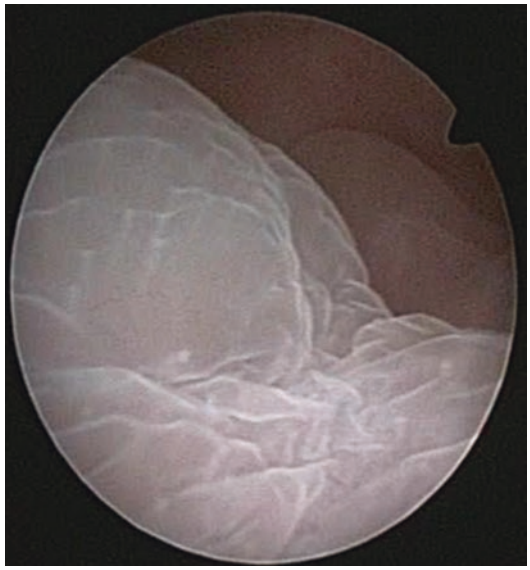

Fig. 8.18 Late Secretory phase (courtesy of Dr. Luis Alonso Pacheco)

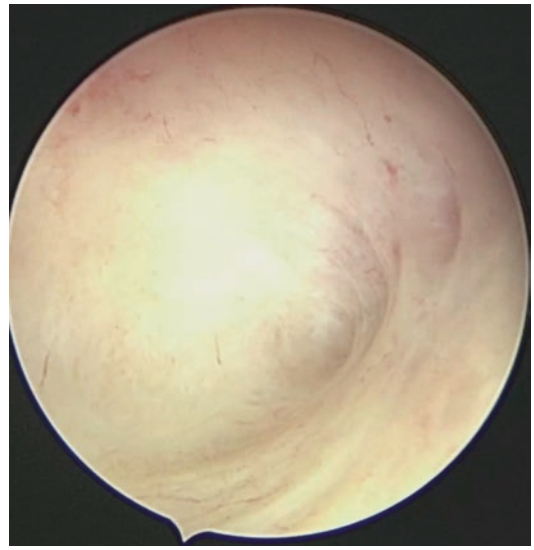

Fig. 8.20 Atrophic endometrium—left lateral wall and ostium

Atrophic (Postmenopausal) Endometrium

The endometrium is thin white and smooth (Figs. 8.19 and 8.20). The lack of surface irregularities gives an overall featureless (bald) appearance (caused by revealed myometrial fibres). Fragile and irregular vasculature is visible.

8.3 In a Nutshell

- Hysteroscopy is a very important diagnostic tool in the management of infertility.
- It has been employed in studying endometrial pathologies.

- Hysteroscopic examination could provide useful morphological information to evaluate the functional state of the endometrium, based on specific changes in appearance of glandular openings and vasculature on the endometrial surface in a normal ovulatory cycle.
- In treating an infertile woman with intrauterine adhesions, if the basal layer is injured, then regeneration of endometrium is very difficult. While doing curettage in reproductive-age-group women or those having miscarriage, one should be gentle enough to avoid damage to the basal layer.
- The basal layer of the endometrium is important to the hysteroscopist during endometrial ablation. If not completely destroyed, further endometrial regeneration will ensue.

Thus, knowledge of the histology and normal endometrium is very important for a hysteroscopist.

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9 Abnormal Endometrium and Hysteroscopy

Alka Kumar and Atul Kumar

9.1 Introduction

The endometrium is derived from the mucosal lining of the fused Mullerian ducts. It is essential for reproduction and may be one of the most complex tissues in the human body [1].

Histologically, it comprises of glands and stroma. The surface epithelium of the endometrium is low columnar and less responsive to hormonal influences than the glandular epithelium. Endometrial stroma is made up of monomorphic stromal cells, the morphology of which changes in the secretory phase of the menstrual cycle.

The upper two-thirds of the endometrium is the functional layer, i.e. stratum functionalis which is subdivided into two: (1) stratum compactum (towards the surface) and (2) stratum spongiosum (close to the basalis).

The lower one-third of the endometrium is the basal layer, i.e. stratum basalis, which acts as the reserve cell layer and provides regenerative ability to the endometrium following menstruation. The glands here are weakly proliferative [2].

Other components are blood vessels, stromal granulocytes and inconstant foamy cells.

The histologic changes in the menstrual cycle can best be viewed in the stroma and the endometrial glands of the stratum functionalis. The stratum basalis does not undergo significant cyclical changes but instead is the source of endometrial regeneration after menses.

9.2 Cyclic Histological Changes

9.2.1 Menstrual Endometrium

Menstrual endometrium is characterized by an influx of inflammatory cells, thrombi in stromal vessels, apoptosis and gland-stromal dissociation. It is also the early proliferative phase and hence, a mixture of changes associated with menses and the early proliferative endometrium is seen [3].

9.2.2 Proliferative Endometrium

Proliferative endometrium comprises of non-branching, nonbudding, similarly shaped glands evenly distributed throughout a cellular spindly stroma. The changes are further marked by pseudostratification of glands with mitotically active epithelium and associated stromal mitoses [2]. In reality, dating of proliferative endometrium is not

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S. Tandulwadkar, B. Pal (eds.), *Hysteroscopy Simplified by Masters*,
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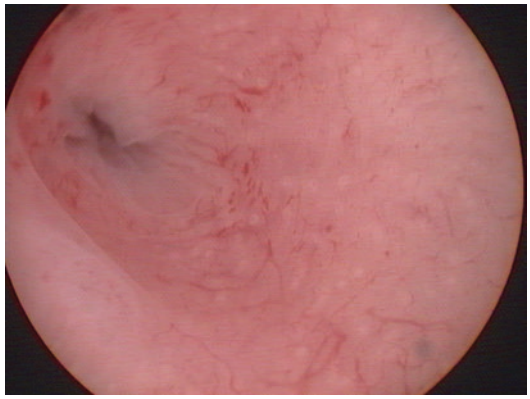

Fig. 9.1 Proliferative endometrium

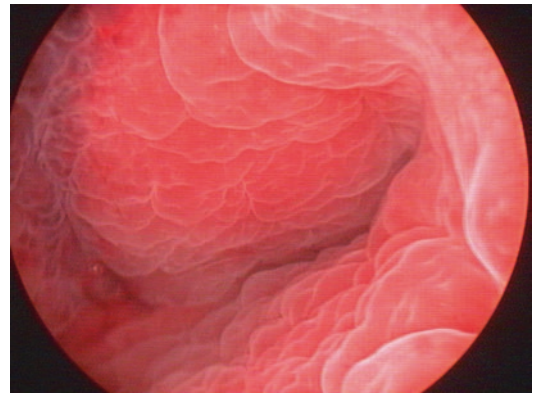

Fig. 9.2 Secretary endometrium

utilized clinically, and so a diagnosis of proliferative endometrium is sufficient [3] (Fig. 9.1).

9.2.3 Interval Endometrium

Interval endometrium is actually a late proliferative endometrium in which the glands are slightly coiled and the epithelium shows spotty, nonuniform subnuclear vacuolation. It is the first evidence of ovulation, marked by beginning of secretory activity. However, presence of this pattern is no guarantee that ovulation has occurred [2, 3].

9.2.4 Early Secretory Endometrium

Early secretory endometrium shows coiled glands composed of cells resembling those found in the proliferative phase. But more than half of these cells contain cytoplasmic vacuoles. These vacuoles serve as the marker of early secretory endometrium [2] (Fig. 9.2).

9.2.5 Mid-Secretory Endometrium

Mid-secretory endometrium comprises of fully coiled secretory glands with luminal secretions. The cell cytoplasm does not contain large vacuoles. Stromal oedema is prominent. However, predeciduation does not begin in this phase [2].

9.2.6 Late-Secretory Endometrium

Late-secretory endometrium is marked by glands with exhausted secretions, saw-tooth appearance, stromal predeciduation and prominent spiral arterioles. Predeciduation begins initially around spiral arterioles and then extends to form islands in the superficial stroma. Increase in the number of stromal granulocytes is also a feature [2].

9.2.7 Endometrial Dating

In evaluating the endometrium, it is important to distinguish carefully between the morphologic postovulatory date assigned to a morphologically normal endometrium and the chronologic postovulatory date. The morphologic date is a summary characterization of the histologic development of the endometrium based on an assessment of glandular and stromal features. These morphologic findings may be summarized in terms of postovulatory days, as depicted [2].

9.2.8 Atrophic Endometrium

In postmenopausal women, the lack of hormonal stimulation leads to endometrial atrophy, with inactive, nonsecretory glands. These glands have a flattened epithelium and are devoid of mitotic activity. The glands may become cystic; however, the epithelium is flattened and nonproliferating [3] (Figs. 9.3 and 9.4).

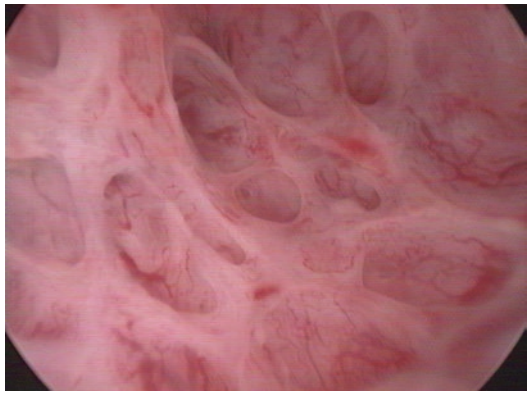

Fig. 9.3 Atrophic endometrium

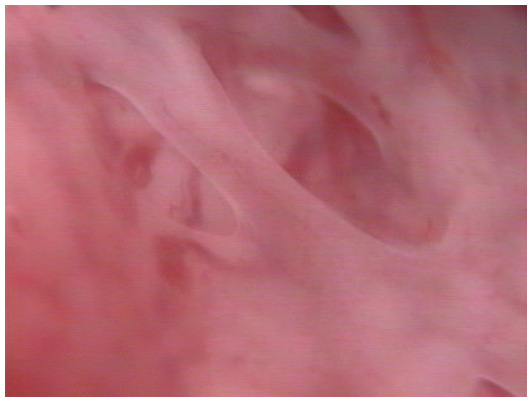

Fig. 9.4 Atrophic endometrium

9.2.9 Hysteroscopic Assessment

While evaluating the cases of infertility with hysteroscopy, one may come across nearly all phases of cyclical changes in endometrium including an atrophic one [2].

Hysteroscopic assessment of the uterine cavity should include the following parameters:

- Uterocervical cavity features.
- Endocervical canal.
- Uterine fluid.
- Uterine axis.
- Uterine shape.
- Uterine size.
- Uterine focal lesions or foreign bodies.
- Tubal ostia.

9.2.10 Endometrial Parameters

- Endometrial thickness.
- Endometrial surface.
- Endometrial colour.
- Vasculature.
- Glandular openings.

Hysteroscopy is a very important diagnostic tool in the management of infertility. But it is not yet used routinely to observe the morphological condition of the endometrium, although it has been employed in studying endometrial pathologies which might cause female infertility [4]. Hysteroscopic examination could provide useful morphological information to evaluate the functional state of the endometrium, based on specific changes in appearance of glandular openings and vasculature on the endometrial surface in a normal ovulatory cycle.

Assessments of the mid-secretory endometrium could be classified as "good", characterized by ring-type glandular openings showing maximum glandular secretion and well-developed varicose-like vessels, or "poor", characterized by dot (no secretory) and/or punctate-type (early secretory activity) glandular openings and find vasculature. In IVF and embryo transfer cycles, the pregnancy rate was significantly higher in patients with "good" hysteroscopic findings than in patients with "poor" findings. More studies are needed to validate these findings.

Hysteroscopic appearance of the mid-secretory endometrium is a good prognostic factor for pregnancy outcome than any other hormonal data like serum progesterone and histological dating of the endometrium [5].

9.2.11 Hysteroscopic Features: Endometrium

Normal functional endometrium has a generally smooth, homogenous and nonvascular appearance. The phase of endometrium can be differentiated on hysteroscopy with experience.

9.2.12 Hysteroscopic Features of Menstrual Endometrium

Menstrual endometrium may be thin if menstruation is nearly complete or may have a patchy reddened "shaggy" appearance caused by irregular endometrial sloughing. Blood and menstrual debris frequently obscure vision.

9.2.13 Hysteroscopic Features of Proliferative Endometrium

Proliferative endometrium is thin and yellow-white or pale pink with little vascularization.

9.2.14 Hysteroscopic Features of Secretory Endometrium

Secretory endometrium is globally thickened, "fluffy" and more difficult to interpret especially if it has a polypoid appearance. The delicate superficial vascular network is more prominent, resulting in increasingly red pink endometrial appearance.

9.2.15 Hysteroscopic Features of Atrophic Endometrium

The endometrium is thin white and smooth. The lack of surface irregularities gives an overall featureless appearance (cause by revealed myometrial fibres). Fragile and irregular vasculature is visible [6–8].

9.2.16 Abnormal Endometrium

Abnormally thickened endometrium can be due to:

- Endometrial hyperplasia: Usually uniformly hyperechoic and tends to be diffuse. Can be a differential diagnosis of many conditions.
- Endometrial polyp: Usually hyperechoic, often focal, may be single or multiple.
- Tamoxifen-related endometrial changes: Variable appearances.
- Hormone replacement therapy (HRT) in post-menopausal female.
- Endometritis: Chronic endometritis, tubercle endometritis.
- Adhesions: Irregular echogenic areas with focal thickening.
- Synechiae.
- Ovarian tumours associated with endometrial thickening, e.g. endometroid carcinoma of ovary.

9.2.17 Evaluation of Endometrium

It can be done mainly on three modes:

1. Imaging the patterns of endometrium by transvaginal ultrasound (TVUS 2D, 3D, Doppler), hysterosonography also known as saline infusion sonohysterography (SIS) and to some extent a magnetic resonance imaging (MRI).
2. Visual assessment by hysteroscopy.
3. Cellular assessment by microscopic evaluation of endometrial samples.

9.2.18 Hysteroscopy

Nowadays, outpatient hysteroscopy is both feasible and highly acceptable, giving a high detection rate of intrauterine pathology.

It allows the operator to take a directed biopsy and is more specific and sensitive than TVUS or blind endometrial sampling.

As an investigation for abnormal uterine bleeding, it was recommended by both the Royal College of Obstetricians and Gynaecologists and the American College of Obstetricians and Gynaecologists in 1994.

With the availability of small diameter hysteroscopes and small operative instruments, nowadays hysteroscopy can be performed in an office setting.

In diagnosing hyperplasia with the help of hysteroscopy, we may get varied patterns. A specific pattern does not exist for each kind of hyperplasia.

The following are the commonly found hysteroscopic aspects:

- Focal or diffuse endometrial thickness.
  - Benign endometrial hyperplasia includes both simple and complex forms and it is apt to be associated with dysfunctional bleeding and hyperestrogenic states.
  - The plasticity of the mucosa makes it possible to estimate its thickness by means of the pressure of the endoscope on the uterine wall resulting in an indentation.
- Nonhomogeneous endometrial regeneration.
- Cystic glandular hyperplasia—raised glandular orifices. Presence of cystic dilatations or cystic atrophy.
- Increased vascularization.
- Increased bleeding.
- Irregular arrangement and concentration of the glandular orifices.
- Presence of ciliate images.

9.2.19 Endometrial Hyperplasia

Endometrial hyperplasia is characterized by proliferation of endometrial glands resulting in a greater gland-to-stroma ratio than observed in normal endometrium.

The classification of endometrial hyperplasia is based upon two factors:

1. The glandular/stromal architectural pattern which is either simple or complex.
2. The presence or absence of molecular atypia.

Endometrial hyperplasia virtually always results from chronic oestrogen stimulation unopposed by the counterbalancing effects of progesterone leading to a wide range of manifestation creating various clinical conditions.

- Women at extremes of age groups, i.e. puberty and perimenopause due to anovulatory cycles.
- Women of the reproductive age group due to anovulatory cycles, e.g. polycystic ovary syndrome (PCOS).
- Postmenopausal women on oestrogen therapy.
- Obese women with a high rate of peripheral conversion of androgens to oestrogens.
- Women on tamoxifen, a nonsteroidal antiestrogenic compound used for treatment of breast cancer.

All these conditions giving to conditions like:

- Endometrial hyperplasia.
- Endometrial polyp.
- Endometrial carcinoma.

If one or more of these elements are found, the endoscopist can suspect the presence of endometrial hyperplasia and a directed biopsy should be performed.

But still sometimes the abnormal discoveries raise the probability of finding graver endometrial pathology, e.g. polypoid formations, necrotic areas, friable excrescences and synechiae in the cavity with abnormal endometrium.

9.2.20 Chronic Endometritis

Chronic endometritis is a subtle condition that may cause abnormal uterine bleeding and infertility. Clinically, chronic endometritis in most cases is asymptomatic or accompanied by mild disturbances like spotting, mild and undefined pelvic pain and leukorrhea. Chronic endometritis may have severe reproductive consequences on fertility in spontaneous as well as in vitro fertilization (IVF) cycles [9, 10].

Histologic confirmation of the disease is usually based on superficial stromal oedema, increased stromal density and pleomorphic inflammatory infiltrate dominated by lymphocytes and plasma cells [11, 12].

Chronic endometritis induces specific changes at glandular, stromal and vascular level; these may be hysteroscopically investigated. Many past studies have considered fluid hysteroscopy to be a reliable and useful examination for investigating chronic endometritis [11–13] (Fig. 9.5).

CE has been detected in:

- 14% of women with unexplained infertility
- 23.6% of women with a history of first-trimester miscarriages

Fig. 9.5 Chronic endometritis—micropolyps

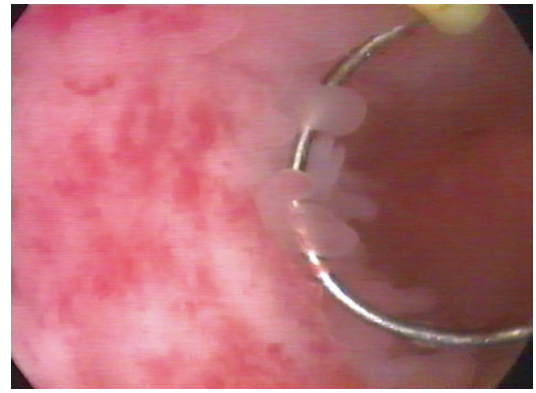

Fig. 9.6 Chronic endometritis

- 57.8% of women with recurrent miscarriages
- 30.3% of patients with repeated implantation failures at IVF.

Chronic endometritis induces altered leukocyte population and, consequently, an aberrant endometrial microenvironment.

The uterine dysperistalsis induced by CE may be an important cause of infertility.

Hysteroscopic diagnosis of chronic endometritis is based on the following features:

1. Strawberry appearance: Prominent white glandular orifices surrounded by hyperaemia. Such lesions are localized or scattered throughout the cavity.
2. Stromal oedema.
3. Endometrial thickening (homogenous or non-homogeneous) caused by stromal oedema.
4. Micropolyps less than 1 mm of size.

The above hysteroscopic features are better appreciated if the hysteroscope is moved closer to the endometrium with increased at source magnification [11, 12] (Fig. 9.6).

9.2.21 Tubercular Endometritis

This is a type of chronic endometrial inflammation which affects the receptivity of endometrium. So even a good quality embryo fails to implant because of inherent problems within the endometrium. In genital tuberculosis, endometrial receptivity is affected in three ways: (a) adverse impact on immunophysiologic "markers" or molecules—these molecules are essential to make the endometrium receptive for embryonic implantation; (b) disordered vascularization of the endometrium—by immunomodulatory mechanism causing vascular thrombus formation, activation of antiphospholipid antibodies and reduction of subendometrial blood flow by tubercular involvement of the basal layer of endometrium through hematogenous spread via basal endometrial artery; and (c) atrophy of endometrium and synechiae formation.

Being a paucibacillary disease, demonstration of *Mycobacterium tuberculosis* is not possible in all cases. Various blood tests, nonspecific tests and serological (e.g. PCR) sonoradiological investigations like USG, HSG and MRI tried to diagnose this disease.

9.2.22 Hysteroscopy

Many past studies have considered fluid hysteroscopy to be a reliable and useful examination for investigating endometrial tuberculosis [14–21].

Endometrial curettings taken under hysteroscopic control in the premenstrual phase, with tissue particularly obtained from the two cornua, should be sent for AFB smear, AFB culture in Lowenstein-Jensen media or BACTEC Culture, guinea-pig inoculation or polymerase chain reaction (PCR). As tubercular endometritis is present only in 60–70% of cases of genital TB, a negative biopsy does not rule out genital TB.

Colonies are seen if the bacillary count is more than 1000 bacilli.

However, improvement in media have allowed colonies to grow even when the count is 100 bacilli.

Hysteroscopy is a useful modality in diagnosing endometrial tuberculosis. Classical hysteroscopic findings of endometrial tuberculosis is a rough dirty-looking bizarre pale endometrium with gland openings not seen and with overlying whitish deposits [14–18, 20, 21] and adhesions. However, all these signs may not be seen in the same case or their intensity may vary. In order to reach to a diagnosis, all the markers of tuberculosis have to be carefully evaluated. Whitish deposits are the most pathognomonic of tuberculosis; however, they may not be always be seen especially since the superficial layer of the endometrium sheds every 28 days, and along with the endometrium, the said deposits also shed [22]. Hence, the best time for conducting hysteroscopic examination is in the premenstrual phase so that any overlying deposits are not missed out. Large tubercles are also often seen. The confirmation of diagnosis of tuberculosis is made by PCR and BACTEC culture.

The hysteroscopic markers of endometrial TB are:

1. Bizarre endometrial architecture (Fig. 9.7).
2. Tubercular deposits (microscopic to large macroscopic structures) (Fig. 9.8).
3. ILL-defined endometrial gland openings (Fig. 9.9).
4. Adhesions/synechiae (Fig. 9.10).

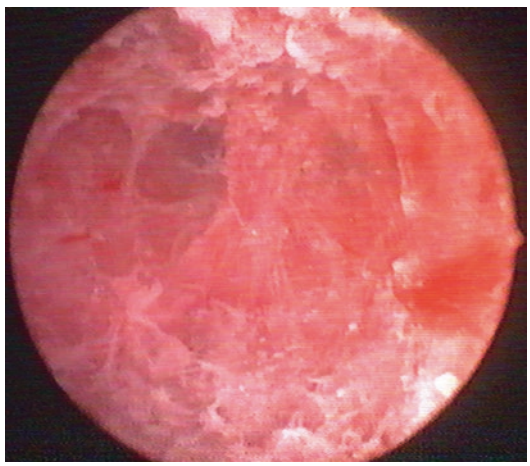

Fig. 9.7 Endometrial tuberculosis—bizarre endometrium

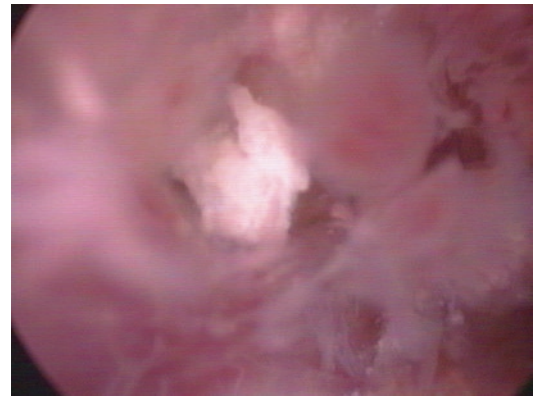

Fig. 9.8 Endometrial tuberculosis—tubercle

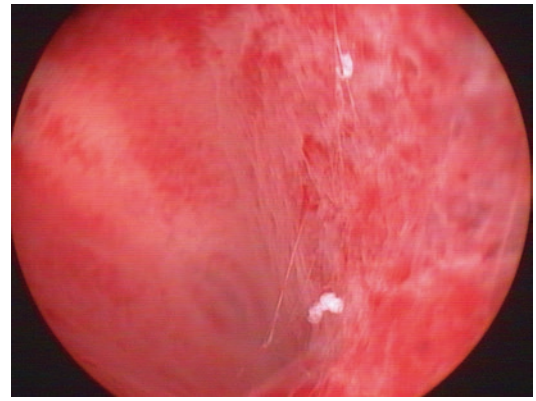

Fig. 9.9 Endometrial tuberculosis—flimsy adhesion

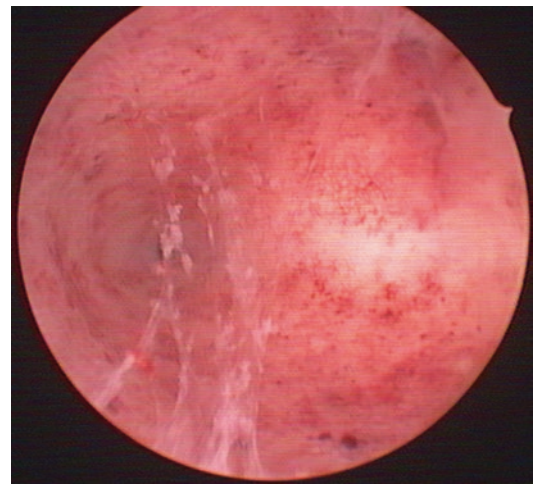

Fig. 9.10 Endometrial tuberculosis—cobweb adhesions at cornua

Endometrial scarring is one of the pathognomonic features in endometrial tuberculosis especially if whitish deposits overlying the endometrium are also seen. Endocervical scarring is also frequently seen in endometrial tuberculosis.

In endometrial tuberculosis, intraluminal adhesions in the interstitial part of the fallopian tube can often be viewed at hysteroscopy by placing the microhysteroscope tip very close to the tubal orifice and viewing with a source magnification of 25× [23].

At times the whitish deposits do not overlie appear the endometrium and instead they are anchored to flimsy adhesions by being impregnated in the same [17]. These flimsy adhesions are not shed with menstruation; hence, the impregnated deposits are seen even in the postmenstrual phase.

In some cases, the whitish deposits are not seen over the endometrium at hysteroscopy. Such deposits are seen after vital staining with methylene blue dye. In such cases, the hysteroscope is removed and chromopertubation is done with methylene blue dye, followed by reintroduction of the hysteroscope. Glistening white, highly reflective deposits situated are observed against the background of a dark blue-stained endometrium resembling a "starry sky" appearance [17]. We have observed the starry sky appearance and used it to diagnose endometrial tuberculosis on multiple occasions over a 21-year period. It appears that the methylene blue dye is not taken up by the caseous tubercular deposit but is taken up by the surrounding endometrium. The unstained caseous deposit reflects white light in contrast to the surrounding dark blue endometrium, thereby giving a starry sky appearance.

Hysteroscopic visualization of the endometrium after antitubercular therapy often shows an improvement in the mucosal morphology. A closer visualization at increased magnification is helpful in demonstrating the remnants of a healing tubercular pathology after antitubercular therapy [24]. Relook hysteroscopy after antitubercular therapy guides the surgeon towards prognosis and results of anti-tubercular therapy.

9.2.23 Comments

Hysteroscopy was born to look for endometrial pathology beyond the diagnostic accuracy of other image explorations, such as ultrasound, hysterosalpingogram or blind biopsy/dilatation and curettage. Not only is it able to diagnose organic and/or structural abnormalities but also the normal development of endometrial mucosa [25].

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10 Dating the Endometrium Through Hysteroscopy Without the Need for Biopsy

Sujata Kar and Kirty Nanda

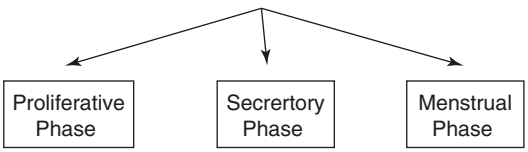
10.1 Introduction

During the menstrual cycle in a normal woman, the endometrium undergoes different phases. The histologic features of what constitutes a "normal" endometrium change with a woman's age, through the premenstrual, reproduction, premenopausal, and postmenopausal years.

In fact, the endometrium is one of the most dynamic target tissues in women. During the reproductive years, deviation from the normal, either in histologic pattern or in temporal relationship to ovulation, often indicates underlying abnormalities that may cause female infertility.

10.2 Different Phases of Endometrial Cycle

The endometrial cycle is divided into three phases.



10.2.1 The Proliferative Phase

This phase starts from the end of the menstrual period to ovulation, i.e., between the 4th and 14th day of the cycle. During this phase, egg development occurs and is mainly estrogen mediated. The endometrium reaches a thickness of around 1–3 mm. During this phase, the endometrial lining grows due to development of the endometrial glands, the stroma, and the vascular component.

10.2.2 The Secretory Phase

Also known as the luteal phase, this begins at the time of ovulation up to menstruation, i.e., between the 14th and 28th days of the cycle. Due to production of high level of estrogen and progesterone by the corpus luteum, the endometrium reaches up to 5–6 mm thickness. The glands undergo some morphological changes and secretory activity, becoming more tortuous and dilated. The endometrial spiral arteries are also developed.

10.2.3 The Menstrual Phase

In the absence of pregnancy, a sudden decline of estrogen and progesterone production by the corpus luteum produces endometrial ischemia due to vasoconstriction of the spiral arteries between 1 and 24 hours before menstruation. After the period of vasoconstriction, there is return of

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blood flow to the superficial layers of the endometrium, resulting in detachment only of the basal layer. During this phase, uterine contractions occur to facilitate the expulsion of endometrial tissue.

10.3 Why Dating of Endometrium Is Needed and How It Is Done

The dating of endometrium is an important part of the evaluation of woman with infertility. As stated before, the cyclical structural changes show the metabolic functions which are regulated by ovarian estrogen and progesterone. Due to these, the endometrium is considered one of the most sensitive indicators of the hypothalamic pituitary ovarian hormonal axis. As a result, morphologic evaluation of the endometrium is used in diagnostic evaluation of infertile patients to determine whether ovulation is occurring. Again, it is done to rule out the luteal phase defect in infertility workup. In addition to defining the precise histologic date, an endometrial biopsy is part of the infertility workup to exclude other organic uterine abnormalities. Dating of the endometrium is also required for judging endometrial receptibility in IVF techniques. Traditional histologic dating of the endometrium has remained the gold standard for nearly 50 years. This is done by endometrial biopsy which is an office procedure done using a small curette or pipelle aspiration and sent for histological examination.

The biopsy findings help confirm that ovulation occurred and indicate whether there was sufficient secretory effect, mediated by progesterone, during the luteal phase. To utilize fully the morphologic interpretation, the gynecologist compares the histologic date to the clinical data, including the date of the rise in the basal body temperature, the time of the serum luteinizing hormone (LH) surge, detection of LH in urine, transvaginal ultrasound evaluation of follicular or corpus luteum development and serum progesterone level, or subtraction of 14 days from the onset of menses. Consequently, the biopsy typically is timed to coincide with the luteal (secretory) phase of the cycle. Apart from histopathological studies, the tissue can also be studied for antibodies and immunohistochemistry for cyclical changes in endometrial integrins expression.

The major drawback of this is it is an invasive procedure and only a small part of endometrium is evaluated. Thus, there is a big chance of missing some pathology in the rest of the endometrium. A high interobserver and intraobserver variation has further limited the clinical utility of traditional dating techniques.

Dating by sonography can also be done. The ultrasound appearance of the endometrium differs throughout the cycle, and the echogenicity of the endometrium is studied. During menstruation, the endometrium appears as a thin, irregular interface. The sloughed tissue and blood give a central echogenicity. In the proliferative phase, the endometrium is hypoechoic which is the reflection of the straight and orderly arrangement of the glandular elements. The central thin echogenic line is the specular reflection from the endometrial surfaces, giving a three-layered view in the periovulatory stage. During secretory phase, the endometrium achieves its maximal thickness and echogenicity due to its distended tortuous glands containing their secretions.

10.4 Hysteroscopic Dating

The development of a new generation of hysteroscopes, the microhysteroscope with variable magnifications ranging from 1:1 to 150:1, which enable a panoramic vision of the uterine cavity and a direct visualization of the form and location of macroscopic pathological entities, the appearance of the endometrial vascularization as an exploration at the cellular level and the blood vessel level; dating of endometrium has been made possible.

Sl. no	Phase	Abbreviation	Days (28-day cycle)
1	Early proliferative phase	EPP	3–8
2	Late proliferative phase	LPP	9–13
3	Ovulatory phase	OP	14–16
4	Early secretory phase	ESP	17–22
5	Late secretory phase	LSP	23–25
6	Premenstrual phase	PM-MP	26–2

With the development of a new generation of Hysteroscopes: the microhysteroscopes, which has variable magnifications ranging from 1:1 to 1:150, many things became possible. Panoramic vision of the uterinecavity, direct visualisation of form and location of macroscopic pathology, exploration of blood vessels and vascularisation at cellular level, and this made dating of endometrium possible.

Early Proliferative Phase (EPP): At the end of the menstrual period, only the basal layer of the endometrium with its basal arteries remains. New vessels then grow from the stumps of the old. Arterioles (spiral arteries) from the basal arteries come off at right angles and are directed toward the surface of the endometrium. They are very small and very straight in the first part of their course. The basal arteries that run parallel to the endometrial surface and parallel to one another are mainly seen in hysteroscopy at this phase. Small coiled arteries that run perpendicular to the endometrial surface are seen as interrupted or punctate lines.

Late Proliferative Phase (LPP): In this period, there is a rapid growth of the coiled arteries. They get more and more convoluted and their spiralization is easily visualized.

Ovulation Phase (OP): There is no morphologic pattern of the endometrium that gives the clue to the exact day of ovulation. A gap of 36–48 hours exists before one sees the characteristics of the onset of the early secretory phase.

Early Secretory Phase (ESP): The coiled arteries reach the superficial part of the lamina functionalis now and form a network of capillaries around the glandular openings. As there is no densification of the stroma yet, we can see vessels on two different planes that tend to shift one over another, a deeper layer being the coiled arteries and a superficial layer being the capillaries that form a fine reticulum around the glands, just beneath the epithelial surface.

Late Secretory Phase (LSP): At this time, the endometrium is at its maximal thickness, i.e., of 7–8 mm. Due to accumulation of secretions, stromal edema, and pre-decidual reactions, the endometrium appears dense. The underlying coiled arteries are not visualized with the scope anymore. Hysteroscopically we can only see the superficial network of capillaries. The stromal edema gives an ivory color to the endometrium.

Premenstrual-Menstrual Phase (PM-MP). The superficial network of capillaries still exists, but blood collections are formed in small pools near the endometrial surface. In menstruation, the endometrial shedding starts near the cornual parts of the fundus uteri and runs in a circular way toward the isthmus.

Table 10.1 Hysteroscopic picture through the menstrual cycle

	Menstrual	Proliferative	Early luteal	Late luteal
Days	1–4	5–14	15–21	22–28
Color	Red	Pink	White	White
Surface	Irregular	Smooth	Wavy	Spongy
Thickness	0–1 mm	2–5 mm	>6 mm	>7 mm
Glands	Absent	White dots	Prominent	Absent
Notch	No	Hemorrhagic	Serous	Serous
Vessels	No	Thin	Absent	Absent

Role of Hysteroscopy in Infertility and Recurrent Pregnancy Loss

11

Bhavana Mittal

Infertility workup includes many evaluations and assessments. Hysteroscopy is a valuable diagnostic and therapeutic modality in the management of infertility.

11.1 The Uterine Factor in Infertility and Recurrent Pregnancy Loss

Uterine factors can be found in only 2–3% of infertile women, but intrauterine lesions are much more common in this setting (40–50%) [1, 2]. These lesions can compromise spontaneous fertility as well as reduce pregnancy rates in assisted reproduction [1, 2].

11.2 Hysteroscopy for Evaluation of Uterine Factor

Evaluation of the uterine cavity is a basic step in female infertility workup. Classically, hysterosalpingography, hysterosonography, and transvaginal sonography are most commonly used for this purpose.

Hysteroscopy, however, is considered the gold standard for diagnosis of intrauterine lesions [1–3].

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The benefit of the systematic use of hysteroscopy in the initial assessment of infertility remains unclear. Systematic hysteroscopy before IVF is a widely accepted practice which is supposed to improve pregnancy rates but still lacks scientific evidence. After repeated implantation failure in IVF cycles, uterine cavity should be reevaluated by hysteroscopy and this practice has been demonstrated to improve pregnancy rates [1, 4].

Hysteroscopy for infertility (indications) [5]:

1. Abnormal hysterosalpingogram.
2. Thin endometrium.
3. Abnormal uterine bleeding.
4. Suspected intrauterine pathology.
5. Uterine anomalies (along with laparoscopy).
6. Unexplained infertility.
7. Recurrent pregnancy loss.
8. Recurrent implantation failure.

11.3 Hysteroscopy for Treatment of Uterine Factor

No consensus on the effectiveness of hysteroscopic surgery in improving the prognosis of subfertile women is available.

The debate regarding the role of hysteroscopic surgery in the management of female infertility remains as the published studies do not reach a consensus on the benefit of such an intervention in this setting. The randomized trials do not

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clearly demonstrate that surgical correction of all intrauterine abnormalities improves IVF outcome.

Published observational studies suggest increased pregnancy rates after the hysteroscopic removal of endometrial polyps, submucous fibroids, uterine septum, or intrauterine adhesions, which can be found in 10–15% of women seeking treatment for subfertility [1].

More randomized controlled studies are needed to substantiate the effectiveness of the hysteroscopic removal of suspected intrauterine pathology in women with unexplained subfertility or prior to assisted reproductive technology [6].

A recent review on the effectiveness of hysteroscopy in improving pregnancy rates in subfertile women without other gynecological symptoms concluded that there is scarce evidence to support the widespread use of hysteroscopic surgery in the general subfertile population [7].

11.4 Acceptance of the Procedure

There are many randomized controlled trials on technical feasibility and patient compliance demonstrating that the procedure is well tolerated and effective in the treatment of intrauterine pathologies [8, 9].

11.5 Types of Hysteroscopes Used

Most diagnostic hysteroscopes of less than 5 mm outer diameter (OD) do not provide adjacent channels for operations and are strictly for diagnostic use. However, continuous flow systems have been successfully adapted to small-caliber hysteroscopes, allowing the use of liquid media to be used, permitting the performance of some minor surgical procedures. Major barriers to successful office hysteroscopy include pain, cervical stenosis, and poor visualization of the cervix. Therefore, preoperative patient selection and counseling are very important.

Poor candidates for office hysteroscopy include patients who have cervical stenosis, high levels of anxiety, comorbidities, limited mobility, or significant uterine pathology requiring operative procedures. Office hysteroscopy should be brief and usually consists of either diagnostic or minor operative procedures.

The operative hysteroscopes are larger and usually have a 7–8 mm OD and a 7-French operating channel to introduce instrumentation, usually of the semirigid type. Hysteroscopy can be performed using larger operative hysteroscopes (7 mm OD) under local anesthesia. Extensive dissections or procedures using the resectoscope are better performed under regional, spinal, or general anesthesia.

11.6 Specific Situations

11.6.1 Fibroids

When TVS shows submucous fibroid or HSG reveals a filling defect in the uterine cavity, sonohysterography (SIS) or office hysteroscopy can more precisely define the location and attachment of the lesion and determine whether a submucous myoma is amenable to hysteroscopic myomectomy [10]. Despite high-quality evidence from a Cochrane systematic review [11] demonstrating that SIS and hysteroscopy are equivalent for the diagnosis of submucous fibroids, with both being superior to transvaginal ultrasonography (TVUS), the American Association of Gynecologic Laparoscopists (AAGL) [12] recommends that magnetic resonance imaging (MRI) is superior to other imaging and endoscopic techniques in characterizing the relationship of submucous leiomyomas with the myometrium and uterine serosa. The AAGL (2012) [12] considers HSG less sensitive and specific when submucous myomas are concerned. Hysteroscopy revealed high sensitivity, specificity, and accuracy in the diagnosis of submucous fibroids and a good correlation with histological diagnosis [13].

The interference of fibroids on fertility largely depends on their location. Hysteroscopy appears unnecessary when the uterine cavity contour is normal. Submucous fibroids interfere with fertil-

ity and should be removed in infertile patients, regardless of the size or the presence of symptoms [1, 2].

In a RCT on the treatment of submucous myomas in infertile women [14], a better possibility of becoming pregnant after hysteroscopic myomectomy with a relative risk of 2.1 (95% confidence interval 1.5–2.9) was detected.

Klatsky et al. [15] concluded that there is strong evidence favoring hysteroscopic myomectomy for submucous fibroids in women before undergoing ART.

A recent Cochrane review [1] tried to assess the effects of the hysteroscopic removal of submucous fibroids in women with otherwise unexplained subfertility or prior to intrauterine insemination, in vitro fertilization (IVF), or intracytoplasmic sperm injection (ICSI). In women with otherwise unexplained subfertility and submucous fibroids, there is no evidence of benefit with hysteroscopic myomectomy compared to regular fertility-oriented intercourse during 12 months for clinical pregnancy (odds ratio (OR) 2.4, 95% confidence interval (CI) 0.97–6.2, and $P = 0.06$, 94 women) and miscarriage (OR 1.5, 95% CI 0.47–5.0, and $P = 0.47$, 94 women). Nonetheless, the quality of the evidence considered was very low.

According to the ASRM [10], hysteroscopic myomectomy is indicated for intracavitary myomas and submucous myomas having at least 50% of their volume in the uterine cavity.

In infertile women and those with recurrent pregnancy loss, myomectomy should be considered only after a thorough evaluation has been completed.

In experienced hands, hysteroscopic myomectomy is minimally invasive, safe, and effective [16].

11.6.2 Mullerian Anomalies

The current literature regarding the frequency and probable causes of infertility among women with congenital uterine anomalies is insufficient to allow any robust conclusions to be drawn [17]. It appears that women with a history of miscarriage or miscarriage and infertility have higher prevalence of congenital uterine anomalies compared with the unselected population [18].

Although HSG remains a useful screening tool for the diagnosis of a normal or abnormal uterine cavity, showing a good sensitivity for diagnosing uterine malformations, it cannot reliably differentiate between different types of congenital uterine anomalies, not allowing appropriate classification [4].

Saravelos et al. [19] reviewed the medical literature in order to assess the diagnostic accuracy of different methodologies and estimate the prevalence of congenital uterine anomalies in women with infertility and recurrent miscarriage. They concluded that the most accurate diagnostic procedures were combined hysteroscopy and laparoscopy, sonohysterography (SIS), and possibly three-dimensional ultrasound (3D US).

As hysteroscopy does not allow evaluation of the external contour of the uterus, some may consider it as a suboptimal test [18].

The **unicornuate uterus** is an uncommon anomaly, which may be associated with relatively poor reproductive outcome depending on a number of factors such as variations in the vascular contribution from the uterine artery and uteroovarian artery of the contralateral side, extent of the reduction of muscular mass of a unicornuate uterus, degree of cervical competence, and presence and extent of coexistent pelvic disease such as endometriosis. The rudimentary horn can be removed by laparotomy or laparoscopy.

The **bicornuate uterus** is a common congenital anomaly and is associated with good reproductive outcomes. **Uterus didelphys** has a relatively good prognosis for achieving pregnancy when compared with other uterine anomalies [2].

Combining diagnostic modalities can improve diagnostic accuracy, but concurrent hysteroscopy and laparoscopy remain the gold standard for diagnosing the **septate uterus** [2]. Most studies of metroplasty for a septate uterus combine women with recurrent miscarriage and infertility, and no study has been published that randomizes infertile women to treatment versus no treatment. For this reason, controversy exists as to whether infertile women should undergo metroplasty [2].

Hysteroscopic metroplasty in women with septate uterus and unexplained infertility could improve clinical pregnancy rate and live birth rate in patients with otherwise unexplained infertility [20, 21].

Hysteroscopic metroplasty in women with recurrent miscarriage and a septate uterus is being performed in many countries to improve reproductive outcomes in this setting. No randomized controlled trial evaluating the effectiveness and possible complications of hysteroscopic metroplasty has been published so far [22].

The prevalence of the **arcuate** uterus in women with recurrent pregnancy loss (RPL) is 12.2%, whereas in the general/infertile population, it is 3.8%. Such high prevalence in the RPL population suggests a possible causal relation between this type of uterine anomaly and RPL [19].

11.6.3 Endometrial Polyps

Little is known about the association between endometrial polyps and fertility. The gold standard for diagnosis is hysteroscopy and hysteroscopic polypectomy remains the mainstay of management [13]. Management may be conservative, with up to 25% of polyps regressing, particularly if less than 10 mm in size. Polyps can distort the endometrial cavity, may have a detrimental effect on endometrial receptivity, and increase the risk of implantation failure [23].

A recent Cochrane review [1] tried to assess the effect of hysteroscopic polypectomy on the results of intrauterine insemination (IUI). Apparently, the hysteroscopic removal of polyps prior to IUI increases the odds of clinical pregnancy compared to diagnostic hysteroscopy and polyp biopsy only (OR 4.4, 95% CI 2.5–8.0, and $P < 0.00001$).

Implantation and clinical pregnancy rates were statistically significantly increased after hysteroscopic polypectomy in a group of women with recurrent implantation failure after IVF [24].

In conclusion, it appears that polypectomy prior to IUI or IVF (even in cases with previous implantation failure) increases the chances of pregnancy.

11.6.4 Assisted Reproductive Technology

A systematic review comparing the outcome of IVF treatment performed in patients who had outpatient hysteroscopy in the cycle preceding their IVF treatment with a control group in which hysteroscopy was not performed was conducted. The results of five studies showed evidence of benefit from outpatient hysteroscopy in improving the pregnancy rate in the subsequent IVF cycle [25].

Another recent study included 157 women with a history of recurrent IVF failures (two or more) who underwent hysteroscopy (diagnostic or operative, as appropriate) to evaluate the endometrial cavity. Abnormal hysteroscopic findings were found in 44.9% of the patients in this study, and 75 women (48.1%) became pregnant following hysteroscopy. Of these pregnancies, 36 occurred in women with corrected endometrial pathology, the majority of which was identified as endometrial polyps [26] (Cenksoy et al., 2013).

The safety and diagnostic value of hysteroscopy before IVF were examined in 217 infertile women. In 69 women (31.8%), hysteroscopy identified intrauterine lesions (polyps, septa, submucosal leiomyomas, or synechiae) that led to operative hysteroscopy. The authors concluded that diagnostic hysteroscopy presents significantly higher sensitivity than TVS and HSG in the diagnosis of intrauterine lesions. Thereby, diagnostic hysteroscopy should be performed before IVF in all patients, including women with normal TVS and/or HSG findings, because a significant percentage of them have undiagnosed uterine disease that may adversely affect the success of fertility treatment [25].

The benefit of hysteroscopic surgery was further corroborated in a retrospective matched control study by Tomaževič et al. [27]. These authors evaluated the influence of septate, subseptate, and arcuate uterus on pregnancy and live birth rates in 2481 in conventionally stimulated IVF/intracytoplasmic sperm injection (ICSI) cycles. Pregnancy rates after embryo transfer before hysteroscopic surgery were significantly lower, both

in women with subseptate and septate uterus and in women with arcuate uterus compared with controls. When live birth rates were considered, differences were more evident.

Two studies address the importance of the morphological evaluation of the uterus through assessment of the effect of office hysteroscopy on IVF outcomes in women undergoing IVF for the first time and in women with recurrent implantation failure [19].

In the first study, hysteroscopy before in vitro fertilization (inSIGHT), a multicenter, randomized controlled trial between May 25, 2011, and Aug 27, 2013, randomly assigned 750 women to undergo either hysteroscopy (n = 373) or immediate IVF (n = 377) [28].

They concluded that routine hysteroscopy does not improve livebirth rates in infertile women with a normal transvaginal ultrasound of the uterine cavity scheduled for a first IVF treatment. Also, women with a normal transvaginal ultrasound should not be offered routine hysteroscopy.

In the other study, hysteroscopy in recurrent in vitro fertilization failure (TROPHY), a multicenter, randomized controlled trial between Jan 1, 2010, and Dec 31, 2013, randomly assigned 350 women to the hysteroscopy group and 352 women to the control group.

They concluded that outpatient hysteroscopy before IVF in women with a normal ultrasound of the uterine cavity and a history of unsuccessful IVF treatment cycles does not improve the livebirth rate.

They also concluded that further research into the effectiveness of surgical correction of specific uterine cavity abnormalities before IVF is warranted.

11.6.5 Chronic Endometritis (CE) in Women with Recurrent Pregnancy Loss (RPL) and Recurrent Implantation Failure (RIF)

A high prevalence of immunohistochemically confirmed CE in women with RIF and RPL has been found. Office hysteroscopy is a useful diagnostic tool but should be complemented by an endometrial biopsy for the diagnosis of CE.

The endometrial factor in recurrent implantation failure after IVF and recurrent pregnancy loss is under constant scrutiny [26].

Key Learning Points

- Uterine factors can be found in only 2–3% of infertile women, but intrauterine lesions are much more common in this setting (40–50%).
- As it is an expensive and invasive method for uterine cavity evaluation, it should be reserved for further evaluation and treatment of abnormalities defined by less invasive methods such as 3D TVS, HSG, and sonohysterography [29].
- Hysteroscopy for infertility is indicated in women with abnormal hysterosalpingogram, thin endometrium, abnormal uterine bleeding, suspected intrauterine pathology, uterine anomalies (along with laparoscopy), unexplained infertility, recurrent pregnancy loss, and recurrent implantation failure.
- Published observational results suggest a benefit for resection of submucosal leiomyomas, adhesions, septum, and at least a subset of polyps in increasing pregnancy rates.
- More randomized controlled studies with adequate controls are needed to substantiate the effectiveness of the hysteroscopy prior to assisted reproductive technology (IUI, IVF, or ICSI).
- In women with recurrent implantation failure, benefit of evaluation of uterine cavity with hysteroscopy has been demonstrated.
- The procedure is well tolerated and effective in the treatment of intrauterine pathologies.

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12 Uterine Malformations and Role of Hysteroscopy

Manjula Anagani and Prabha Agrawal

12.1 Overview

Mullerian anomalies are a group of congenital anomalies of female genital tract and are believed to occur secondary to the in utero disruption of the embryological development of the Mullerian ducts. Adverse obstetric outcomes that have been attributed to septate uterus include infertility, recurrent pregnancy loss, malpresentation, and preterm delivery. The current technical advancements make hysteroscopy a minimally invasive and safe procedure for women to solve many factors that hamper the possibility of pregnancy.

12.2 Incidence

The true prevalence of the uterine septum is difficult to ascertain as many patients are asymptomatic but appear to range from 1 and 2 per 1000 to as high as 15 per 1000 [1]. Their mean prevalence in the population of fertile women is approximately 4.3%, in infertile patients approximately 3.5%, and in patients with recurrent pregnancy losses approximately 13% [2].

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12.3 Classification

The first classification system for categorization of congenital uterine malformations was that of the American Fertility Society (AFS) published in 1988, mostly based on the previous work of Buttram and Gibbons (Fig. 12.1) [3].

The most recent classification is by the European Society of Human Reproduction and Embryology (ESHRE) and the European Society of Gynecologic Endoscopy (ESGE) system under the working name CONUTA (Congenital Uterine Anomalies) [4].

12.4 Development

A uterine septum is believed to develop as a result of incomplete resorption of the tissue connecting the two paramesonephric ducts before the 20th embryonic week [1]. The complete septum extends from the fundal area to the internal os. This anomaly is often associated with a longitudinal vaginal septum [5]. AFS criteria define a partial uterine septum as having the central point of the septum at an acute angle and define the length of the septum to be greater than 1.5 cm, with arcuate defined as having a fundal invagination between 1 and 1.5 cm (Fig. 12.2) [1].

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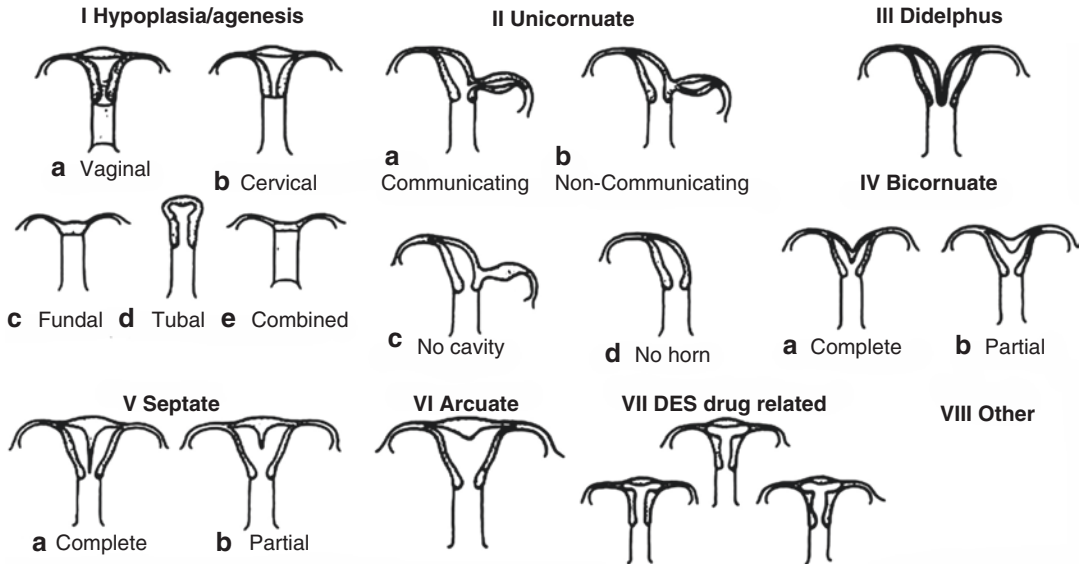

Fig. 12.1 AFS classification of Mullerian duct anomalies [14]

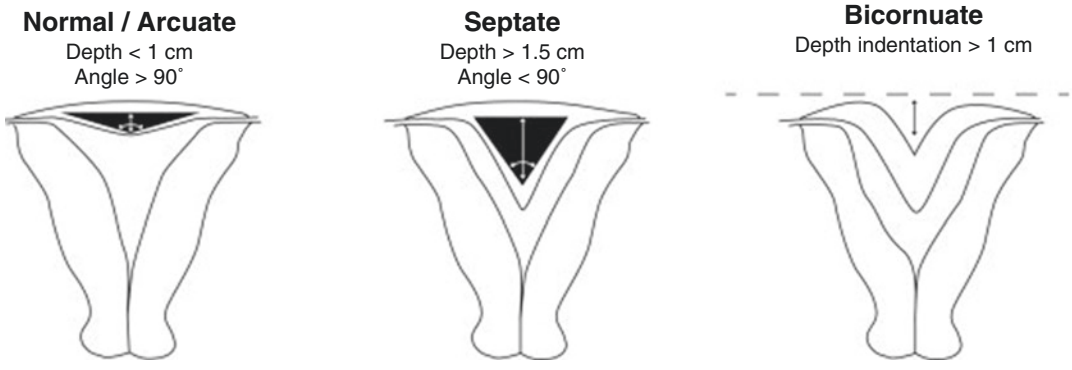

Fig. 12.2 Difference between arcuate, septate, and bicornuate uterus [1]

12.5 Diagnosis

1. History and examination.
2. Transvaginal ultrasound (2D USG/TVS).
3. Three-dimensional ultrasonography (3D USG).
4. Magnetic resonance imaging (MRI).
5. Hysterosalpingography (HSG).
6. Saline infusion sonography (SIS).
7. Hysteroscopy.
8. Combined laparoscopy and hysteroscopy.

12.5.1 Summary

There is fair evidence that 3D USG, SIS, and MRI are good diagnostic tests for distinguishing a septate and bicornuate uterus when compared with laparoscopy/hysteroscopy (Grade B) [1].

It is recommended that imaging with hysteroscopy should be used to diagnose uterine septa rather than laparoscopy with hysteroscopy because this approach is less invasive (Grade B) [1].

12.6 Questions before Intervention (ASRM Guidelines)

1. Does a septum impact fertility? There is insufficient evidence to conclude that a uterine septum is associated with infertility (Grade C) [1].
2. Does treating a septum improve fertility in infertile women? Several observational studies indicate that hysteroscopic septum incision is associated with improved clinical pregnancy rates in women with infertility (Grade C) [1].
3. Does a septum contribute to pregnancy loss or adverse pregnancy outcome? There is fair evidence that a uterine septum contributes to miscarriage and preterm birth (Grade B) [1].

   Some evidence suggests that a uterine septum may increase the risk of other adverse pregnancy outcomes such as malpresentation, intrauterine growth restriction, placental abruption, and perinatal mortality (Grade B) [1].
4. Does treating a septum improve obstetrical outcomes? Some limited studies indicate that hysteroscopic septum incision is associated with a reduction in subsequent miscarriage rates and improvement in live-birth rates in patients with a history of recurrent pregnancy loss (Grade C) [1].

   Some limited studies indicate that hysteroscopic septum incision is associated with an improvement in live-birth rate in women with infertility or prior pregnancy loss (Grade C) [1].
5. Are septum characteristics associated with worse reproductive outcomes? There is insufficient evidence to conclude that obstetric outcomes are different when comparing the size as defined by length or width of the uterine septa (Grade C) [1].
6. How long after surgical treatment of a uterine septum should a woman wait to conceive? Although the available evidence suggests that the uterine cavity is healed by 2 months postoperatively, there is insufficient evidence to advocate a specific length of time before a woman should conceive (Grade C) [1].

12.7 Advantages

Advantages of hysteroscopic metroplasty are:

1. Short surgery with a shorter hospitalization time.
2. Decreased need for analgesia.
3. Reduced morbidity.
4. Reduced costs.
5. No abdominal or transmyometrial scars.
6. Avoiding risk of possible intra-abdominal infections and adhesions.
7. No reduction in uterine volume.
8. Shorter interval to conception after operation.
9. Lower risk of uterine rupture during pregnancy.
10. Vaginal delivery not contraindicated.

12.8 Preoperative Workup

1. Informed Consent
2. Proper patient selection.
3. Timing of surgery—in the follicular phase as early as possible.
4. Cervical cultures—if needed.
5. Pregnancy test—if needed.
6. Preoperative cervical ripening—with synthetic laminaria tents or vaginal misoprostol 100–400 μg 9–10 h before surgery.
7. Preoperative thinning of endometrium—There is insufficient evidence for or against recommending danazol or GnRH agonists to thin the endometrium prior to hysteroscopic septum incision (Grade C) [1].

12.9 Procedure

Hysteroscopy presents unique challenges including cervical dilation, access to rudimentary horns, and maintenance of laterality in specimens [6]. Hysteroscopy helps to differentiate between a communicating and a noncommunicating uterine horn when in doubt and the noncommunicating/rudimentary uterine horn then can be completely removed (Figs. 12.3a, b and 12.4).

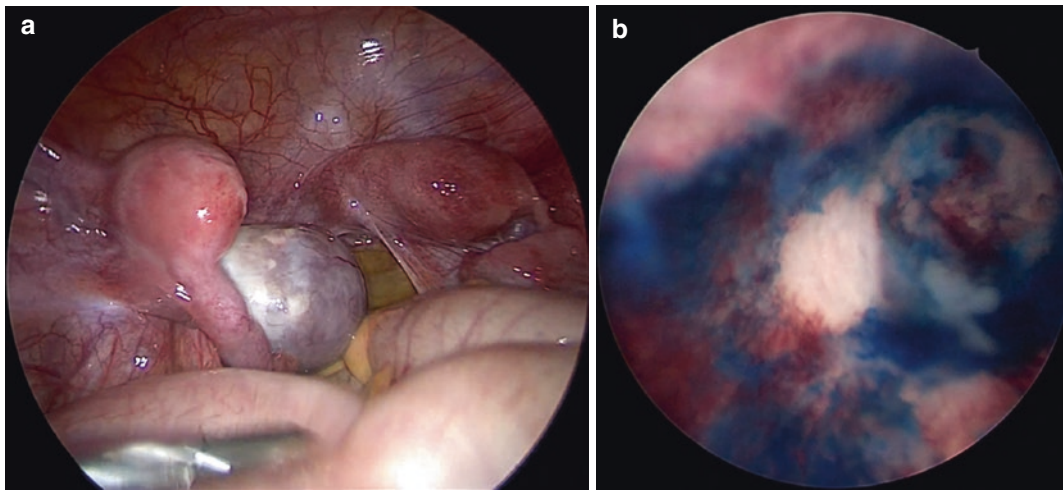

Fig. 12.3 (**a**) Laparoscopic view of the right unicornuate uterus with left rudimentary horn. (**b**) Hysteroscopic view of the right unicornuate uterus

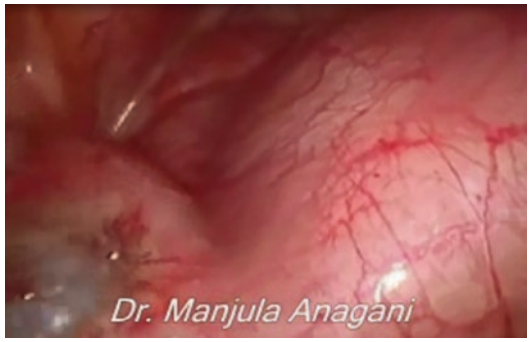

Fig. 12.4 Laparoscopic view of the right unicornuate uterus with left rudimentary horn dilated by a large hematometra

Two types of hysteroscopic treatment are available: resectoscopic and office hysteroscopic surgery. The indications for resectoscopic surgery are broad-based septa and complete septa with single or double cervix. Treatment of small septa whose apex is easily visible can be done as an outpatient procedure using office mini-hysteroscopic surgery [7].

The common methods of transcervical resection of septum (TCRS) include electroresection, microscissors, and laser. When subfertility is in the clinical background, it is imperative to treat uterine septum incision with the least invasive techniques [8].

1. Microscissors do not require cervical dilation, reducing the electrosurgical risks and occurrence of water intoxication. However, their drawbacks include the difficulty in stopping bleeding, a relatively long operating time, and excessive equipment wear [9].
2. Laser surgery (Nd-YAG laser, diode) has a short operating time, lesser amount of bleeding, a good haemostatic effect, and no damage to surrounding organs, and it can be used in all types of uterine distention fluids. However, it still has some disadvantages—high cost, high operation requirements, and increased risk of gas embolism caused by application of some gases [10].
3. Electrosurgical excision by unipolar wire loop, urologic resectoscope, and Versapoint bipolar electrode.

There was no statistically significant difference between hysteroscopic septal resection using unipolar versus bipolar resectoscope in terms of operation parameters and reproductive outcome [11].

Navigation of cervix is not always easily accomplished [12].

In difficult cases:

1. Proceed under ultrasonographic guidance.
2. Opt for a smaller hysteroscope.

3. Administer paracervical block.
4. Administer a topical cervical anaesthetic.

The use of distending media for the uterus is dependent on the energy source used. The cervix is dilated to 6 mm, the uterus is brought to a midaxial position, and the hysteroscope is inserted up to the level of the external os and slowly advanced into the uterine cavity under direct vision. Once the anatomy has been well defined, incision of the septum may be started (Figs. 12.5 and 12.6). When blue dye is injected the septum due to its fibrotic nature catches blue colour which provides guidance for correct incision. This is called Suha -Levent's sign.

As the septum is slowly incised, the tissues will retract anteriorly and posteriorly. It is crucial to stay in the midsection of the septum as the incision proceeds (Fig. 12.7). As the procedure progresses, it is also important to visualize the position of the ostia to understand how far cephalad to carry the incision.

End point—Dissection of the septum is complete when:

1. The hysteroscope can be moved freely from one tubal ostium to the other without obstruction.
2. The tubal ostia are visualized simultaneously.
3. Bleeding occurs from small vessels at the fundal myometrium (difficult if coagulation current is used).
4. Closer visualization of hysteroscopic light under laparoscopy.

Dissection should be terminated if significant bleeding is encountered, even when complete transection of the septum has not been achieved, for such an event suggests that the myometrium has been violated [8].

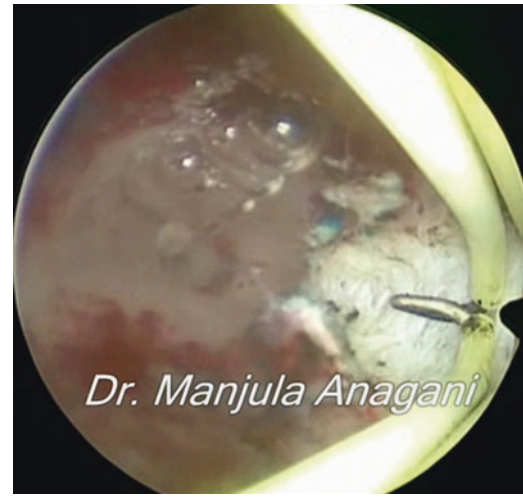

Fig. 12.6 Hysteroscopic septal resection with bipolar

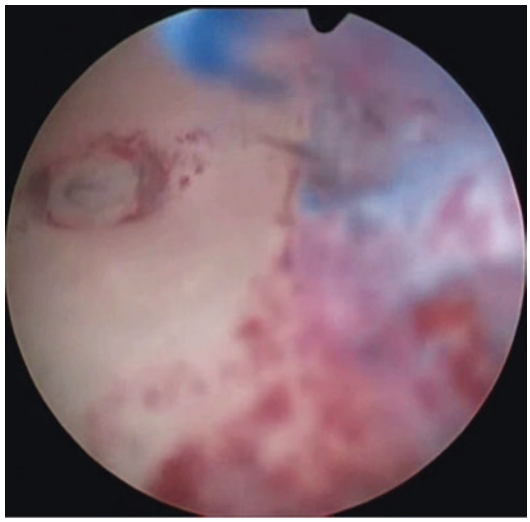

Fig. 12.5 Hysteroscopic view of full-length septum with left ostia

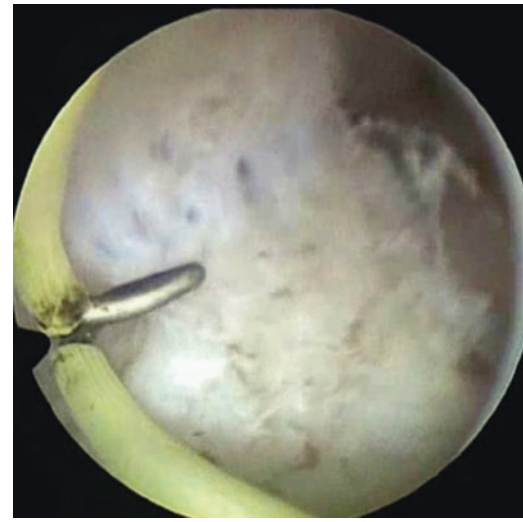

Fig. 12.7 Hysteroscopic septal resection at midline

Duplicate cervix—In the case of a complete septum, with duplicated cervices a Foley catheter bulb may be placed in one of the cavities and then the septum is cut. A recent small randomized study found that resection of the cervical septum was associated with a less complicated surgical procedure and equivalent reproductive outcomes [8].

Outcome—Hysteroscopic metroplasty has been demonstrated to significantly improve the live birth and miscarriage rates to approximately 80% and 15%, respectively [8].

Residual septum—After 2–3 months, patients may be reevaluated with HSG or hysteroscopy to assess the completeness of septal removal. Many studies demonstrate that septal remnants of <1 cm may not worsen the reproductive prognosis [10]. It is still preferable to leave a small portion of septum rather than damage the myometrium or perforate the uterus, because any remaining portions of the septum could always be resected with a subsequent procedure if necessary [8].

Postoperative—Is adhesion prevention needed?

Treatment options that have been proposed to decrease this risk include:

1. Broad-spectrum antibiotic.
2. Foley balloon placement.
3. Intrauterine auto-cross-linked hyaluronic acid gel.
4. Postoperative oestrogen therapy.
5. Placement of an IUD.
6. Copper IUD plus conjugated oestrogens and progesterone.

Summary statement: There is insufficient evidence to recommend for or against adhesion prevention treatment or any specific method following hysteroscopic septum incision (Grade C) [1].

12.10 Complications

1. Inadequate cervical dilation leading to cervical tears, creation of a false passage, and inability to complete the procedure.

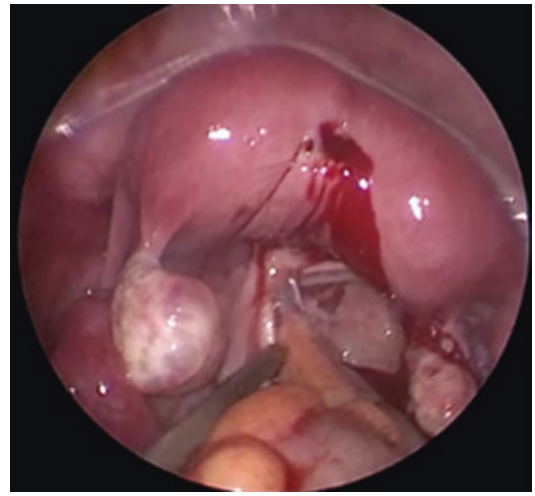

Fig. 12.8 Laparoscopic view of uterine perforation

2. Uterine perforation—Cervical stenosis, severe uterine anteflexion or retroflexion, and operator inexperience all increase the risk of perforation [13]. Perforation is recognized by a sudden feeling of give way/loss of resistance or inability to maintain the distention (Fig. 12.8). It can be reduced if continuous flow hysteroscopic equipment is used. To prevent thermal injury, activate the foot pedal only during the return phase of electrode toward the sheath, never during a forward movement. Concomitant use of USG/laparoscopy can prevent it.

   Management: If perforation is due to non-energy instrument, strict observation in post-op period is advisable. If any hemodynamic deterioration is noted, plan for immediate laparotomy/laparoscopy. If perforation is due to energy instrument, immediate laparotomy/laparoscopy to ensue adjacent organs injury is considered.
3. Fluid overload—Excessive infusion pressure that results in excessive intrauterine pressure is the most important risk factor especially if using electrosurgery and hypotonic media [13].

   Prevention—Follow the basic principle to use the lowest pressure to achieve a clear view of the uterine cavity (50–80 mmHg) [13]. Complete surgery as quickly as possible. Alert the surgeon and anaesthetist as soon as deficit

exceeds 1000 mL. If deficit exceeds 1500 mL, it is advisable to terminate the procedure [11]. Monitor baseline electrolytes. If Na <125 mEq/L, terminate the procedure.

4. Gas emboli is—due to faulty methods or use of laparoscopic insufflator to infuse CO_2 in uterus. Prevention: Avoid the Trendelenburg position and keep the os occluded to prevent entry of room air. Keep the last dilator inside till resectoscope is assembled. Limit repeated removal-reinsertion of the resectoscope. Keep anaesthetist informed about the operative procedures which can open venous sinuses and cause air entry so that they can monitor end tidal CO_2 and diagnose air embolism early.
5. Intraoperative bleed—Immediately aspirate the blood and increase the pressure of distention media above the mean arterial pressure. Coagulation with 3 mm ball electrode or intrauterine Foley balloon compression with 3–5 mL saline can be done for 6–12 h.
6. Electrosurgical thermal injuries to viscera usually following perforation [13].
7. Postoperative Infection can occur with history of pelvic inflammatory disease, preoperative use of laminaria tent, repeated insertion, and removal of hysteroscope through cervix and tissue fragments left in utero [13].
8. Post-op bleeding, intrauterine adhesions, neuropathy due to improper patient positioning, and vaginal burns.
9. Uterine rupture during pregnancy—Risk is correlated with excessive septal excision, penetration of the myometrium, uterine wall perforation, and excessive use of cautery during septum incision [1].

12.11 Conclusions

Hysteroscopic metroplasty has now replaced transabdominal approach, making it the gold standard for treatment of septate uterus. Clinical evidence from the studies analysed suggests an improvement in reproductive outcomes after hysteroscopic resection of the septum, particularly in infertile women and women who have experienced recurrent miscarriages (NICE guidelines 2015; ASRM guidelines, 2016). In a patient with no history of infertility or prior pregnancy loss, it may be reasonable to consider septum incision after counselling about the potential risks and benefits of the procedure (ASRM guidelines, 2016).

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13 Hysteroscopy and Endometrial Polyps

Narendra Malhotra and Nitin Shah

Endometrial polyps are exophytic growths of the mucous linings of the endometrium. They differ in size, shape, number and appearances. The surface epithelium of the polyp is smooth and similar to surrounding epithelium. They differ from pedunculated fibroids in the manner of surface epithelium and vascularity through the peduncle along with the surface of the growth. Polyps can be associated with glandular hyperplasia and can remain latent for a longer period of time.

Grossly, they are pink-grey to white in colour, with smooth and glistening surface. The tip or the entire polyp can be haemorrhagic. Found mostly in fundal or cornual regions, polyps range from millimetres in size to those that occupy the whole uterine cavity. Some other intrauterine pathologies like endometrial hyperplasia, sarcoma or even carcinoma may show polypoid appearance.

The impact of polyps on infertility mainly depends upon its size and location. Depending upon their location, they may cause mechanical obstruction (e.g. tubocornual polyp), by their association with endometriosis or by the expression of enzyme aromatase. 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 and number of their polyps.

Endometrial polyps are a cause of abnormal uterine bleeding (AUB) (Table 13.1) although as with leiomyomas, most endometrial polyps are asymptomatic. Endometrial polyps can cause menorrhagia and metrorrhagia, and they may be associated with dysmenorrhea [1]. The incidence of endometrial polyps increases with age throughout the reproductive years .The diagnosis is based on either visualization with hysteroscopy or sonohysterography or the microscopic assessment of tissue obtained by a biopsy done in the office or a curettage specimen. One study using sonohysterography found polyps in 33% of symptomatic premenopausal women older than the age of 29 years who were experiencing abnormal bleeding versus 10% in asymptomatic women [2].

Table 13.1 PALM-COEIN classification of AUB

Structural causes (PALM)		Nonstructural causes (COEIN)	
Polyps	AUB-**P**	Coagulopathy	AUB-**C**
Adenomyosis	AUB-**A**	Ovulatory dysfunction	AUB-**O**
Leiomyomas • submucosal • other	AUB-**L** AUB-L SM AUB-LO	Endometrial (primary disorders of mechanisms regulating local endometrial haemostasis)	AUB-**E**
Malignancy and hyperplasia	AUB-**M**	Iatrogenic Not yet specified	AUB-**I** AUB-**N**

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In this study, polyps also were associated with leiomyomas, both intracavitary and intramural, which were present in 13% and 58%, respectively, of symptomatic women with bleeding. Endometrial polyps can regress spontaneously.

In one study in which asymptomatic women underwent repeat sonohysterography after 2.5 years, four of seven polyps resolved; these polyps tended to be smaller than those that did not resolve [3]. The larger polyps were more likely to result in abnormal bleeding. A review of the pathology of resected polyps suggests that the chance of malignancy is less than 5% and likely approximates 0.5% [1]. In one large series, it was rare to find atypia or carcinoma in an endometrial polyp from a premenopausal woman [4].

Endometrial polyps and other abnormalities can be seen in women who are taking tamoxifen. These polyps are more likely to involve cystic dilation of glands, stromal condensation around the glands, and squamous metaplasia of the overlying epithelium [5]. These polyps can be benign, although they must be distinguished from endometrial malignancies, which may also occur with this medication. The incidence of endometrial polyps not associated with tamoxifen increases with age during the reproductive years; it is not clear, however, whether the incidence subsequently peaks or decreases during the postmenopausal years [1]. Endometrial polyps are more likely to be malignant in postmenopausal women, and hypertension has been associated with an increased risk of malignancy [4].

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% [6, 7]. Because of the influence of circulating oestrogen on the development of endometrial polyps, the higher incidence seen in the infertility population may be related to the hyperoestrogenemia associated with prior cycles of COH. A recent prospective study of 224 infertile women who underwent hysteroscopy suggested a 50% pregnancy rate achieved with polypectomy [8]. Timed hysteroscopic evaluation and treatment immediately before COH has proven beneficial [9]. In contrast, of 83 patients who were diagnosed with an endometrial polyp during COH for IVF and who underwent hysteroscopy immediately after oocyte retrieval, only 58% had histopathologic confirmation of the diagnosis [10]. Although pregnancy rates in these women were similar to those of other IVF patients, spontaneous abortion rates appeared higher in those patients with polyps [10].

The threshold of parameters, such as size and number of polyps, at which infertility or miscarriage risk is elevated has not been well described. Nonetheless, the evidence to date indicates that the targeted removal of endometrial polyps to optimize fertility outcomes is prudent.

13.1 Diagnosis

A pelvic ultrasonographic examination may be helpful in delineating anatomic abnormalities if the examination results are suboptimal or if an ovarian mass is suspected. A pelvic ultrasonographic examination is the best technique for evaluating the uterine contour, endometrial thickness and ovarian structure [11] (Figs. 13.1 and 13.2). The use of a vaginal probe transducer allows assessment of endometrial and ovarian disorders, particularly in women who are obese. Because of variation in endometrial thickness with the menstrual cycle, measurements of endometrial stripe thickness are significantly less useful in premenopausal than postmenopausal women [12]. Sonohysterography is especially helpful in visualizing intrauterine problems such as polyps or submucous leiomyoma [12]. Although these

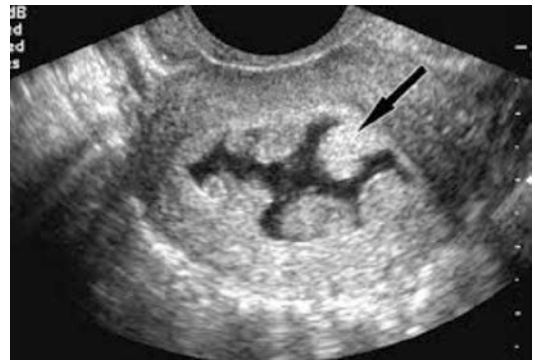

Fig. 13.1 Sonohysterography showing multiple polyps

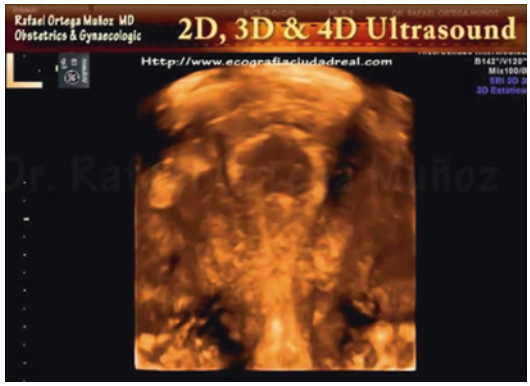

Fig. 13.2 3D sonographic pictures of endometrial polyp

sonographic techniques are helpful in visualizing intrauterine pathology, histologic evaluation is required to rule out malignancy [12].

13.2 Management

Although endometrial polyps can be removed with blind curettage, many are missed [13–16]. Therefore, known or suspected endometrial polyps are more successfully treated with hysteroscopic guidance, which can often be performed in a clinic or office using local anaesthesia. Hysteroscopy may be used either to evaluate the result of blind curettage or use of grasping forceps, or preferably, with appropriate operating sheaths, to guide directed removal with small-calibre scissors or grasping forceps. Alternatively, for larger polyps, a uterine resectoscope may be used to sever the stalk or morcellate the lesion.

13.3 Hysteroscopy for Polypectomy

Curettage proved ineffective being a blind procedure. Hysteroscopic resection of polyp has delivered a great amount of convenience and efficiency.

Polypectomy performed with smaller-calibre operative hysteroscopes in the office environment provides patients with the benefits of awake procedures and less risks than those associated with use of general anaesthesia in the operative room or ambulatory surgical centre. Operative hysteroscopy, however, does require surgical skills beyond what is required for basic diagnostic procedures.

Endometrial polyp represents the most common intracavitatory finding in the infertile patient population.

13.4 Polypectomy

13.4.1 Operative Instrument Orientation

Placing the operative instrument into the visual field, one can determine the best angle of approach to pathology based on size and location of polyp attachment to the uterine wall. In general, the best approach to pathology will be in parallel to the uterine wall with the operative instrument having access to the polyp base at right angles. This approach maximizes the amount of tissue accessible to the instrument and creates the best fulcrum point for movement of the hysteroscope away from the uterine wall. It is extremely important to remember that one must move the instrument and hysteroscope together (Fig. 13.3).

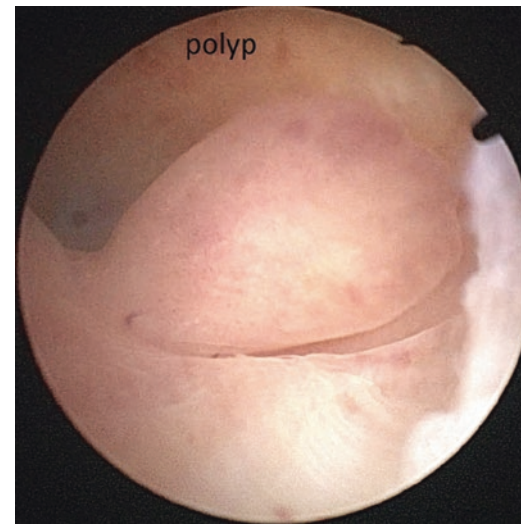

Fig. 13.3 Pedunculated lateral wall endometrial polyp

When the operative instrument transects the base of the polyp, exposure to the remaining attached tissue is made possible by using the instrument/hysteroscope and stretching out the attachment parallel to and away from the uterine wall. This manoeuvre will expose the base, allowing transection of the attachment to occur.

13.4.2 Polyp Size

Removal of polyps after separation from the uterus can become challenging if the polyp is significantly larger than the diameter of the internal cervical os, cervical canal or external cervical os. A decision for polypectomy, therefore, must include a plan for tissue retrieval. Ideally, if the polyp was separated intact, keeping it intact at removal is preferable for pathologic evaluation. However, the particular clinical circumstance may ultimately dictate how complete removal of the polyp is accomplished.

The large polyps must be removed in pieces if necessary. This will require segmental transection of the polyp into separate pieces (Figs. 13.4 and 13.5). Near-total segmental transection prior to complete separation from the uterus allows for the tissue to conform to the cervical dimensions as it is pulled through the cervical canal. A gentle continuous rotation of the tissue while pulling can sometimes be helpful to contract the tissue further for removal.

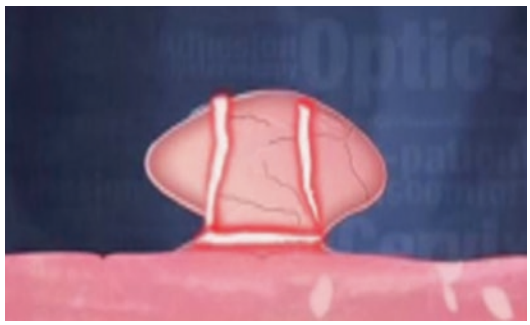

Fig. 13.4 A large endometrial polyp sometimes be sequentially segmented and individual segments removed. The illuminated lines show how the segments would be transected

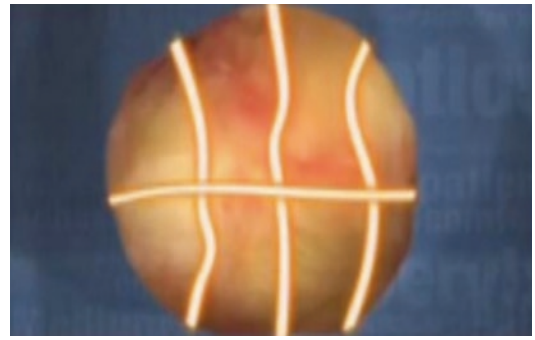

Fig. 13.5 Sometimes more segments are to be created to allow it to conform dimensions of the cervix during retrieval

13.4.3 Estimation of Polyp Size Via Hysteroscopy

There are several ways to estimate the dimensions of endometrial polyps, which are potentially quite inaccurate given by the magnified visual field. Because of the magnification, estimate of polyp size will generally be much larger than the actual size. A good way to learn how to estimate size is by using a known measurement, such as the diameter of the hysteroscopic sheath or distance between the tips of operative instruments. This directly and incrementally measures polyp dimensions under visualization during removal. Of course, most polyps can be measured once removed from the uterine cavity using a small-millimetre ruler.

13.4.4 Polyp Density

Polyp tissue density is important in several ways. Dense tissue will require instruments such as sharper scissors. Dull instruments may not be efficient or may be entirely inadequate. Dense tissue will often take more time to transect as it is not as amenable to manipulations with the hysteroscope or instrument as softer tissue. Dense tissue may not conform to the cervical openings as easily as softer more compliant tissue of similar size (Fig. 13.6).

The tenaculum is an optimal instrument for grasping more dense tissue because the tips of the

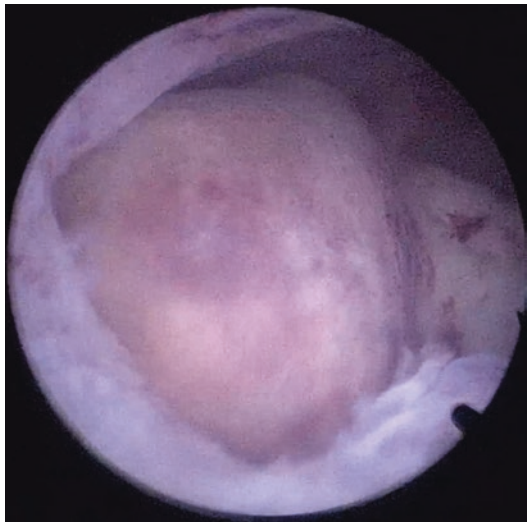

Fig. 13.6 Dense endometrial polyp

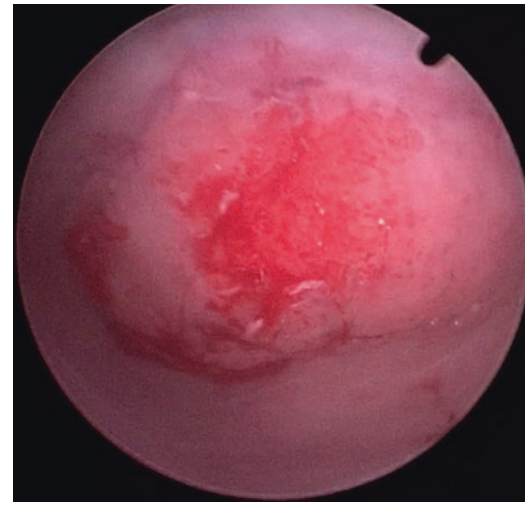

Fig. 13.7 Sessile lateral wall polyp

instrument open wide and will penetrate into dense tissue for a tenacious hold. Fragile tissue is generally a sign of abnormality such as hyperplasia or carcinoma and special care with tissue manipulation is warranted to maintain the tissue integrity during removal. Fragile tissue or soft polyps are better removed with a grasper whose serrated jaws can hold tissue more gently than can a tenaculum because the tips of the latter instrument will easily tear through fragile or soft tissue.

13.4.5 Polyp Attachment

13.4.5.1 Sessile Polyp

Broad based and sessile polyps are generally attached at the widest dimension of the polyp. A larger area of attachment requires more transection than for a pedunculated attachment (Fig. 13.7). This sessile attachment requires a technique of lifting the tissue from the uterine wall after transecting in order to continually expose the base of the polyp. Once separated, the polyps are removed in a similar fashion as other polyps based on tissue density and the dimensions.

13.4.5.2 Fundal Polyp

Fundal attachment poses an added difficulty for tissue removal. The axis of the hysteroscope and, therefore, the operating instrument should be at right angles to the plane of tissue resection. Unlike polyps attached to the sidewalls or the anterior or posterior walls, the fundal wall is an impediment to being able to transect tissue with the blade of the scissors and the tip must be used instead. It is recommended to use blunt-tipped scissors for fundal pathology removal to avoid unnecessary tissue trauma that could be created with a sharp-tipped instrument. The base of the polyp is exposed by using the hysteroscope/instrument to pull the tissue down and away from the fundus. By using just the tips of the scissors to make small incisions, tissue is released off the uterine wall (Fig. 13.8).

13.4.6 Polyp Retrieval

Grasping tissue for retrieval is made easier by the following steps. First, it is important to closely control the fluid inflow and outflow through the hysteroscope. Small tissue pieces can move significantly and if totally separated from the wall of the uterus, will float and swirl in the inflow current. By decreasing the inflow or closing the channel entirely, disruptive currents are inhibited and it is easier to grasp the pathology for removal. Simultaneously closing the outflow temporarily

Fig. 13.8 Hysteroscopic view of a pedunculated fundal polyp

during retrieval will maintain uterine distention for visualization.

Second, leaving the polyp attached by just a small fragment of tissue will keep the polyp in place for subsequent grasping and removal. The final separation of the polyp from the uterine wall, in this scenario, requires only a slight twist or tug from the retrieving instrument. This often requires less time for removal than waiting for free-floating pieces to settle.

Third, once the tissue is grasped by the operative instrument, removal is accomplished by holding the tissue in the instrument and removing the hysteroscope and from the uterine cavity and cervix as one unit.

Polyp generally cannot be pulled through the hysteroscope operative channel due to its small diameter. One must also keep in mind the size relationship of the polyp to the cervical diameter and tissue density for the tissue to pass through easily.

Whenever possible, the polyp should be grasped for removal at the most narrow dimension which will allow that edge of the polyp to be pulled into the canal of the cervix first. This allows the polyp to elongate in the cervix and improves the likelihood of successful removal.

And finally, if the inflow channel has not previously been closed, it should be closed during the removal of the hysteroscope. Many a times, grasp on specimens has been lost due to the rushing flow of fluid.

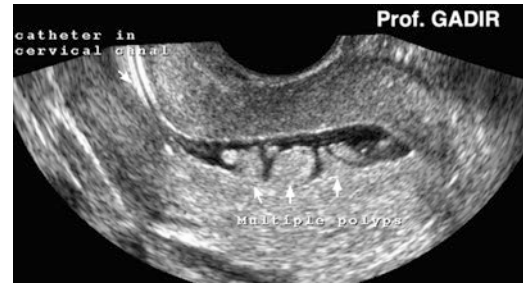

Fig. 13.9 Ultrasonography image showing multiple polyps in the uterine cavity

13.4.7 Multiple Polyps

If there are multiple polyps, then it is recommended to transect as many as possible, leaving a small attachment on each. It is most efficient not to change the type of instrument in the operative channel unless really necessary.

Once at the retrieval procedure, the instrument is changed to a grasping instrument. Multiple insertions and removals of the hysteroscope may be needed when there are many polyps. Instruments such as the tenaculum may facilitate grasping more than one polyp at a time for removal, depending on the size and density of the polyps (Fig. 13.9).

13.5 Postoperative Bleeding

Postoperatively, bleeding after polypectomy always occurs. However, significant bleeding is not usual.

Intrauterine pressure from uterine distention generally provides a tamponade for minor bleeding. The continuous flow hysteroscope allows the surgeon to balance inflow and outflow to adequately provide tamponade but to also keep the visual field clear of blood. At the end of the procedure, the intrauterine pressure can be decreased by decreasing the inflow of fluid and watching for significant bleeding.

Remember, because of the magnification with hysteroscopy, the amount of bleeding present will often be overestimated. Once the uterine cavity has been evacuated of fluid and allowed to contract, bleeding likely will not be significant. If one is performing polypectomy with electrosurgical instruments, bleeding is generally avoided. Counsel the patient that she will have minor bleeding for several days and perhaps mild to moderate cramping amenable to over-the-counter analgesics.

Key Learning Points

- Endometrial polyps are exophytic growths of the mucous linings of the endometrium and can remain latent for a longer period of time.
- Even in the absence of abnormal uterine bleeding, endometrial polyps may be discovered in women with infertility.
- 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 and number of their polyps.
- The evidence to date indicates that the targeted removal of endometrial polyps to optimize fertility outcomes is prudent.
- Sonohysterography is especially helpful in visualizing intrauterine problems such as polyps or submucous leiomyoma.
- Although endometrial polyps can be removed with blind curettage, many are missed. Therefore, known or suspected endometrial polyps are more successfully treated with hysteroscopic guidance.
- Polypectomy performed with smaller-calibre operative hysteroscopes in the office environment provides patients with the benefits of awake procedures and less risks than those associated with use of general anaesthesia.
- The best approach to pathology will be in parallel to the uterine wall with the operative instrument having access to the polyp base at right angles.
- The large polyps must be removed in pieces if necessary. This will require segmental transection of the polyp into separate pieces.
- Dense tissue will often take more time to transect as it is not as amenable to manipulations with the hysteroscope or instrument as softer tissue.
- The sessile attachment requires a technique of lifting the tissue from the uterine wall after transecting in order to continually expose the base of the polyp.
- The fundal wall is an impediment to being able to transect tissue with the blade of the scissors and the tip must be used instead. It is recommended to use blunt-tipped scissors for fundal polyp removal. The base of the polyp is exposed by using the hysteroscope/instrument to pull the tissue down and away from the fundus and cut continuously to separate the tissue.
- Polyp generally cannot be pulled through the hysteroscope operative channel due to its small diameter. One must also keep in mind the size relationship of the polyp to the cervical diameter and tissue density for the tissue to pass through easily.
- If there are multiple polyps, then it is recommended to transect as many as possible, leaving a small attachment on each.
- Intrauterine pressure from uterine distention generally provides a tamponade for minor bleeding.
- Because of the magnification with hysteroscopy, the amount of bleeding present will often be overestimated.
- Counsel the patient that she will have minor bleeding for several days and perhaps mild to moderate cramping amenable to over-the-counter analgesics.

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Submucous Myoma and Hysteroscopy

14

Nilesh Unmesh Balkawade

14.1 Introduction

Leiomyoma, often called as myoma, is the most common benign neoplasm in the female genital tract [1]. It is postulated to be caused by oestrogens and progesterones which proliferate tumour growth. Hence, fibroids are a rare occurrence before menarche and reduce after menopause.

The exact prevalence of fibroids is not known because majority remain asymptomatic. In a population-based study in the USA, 51% of randomly selected premenopausal women with no previous history of myomas received an ultrasound-based diagnosis of uterine fibroids [2]. Myomas can manifest clinically in 25% of cases and asymptomatic myomas are described in 20–70% of all women (and in well over 80% of black women) [3, 4].

Fibroids are the most common uterine tumour in the reproductive age group, affecting 20–50% of these women [5]. Fibroids are found in 20–40% of women during reproductive age and 11–19% in perimenopausal age [6]. Prevalence of fibroid in India in reproductive-aged women was shown to be 11–50% in different studies [7, 8]. Prevalence of infertility patients and RPL cases is higher.

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It is more than likely that submucous myomas originate in the junctional zone (JZ) of the myometrium. JZ thickness changes throughout the menstrual cycle. JZ myocytes show cyclic changes in oestrogen and progesterone receptors.

Submucous myomas, especially multiple submucous myomas, may impact future embryo implantation as well as pregnancy outcomes through anatomic modification of the endometrial cavity (mainly because of mass effect) [9]. Myomas >30 mm and located on the posterior uterine wall have a significantly higher pregnancy loss rate [10].

Preoperative Evaluation of Submucous Fibroids according to European Society of Gynaecological Endoscopy (ESGE) Classification [11] as shown in Figs. 14.1 and 14.2.

Type 0

- Entirely within the endometrial cavity
- No myometrial extension (pedunculated)

Type I

- <50% myometrial extension (sessile)
- <90° angle of myoma surface to the uterine wall

Type II

- ≥50% myometrial extension (sessile)
- ≥90° angle of myoma surface to the uterine wall
- Modified from Wamsteker K et al. (1993)

S. Tandulwadkar, B. Pal (eds.), *Hysteroscopy Simplified by Masters*,
https://doi.org/10.1007/978-981-15-2505-6_14

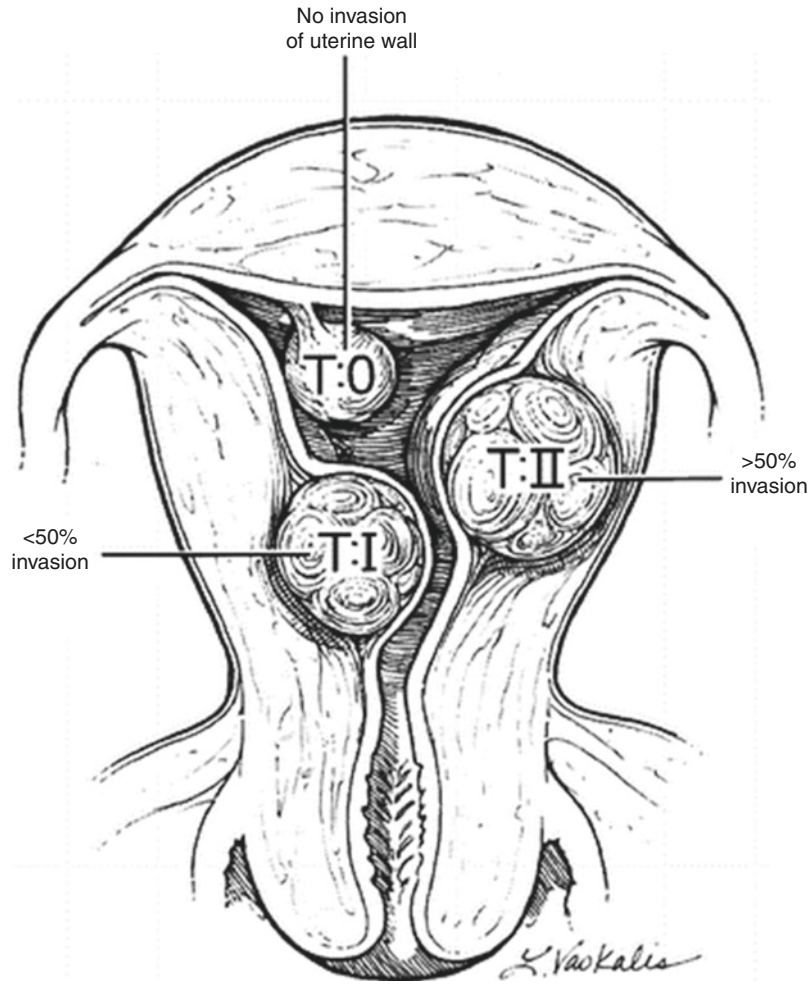

Fig. 14.1 Classification of submucous myoma

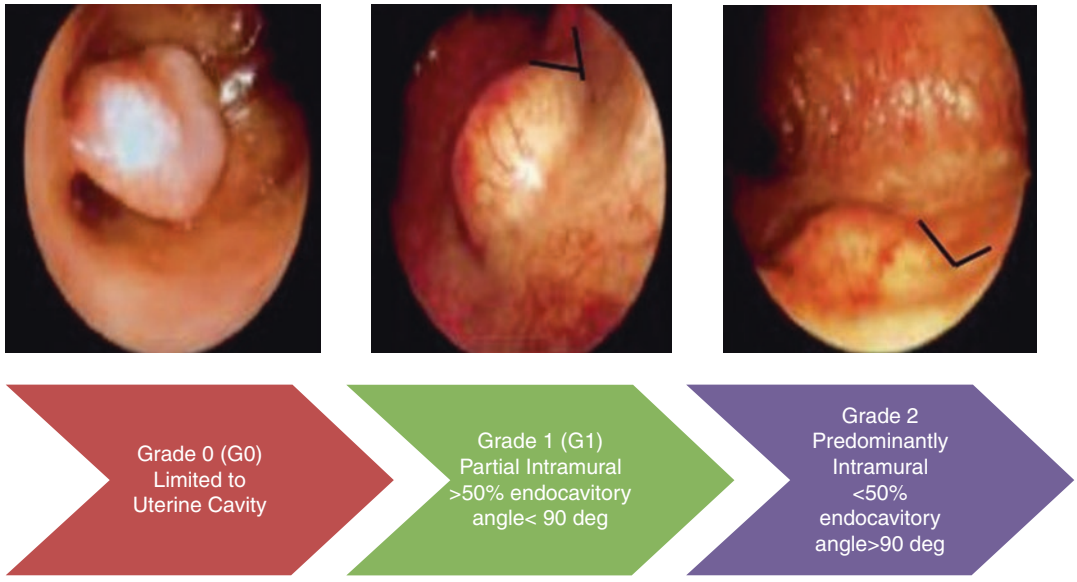

Fig. 14.2 Hysteroscopic picture of different types of submucous myomas

14.2 FIGO PALM COEIN Classification of Myomas [12] Fig. 14.3

Lasmar's STEP-W System of Classification (Tables 14.1 and 14.2): This classification in useful to predict perioperative outcomes like the likelihood of completing myoma resection hysteroscopically and the amount of fluid deficit. Classifying submucous fibroids using the STEPW classification permits greater correlation (than ESGE classification) with complete or incomplete removal of the myoma by hysteroscopic myomectomy.

Some studies do suggest that the new classification gives more clues as to the difficulties of hysteroscopic myomectomy than the standard ESGE classification [14, 15].

At present there is insufficient data to comment on which system is the best amongst all. However, these classifications are definitely useful to clinically asses the myomas, plan surgery, and predict perioperative outcomes.

14.3 Clinical Features

It is generally perceived that the symptoms of HMB, infertility, and recurrent pregnancy loss largely occur as a result of lesions that distort the endometrial cavity that are therefore adjacent to the endometrium. The most common cause of the patients to seek medical advice was menstrual disorder (37.7%) which included heavy, irregular or no periods [7]. Other symptoms include noncyclic pain, abdominal protuberance, painful intercourse or pelvic pressure, and bladder or bowel dysfunction [3, 16].

They are also associated with reproductive problems, including impaired fertility, pregnancy complications and loss, and adverse obstetric outcomes [17].

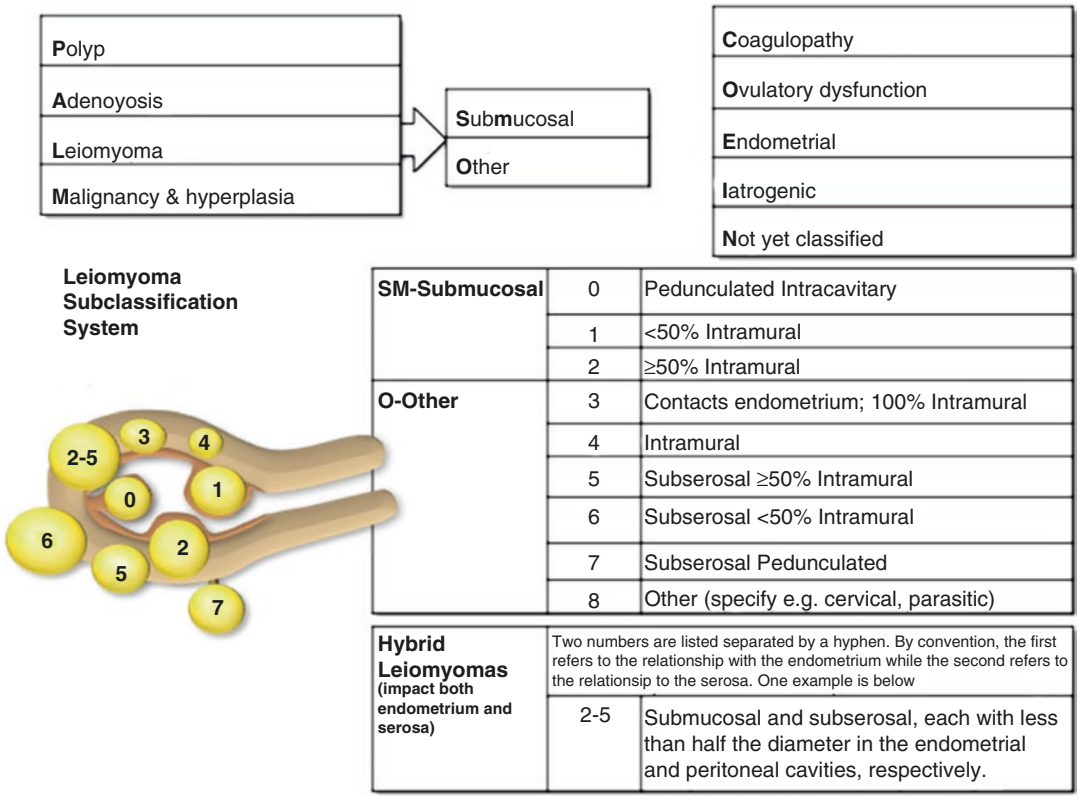

Fig. 14.3 FIGO PALM COEIN classification

Table 14.1 Presurgical classification of submucous myomas [13]

	Largest myoma diameter	Extension of myoma base to endometrial cavity surface	Location along uterine wall (third)	Penetration of myometrium	Wall
Points	**S**	**T**	**E**	**P**	**W**
0	2 cm	1/3	Lower	0	A/P
1	2–5 cm	1/3 to 2/3	Middle	<50%	Lat
2	>5 cm	2/3	Upper	≥50%	
Total					

STEPW (size, topography, extension, penetration, wall) classification system
Total score _____ 1 _____ 1 _____ 1 _____ 1 _____

Table 14.2 Scoring system [13]

Score	Group	Therapeutic options
0–4	I	Low-complexity hysteroscopic myomectomy
5–6	II	High-complexity hysteroscopic myomectomy. Consider GnRH use. Two-step myomectomy
7–9	III	Consider alternative to hysteroscopy

14.3.1 Submucous Myoma and Fertility

As size, location, and number of fibroids affect the fertility, so does the mechanism!

(a) **Physical Factors**—Although physical impedance to the transport of sperm, egg, or embryo has been proposed as a mechanism for affecting fertility, this by itself is unlikely to be the sole mechanism responsible.

(b) **Alteration of Uterine Contractions**—Uterine contractions increase in frequency in the early follicular phase from the fundus to cervix, whereas in the peri-ovulatory and luteal phase, their direction is reversed from the cervix to fundus [18]. Fibroids influence the contractility of the myometrium and induce a chronic inflammatory reaction, both of which cause difficulty in implantation [19]. One study has demonstrated accelerated mid-luteal uterine peristalsis (defined as ≥2 peristaltic movements in 3 min) in the presence of intramural fibroids using MRI and restoration of fertility by doing myomectomy [20].

(c) **Cytokine Factors**—Certain intrauterine cytokines are thought to be responsible for implantation and early embryonic development. These have been shown to be reduced in mid-luteal uterine washings of women with submucosal fibroids [21].

(d) **Genetic**—Endometrial HOXA10, HOXA11, and BTEB1 gene expression has been shown to modulate endometrial receptivity. The reduction or absence of HOXA10 in the uterine endometrium leads to infertility due to the inability of the embryo to implant [22]. Rackow et al. demonstrated a significant reduction in concentration of these genes during follicular phase in infertile women with submucosal fibroids (FIGO L0 to L2). Interestingly, the reduction was present throughout the uterine cavity and not just in the endometrium overlying the fibroid [23]. Statistically, significant increase in fertility is observed in women with submucosal fibroid treated by myomectomy [24].

14.3.2 Submucous Myoma and Menorrhagia

Some studies claim the hypothesis that ulceration of either the mucosa overlying a submucous myoma or the opposing endometrium could be responsible for the bleeding. However, it is rarely seen during hysteroscopy.

Studies have shown hyperplastic changes in the endometrium as cause for excessive bleeding [25]. Other causes include enlargement of the endometrial surface and venous congestion due to compression.

It seems likely that in most instances the mechanical or molecular mechanisms involved in endometrial haemostasis are disturbed. Unfortunately, there are no available studies that have adequately investigated these hypotheses. In a minority of cases, the perimyoma vasculature is likely the source of the bleeding.

14.3.3 Submucous Myoma and Dysmenorrhoea

Secondary dysmenorrhoea has been shown to be specifically associated with submucous myomas. The contractions as a result of the tendency of the uterus to expel an intracavitary structure are the most likely cause for the symptoms of pain that occurs.

14.3.4 Submucous Myoma and Pregnancy Loss

Submucous myomas are usually associated with an increased risk of early pregnancy failure [26].

Exact cause is not known but histologically, the endometrium overlying submucous myomas and opposite the myoma shows glandular atrophy, which may impair implantation and nourishment of the developing embryo [27].

14.4 Diagnosis

A variety of diagnostic techniques are available for diagnosing submucous fibroids and deciding the line of management. A Cochrane systematic review has shown SIS and hysteroscopy to be equivalent for the diagnosis of submucous leiomyomas, with both superior to TVUS [28] .

1. **Transvaginal ultrasound (TVUS)**—The sensitivity of transvaginal ultrasound to diagnose myomas averages 94% (range, 62–100%) with a specificity of 98% (PPV 82–90%, NPV 96–98%) [29].
2. **Contrast-enhanced ultrasound** (saline infusion sonohysterography—SIS)—The uterine cavity is filled with NaCl 0.9% as a contrast medium before the ultrasound is carried out. It gives added information about cavity of the body of the uterus as well as the uterine wall. The distance between the myoma and the serosa can be measured which helps in planning the surgery [30].
3. **Hysteroscopy**—It is considered as the gold standard for the diagnosis of the cavity lesions. The sensitivity and specificity is almost the same as that in SIS.
4. **Hysterosalpingography** (HSG)—It has low reliability in detecting intracavitary abnormalities with up to 32% false-positive rates.
5. **MRI**—Limited availability and costs restrict its use. So, it should be considered in complex, minimally invasive procedures (e.g. large, type II myomas).

14.5 Non-resectoscopic Treatment

- Expectant.
- Medical.
- Uterine artery embolization.

These topics are beyond the scope of this chapter which tries to find answers to submucous myoma with the use of hysteroscopy.

14.6 Hysteroscopic Myomectomy

Historically, by far the most common hysteroscopic technique has been transcervical resectoscopic myomectomy (TCRM) with a modified urologic resectoscope, first reported in 1976 [31].

Hysteroscopic myomectomy would appear to help restore cavity dimensions and subsequently improve fertility outcomes. The risk of endometrial damage and intrauterine adhesions, and its subsequent effect on conception and pregnancy outcomes, has to be discussed with patient during preoperative counselling.

Methods of hysteroscopic myomectomy—There are three basic methods for removing leiomyomas under hysteroscopic direction: morcellation, cutting with an electrosurgical loop, and vaporization.

Mechanical	Cut stalk (this is mainly for prolapsed fibroid through the cervix) Done for Gr 1 myomas (Fig. 14.5)
Resection (using resectoscope)	Uses electrocautery, usually bipolar energy. However, monopolar energy can also be used. Used in Gr2 (Fig. 14.4) and some Gr 3 lesions
Versapoint®	Bipolar energy vaporization and dissection. Used mainly for small lesions
MyoSure® TruClear®	Using fast-cutting blade and tissue retrieval technology
Laser	Vaporize Morcellate Dissect Myolysis

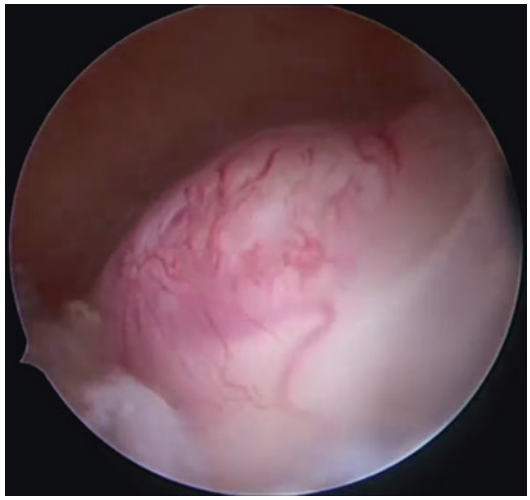

Fig. 14.4 Submucous myoma Gr 1 ESGE

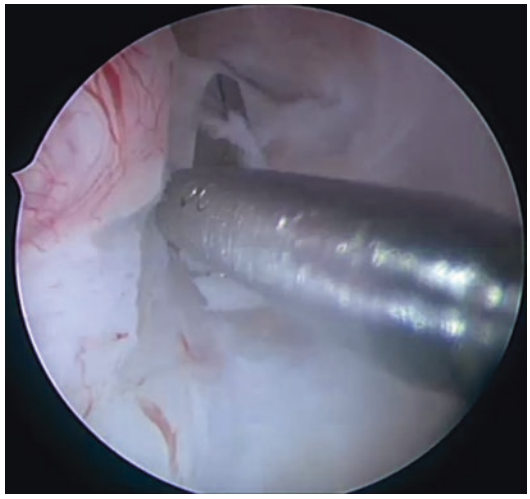

Fig. 14.5 Mechanical removal—cutting stalk with scissors in small Gr 0 submucous myomas

14.6.1 Checklist—Preoperative

- Informed consent, patient rights.
- History/Physical examination, work history, any previous work-up and results.
- Current medications, any history of reactions to drugs in past.
- Confirmation fasting status.
- Airway assessment.

14.6.2 Checklist Intraoperative

- Surgical time out.
- Record of medications administered.
- Vital signs at 5-min intervals.
- Blood pressure.
- Pulse.
- Oxygen saturation.
- End tidal CO_2 (optional).

Use of NSAIDs: Double-blind placebo trial demonstrates significant reduction in post-procedure pain, *no* significant benefit in discomfort during procedure.

Cervical Ripening: There is moderate quality evidence that use of misoprostol for preoperative ripening of the cervix before operative hysteroscopy is more effective than placebo or no treatment and is associated with fewer intraoperative complications such as lacerations and false tracks (Cochrane).

Options – Misoprost 200–400 mcg by mouth or intra-vaginally at bedtime prior to procedure. If a very tight cervix is suspected, then begin above regimen 2 days before procedure as well as at bedtime prior to procedure [32–34].

Prophylactic Antibiotics: It is usually not indicated except in cases of hysteroscopic resection of fibroid with a history of pelvic inflammatory disease [35].

Endometrial Preparation: While this may decrease blood loss and allow for an easier and more complete resection of submucous myomas in most cases, it may be avoided by timing the procedure in the follicular phase or gently clearing the endometrium by MVA.

Preparation with a GnRH agonist is mainly indicated for large submucous myomas or following the primary procedure in two stage procedures [36].

Pretreatment with GnRH Agonist may be Indicated in the Following:

- Subfertility.
- Myomas with a diameter of 4 cm or more.

- An adverse location in the cavity of the body of the uterus, e.g. in the uterine horn.
- Anaemia due to bleeding disorders.
- Type II myomas.

Intracervical Vasopressin: Vasopressin is a neurohypophyseal hormone that initiates contractions of smooth muscle and blood vessels in the uterus and elsewhere.

A RCT evaluated injection of 10 mL (20 mL total) of a dilute solution of vasopressin solution (4 U in saline solution 80 mL) at 3:00 and 9:00 of the cervix at the time of hysteroscopy significantly reduced force for dilation but no difference in the incidence of cervical trauma. However, it has shown to decrease fluid absorption by causing uterine contractions [37].

Technique(s): Loop electrosurgical resection is performed with the electrode activated with low voltage ("cutting") current to allow the repetitive creation of "strips" of myoma (shown in Fig. 14.6), with periodic interruptions of the procedure to allow removal of the tissue fragments. Bulk electrosurgical vaporization is performed with a large surface-area electrode activated with low-voltage current to vaporize relatively large volumes of tissue. Vaporization with the electrodes has been shown to result in significantly less systemic absorption of distension media [38].

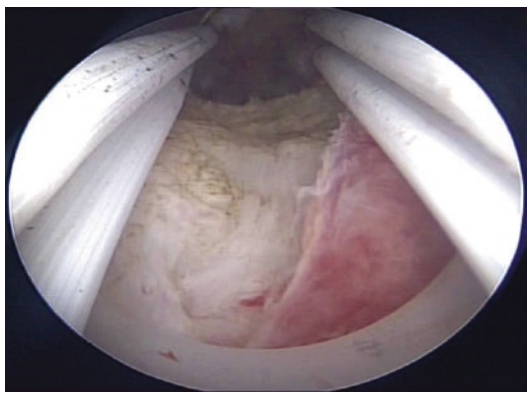

Fig. 14.6 Hysteroscopic resection of submucous myoma by bipolar current

The resection should be limited to the myoma without resecting the adjoining endometrial tissue. After a part of the myoma is removed, the intramural portion of the fibroid inverts into the endometrial cavity. The loop can often be used to separate the fibroid from the pseudocapsule. Using the cutting mode at *80–100 watts* provides clean cuts through the myoma. Resection should always start at one side and move horizontally across to the other side. After initial excision of the intracavitary portion of the fibroid, the intramural component will typically expel into the cavity. Repeatedly increasing and reducing the intrauterine pressure often pushes the intramural component into the cavity, facilitating excision (hydrostatic massage). In large myomas, a two-stage procedure may be planned with a GnRH analogue depot administered between stages.

Advantages of Resectoscope

- Unipolar as well as bipolar.
- Less expensive.
- Effective even with deep-seated submucous myomas.
- Other associated conditions like polyps, septa, etc., can be managed with the same setting.

Disadvantages

- Long and steeper learning curve.
- Insertion and reinsertion required in large myomas.
- Insertion, cutting, retrieval, and reinsertion (ICRRI) cycles pose a major problem with cervical stenosis.
  - Newer approaches.

14.6.3 Versapoint

Advantages:

- Saline environment automatically transfers electrosurgical current from the active to the dispersive electrode to prevent unintended energy pathways.

- Increased resection speed plus the safety of bipolar technology.
- The 4.0 mm bipolar loop for - 77% more tissue removed in cut mode vs. the 2.5 mm loop.

14.6.4 Complications

Postmyomectomy intrauterine synechiae are more common after multiple submucous myomectomies. In such circumstances, and when fertility is an issue, second-look hysteroscopy and appropriate adhesiolysis should be considered.

14.6.4.1 Trauma

Perforation of the uterus with or without damage to adjacent organs can occur especially if surgeon is not experienced or the myoma is large. If perforation occurs with an activated electrode, one has to assume that there has been a bowel injury until proven otherwise, and laparoscopy or laparotomy is recommended [39].

14.6.4.2 Fluid Retention

Perforation and cervical trauma occur in approximately 0.7–0.8% of cases and commonly occur during cervical dilatation and sometimes during resection of a septum, intrauterine adhesion, or a large myoma. Risk factors include cervical stenosis, severe uterine anteflexion or retroflexion, distortion of the cervical canal due myomas, and adhesions.

Injuries caused by sharp or electrosurgical instruments may need a diagnostic laparoscopy to identify bleeding or visceral injury. A bleeding rent should be sutured with 1-0 polyglactin to preempt a potential weakness during future pregnancies. Perforation with an electrosurgical instrument requires immediate exploration with a laparoscope or laparotomy.

Fluid overload is rare with electrolyte-containing fluids. Nonelectrolyte, hypotonic media, which are nonconductive, may be associated with hyponatraemia, hypervolemia, hypotension, pulmonary oedema, cerebral oedema, and cardiovascular collapse [40].

1 L of Hypotonic Media—Serum Sodium Decreases by 10 mEq/L.

If the patient's sodium level is less than 120 mEq/L, she is at risk for generalized cerebral oedema, seizures, and even death.

Stop procedure if a fluid deficit is greater than 1500 mL or if the sodium level is less than 125 mEq/L.

Prevention—Whether using monopolar or bipolar current, pressures should stay below 100–120 mmHg to avoid excessive absorption. Goals are:

- Prevention of excess absorption.
- Early recognition of excess absorption.
- Choosing the distending medium least likely to cause complications in the event of excess absorption.

14.6.4.3 Hemorrhage

If bleeding persists after surgery, a 12 Fr. Foley catheter balloon filled with 15–20 mL of fluid may be used as an intrauterine tamponade with uterine artery embolization as a backup.

14.6.4.4 Infection

Pelvic pain, fever, localized lower abdominal guarding, and cervical movement tenderness. Treated with cephalosporins + amikacin + metronidazole.

14.7 Guidelines

14.7.1 Rationale

Submucous fibroids causing distortion of the endometrial cavity adversely influence fertility. Hysteroscopic myomectomy has been reported to yield pregnancy rates of 17–77%. For patients with recurrent miscarriage and intracavitary fibroids, surgery increases rates of viable pregnancy outcomes.

14.7.2 Guideline

(From Consensus Statement from the Global Congress on Hysteroscopy) [41].

For women desiring future fertility, or who are currently infertile, an abdominal approach to

submucous myomectomy should be considered when there are three or more submucous myomas or in other circumstances where hysteroscopic myomectomy might be anticipated to damage a large portion of the endometrial surface (Level B).

When immediate fertility is a priority and in the presence of ≥1 asymptomatic submucous myomas ≥15 mm, hysteroscopic myomectomy is recommended.

Type 0 and type 1 submucous myomas are more likely to be completely removed in a one-step approach; conversely, type 2 submucous myomas could require a multistep procedure.

Medical therapy aiming to induce endometrial atrophy and reduce the size of the myoma may be considered before hysteroscopic myomectomy for submucous myomas ≥15 mm [41].

14.8 Contraindications

14.8.1 Absolute

- Inexperienced surgeon.
- Pregnancy.
- Physician unfamiliar with equipment.
- Acute pelvic infection.
- Genital tract malignancy.
- Completely intramural or subserosal.

14.8.2 Relative

Myoma >3 cm and >50% within the myometrium.

14.9 Hysteroscopic Morcellators

In 2005, Emanuel and Wamsteker reported the use of a mechanical hysteroscopic morcellator for the removal of endometrial polyps and leiomyomas. It is approved by FDA as TruClear, MyoSure, and Symphion [42].

Advantages:

1. It prevents the theoretic risks of electrosurgery and low-viscosity anionic distention media.
2. It overcomes the challenge of tissue retrieval during myomectomy.
3. One may choose to avoid electrosurgical energy and possible burns.
4. Prevents the need for insertion and reinsertion cycle for chip removal (ICRRI cycle).
5. Requires a shorter learning curve.
6. Suitable for "see-and-treat" hysteroscopy.

Disadvantages:

1. The use of a relatively cumbersome "offset" operative hysteroscope equipped.
2. Hysteroscopic morcellators are limited by their side-cutting windows which are ideally designed for operating in the lower 2/3 of the uterus. They function poorly at the fundus and uterine cornua.
3. Mechanical systems are associated with intrauterine pressure loss.
4. Expensive.

MyoSure: The MyoSure® (Fig. 14.7) tissue-removal system uses a probe with a small blade powered by an electromechanical drive system, which enables simultaneous rotation and reciprocation of the cutter to remove quickly both fibroids and polyps. It has a fast cutting rate of 1.5 grams per minute. The specimen is captured intact (since there is no radiofrequency energy used) in a vacuum canister. The unique cutter is also connected to a vacuum source that continuously aspirates resected tissue. This is done via a side-facing cutting window in the outer tube which limits the depth of tissue resected. This decreases the chances of perforation. When the device is not cutting, the cutting window automatically closes to prevent a loss of uterine distension.

14.10 Laser

The use of hysteroscopic laser energy for enucleation of submucous myomas is a novel therapeutic option [43].

When mass extraction is not possible, hysteroscopic total enucleation of submucous myoma with laser leaving the mass free inside the uterine cavity is a feasible and safe therapeutic option.

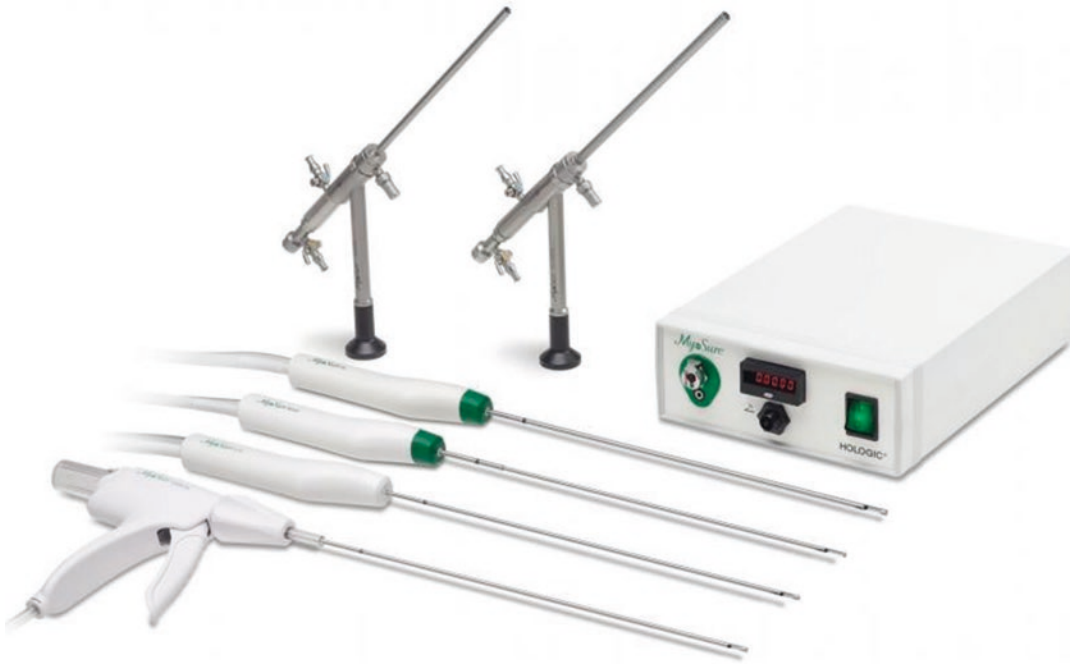

Fig. 14.7 MyoSure device

Patients were prepared with desogestrel 75 μg/day, for at least 6 weeks before the procedure to achieve endometrial atrophy. Myoma resection was performed with high-power 980 nM diode laser using a 1000-micron diamond probe. The technique can be carried out as an outpatient procedure and without anaesthesia. The enucleated fibroid has no vascularization and a necrosis process begins, reaching a stage of a smooth mass that can be pushed out without causing major discomfort. A transvaginal ultrasound examination was performed within 60 to 90 days after the hysteroscopic procedure to assess the presence or absence of myoma inside the uterine cavity. This study has given very high patient satisfaction course and proves to be a great treatment modality in the near future [43].

Take-Home Message

- Submucous fibroids account for 5% of all leiomyomas.
- In cases of submucous myomas, transvaginal ultrasound is currently the best and most commonly used first-line imaging technique (B). Contrast-enhanced ultrasound may help in certain situations while planning for surgery.
- Hysteroscopic resection is the gold standard for the treatment of symptomatic submucous fibroids. Especially, submucous myomas no larger than 4 cm should preferably be removed hysteroscopically (B).
- Preoperative GnRH analogues can be used in cases of larger submucous myomas (A2). Also it can be used in type II Submucous myomas, myomas at unfavourable location, anaemia & sub-fertility.
- When hypotonic distension medium is used, an automatic pump system should be used to calculate the fluid deficit. It should not exceed 1500 mL.
- Antibiotic prophylaxis is advisable (C).
- Intrauterine tamponade with balloon catheter can be considered in case of severe bleeding (D).
- More hysteroscopic myomectomy procedures are done as outpatient procedures nowadays. This is mainly because of the development of smaller-diameter safer equipment and improved experience.
- Hysteroscopic myomectomy of submucous fibroid improves success rates of assisted conception techniques.

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15 Hysteroscopic Myomectomy: Biological and Clinical Impact of Myomectomy by Pseudocapsule Sparing

Andrea Tinelli

15.1 Introduction

Uterine fibroids, myomas or leiomyomas, are the most common benign genital tumors, with high rate in general population [1]. In women aged 19–82 years, almost 25% had fibroids, and 20–30% of reproductive age women show fibroids (Fig. 15.1), with a continuous incidence increasing in pregnancy and a first trimester of pregnancy prevalence in about 10.7% of pregnants [1].

Anatomically, myometrium has smooth muscle cells with a delicate network of arteries, veins, and lymphatic vessels. Fibroids are composed of disordered fascicles of smooth muscle cells with varying amount of fibrous tissue [2] (Fig. 15.2); fibroids are structurally rigid, characterized by excessive deposition of disordered components of extracellular matrix (ECM), especially collagen I, III, and IV, proteoglycans, and fibronectin [3] (Fig. 15.3). During its growth, myoma induces the

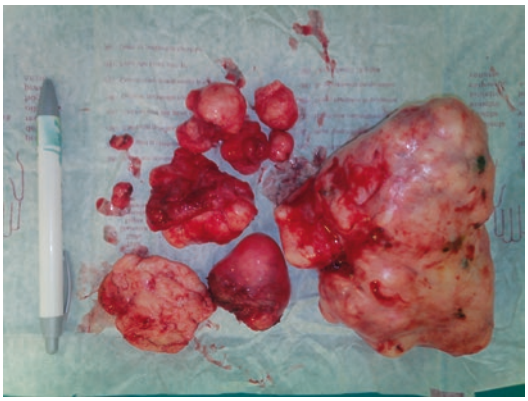

Fig. 15.1 Image of multiple fibroids of various sizes removed during a multiple laparotomic myomectomy; the pen is the comparison measure for the size of the fibroids

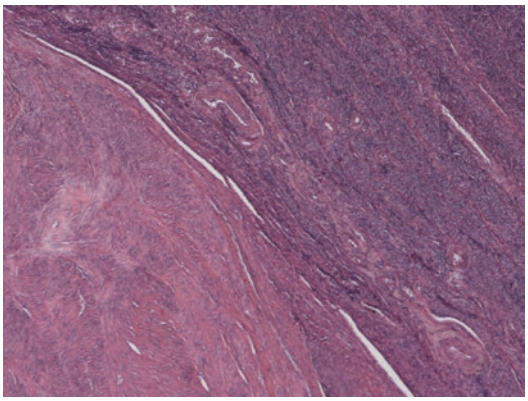

Fig. 15.2 Histological section, on 4×, of fibroids composed of disordered fascicles of smooth muscle cells, lower left, with varying amount of fibrous tissue; top right shows myometrium

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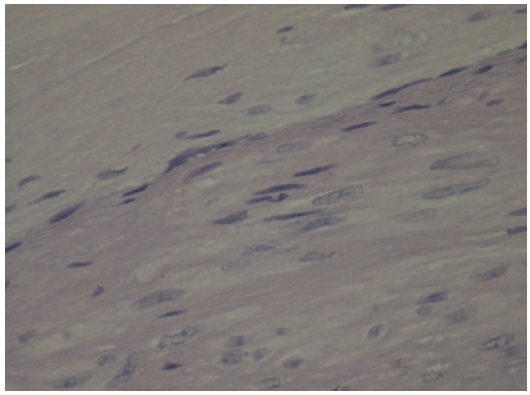

Fig. 15.3 Histological section, on 40×, of fibroids characterized by excessive deposition of disordered components of extracellular matrix (ECM), especially collagen I, III, and IV, proteoglycans, and fibronectin

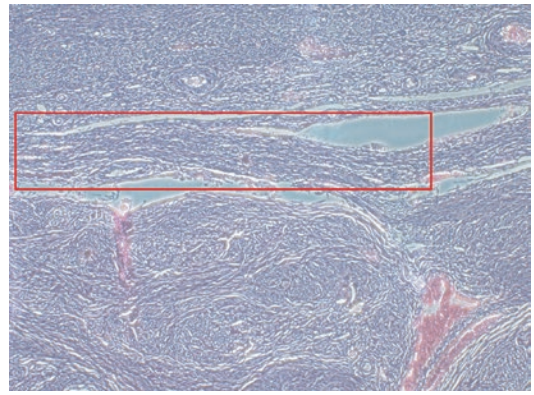

Fig. 15.5 Histological section, on 10×, of myoma pseudocapsule (highlighted in red box) placed in the middle of the myometrium at the top and at the fibroid at the bottom

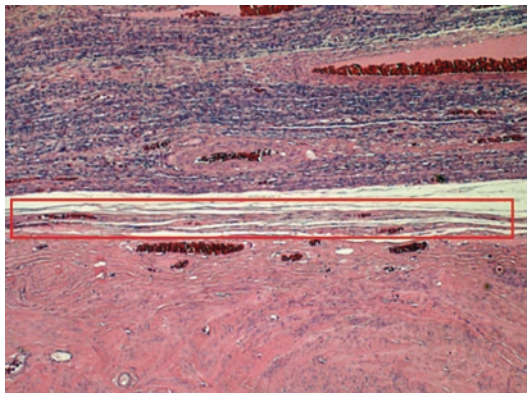

Fig. 15.4 Histological section, on 4×, of myoma pseudocapsule (highlighted in red box) placed in the middle of the myometrium at the top and at the fibroid at the bottom

progressive formation of a sort of pseudocapsule, due to compression on the surrounding structures and which separates myomas from the healthy myometrium [2] (Fig. 15.4).

15.2 Anatomy and Biology of Myoma Pseudocapsule

At the ultrastructural level, visualized by transmission electron microscopy, the pseudocapsule cells have the features of smooth muscle cells similar to the myometrium, indicating that the pseudocapsule is part of the myometrium compressed by the myoma (Fig. 15.5) [4].

This pseudocapsule causes a dislocation action on the myometrium, which is not destructive since the integrity and contractility of uterine structure are maintained [5].

Pseudocapsule is plentiful of collagen fibers, neurofibers, and blood vessels. Occasionally, bridges of collagen fibers and vessels that anchor myoma to myometrium interrupt the continuous surface of the pseudocapsule. Those phenomena result in the formation of a clear cleavage plane both between myoma and the pseudocapsule (Fig. 15.6) and between the pseudocapsule and the surrounding myometrium as well [6].

In microstructural studies of the architecture of the myometrium and the ECM, in presence of fibroids, authors found that the myoma is anchored to the pseudocapsule by connective bridges (Fig. 15.7) but lacks its own true vascular pedicle [4–7], with a vascular network surrounding the myoma into the pseudocapsule (Fig. 15.8).

The biochemical grow factors evaluation in pseudocapsule vessels showed intense angiogenesis in pseudocapsule, probably promoted by the myoma presence itself [6].

As a sort of neurovascular bundle, the myoma pseudocapsule is rich in neuropeptides and neurotransmitters. Investigations showed that myoma pseudocapsules are rich of active neuropeptides

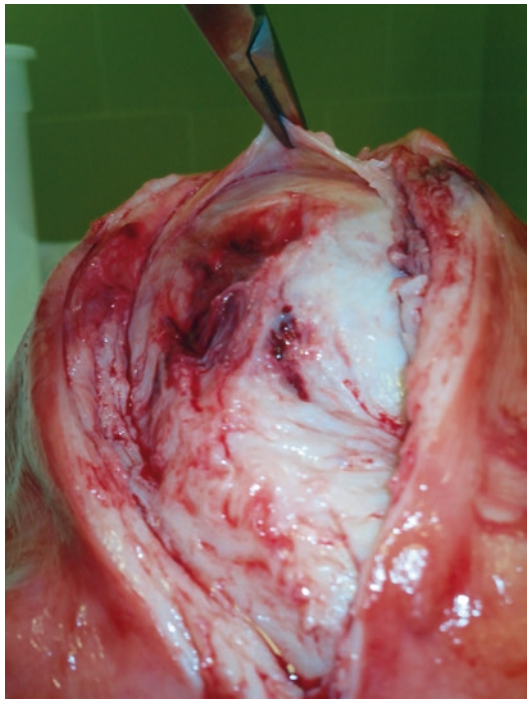

Fig. 15.6 Anatomical section of a uterus with a large myoma inside; the surgeon's clamp highlights the pseudocapsule and the clear cleavage plane both between myoma and the pseudocapsule

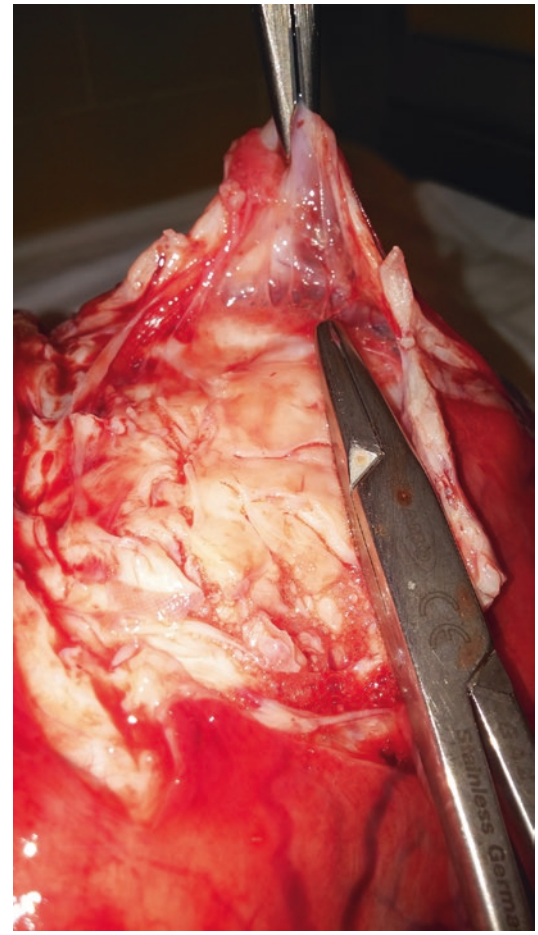

Fig. 15.7 Anatomical section of a uterus with a myoma; the surgeon's forceps highlights the myoma is anchored to the pseudocapsule by connective bridges

and neurotransmitters [8–10]. These substances are thought to have a vital role in wound healing and innervation repair and may be important for both reproductive and sexual function [11]. Literature data indicate that in regenerative processes associated to pseudocapsule sparing, neuropeptides and neurotransmitters are involved in wound healing. Scientific evidence indicates that the nervous system and its neurotransmitters, namely, substance P (SP), vasoactive intestinal peptide (VIP), neuropeptide Y (NPY), oxytocin (OXT), vasopressin (VP), PGP 9.5, calcitonin gene-related peptide (CGRP), and growth hormone-releasing hormone (GHRH), play a role in mediating inflammation and wound healing. Regarding uterine musculature scar physiology, sparing these substances promotes a proper healing of a hysterotomy, as documented by Mettler et al. [11].

Most of abovementioned substances have been highlighted in the myoma pseudocapsule [8–12] and positively impact on myometrial wound healing, an interactive, dynamic process involving neuromodulators, angiogenetic factors, neuropeptides, blood cells, extracellular matrix, and parenchymal cells that follows three complex and overlapping phases: inflammation, tissue formation, and tissue remodeling [6, 11, 13–15].

Growth factors present in the myoma pseudocapsule induce angiogenesis peripherally to myometrium, which is probably enhanced by myoma [16], considering that researches on gene expression in myoma pseudocapsule presented an angiogenic profile in pseudocapsule [17, 18].

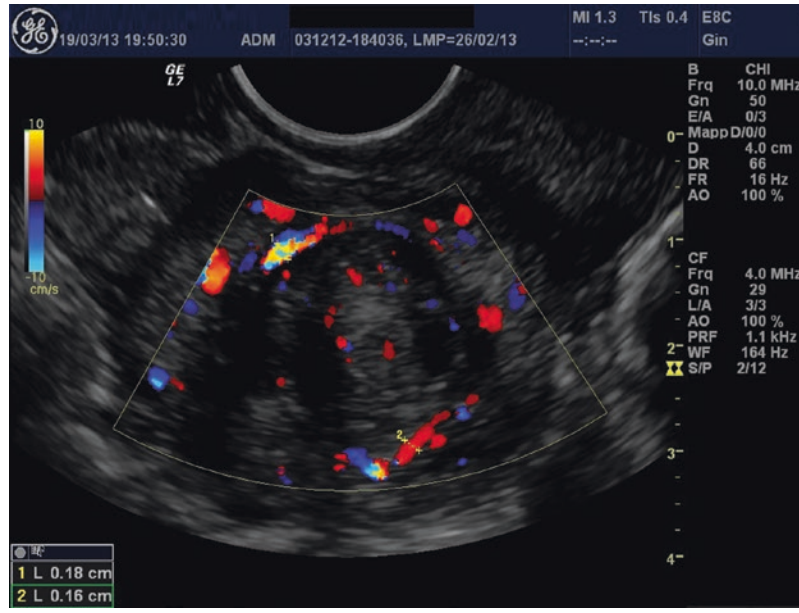

Fig. 15.8 Ultrasonographic image of intramural fibroid, scanned by echo color Doppler, highlighting a vascular network surrounding myoma inside the pseudocapsule, as a "ring of fire"

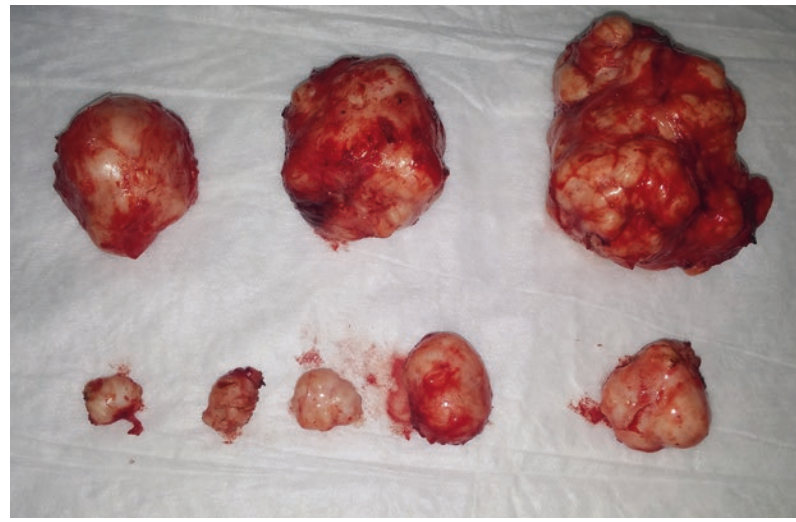

Fig. 15.9 Multiple different fibroids removed during a multiple laparoscopic myomectomy, in a young patient wishing pregnancy

15.3 Translation of Myoma Pseudocapsule Scientific Researches in Surgery

Myomectomy remains the most efficient and mainstay fertility-sparing treatment of fibroids [2, 13] (Fig. 15.9). A correct myomectomy, in addition to improving clinical symptoms and influence quality of life, can improve the fertility rate and reproductive outcome in woman affected by myoma [16, 19]. To the best of our knowledge, literature lacks the data regarding the rationale of the surgical technique, explaining in details all the steps of the surgical techniques, as we tried to do so. In this manner, we explained the rationale for the reproductive surgery procedures, aiming enucleation of myoma with the preservation of its pseudocapsule [13, 20] (Fig. 15.10).

Extensive research performed by gynecologists and urologists, on analogies of myoma

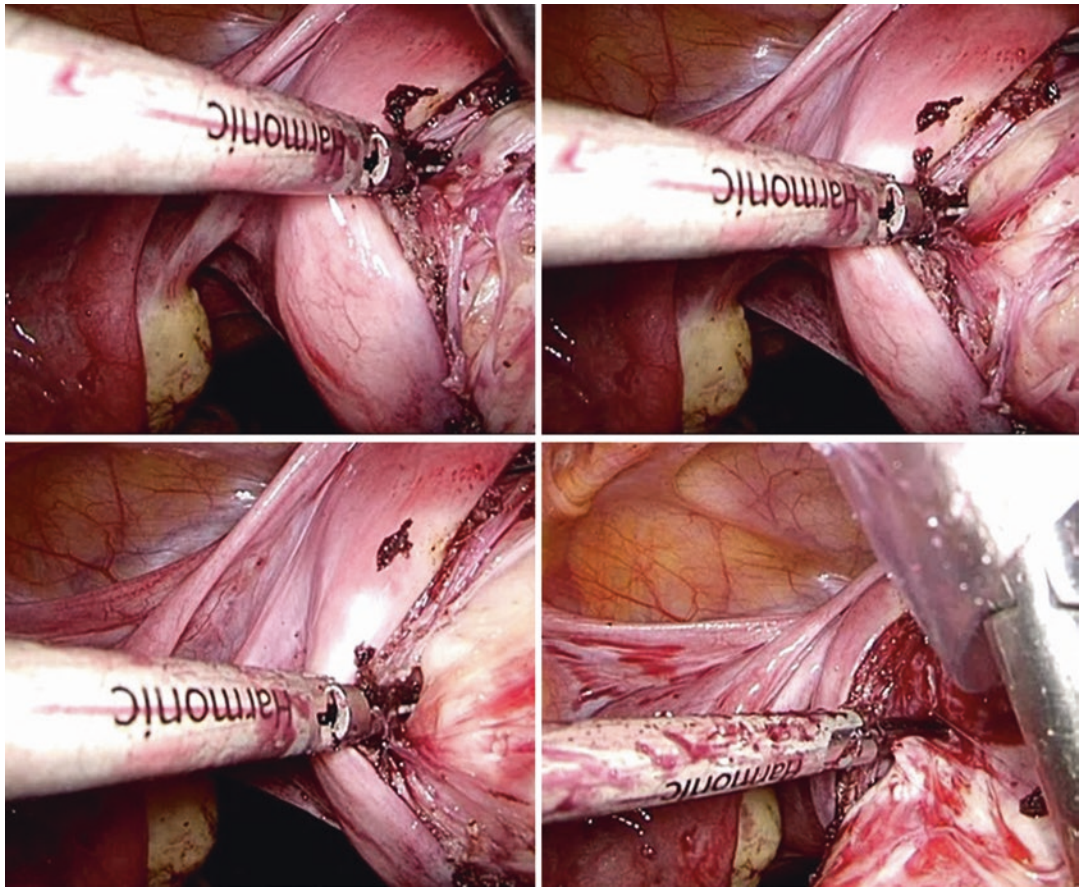

Fig. 15.10 Laparoscopic imaging of pseudocapsule exposure and targeted section with no bleeding, using Harmonic shears surgical instrument

pseudocapsule with the prostate capsule, leads to an idea of a neurovascular bundle surrounding myoma, inside pseudocapsule [13, 21].

Prostate cancer surgery requires preservation of the neurovascular bundles surrounding prostate with the purpose to reduce probability of postoperative impotence and incontinence [13, 21].

These neurovascular bundles are situated on the peripheral to the prostate. With this purpose, both laparoscopic- and robotic-assisted prostatectomies are useful, as the resultant magnification ensures a less traumatic dissection, especially in cases of robotic-assisted surgery [21].

Having in mind these findings regarding the importance of the prostatic capsule and clinical significance of nerve-sparing surgery, data on myoma pseudocapsule and its neurovascular bundle were revaluated and implemented into reproductive surgery [22].

As a result, a distinct surgical technique evolved, called "intracapsular myomectomy," meaning myoma removal from its pseudocapsule [20] (Fig. 15.11).

It is performed, firstly, by coagulating, cutting, and breaking up the fibrous bridges of pseudocapsule and then by stretching and extracting myoma directly from the cut surrounding fibromuscular skeleton. The general myomectomy dogma is that "each surgical fibroid enucleating needs to be gently performed to enhance a correct healing process of the uterine musculature and to facilitate successively the correct uterine musculature anatomical-functional restoring" [13, 15, 21, 22].

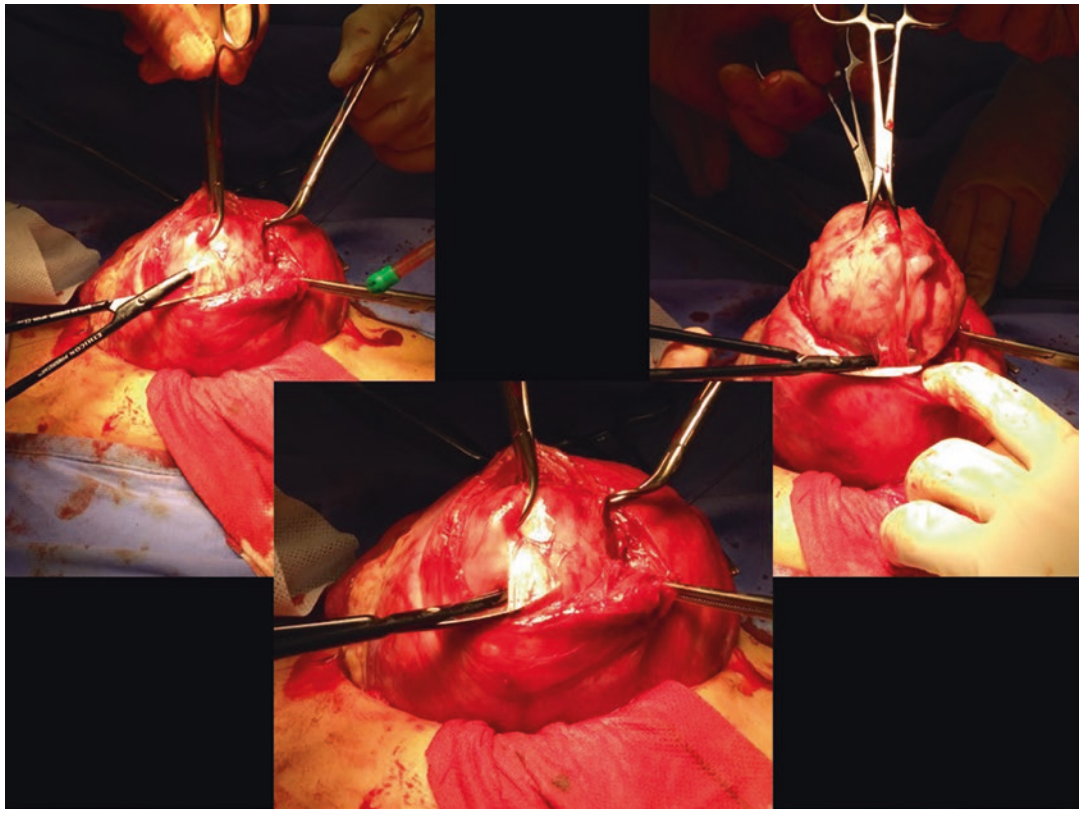

Fig. 15.11 Laparotomic images of intracapsular myomectomy, with exposure of the pseudocapsule using bipolar scissors, inserted in the cleavage plane between pseudocapsule and fibroid (on the left and in the center), to expose the pseudocapsule that is sectioned to the right, in the absence of bleeding

Intracapsular myomectomy meets the essential postulate of myomectomy: performing all manipulations as delicately and bloodlessly as far as possible. Thus, if the myoma is dissected entirely through the pseudocapsule opening, using traction on the surrounding myometrium and a gentle selective low-energy hemostasis on pseudocapsule vessels, the myometrial bed collapses with poor bleeding once the myoma is removed [13, 20].

The surgical principle for intracapsular myomectomy can be applied to all myomectomies, resulting in its implementation for both hysteroscopic, vaginal (Figs. 15.12 and 15.13), laparoscopic, and laparotomic myomectomy, as well as for cesarean myomectomy [21, 22].

15.4 Hysteroscopic Myomectomy by Pseudocapsule Sparing

Currently, the hysteroscopic myomectomy represents the gold standard in treatment of submucous myomas [23]. Nevertheless, the treatment of submucous myomas is probably the hysteroscopic procedure more at risk for surgical complications, which varies from cervix laceration to those potentially fatal as uterine perforation with electrical loop or clinical intravasation syndrome [24, 25].

It is almost difficult to assess the right frequency of surgical complications during hysteroscopic myomectomy for its high variability according to pathology characteristics, surgeon skills, and technique utilized to carry out the procedure [26].

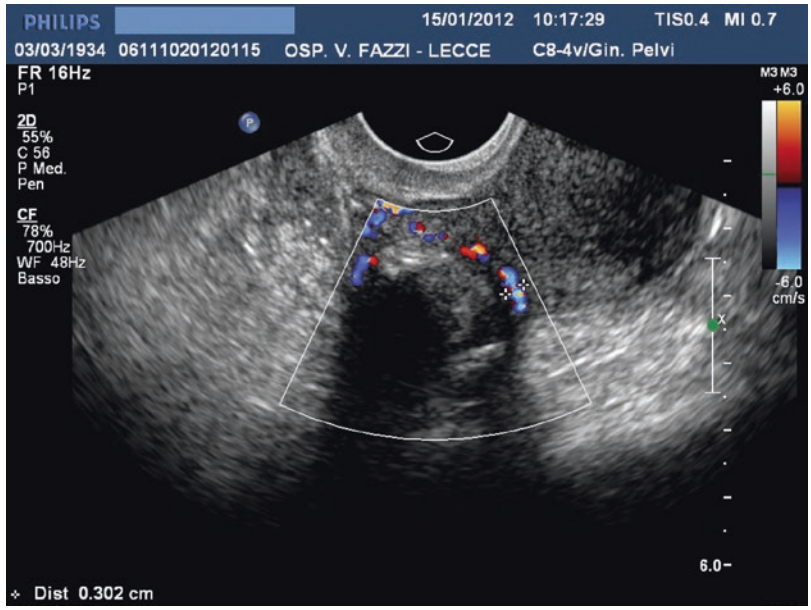

Fig. 15.12 Ultrasonographic image of posterior subserosal fibroid, preoperatively scanned by echo color Doppler, highlighting the "ring of fire"

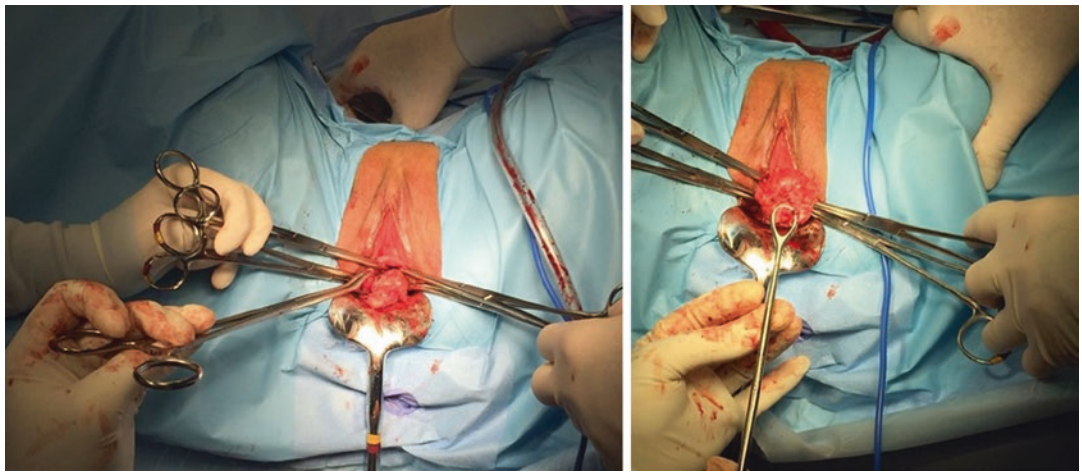

Fig. 15.13 Image of intracapsular myomectomy performed vaginally on a posterior subserosal myoma of the body of the uterus

The treatment of intracavitary myomas with an intramural extension of 50% or more (Fig. 15.14) has always been represented as a challenge for the hysteroscopic surgeons for the increasing risk for intraoperative complications and necessity of multiple-step procedures, with a higher risk in multiple myomas [27, 28].

Resectoscopic slicing still represents the most widely used technique for treating submucous fibroids, and probably for this reason, myomectomy represents the hysteroscopic procedure with a higher complication rate. In addition, the classical slicing technique (Fig. 15.15), even in expert hands, is limited in respecting the

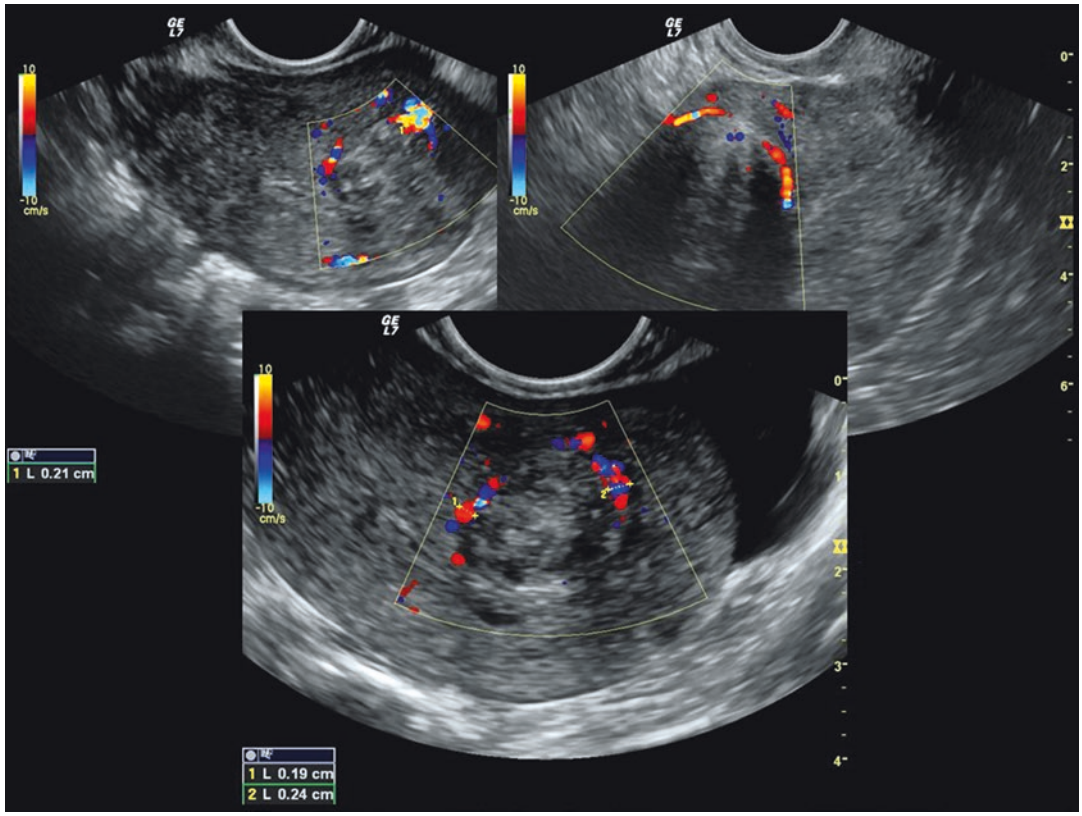

Fig. 15.14 Ultrasonographic image of intracavitary fibroids, scanned by echo color Doppler, highlighting the "ring of fire," with an intramural extension of 50% or more

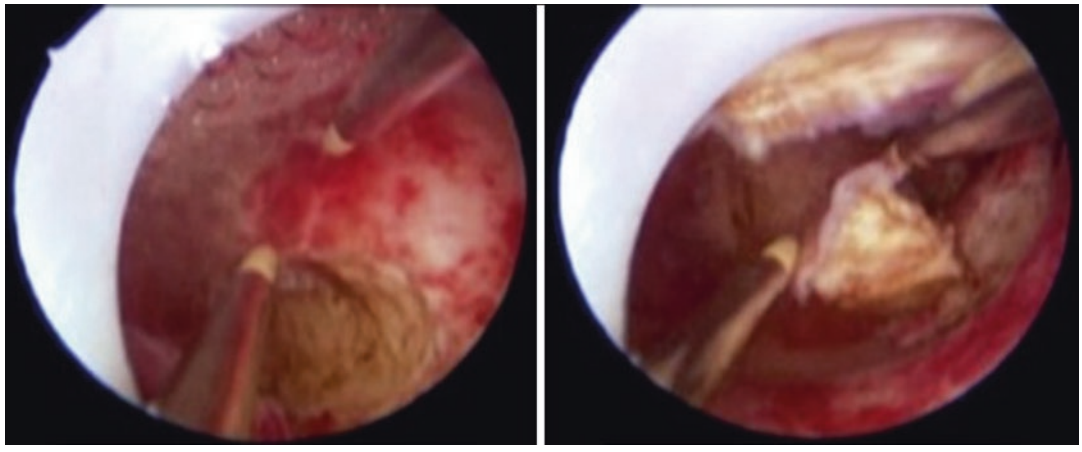

Fig. 15.15 Hysteroscopic myomectomy by traditional slicing technique

pseudocapsule and myometrium sparing after surgery. During the resection of the fibroid intramural part, the "pseudocapsular tissue" can be visualized over the entire resected area but in the context of the uterine wall [29] (Fig. 15.16).

To distinguish the myoma tissue from the pseudocapsule (Fig. 15.17) and from the healthy myometrium could become really arduous for non-skilled surgeons and in case of heavy bleeding. In addition, during the myoma slicing, the

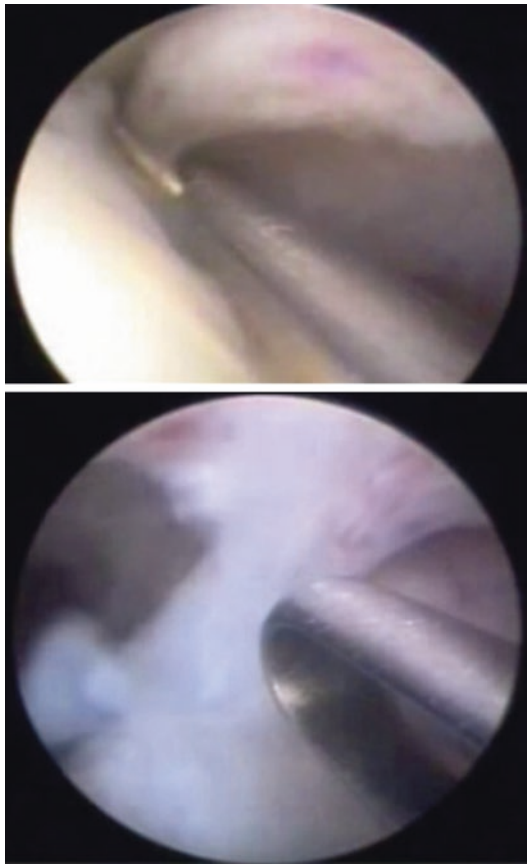

Fig. 15.16 Hysteroscopic myomectomy highlighting of the "pseudocapsular tissue" during myomectomy

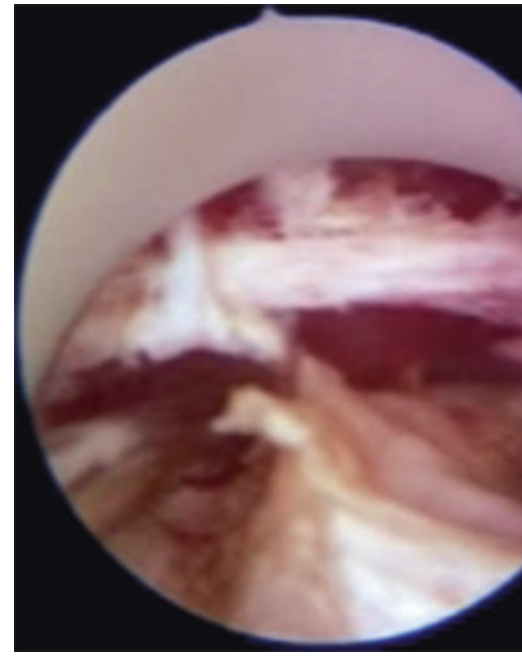

Fig. 15.17 Hysteroscopic myomectomy highlighting of the "pseudocapsular tissue" of white color in the center, from myoma below, during myomectomy

anatomic surgical dissection, by electrical loop, is generally altered, and it is almost impossible to avoid the injury of the myometrial fibers, causing a direct (cutting) and indirect (thermal) damage of the pseudocapsule and surrounding healthy myometrium [30].

This step is responsible for all intraoperative complications during hysteroscopic myomectomy, such as uterine perforation with electrical loop, bleeding, and clinical intravasation syndrome, all often closely interconnected [30].

Moreover, the role of surgical trauma to the healthy tissue of the uterine wall during hysteroscopic surgery in developing of synechiae is well known and already described [31].

The ideal hysteroscopic myomectomy should be a simple, well-tolerated, safe, and effective procedure, ideally in one surgical step [32]. In the last decades, several techniques have been developed in order to overcome the limits represented by the classical slicing for the treatment of the myometrial portion of submucous myomas [2, 23].

The goal of these techniques was the detachment of deep portion of myoma, in order to facilitate the myoma sliding and delivery from the myometrium into the uterine cavity. Authors previously reported advantages from uterine contractions induced by manual massage [33], drugs [34, 35], or changing intrauterine pressure [36]. Combinations of multiple techniques and the ultrasound monitoring were also described [37, 38]. Others instead described the detachment of intramural component of myomas by electrical incision of the fibro-connective bridges, anchoring myoma to its pseudocapsule [39, 40].

Among the techniques conceived with the aim to go beyond the limits represented by the classical slicing, the first described was the cold loop hysteroscopic myomectomy in 1995 [41]. This method shifted the traditional approach by electric slicing to a different approach: the mechanical enucleation of the myoma from its pseudocapsule (Fig. 15.18), taking advantage from the physiological contraction of myometrium. Dr. Mazzon,

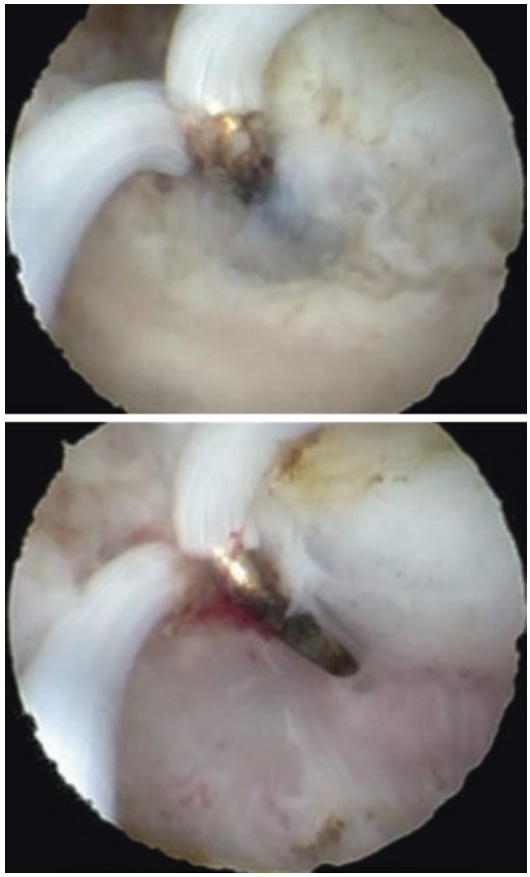

Fig. 15.18 The cold loop hysteroscopic myomectomy: through a loop, surgeon cut the pseudocapsule, highlighted on the top, and enters the avascular cleavage plane between myoma and pseudocapsule; then the myoma is progressively pushed down to make it come out of its fovea inside the uterine cavity

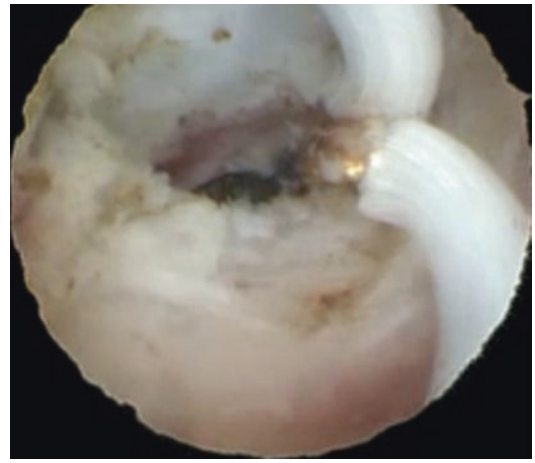

Fig. 15.19 The cold loop hysteroscopic myomectomy: the loop penetrates into the space between myometrium and myoma, respecting the anatomy of the uterine musculature

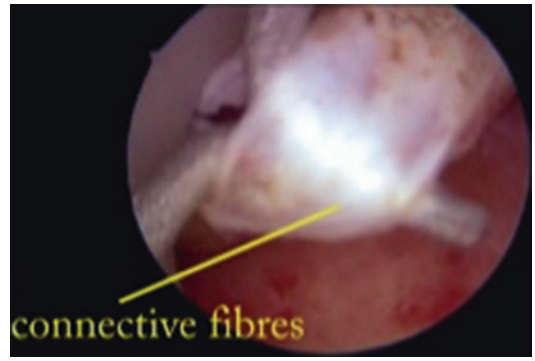

Fig. 15.20 The cold loop hysteroscopic myomectomy: the loop highlights the fibro-connective bridges that anchor the fibroid to its pseudocapsule

the father of this method [41], named the technique "cold loop myomectomy," and it represented a revolution in the hysteroscopic treatment of submucous fibroids. The cold loop hysteroscopic myomectomy allows to correctly distinguish the anatomical planes, respecting the anatomical and functional integrity of the myometrium and the pseudocapsule (Fig. 15.19) while at the same time ensuring a safe and effective procedure. Generally, the fibro-connective bridges that anchor the fibroid to its pseudocapsule are mechanically disconnected by the cold loops (Fig. 15.20), allowing to enucleate the intramural component of the myoma, without any consequence to the surrounding healthy myometrium. The cold loops between myoma and pseudocapsule allow to avoid uterine perforation by electrical loop and dramatic injury to abdominal organs or vessels. In addition, in case of perforation by cold loops, the damage induced can be considered as the same with a Hegar dilator [30, 41].

The respect of the myometrium also increases the free myometrial margin thickness [42]. Moreover, the uterine contraction and the

respect of the myometrial muscular fibers decrease the risk of bleeding and the absorption of the distension medium, enhancing the possibility to accomplish the treatment in a single procedure. The pseudocapsule respect enhances the myometrial physiologic healing, reducing drastically the scar and adhesions, with a favorable impact on successive fertility and decreased uterine rupture risk. Although it is not possible to consider as the treatment of choice, the pseudocapsule sparing during hysteroscopic myomectomy seems to be an excellent option for the treatment of submucous myomas [2, 23], as it is a safe and effective procedure, respecting the fibroid pseudocapsule, allowing to accomplish the treatment in only one surgical step in a high number of cases [28, 43].

15.5 Conclusions

The pseudocapsule sparing during myomectomy is a technique based on muscular physiology and respect for anatomy [44, 45]. It allows us to enucleate a fibroid, respecting the surrounding structures through different approach techniques: laparotomic, laparoscopic, vaginal, and hysteroscopic. The benefit is visible during the enucleation of the fibroids as bleeding is reduced and the anatomical planes are largely detected. In addition, it provides significant benefits in terms of uterine muscular healing. Both clinical and ultrasound investigations on scar site after myomectomy by pseudocapsule sparing suggested better functional results regarding myometrial integrity when compared to myomectomy scars following myomectomy in nonpregnant patients. Researches also suggested that favorable healing environment caused by pregnancy-induced activation of the immune system enables safe vaginal delivery in subsequent pregnancies even following cesarean myomectomy, always by intracapsular method [46] (Fig. 15.21).

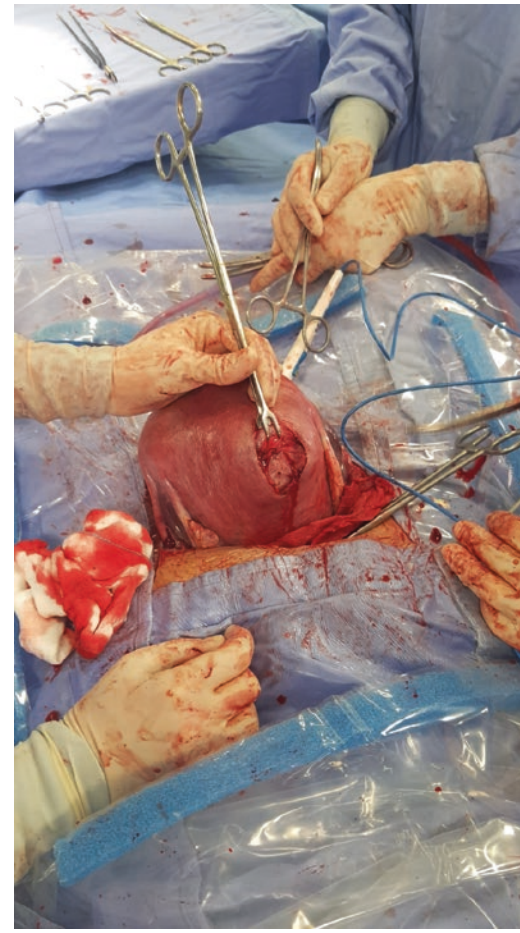

Fig. 15.21 Cesarean myomectomy of a posterior intramural myoma of the uterine body, enucleated by intracapsular technique after anterior myorrhaphy after fetus and placenta extraction

Conflict of Interests Author certifies that there is no actual or potential conflict of interest in relation to this article, and I reveal any financial interests or connections, direct or indirect, or other situations that might raise the question of bias in the work reported or the conclusions, implications, or opinions stated—including pertinent commercial or other sources of funding for the individual authors or for the associated departments or organizations, personal relationships, or direct academic competition.

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Adenomyoma and Hysteroscopy

16

Sejal Naik and Sweta Patel

16.1 Introduction

Adenomyomas are benign overgrowths of the glandular endometrium within the muscular myometrium; if large, they can cause the same distortion of the endometrial cavity seen with fibroids and thus possibly contribute to menorrhagia, dysmenorrhea, infertility, recurrent pregnancy losses, recurrent implantation failures, etc. Although not very common, with introduction of non-invasive imaging techniques like MRI and 3D transvaginal ultrasound, increasing number of cases have been reported. Majority (80%) of cases were reported between the age 40 and 50 years; with increasing age of marriage and of first conceptions, more cases are being reported with subfertility. Adenomyosis prevalence was reported as high as 38.2% [1, 2]; in those with previous ART, failure is 34.7%. Not only adenomyosis has great impact on fertility treatment, with 28% reduction in the likelihood of clinical pregnancy at in vitro fertilisation/intracytoplasmic sperm injection (IVF/ICSI), but presence of adenomyosis also increase the risk of miscarriage (more than double) and reduction in the likelihood of delivering a viable baby by overall 30%. This rise in miscarriage rate is observed in donor cycles too, i.e., it is independent of oocyte and embryo quality [3, 4].

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Histologically, they are composed of glands lined by endometrial-type epithelium. They may also contain blood-filled cyst, also lined with endometrial epithelium. Microscopic examination helps to differentiate them from other tumours which they may mimic [5].

16.2 Role of Hysteroscopy in Diagnosis of Adenomyoma

Hysteroscopy is more specific but less sensitive in diagnosis of adenomyosis. One can see variety of presentation with adenomyosis and hence subjected to under/overreporting. It offers the advantage of direct visualisation of uterine cavity and the option of collecting histological biopsy samples under visual control (Figs. 16.1, 16.2, 16.3).

Following are different patterns indicative of diagnosis of adenomyosis:

1. Irregular endometrium with tiny openings seen on the endometrial surface in both proliferative and secretary phases.
2. Fifty percent cases have an abnormal hypervascularisation in both proliferative and secretary phases.
3. Fibrous cystic appearance of intrauterine lesion.
4. An endometrial "strawberry pattern".
5. Haemorrhagic cystic lesions assuming a dark blue or chocolate brown appearance.

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https://doi.org/10.1007/978-981-15-2505-6_16

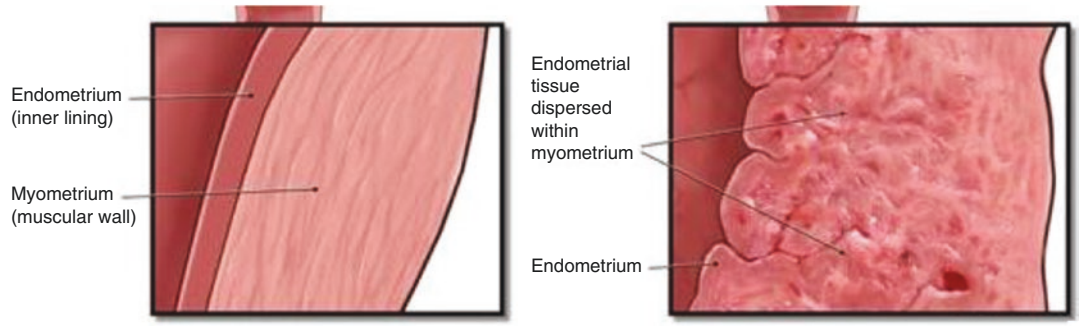

Fig. 16.1 Abnormal subendometrial myometrium. (Courtesy: Practical Endoscopy Tips by Expets, Dr. Sunita Tandulwadkar)

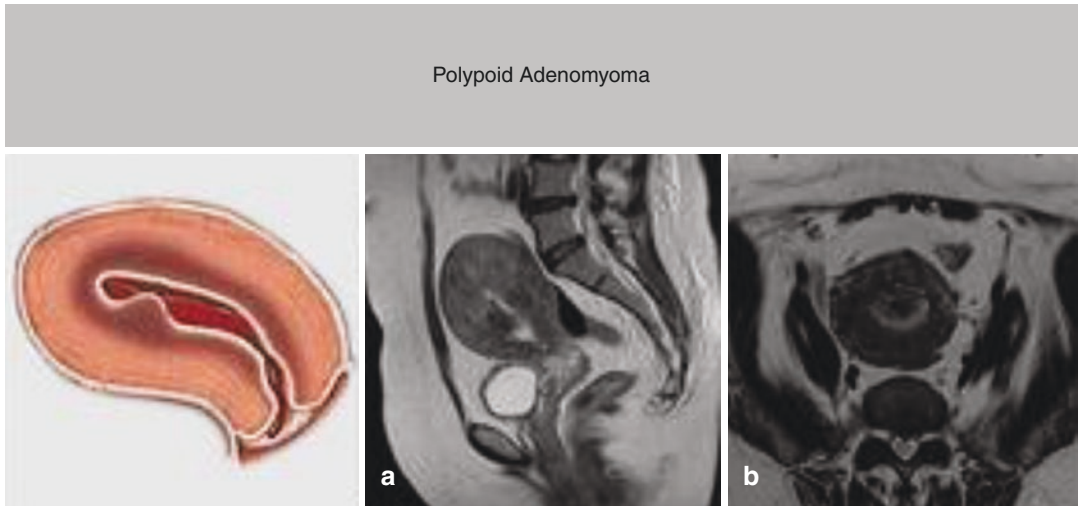

Fig. 16.2 Pictorial presentation and MRI findings of polypoidal adenomyoma. (Courtesy: Practical Endoscopy Tips by Expets, Dr. Sunita Tandulwadkar)

16.3 Therapeutic Hysteroscopic Procedures for Adenomyoma

16.3.1 Resectoscopic Biopsy Sampling

To assess the extent of adenomyosis, infiltration biopsy is performed using a resectoscope with a diathermy loop. To obtain adequate biopsy with this approach, it is necessary to have a specimen rendering both the endometrium and the underlying myometrium layer and then take a second biopsy deeper into the dent left behind by the first.

On resectoscopic biopsy sampling, following techniques can be strongly suggestive of adenomyosis:

1. Irregular subendometrial myometrium (spiral/fibrotic) (Fig. 16.1).
2. Contortion of normal myometrial architecture noticeable during resection.
3. Presence of intramural endometriomas.

16.3.2 Spirotome

It operates with two devices: the receiving needle with a cutting helix at the distal end and a cutting cannula as an outer sheet. The correct direction and position of the helix point must be under continuous ultrasound imaging and hysteroscopic control (Fig. 16.4).

So the Spirotome can be directed towards any intramural localised lesion such as cystic adeno-

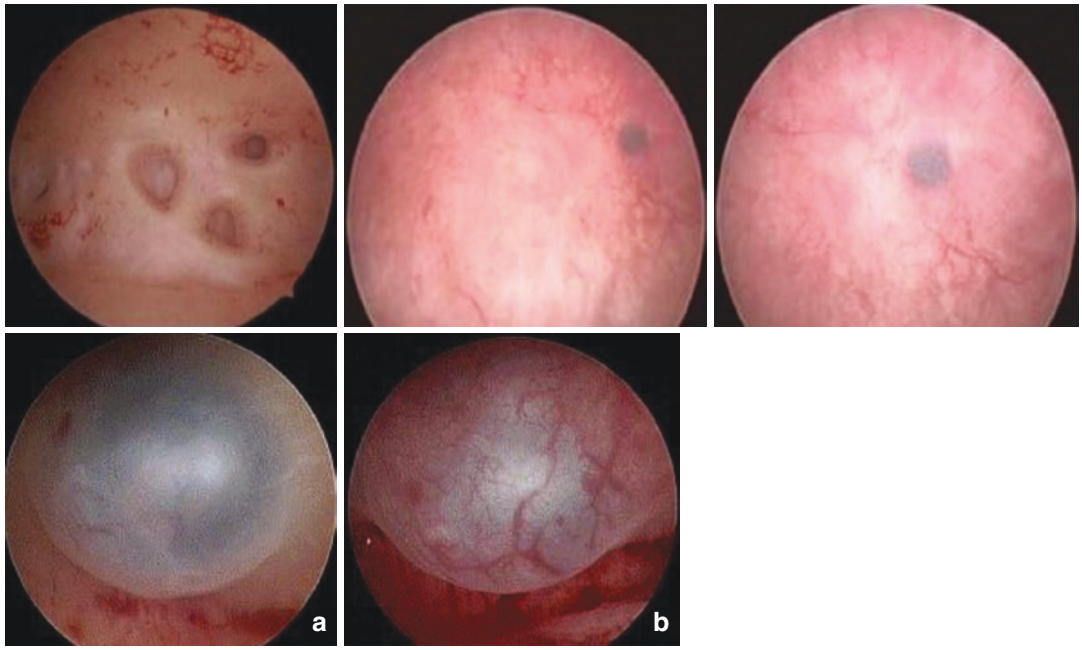

Fig. 16.3 Hysteroscopic findings of adenomyosis, punctuations, haemorrhagic cysts, and blebs. (**a**, **b**): Haemorrhagic cyst of adenomyosis. (Courtesy: Practical Endoscopy Tips by Expets, Dr. Sunita Tandulwadkar)

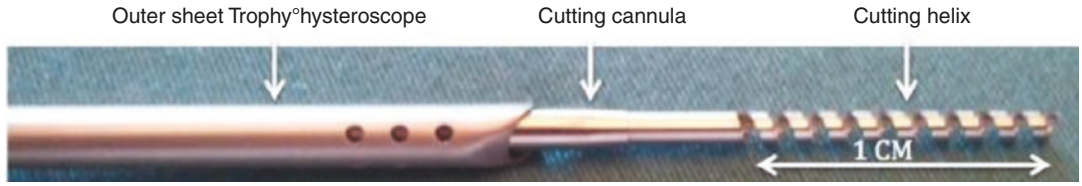

Fig. 16.4 Spirotome. (Courtesy: Practical Endoscopy Tips by Expets, Dr. Sunita Tandulwadkar)

myosis. Spirotome is a very useful innovation under ultrasound guidance. Access is gained to intramural cystic lesions. Treatment by resection or bipolar coagulation can be performed [6].

16.3.3 Resectoscopic Ablative Technique

In case of submucous cystic adenomyotic lesion or an adenomyoma bulging into the uterine cavity, direct hysteroscopic access is possible. Using 5-Fr scissors during hysteroscopy allows a clear dissection of the myometrial wall of the cyst from the surrounding myometrium.

Instead of dissection with scissors, an ablative technique that destroys the inner cystic wall is a possible treatment option. This is indicated in cases of superficial adenomyotic nodules >1.5 cm in size, and for diffuse superficial adenomyosis, endometrial ablation may be performed with the additional removal of the underlying myometrium mainly in women not desiring future pregnancy.

Deep diffuse adenomyosis is not manageable with the hysteroscopic approach. Resectoscopic treatment in such cases not only fails to reduce symptoms but may even have adverse effects in that it masks the onset of deep adenomyosis developing below the endometrial scar tissue which may be prone to malignant transformation.

Focal adenomyoma protruding into uterine cavity is incised, evacuated and resected using resectoscope with cutting loop. If lesion is

deeply implanted, the nodule may be first mobilised using various techniques that cause it to migrate into the uterine cavity that can be resected with cutting loop until it can be completely removed. The surgical procedure is completed by coagulating the implantation base of the lesion.

The goal of surgery is to remove all adenomyotic tissue without damage to healthy surrounding myometrial fibres. The lack of a distinct cleavage plane indicating the normal myometrial tissue can make the procedure quite challenging (Figs. 16.5 and 16.6).

Superficial diffuse adenomyosis may be treated with endomyometrial ablation by electrode or Versapoint. It differs from the classical method of endometrial ablation as resection is not deep up to the sub-endometrium and the first 2–3 mm of myometrium, but continued slicing of myometrial layer until healthy myometrium is visualised and the procedure is completed by coagulation of endometrial residue. In case of persistence and/or recurrence of diseases, a second stage surgical procedure may be performed. The limitation of this procedure is it does not leave any tissue for histopathological examination.

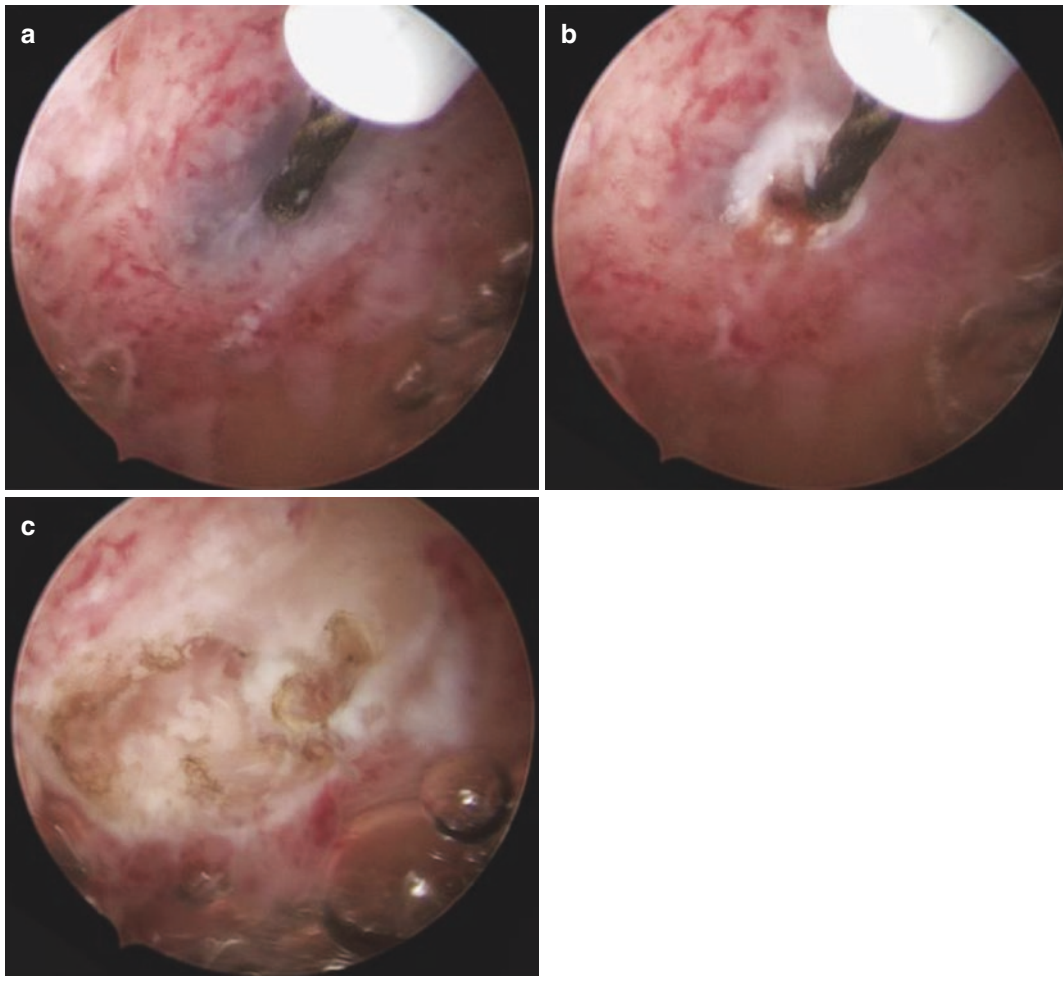

Fig. 16.5 Evacuation of hypothesised superficial adenomyotic cysts with a 5 -Fr bipolar electrode (KARL STORZ, Germany). Panoramic image of the small cystic lesion (**a**). Incision and drainage of the cystic lesion (**b**, **c**). (Courtesy: Practical Endoscopy Tips by Expets, Dr. Sunita Tandulwadkar)

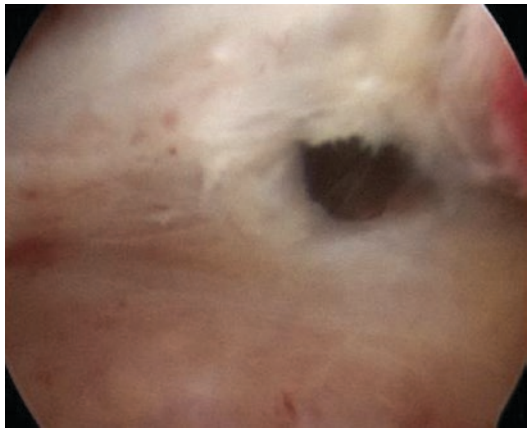

Fig. 16.6 Hysteroscopic image of cystic adenomyotic lesion at the fundus of uterus affected by diffuse adenomyosis (diagnosis was confirmed at histological exam on target-eye biopsies), after incision with bipolar electrodes. (Courtesy: Practical Endoscopy Tips by Expets, Dr. Sunita Tandulwadkar)

16.4 Advantages and Limitations

Hysteroscopy offers an alternative access to cystic adenomyosis, producing minimal tissue damage. It is a viable option only in selective cases of the focal or diffuse superficial subtypes. It is possible to enucleate superficial focal adenomyomas or to evacuate cystic haemorrhagic lesions of less than 1.5 cm in diameter using mechanical instruments and/or bipolar electrodes. But these treatments are feasible only when the lesions are directly recognisable at hysteroscopy as they bulge into the endometrial cavity, thus favouring a minimally invasive dissection.

16.5 Complications

Complications are similar to hysteroscopic myomectomy and can be more severe and frequent as absence of clear capsule and demarcation between normal and pathological myometrial areas, which lead to increase chances of haemorrhage, perforation and rupture during pregnancy or labour.

16.5.1 Intraoperative

16.5.1.1 Traumatic Injuries

Traumatic injuries are more common during operative hysteroscopy. Cervical tear, lacerations by tenaculum and dilatation are noticed. Perforation of cervix and uterus is most common complication during dilatation or insertion of hysteroscope especially in acutely anteflexed or retroflexed uterus and in stenotic cervix. It can be avoided by inserting a scope under vision. Laparoscopy may be considered if suspected active bleeding.

Complex perforation occurs with forceps, scissors, resectoscope and electrosurgical instruments. Concomitant laparoscopy is mandatory to prevent or immediately detect perforation. Thermal injuries to bowel, bladder or large vessels can also occur.

16.5.1.2 Primary Haemorrhage

Achieving haemostasis may be challenging at times, and steps should be planned beforehand to minimise blood loss. Pretreatment with GnRH analogue has shown to reduce blood loss in hysteroscopic myomectomy. There is little record of its use in adenomyoma, but the effect should be similar since analogues cause myometrial contraction and shrinkage of oestrogen-dependent tumours.

It is the second most common complication of hysteroscopy and occurs in 2.5 per 1000 cases. The major causes of primary haemorrhage during resection or ablation are operating or resecting too deeply in the myometrium and resecting close to endocervix, or on lateral wall near uterine artery. Individual bleeding vessels should be coagulated separately. If bleeding continues, the operation should be abandoned. The use of haemostatic balloon is common in obstetric haemorrhage. There is also an increasing use of balloons and Foley catheter in hysteroscopic surgeries and cervical and scar pregnancy to control bleeding. Because these devices provide tamponade within the cavity, they can provide effective haemostasis in cases where tumours or polyps are removed from the endometrial cavity. Foley catheter is inserted into the cavity and inflated. It usually controls the bleeding, and it can be removed after

6 hours. Vasopressin (20 U in 20 mL saline) may be injected into the cervix to reduce bleeding from the lower uterine segment. If facilities are available for uterine artery embolisation, it can be tried before considering hysterectomy.

Surgery combined with postoperative analogue treatment appears to be effective in reducing relapse of symptoms and may be appropriate in women willing to postpone their efforts to achieve conception [7].

16.5.1.3 Gas Embolism

Air embolism is a rare but devastating complication of hysteroscopy. Brooks has reviewed seven cases of air embolism with five fatalities. First recognisable change of gas embolism is decrease in end-tidal CO_2. This is followed by hypoxia, tachycardia, tachypnoea, hypotension and then cardiovascular collapse with bradycardia, hypotension and subsequent asystole. Auscultation over the precordium reveals typical mill wheel murmur. Following steps should be taken when gas embolism is diagnosed:

- Remove hysteroscope to discontinue insufflation; make sure vagina is closed or occluded with a wet sponge.
- Turn patient to left side to elevate, and keep gas in the right side of the heart, decreasing the chance of paradoxic embolus.
- Consider precordial thumps to break up air pocket.
- Administer intravenous bolus of normal saline.
- Consider echocardiography to identify and possibly aspirate gas from the right side of the heart.

Transferring the patient to an intensive care unit is mandatory because pulmonary oedema and adult respiratory distress syndrome are likely sequelae of air embolism.

16.5.2 Postoperative and Late Complications

16.5.2.1 Infection

The most common infections are uncomplicated cystitis, endometritis or parametritis. The operation is better avoided in presence of STD, vaginal discharge or recurrent acute PID. Prophylactic antibiotics may decrease the risk of postoperative infection.

16.5.2.2 Uterine Synechiae

Exact incidence of uterine synechiae following adenomyoma resection is not known but thought to be more than that with hysteroscopic myomectomy. Touboul et al. found that the incidence of uterine synechiae after bipolar hysteroscopic resection of fibroids was 7.5%. The incidence of adhesions after unipolar system use was higher in a study by Taskin et al.: 31.3% in patients with solitary fibroid and 45.5% in those with multiple fibroid. This lower incidence with bipolar system can be explained by the prevention of lateral thermal damage and stray current passage to surrounding structures, thus preventing the formation of scar tissue and adhesions. Intrauterine copper device, few weeks treatment with oestrogen and progesterone, can be tried to prevent synechiae. LNG IUS can be a choice for those who do not desire fertility in near future.

16.5.2.3 Uterine Rupture During Pregnancy

Uterine rupture during pregnancy has been reported after hysteroscopic myoma resection. Precipitating events include mechanical or electrosurgical perforation. A recent review of surgical techniques for hysteroscopic myomectomy cited two cases of uterine rupture in pregnancy following hysteroscopic resection of a fibroid.

16.6 Outcome After Correction

In contrast to the healing process after hysteroscopic myomectomy, where a normal uterine cavity is expected, resection or ablation of adenomyotic cysts bulging into the uterine cavity results in a visible defect of the myometrium.

The hysteroscopic technique has the advantage of leaving the outer myometrium intact and avoiding an abdominal scar.

After appropriate therapy of the space-occupying intrauterine lesions, seven patients (77.8%) achieved successful pregnancy and two

patients (22.2%) had recurrent miscarriage. In the normal hysteroscopy group, eight patients (57.1%) had recurrent miscarriages, two patients (14.3%) had infertility and four patients (28.6%) achieved successful pregnancy with no further therapy.

Hysteroscopy has revolutionised the way to approach adenomyosis in terms of both diagnosis and therapy. Laparoscopic adenomyomectomy can only be planned in case of RPL or RIF to reduce symptoms or volume with average PR (50%) and LBR (36.2%).

Because the incidence of adenomyosis is increasing with age and as women are postponing their childbearing, increase in incidence of adenomyotic pathology in those patients referred for fertility treatment can be expected. Therefore, uterine exploration should not only focus on a careful inspection of the endometrial cavity but also entail an evaluation of the uterine wall with special attention to the junctional zone. This can routinely be performed in an office setting using 3D ultrasound and office mini-hysteroscopy.

Key Learning Points

- Incidence of adenomyosis is increasing with improvements in diagnostic techniques and understanding the variety of presentations. Incidence of infertility with adenomyosis is also rising due to postponing marriage and age at first childbirth. One should make a habit of inspecting endometrial cavity as well as uterine wall while performing 3D ultrasound to pick early disease.
- Hysteroscopy is more specific but less sensitive in diagnosis of adenomyosis. Hysteroscopy can detect only those lesions which indent into the cavity or deep myometrial. Out of all, altered hypervascularisation is most common presentation.
- Various techniques can be tried for hysteroscopic ablation of adenomyotic lesion by expert, with similar care and preparation like hysteroscopic myomectomy by resectoscope, Spirotome, Versapoint, etc., with very less complications rate.

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17 Uterine Synechiae and Postoperative Care

Karine Matevossian and Aarathi Cholkeri

Uterine synechiae, or intrauterine adhesions (IUA), are often underdiagnosed but can lead to infertility and abnormal menstruation. They most commonly occur after uterine instrumentation. Often, the underlying pathophysiology is damage to the basilar endometrium [1]. This results in fibrous connective tissue bands that may have glandular tissue [2]. Synechiae range from minimal adhesions to total obliteration of the uterine cavity. Adhesions can be filmy or dense. Most often, they are located in the cavity but can also occur in the cervicoisthmic area. On histology, adhesions can be fibromuscular, endometrial, myometrial, or connective tissue. The worst prognosis is seen with dense fibrous adhesions without endometrial glands [2].

17.1 Risk Factors

Endometrial curettage in pregnancy is the most frequent cause of uterine adhesions, with 30% of synechiae forming after a curettage for a missed abortion [3]. Postpartum curettage is another major risk factor, particularly in the first 2–4 weeks postpartum [4]. Additionally, 2% of patients who undergo manual placenta removal develop synechiae [4]. Several other pregnancy-related risks include previous cesarean sections, placenta accreta, and postpartum endometritis [5].

Hysteroscopic surgery, both endometrial ablation and resectoscopic surgery, can lead to synechiae. Studies have shown that using bipolar energy results in less adhesion formation than monopolar energy when resecting fibroids [6]. Other causes of synechiae include dilation and curettage in nonpregnant women, severe endometritis or fibrosis, pelvic irradiation, and endometrial tuberculosis [2]. Adhesions can form from myomectomy and intrauterine surgeries [2].

17.2 Symptoms

Patients with IUAs can present with a spectrum of symptoms. Some may have no disturbances in their menstrual cycle but present with infertility secondary to obstruction of the tubal ostia (Figs. 17.1 and 17.2) or partial obstruction of the endocervix (Figs. 17.3 and 17.4). Women may also present with recurrent abortions [7]. Commonly, patients present with menstrual irregularities or amenorrhea [2]. About two-thirds of women will present with amenorrhea [8].

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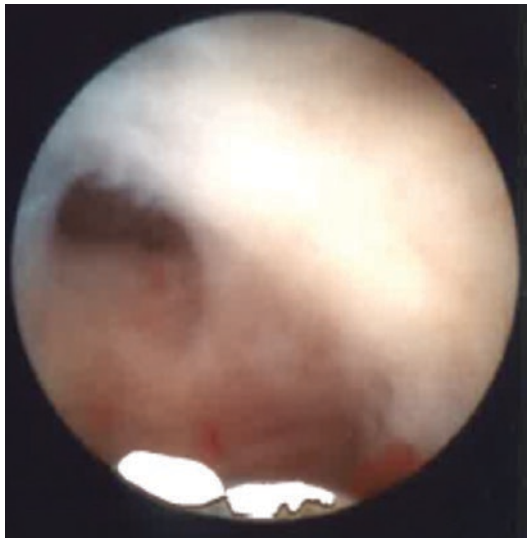

Fig. 17.1 Endocervical stenosis from adhesions

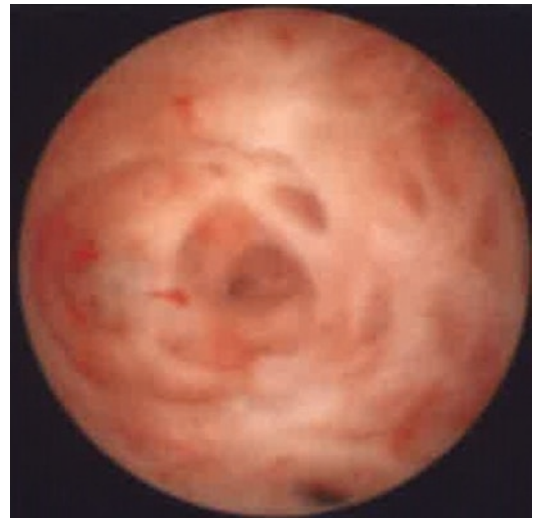

Fig. 17.3 Cornual scarring after endometrial ablation

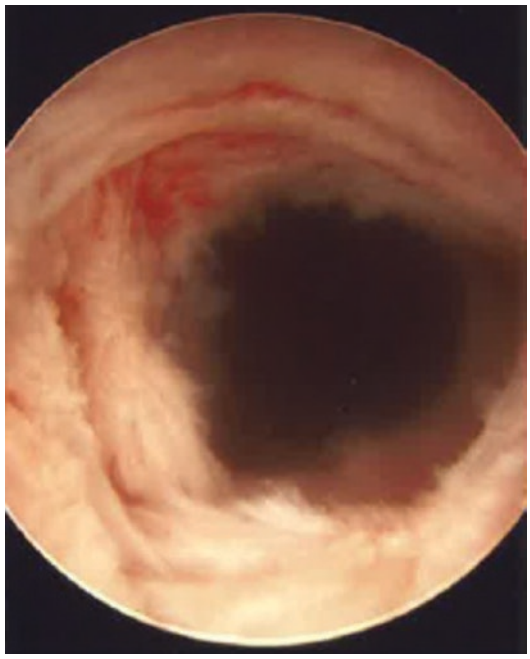

Fig. 17.2 Correction of endocervical canal after lysis of adhesions

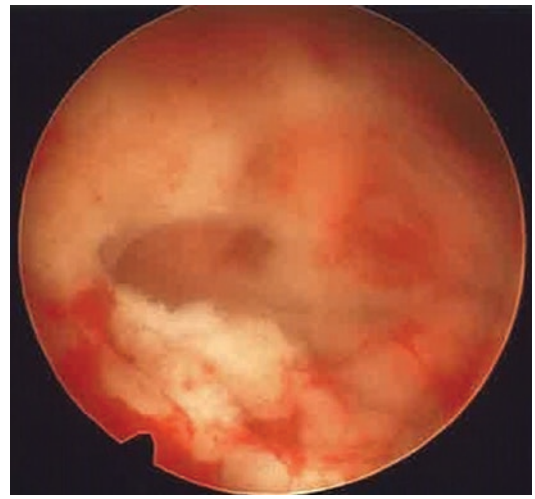

Fig. 17.4 Right tubal ostia visualized after adhesiolysis of cornual scarring

However, the severity of menstrual disturbances does not necessarily correlate with the extent of adhesions [7]. Two to three percent of patients with severe disease will have no menstrual irregularities or pain [8]. In some women, scarring of the cervix or lower uterine segment can cause cyclic pain due to functional endometrium and blood trapped above the scarred tissue. If these patients do not undergo treatment promptly, retrograde menstruation can occur through a patent fallopian tube and possibly lead to endometriosis [7].

17.3 Diagnosis

The true incidence of uterine synechiae is unknown. One study, however, did find an incidence of 1.5% in women who underwent hysterosalpingography (HSG) [9]. Another study found a rate of 13% in those undergoing a routine infertility workup [10].

Diagnosis of synechiae begins with a thorough history evaluating for predisposing risk factors and causes of endometrial trauma. Other reasons for amenorrhea and menstrual irregularity, such as pregnancy, should be ruled out. Hysteroscopy is the diagnostic gold standard. Direct visualization allows for evaluation of endometrial quality and the extent and type of adhesions. Physical examination often fails to diagnose synechiae. However, a transcervical sounding can reveal obstruction near the cervical os [11].

Radiologic investigation is somewhat inferior to hysteroscopy in diagnosing IUA. 2D transvaginal ultrasound can evaluate endometrial thickness and the presence of hematometra (Figs. 17.5 and 17.6) [8]. Saline infusion sonohysterography (SIS) is highly accurate at diagnosing synechiae as well as other intrauterine abnormalities. The respective sensitivity and specificity of diagnosing IUAs have been reported up to 82 and 99% [8]. Both methods can show "skip lesions" created by focal or partial obliteration of the endometrium [8]. HSG is fairly sensitive (75–81%), and specific (80%) for diagnosis [8]. However, it has a very high false-positive rate of 39% and positive predictive value of 50% [8]. Some experts recommend performing an HSG before hysteroscopy. It offers the opportunity to determine tubal patency, is more cost-effective, and allows for surgical planning. When an HSG is correctly performed, a normal exam rules out IUA [7]. 3D ultrasound can be more effective in diagnosing synechiae with an 87% sensitivity and 45% specificity [8]. At this time, magnetic resonance imaging is not recommended for diagnosis [8].

There are several classification systems for synechiae, but none have been agreed upon as the universal standard. The first system was created by March et al. based on hysteroscopic findings. Table 17.1 shows a summary of several of the classification systems.

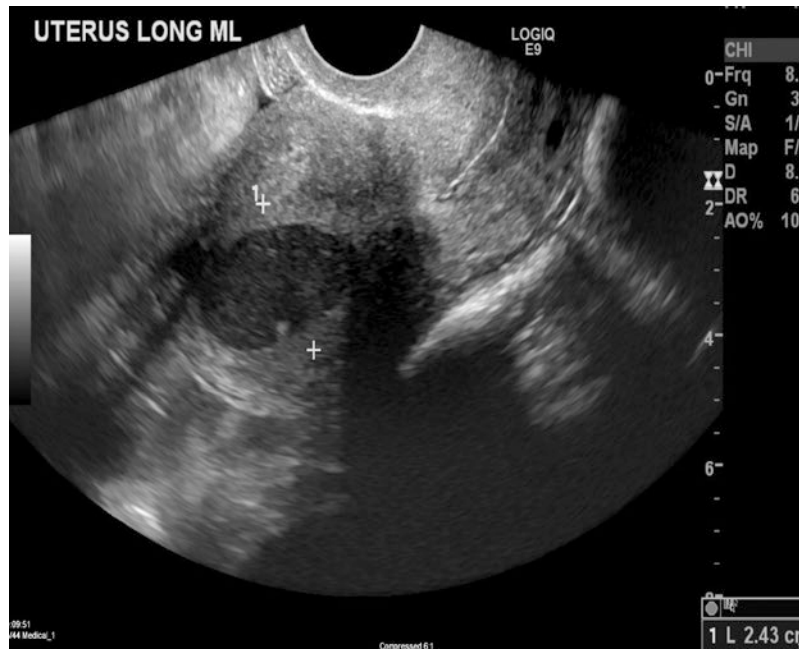

Fig. 17.5 Transvaginal sagittal image of central hematometra

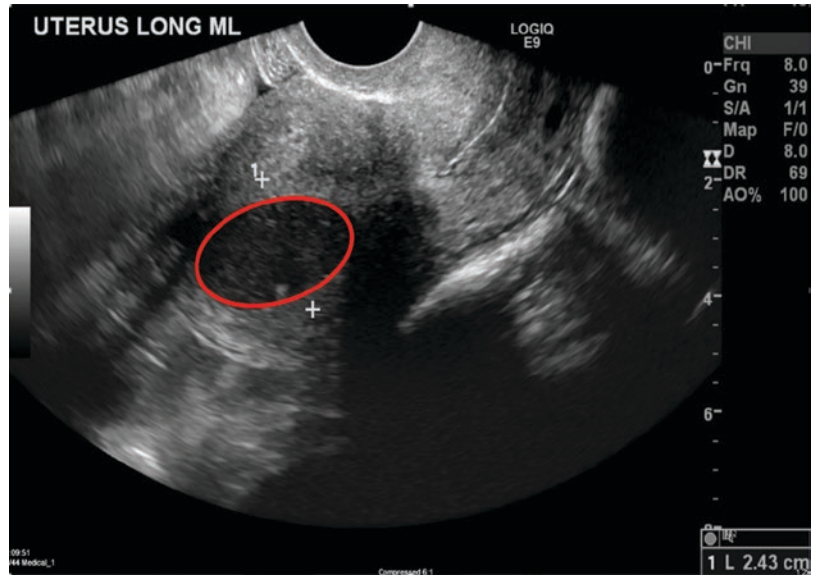

Fig. 17.6 Transvaginal sagittal image of central hematometra outlined within red circle

Table 17.1 Classification of Uterine Synechiae

Source	Distinctions	Method
March et al. [12]	Based on adhesion type and extent of cavity involved. Adhesions classified as minimal, moderate, or severe	Hysteroscopy
European Society for Hysteroscopy Classification of IUA [13]	Adhesions separated into grades I–IV based on adhesion type, location, and clinical symptoms	Hysteroscopy, HSG, and symptoms
Nasr et al. [14]	Clinicohysteroscopic scoring system for predicting prognosis after hysteroscopic adhesiolysis	Hysteroscopy and menstrual and obstetric history
American Fertility Society [15]	Adhesions classified based on extent of cavity involved, type of adhesion, and menstrual history	Hysteroscopy, HSG, and menstrual history
Valle and Sciarra [16]	Adhesions graded as mild, moderate, or severe based on adhesion type and extent of occlusion of uterine cavity	Hysteroscopy
Donnez and Nisolle [17]	Adhesions separated into degrees I–III based on location (central vs. marginal) and type	Hysteroscopy or HSG

17.4 Treatment

Surgical management is the ideal treatment for synechiae. Hysteroscopic lysis of adhesions can be performed to restore the uterine cavity to its normal shape and free the tubal ostia. Surgery is very effective with 80% of patients having a normal cavity after one hysteroscopic adhesiolysis by high-volume surgeons [8]. About 70% of patients have a return to regular menstrual cycles [18]. For filmy adhesions, blunt dissection can be performed. For more substantial adhesions, adhesiolysis can be done with hysteroscopic scissors, electrosurgery, or laser. Adhesions should be separated until the normal anatomy is restored and both ostia are visualized.

Dense adhesions that feel hard may need electrosurgery to take them down [10]. This can be performed with monopolar or bipolar energy. The latter is advantageous because it allows for the use of normal saline, decreasing the risks of fluid absorption. Bipolar energy also has a decreased thermal effect [7].

In general, it is better to perform adhesiolysis without electrosurgery to minimize damage to healthy endometrium and prevent recurrence.

Additionally, using electrosurgery has been shown to have decreased pregnancy rates [8]. There is some evidence of decreased bleeding with the use of electrosurgery [7]. However, increased bleeding occurs when myometrium is unintentionally lysed because of difficulty distinguishing the tissue from synechiae [1].

Another technique is the use of the yttrium-aluminum-gamet (YAG) laser. The laser allows for quick dissection of lateral wall adhesions. However, it is expensive and not readily available. Additionally, the laser can cause thermal damage, up to 1 cm, from heat diffusion and create bubbles that obstruct the operative field [10].

Most patients can undergo hysteroscopic adhesiolysis in the office. Optimal candidates for in-office procedures will have minimal to moderate adhesions, an anticipated procedure time of 15 min or less, and no cervical stenosis [8]. In-office hysteroscopy does not require IV sedation, and the majority of cases are done with NSAIDs, avoiding the risks associated with anesthesia.

The severity of adhesions is correlated with increased risk of perforation. The risk increases with each subsequent adhesiolysis. Severe adhesions have a 7% risk of perforation during dilation and a 1–3% risk during dissection [10]. If perforation occurs, electrosurgery poses a risk of thermal injury to surrounding organs and structures [8]. Intraoperative transabdominal ultrasound guidance can help identify anatomy that has been distorted by the adhesions and reduce the risk of perforation.

Fluoroscopic guidance may also be used in cases of severe disease. A spinal needle is used in parallel to the hysteroscope to inject radiographic contrast medium. This allows for radiographic orientation and assessment of tubal patency [10].

Laparoscopy concomitantly with hysteroscopy can be performed to decrease the risk of perforation. However, given the increased risks and complications, it is not currently standard practice.

There are several non-hysteroscopic techniques that may be used. The first is a pressure lavage in which saline is injected into the uterus under ultrasound guidance to expand the cavity and break up mild to moderate filmy adhesions [19]. Another form of blunt disruption uses an insemination catheter filled with iodine contrast medium. This creates a continuous, ongoing HSG leading to complete adhesiolysis [19].

Lastly, hysterotomy can be performed if the adhesions prevent a hysteroscope from entering the endocervical canal and lower uterine segment. This should only be done if imaging previously showed some areas of normal endometrium and the cavity is not completely obliterated [7].

17.5 Postoperative Care

Multiple methods have been proposed for the prevention of recurrent synechiae. The more severe the initial adhesions, the more likely they are to reform. The majority of patients receive high-dose estrogen, with or without progesterone, immediately postoperatively to stimulate growth of the atrophic and damaged endometrium. Most commonly, estrogen is given for 1–3 months, and a progesterone test can be done to induce menstruation if needed [10]. Of those patients who receive hormone therapy, 64–100% will have improvement in menstruation patterns [20]. In our practice, we use estradiol 2 mg twice daily for 30 days with micronized progesterone added on days 26–30.

A less agreed upon method is the insertion of an intrauterine device (IUD) to maintain the separation between the uterine walls. The copper and levonorgestrel T-shaped IUDs may disrupt the development of normal endometrial tissue because of their local inflammatory reactions. Therefore, the preferred IUD is an inert loop, but it is not available in many areas [21]. This technique has shown some promise in mild to moderate adhesions. It is important that the removal of the IUD is done carefully to avoid damage to the endometrium [10]. Newer studies have been performed by wrapping an IUD in anti-adhesive barriers like Interceed, an oxidized, regenerating cellulose. However, patients had over a 75% recurrence rate with both just the IUD and the IUD with Interceed. The IUD alone group required a median of four repeat surgeries versus three in the Interceed group [22].

Another mechanical method is the use of an intrauterine balloon or Foley catheter [1]. It is placed immediately post hysteroscopy and kept intrauterine. Most clinicians place the catheter for 7–14 days. If long term, the patient will need prophylactic broad-spectrum antibiotics like doxycycline [2]. Some surgeons place the patient concomitantly on estrogen [2].

Several barrier methods have been developed but are considered more experimental. Seprafilm is a bioabsorbable membrane from chemically modified hyaluronic acid and carboxymethylcellulose. In randomized, controlled, blind studies, Seprafilm has been shown to be very effective. Of those patients with no previous history of curettage treated with Seprafilm, 100% achieved pregnancy within 8 months versus 54% of control patients. For those who had one or more previous D&Cs, 90% of those treated with Seprafilm had no adhesions on repeat hysteroscopy versus 50% of the controls [23]. Another technique is the use of auto-cross-linked hyaluronic acid gel (ACP). In a study looking at adhesion formation after resectoscope hysteroscopy, ACP was shown to significantly decrease the development of synechiae and the severity of adhesions [24].

A retrospective study comparing the intrauterine balloon, IUD, and hyaluronic acid gel found that the intrauterine balloon and IUD were significantly more effective at preventing recurrent adhesions. The rate in the hyaluronic acid gel group was similar to the control group [25].

Amnion grafts with stem cells to regenerate the uterine endometrium have been studied as well. However, current randomized controlled studies have shown no significant improvement with their use [8]. Researchers are also investigating if autologous cell therapy with CD 133+ bone marrow-derived stem cells may help treat refractory cases. The results are promising and show return to menstruation and successful pregnancy, but the cohort was small [26].

A second-look outpatient hysteroscopy can be performed after withdrawal bleeding to assess for recurrence. Alternatively, this can be performed by HSG. Some experts recommend a second-look hysteroscopy within 2 weeks of initial surgery to bluntly break newly reforming adhesions before they are dense [8]. Another hysteroscopy is performed at 4 weeks to evaluate resolution of synechiae [8]. When performing a repeat hysteroscopy or adhesiolysis, it is important that the surgeon does not damage normal endometrium.

17.6 Impact on Fertility

The resolution of infertility and conception rate is related to adhesion severity. It may also depend on return to regular menstruation and the reformation of synechiae. One retrospective study found that after adhesiolysis, the conception rates in women with mild, moderate, and severe disease were 64.7%, 53.6%, and 32.5%, respectively [27]. When compared to the general population, these patients had a slightly lower live birth rate of 64.1% and a higher miscarriage rate of 20.5% [27]. Another retrospective study found that the mean time to conception after adhesiolysis was 12.8 months. The conception rate for mild, moderate, and severe disease was 58%, 30%, and 33.3%, respectively. The likelihood to conception increased with improved menstruation, 44.3%, versus those who had amenorrhea, 10%. Overall, 97.2% of patients conceived within 24 months. The live birth rate in this study was higher at 86.1% with a lower miscarriage rate of 11.1% [28]. Previous research has shown these pregnancies have an increased risk for placenta accreta and second trimester loss secondary to cervical incompetence [1].

Key Learning Points

- Uterine synechiae can cause infertility, disruptions in menstrual cycles, and pregnancy complications.
- The gold standard for diagnosis is hysteroscopy, but hysterosalpingography and saline infusion sonohysterography can also be used.
- The best treatment is hysteroscopic adhesiolysis which can be done in an office setting. A second-look hysteroscopy can be performed to evaluate for recurrence.
- Most practitioners use hormone therapy postoperatively. Inert IUDs and intrauterine balloons have been shown to be effective in preventing recurrence.

- Overall patients without severe disease do well, with a high rate of return to menstrual cycles and increased live birth rates.

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18 Hysteroscopic Diagnosis of Endometrial Tuberculosis

Alka Kumar and Atul Kumar

18.1 Genital Tuberculosis

It is estimated that two of every five Indians are infected with TB bacillus, and there is strong chance that at least 10% of them will develop tuberculosis during their lifetime [1, 2].

It is one of the leading cause of mortality among women of reproductive age. Pulmonary infection continues to be the most common type, but extrapulmonary TB, such as genital and urinary, are now becoming more prevalent in the younger populations [3, 4].

Worldwide incidence of female genital tuberculosis in infertile population has been reported as 5–7% [5, 6] with the range varying from under 1% in the USA to about 10% in India [7].

Due to difficult and often late diagnosis of GTB, pregnancy outcome is poor despite treatment.

Primary genital tuberculosis is rare but has been reported in women when sexual partner had active genitourinary infection [8].

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The mode of spread is usually hematogenous or lymphatic and occasionally occurs by the way of direct contiguity with intra-abdominal or peritoneal focus [9, 10]. The focus in the lungs often heals, and the lesion may lie dormant in the genital tract to reactivate in later life. The term extrapulmonary tuberculosis (EPTB) is used to describe isolated occurrence of TB at sites other than lung. It is estimated that 5–13% of all pulmonary TB patients develops genital involvement.

Genital organs affected by tuberculosis in order of frequency are fallopian tubes (95–100%), endometrium (60–70%), ovaries (20–30%), cervix (5–10%), and rarely vagina and vulva (1–2%).

It easily masquerades as any other gynecological condition and is often inadvertently stumbled upon during the workup for infertility.

Therefore, a high index of suspicion is required on the part of the clinician to diagnose the condition, especially before irreversible organ damage has occurred.

The major presenting symptoms are infertility, pelvic pain, poor general health, and menstrual disturbances like menometrorrhagia, oligomenorrhea, and amenorrhea [11, 12].

Endometrial tuberculosis tends to manifest as infertility and/or lower abdominal pain. Endometrial tuberculosis may have severe reproductive consequences on fertility in spontaneous as well as in vitro fertilization cycles. The consequences of GTB are as follows:

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Infertility: It is the most common presentation of GTB (40–80%) among genital TB cases responsible for both primary and secondary infertility:

- Blockage of tubes, tuberculous endosalpingitis, and perisalpingitis causing loss of tubal functions, adhesions, and TO masses.
- Ovarian affection causing anovulation, ovarian abscess, and destruction.
- Tubercular endometritis causing.
  - Synechiae.
  - Granular ulcerative lesions.
  - Ostial fibrosis.
  - Obliteration of endometrial cavity.
  - Changes in immunocompetent LGL (large granular lymphocytes) in endometrium resulting in inflammation which disturbs the cytokine balance because of TH 1 dominance resulting in inhibition of trophoblast invasion and implantation failure in miscarriage.

Reproductive failure: Conception is difficult in the presence of genital tuberculosis, and when it occurs, it is complicated by abortion or an extrauterine location which results in ectopic pregnancy.

Tubercular endometritis: This is a type of chronic endometrial inflammation which affects the receptivity of endometrium. So even a good-quality embryo fails to implant because of inherent problems within the endometrium. In GTB, endometrial receptivity is affected in three ways: (a) Adverse impact on immunophysiologic "markers" or molecules; these molecules are essential to make the endometrium receptive for embryonic implantation. (b) Disordered vascularization of the endometrium by immunomodulatory mechanism causing vascular thrombus formation, activation of antiphospholipid antibodies, and reduction of subendometrial blood flow by tubercular involvement of the basal layer of endometrium through hematogenous spread via basal endometrial artery. (c) Atrophy of endometrium and synechiae formation.

Being a paucibacillary disease, demonstration of *Mycobacterium tuberculosis* is not possible in all cases. Various blood tests, nonspecific tests, and serological (e.g., PCR) and sonoradiological investigations like USG, HSG, and MRI are tried to diagnose this disease.

In postmenopausal women, genital TB may present with postmenopausal bleeding, persistent leukorrhea, pyometra, or an enlarged, tense, tender uterus [13].

Ultrasonography (USG): USG has a very limited role in diagnosis of endometrial TB. But some findings on transvaginal sonography (TVS) raise the suspicion of TB. The findings can be endometrial synechiae, fluid collection in endometrial cavity, irregular endometrium, and less or no endometrial growth in response to growing follicle in ovulation study. Doppler studies may show low uterine artery perfusion and high resistive index at the time of hCG trigger and embryo transfer [14].

Hysterosalpingography (HSG): It is a very useful procedure for evaluating the internal architecture of the uterine cavity. In cases of intrauterine synechiae, it helps in knowing the contour and irregularity of the uterine cavity. Previous hysterosalpingography really guides us in very bad cases of uterine synechiae while performing hysteroscopy.

- In endometrial TB, the synechiae and intrauterine adhesions are characteristically irregular, angulated, and stellate shaped with well-demarcated borders.
- Unilateral scarring may cause obliterations of uterine cavity on one side, giving rise to a pseudounicornuate uterus.
- Scarring in TB may result in conversion of triangular uterine cavity into a T-shaped cavity. An asymmetric small-sized uterine cavity is usually due to TB.

Hysteroscopy: Many past studies have considered fluid hysteroscopy to be a reliable and useful examination for investigating endometrial tuberculosis [14–21].

Endometrial curettings taken under hysteroscopic control in the premenstrual phase, with tissue particularly obtained from the two cornua, should be sent for AFB smear, AFB culture in

Lowenstein-Jensen media or BACTEC culture, guinea pig inoculation, or polymerase chain reaction (PCR). As tubercular endometritis is present only in 60–70% of cases of genital TB, a negative biopsy does not rule out genital TB.

Colonies are seen if the bacillary count is more than 1000 bacilli.

However, improvement in media has allowed colonies to grow even when the count is 100 bacilli.

Hysteroscopy is a useful modality in diagnosing endometrial tuberculosis. Classical hysteroscopic findings of endometrial tuberculosis is a rough, dirty-looking, bizarre, pale endometrium with gland openings not seen and with overlying whitish deposits [14–19, 21] and adhesions (Fig. 18.1). However, all of these signs may not be seen in the same case or their intensity may vary. In order to reach to a diagnosis, all the markers of tuberculosis have to be carefully evaluated. Whitish deposits are the most pathognomonic of tuberculosis; however, they may not be always seen especially since the superficial layer of the endometrium sheds every 28 days, and along with the endometrium, the said deposits also shed [22]. Hence, the best time for conducting hysteroscopic examination is in the premenstrual phase so that any overlying deposits are not missed out. A classical endometrial deposit under high magnification is seen in Fig. 18.2. Large tubercles are also often seen (Fig. 18.3). The confirmation of diagnosis of tuberculosis was made by PCR and BACTEC culture.

The hysteroscopic markers of endometrial TB are:

1. Bizarre endometrial architecture.
2. Tubercular deposits (microscopic to large macroscopic structures).
3. ILL-defined endometrial gland openings.
4. Adhesions/synechiae.

Endometrial scarring is one of the pathognomonic features in endometrial tuberculosis

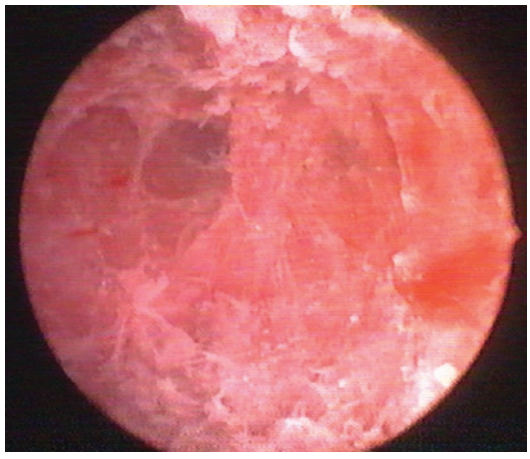

Fig. 18.1 A bizarre, pale, scarred, thin, dirty-looking endometrium with whitish deposits and flimsy adhesions and with no endometrial gland openings visible

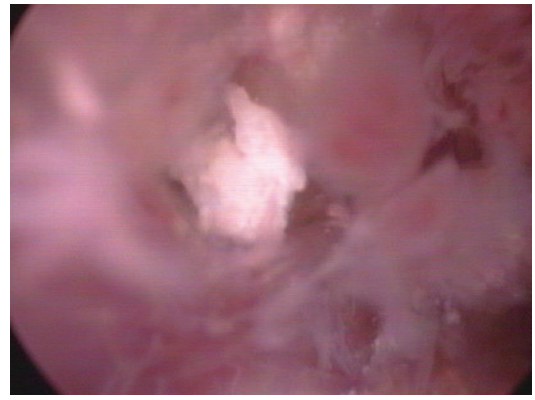

Fig. 18.2 A solitary endometrial tubercular deposit seen under high magnification

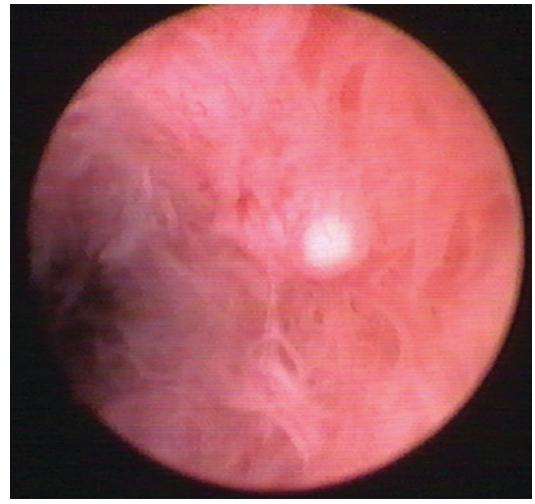

Fig. 18.3 A whitish tubercle is present over the scarred left lateral wall of the endocervical canal

especially if whitish deposits overlying the endometrium are also seen. Endocervical scarring is also frequently seen in endometrial tuberculosis.

In endometrial tuberculosis, intraluminal adhesions in the interstitial part of the fallopian tube can often be viewed at hysteroscopy by placing the microhysteroscope tip very close to the tubal orifice and viewing with a source magnification of 25× [17].

At times, the whitish deposits do not overlay the endometrium, and instead, they are anchored to flimsy adhesions by being impregnated in the same [18] (Fig. 18.4). These flimsy adhesions are not shed with menstruation; hence, the impregnated deposits are seen even in the postmenstrual phase.

In some cases, the whitish deposits are not seen over the endometrium at hysteroscopy. Such deposits are seen after vital staining with methylene blue dye. In such cases, the hysteroscope is removed, and chromopertubation is done with methylene blue dye, followed by reintroduction of the hysteroscope. Glistening, white, highly reflective deposits situated are observed against the background of a dark blue-stained endometrium resembling a "starry sky" appearance [18] (Fig. 18.5). We have observed the starry sky appearance and used it to diagnose endometrial tuberculosis on multiple occasions over a 21-year period. It appears that the methylene blue dye is not taken up by the caseous tubercular deposit but is taken up by the surrounding endometrium. The unstained caseous deposit reflects white light in contrast to the surrounding dark blue endometrium, thereby giving a starry sky appearance.

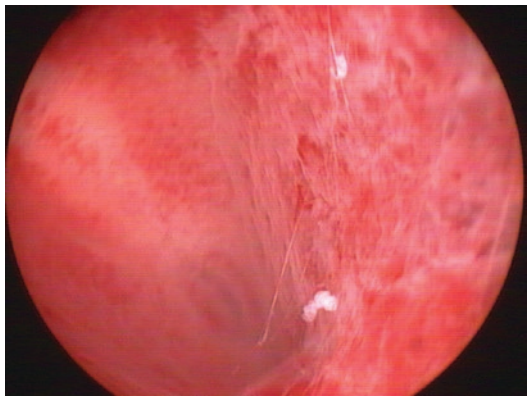

Fig. 18.4 Tubercular deposits impregnated over flimsy adhesions

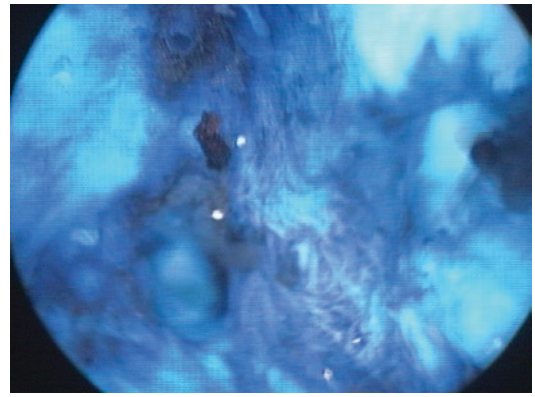

Fig. 18.5 Starry sky appearance over the anterior uterine cavity wall

At times, panoramic hysteroscopy with 1× magnification using a conventional telescope (27,005 BA, Karl Storz GmbH & Co., Tuttlingen, Germany) reveals an endometrium unremarkable except for subtle scarring, which could also be overlooked. The endometrium is next visualized using a Hamou Micro-Hysteroscope II (26,157 BT, Karl Storz) [17, 20] in the panoramic view at 20× at-source magnification, which reveals a rough-looking endometrium as though it had been sprinkled with a coarse whitish powder. The endometrial surface is bumpy, with diffusely scattered small conical papillary projections, and no endometrial glands are observed [20]. Herein, the term "at-source magnification" relates to the magnification provided by the telescope and not by the video mechanism of the telescope.

Hysteroscopic visualization of the endometrium after antitubercular therapy often shows an improvement in the mucosal morphology. A closer visualization at increased magnification is helpful in demonstrating the remnants of a healing tubercular pathology after antitubercular therapy [19]. Relook hysteroscopy after antitubercular therapy guides the surgeon toward prognosis and results of antitubercular therapy.

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Hysteroscopy in Chronic Endometritis

19

Sergio Haimovich and Nili Raz

Abbreviations

CE	Chronic endometritis
IUA	Intrauterine adhesions
LBR	Live birth rate
OPR	Ongoing pregnancy rate
PC	Plasma cells
RIF	Repeated implantation failure
RPL	Recurrent pregnancy loss
TCRA	Transcervical resection of adhesions
UI	Unexplained infertility

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19.1 Definition, Epidemiology, and Etiology

Chronic endometritis is a persistent inflammation of the endometrium, characterized by plasma cell infiltration of endometrial stroma [1].

Chronic endometritis is histologically detected in 8% of endometrial specimens of women with clinically suspected cervicitis, in 3–10% of women who undergo endometrial biopsy to investigate abnormal uterine bleeding, and in 12–46% of hysteroscopy-guided endometrial biopsies in infertile patients [1–4].

A strong association between endometriosis and chronic endometritis was also described [5].

Research detected microorganisms in the endometrial cavity of healthy asymptomatic women, i.e., the uterine microbiome, thus challenging the previous paradigm about endometria being sterile [6–9]. It is not yet clear whether CE follows acute endometritis or is caused by other factors, yet the finding that antibiotic treatments might be an effective treatment for CE suggests it has an infectious origin [10]. Bacteria found in uterine cavity of CE patients are *Staphylococcus* spp., *Escherichia coli, Enterococcus faecalis, Klebsiella pneumoniae, Corynebacterium*, and *Mycoplasma/Ureaplasma* spp. [6, 11, 12]. Theories about the origin of the uterine microbiota include vagina (via ascending pathway), peritoneum (via fallopian tubes), and oral gingivitis

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(via hematogenous spread) [7, 9, 10, 13]. Predisposing conditions to CE were found to be intrauterine leiomyomas, a recent endometrial biopsy, or curettage and IUD use [14, 15]. Altered maternal immune tolerance toward the embryo, immunologic effects on the mechanisms of implantation, and a defective trophoblastic invasion, all effected by altered distribution of immune cells, such as natural killer cells in the endometrial mucosa of infertile CE patients, might be part of the pathophysiology of the effect of CE on reproduction. For example, chronic endometrial inflammation can alter endometrial cytokine and chemokines production (such as IL11, *CCL4 exe*), a decrease in CD56 lymphocytes, and an increase in CD16 lymphocytes [16] and B cells infiltrating and aggregating in the stroma of the endometrial functional layer and epithelial cells, related to aberrant expression of adhesion molecules and cytokines in the endometrium [17]. These mechanisms can result in decreased endometrial receptivity of embryos and other symptoms mentioned in this chapter.

19.2 Symptoms

Unlike acute endometritis which presents with abdominal pain, fever, discharge, and sometimes leukocytosis, CE is mostly asymptomatic, making CE rarely clinically suspected [11]. CE was described as associated with abnormal uterine bleeding [14], pelvic pain, dyspareunia, leukorrhea [10, 18], recurrent abortion, RIF, and infertility [19, 20].

19.3 Diagnosis

CE is mostly asymptomatic and not identified by most diagnostic tests.

The gold standard for the diagnosis is histological testing of an endometrial biopsy, mainly identification of plasma cells in the endometrial stroma [21]. In 1981, Greenwoods and Moran described the morphologic features found to be of value in diagnosing CE: superficial stromal edema, increased stromal density, and pleomorphic stromal inflammatory infiltrate dominated by lymphocytes, in the absence of premenstrual changes or any other significant pathologic endometrial lesions. When these changes were present, a plasma cell infiltrate was invariably found [14]. More histological features described as associated with chronic inflammation were abnormal percentages of lymphocytes, leukocytic infiltration of both glands and stroma, high stromal cell proliferation, dissociated maturation between the epithelium and stroma, a pronounced predecidual reaction, and the presence of eosinophils or macrophages [10, 14, 22–24].

The search for plasma cells can be interfered with, or mimicked by, other conditions, such as mononuclear inflammatory cell infiltrates, stromal cell proliferation, plasmacytoid appearance of stromal cells, or a pronounced predecidual reaction in a late secretory endometrium [14, 23]. Identification of plasma cells by routine hematoxylin and eosin (H&E) stain (Fig. 19.1) is challenging due to their some-

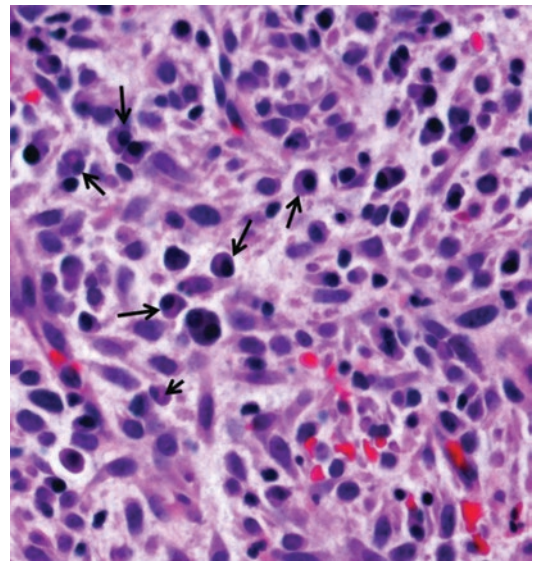

Fig. 19.1 Chronic endometritis. High-power view reveals plasma cells in the stroma (black arrows). H&E, 400× (with permission from Dr. Lea Shekhtman, Pathology Department, Hillel Yaffe Medical Center)

times low numbers and their obstruction by other stromal cells [25].

H&E alone is not enough for CE diagnosis due to high interobserver variability, as shown by Kasius et al., who showed interobserver similar diagnostic categories (no CE, possible CE, and evident CE) in 88% of 100 infertile patient biopsies. The kappa value for interobserver agreement was 0.546 (95% CI: 0.351–0.741), which represents a moderate agreement only. Adding another immunohistochemical stain to the H&E (by CD138 alone or combined with other plasma cell stains such as CD20 and CD79a) improved the kappa value for interobserver agreement to 0.659 (95% CI: 0.463–0.855), which represented a substantial agreement [1]. CD138, a marker for plasma cells which outlines the cell membranes (Fig. 19.2), can thus readily be used [23]. The disadvantages of CD138 as a marker are stromal-glandular background staining and difficulty in visualizing nuclear details of the plasma cells. Lately, MUM1 immunostain demonstrated superiority over CD138 in diagnosing CE (Fig. 19.3). In addition to having a clean background, MUM1 was found to be a more sensitive stain than CD138 for the detection of plasma cells in endometrium. MUM1 is a transcription factor and thus stains the cell nucleus [25].

Cicinelli et al. suggest using a triad of hysteroscopy, standard microbiology culture, and endometrial biopsy to best assess for the presence of CE [6] (Figs. 19.1, 19.2 and 19.3).

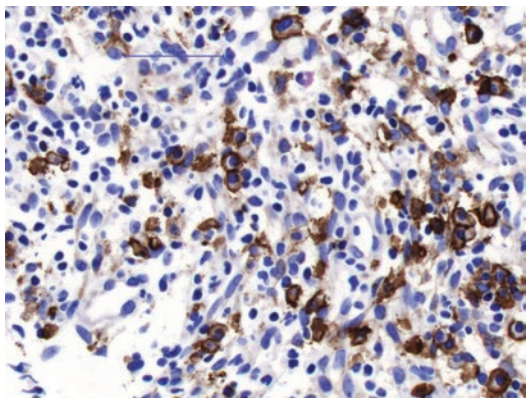

Fig.19.2 A CD138 immunostain highlights the plasma cells, 400× (with permission from Dr. Lea Shekhtman, Pathology Department, Hillel Yaffe Medical Center)

Table 19.1 Hysteroscopic characteristics of chronic endometritis [6, 34–37] (see Figs. 19.4, 19.5, 19.6, 19.7, 19.8 and 19.9)

1. Mucosal edema
2. Focal or diffuse endometrial hyperemia
3. Presence of micro polyps (<1 mm)

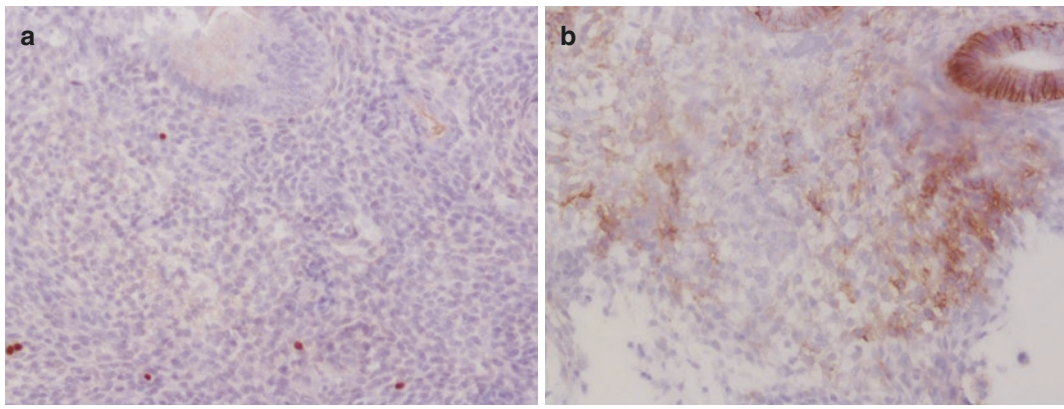

Fig. 19.3 Comparison between MUM1 (**a**) and CD138 (**b**) immunostain highlighting the plasma cells, X200 (same patient) (with permission from Dr. Lea Shekhtman, Pathology Department, Hillel Yaffe Medical Center)

19.4 Chronic Endometritis and Infertility

CE is highly prevalent in patients with infertility: CE was present in 12–46% of the hysteroscopy-guided endometrial biopsies in infertile patients [3, 11, 19]. CE was diagnosed in 14–67.5% of women with RIF [10, 26–29] and 9–56% of women with recurrent miscarriage [10, 28–30].

In RIF patients undergoing IVF treatments, the implantation rate of patients diagnosed with CE was lower than those without CE [3]. Chronic endometritis is highly prevalent in patients with unexplained infertility. Cicinelli et al. investigated 97 women with unexplained infertility using hysteroscopy and biopsy. They found that 57% had CE by hysteroscopy and 56% by histology [26]. These data suggest a correlation between CE and impaired implantation and early embryonal development. Cicinelli et al. also demonstrated, in several studies, that antibiotic treatment in RIF patients and recurrent aborteres improved reproductive outcomes [26, 30, 31]. Chen Y. et al. described that among the 82 women with moderate to severe IUAs (i.e., Asherman's syndrome), undergoing hysteroscopic adhesiolysis (TCRA), the prevalence of CE was 35% and more. When comparing those patients with CE to the patients without CE, a higher adhesion recurrence rate in second look hysteroscopy was found in patients with CE (45%) in comparison with the patients without CE (21%), thus CE may be a contributing factor in higher adhesion recurrence [32].

19.5 Hysteroscopy in CE

CE diagnosis is challenging: Anamnesis, symptoms, physical exam, blood work, and US are not specific. Although histology is the gold standard for diagnosis, it is challenging due to mimicking conditions discussed earlier in this chapter, especially in a late secretory endometrium. This emphasizes the importance of hysteroscopy in CE diagnosis. Hysteroscopy is a useful and reliable technique for detecting chronic endometritis. Hysteroscopy is highly accurate in diagnosing CE and highly correlates with histologic results. A study suggesting a lower sensitivity included only six patients with CE [6, 11, 26, 31, 33–35].

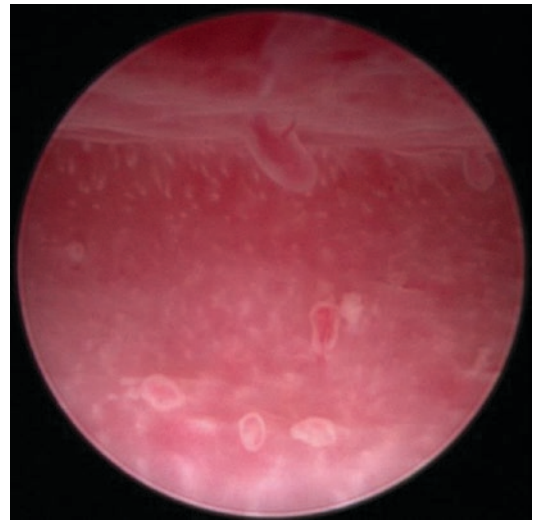

Fig. 19.4 "Strawberry aspect"

CE diagnosis using hysteroscopy is based on direct observation of the uterine cavity and demonstration of micro polyps, stromal edema, and focal or diffuse hyperemia, preferably at the mid-follicular phase of the menstrual cycle when the endometrial lining is the thinnest [34–36]. See Figs. 19.4, 19.5, 19.6, 19.7, 19.8, 19.9 and 19.10.

In their 2008 publication, Cicinelli et al. showed that the diagnostic accuracy of CE by hysteroscopy was 93.4% when using hyperemia, mucosal edema, and micro polyps as diagnostic parameters for CE in hysteroscopy [6, 37]. Zargar et al. reported an 86% sensitivity and 87% specificity for hysteroscopic diagnosis of CE in IVF patients suffering from RIF or RPL, and a 70% and 95% PPV and NPV, respectively [29]. Song D. et al. studied the correlation between hysteroscopy findings and chronic endometritis. They examined 322 biopsies with CD138 cells present and found the prevalence of endometrial hyperemia, endometrial interstitial edema, and micro polyps were 52.5%, 8.4%, and 3.4%, respectively. The κ value of intra-observer and interobserver agreement on the presence or absence of the hysteroscopic feature of CE was 0.86 and 0.73, respectively. The sensitivity, specificity, positive

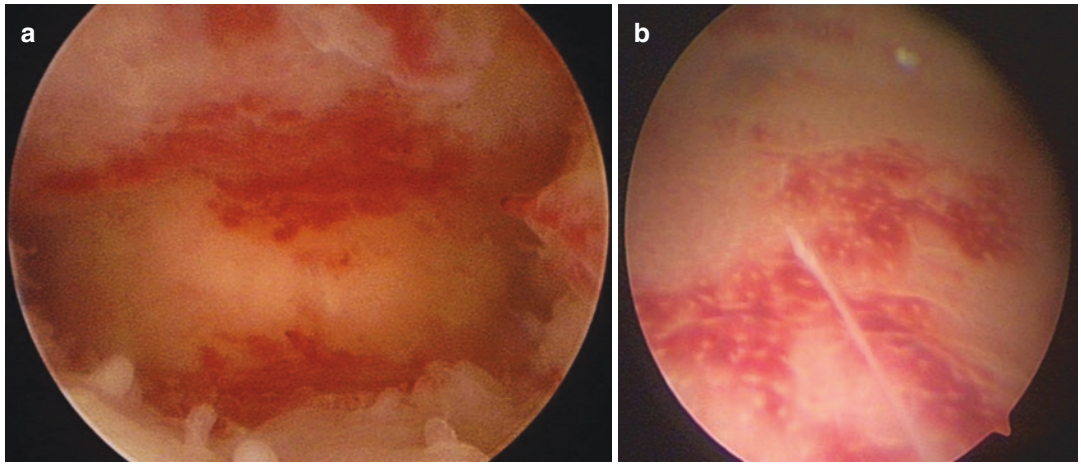

Fig. 19.5 (**a**, **b**) Focal hyperemia

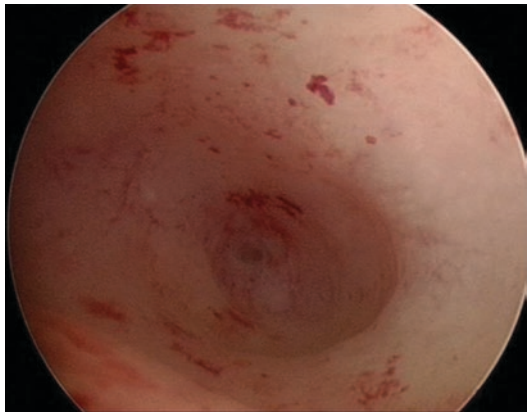

Fig. 19.6 Hemorrhagic spots

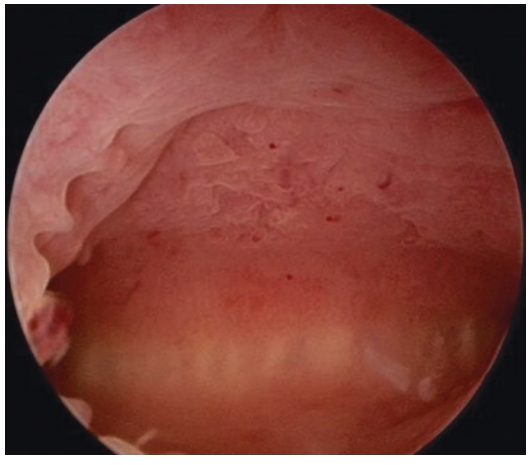

Fig. 19.7 Sparse micro polyps

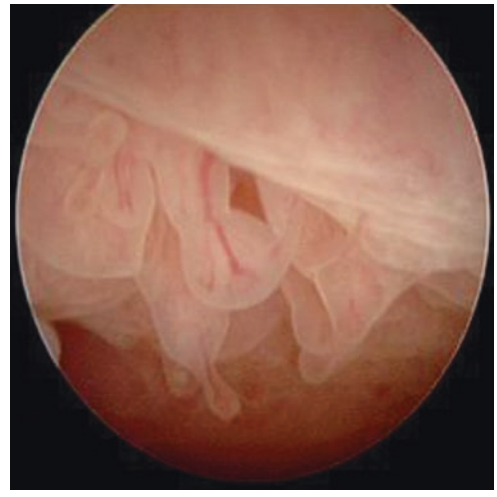

Fig. 19.8 Diffuse micro polyps

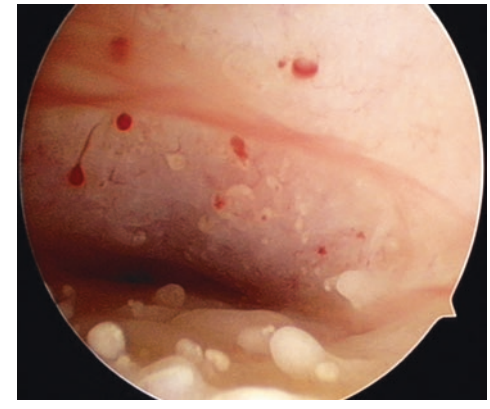

Fig. 19.9 Thick and pale endometrium in the follicular phase due to stromal edema

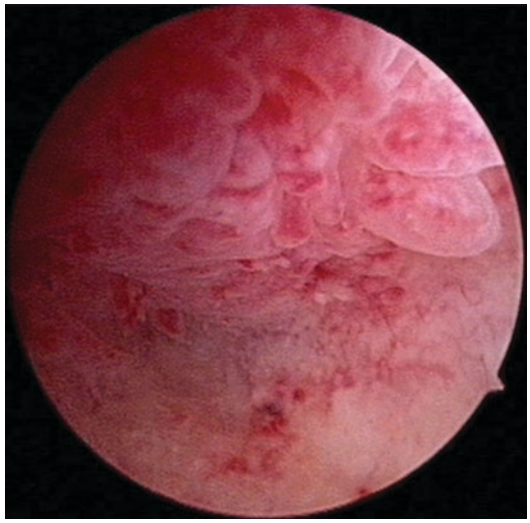

Fig. 19.10 Hyperemic and polypoid endometrium

and negative predictive value, and diagnostic accuracy of the presence of one or more of these hysteroscopy features were 59.3%, 69.7%, 42.1%, 82.8%, and 66.9%, respectively [38]. Cravello L et al. identified "strawberry aspect" pattern in correlation with CE; "strawberry spots" were also described by Song D et al. as hyperemic endometrium, which appears flushed with a white central point [38, 39]. See Fig. 19.4.

In summary, the high prevalence of CE in infertile patients, and especially the effectiveness of treatment in UI patients, suggests that hysteroscopy should be an important part of the pre-ART diagnostic workup, especially in patients with UI, RIF, and recurrent abortions [26] (Fig. 19.10).

19.5.1 Treatment

As increasing amount of evidence suggests the negative impact of CE on fertility, questions arise: Is antibiotic (ABX) an effective therapeutic option? Would ABX treatment (TX) for CE patients restore normal endometrial histology and improve reproductive outcomes? In an effort to solve these dilemmas, several studies demonstrated a very high cure rate, up to 92% after a single antibiotic cycle and 99% after second-line ABX TX in RIF patients. TX protocols were different in those studies: Option no 1: First-line is doxycycline 100 mg, twice a day for 14 days. Second-line was combination of oral metronidazole 250 mg, twice per day, for 14 days and ciprofloxacin hydrochloride 200 mg, twice per day, for 14 days. Option 2 was detailed in the following Cicinelli studies [26, 40–42]. Cicinelli et al. treated 53 UI patients hysteroscopically and histologically diagnosed with CE, with ABX, and with repeated hysteroscopy and biopsy following AXB TX. Antibiotic therapy resulted in chronic endometritis histologic resolution in 82% of patients, while in 17.6%, positive cultures were persistent. UI patients with cured chronic endometritis showed higher pregnancy rate and live birth rate in comparison with both women with persistent disease following ABX TX and women without chronic endometritis diagnosis (spontaneous pregnancy rates were 76.3% vs. 20% vs. 9.5%; live birth rates were 65.8% vs. 6.6% vs. 4.8%, respectively). The ABX protocols used in this study were ciprofloxacin 500 mg twice a day for 10 days for gram-negative infections, amoxicillin + clavulanate 1 g twice a day for 8 days for gram-positive bacteria, josamicine (Josamycin) 1 g or minocycline 100 mg or doxycycline 100 mg twice a day for 12 days for Mycoplasma and Ureaplasma, and ceftriaxone 250 mg IM in a single dose plus oral doxycycline 100 mg twice a day for 14 days plus oral metronidazole 500 mg twice a day for 14 days for women with negative cultures [24]. In patients with RIF and CE who had been treated with ABX and had been cured, improved IVF outcomes were achieved including OPR, LBR, CPR, and IR, in comparison with patients with persistent CE. IVF outcomes (OPR/LBR, CPR, and IR) of women with cured CE were comparable to women without CE. Miscarriage rate was not significantly different between groups [40]. ABX ability to restore normal endometrial histology suggests a causal relationship between CE and defective endometrial receptivity [26]. Regarding recurrent miscarriage, Cicinelli et al. found a significantly higher number of spontaneous pregnancies in RM patients antibiotically cured from CE (78%) in comparison to 15–17% in patients for whom CE was still present at hysteroscopy [30].

In summary, CE negatively affects implantation and fertility. Antibiotic administration treats CE effectively. Treatment can be easily administered in an outpatient setup. When CE is cured by antibiotic in infertile patients mentioned in this chapter (RIF, IU), the pregnancy rates, and in some patients also the live birth rates, significantly improve.

Key Learning Points

- CE is a common underdiagnosed condition.
- CE is mostly asymptomatic, yet it relates to AUB, pelvic pain, and mainly infertility.
- CE is most frequently diagnosed by hysteroscopy and endometrial biopsy. The gold standard for diagnosis is presence of plasma cells in histology.
- The hysteroscopic diagnostic criteria for CE are mucosal edema, focal or diffuse endometrial hyperemia, and presence of micro polyps.
- ABX treatment frequently cures CE.
- CE is closely related to infertility, mostly RIF, RPL, and UI, and curing CE by ABX TX is related to major improvement in fertility (both spontaneous and ART).

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20 Hysteroscopic Retrieval of Lost Intrauterine Devices and Foreign Bodies and Polyps

Neharika Malhotra Bora, Narendra Malhotra, and Anu Sharma

20.1 History

Hysteroscopy is a term derived from the Greek words *hystera*, which means uterus, and *skopeo*, which means "to view," In 1869, Pantaleoni successfully performed this procedure in a living human subject using a tube with external light source without distending uterine cavity.

Hysteroscopy generally is a low-risk technique that uses the endocervical canal, the natural passageway of the body to gain entry into the intrauterine environment. It allows direct visual observation and accurate localization of the pathology.

- The role of hysteroscopy in infertility has been changing as its capabilities are increased.
- Traditionally, hysteroscopy was utilized for diagnostic and operative intervention for endometrial polyps, submucous and pedunculated myomas, intrauterine adhesions, and uterine septa.
- It is also useful for the diagnosis of congenital anomalies and evaluating endocervical anatomy.
- Other modalities for evaluation of the uterine cavity include endometrial biopsy, hysterosalpingogram, ultrasound, sonohysterography, magnetic resonance imaging, and the adjunctive role of laparoscopy.

The British Society for Gynaecological Endoscopy published this statement in December 2018:

> Diagnostic hysteroscopy is a commonly performed investigation; it is safe and of short duration. Most women are able to have the procedure in an outpatient setting, with or without local anaesthesia, and find it convenient and acceptable. However, it is important that women are offered, from the outset, the choice of having the procedure performed as a day case procedure under general or regional anaesthetic. Some centres are also able to offer a conscious sedation service in a safe and monitored environment. It is important that the procedure is stopped if a woman finds the outpatient experience too painful for it to be continued. This may be at the request of the patient or nursing staff in attendance, or at the discretion of the clinician performing the investigation [1].

20.2 Instruments for Hysteroscopy

Selection of the proper instruments is one of the keystones for the performance of a successful surgery [2].

Endoscope is used to transmit light for illumination and carries image to the viewer's eye.

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https://doi.org/10.1007/978-981-15-2505-6_20

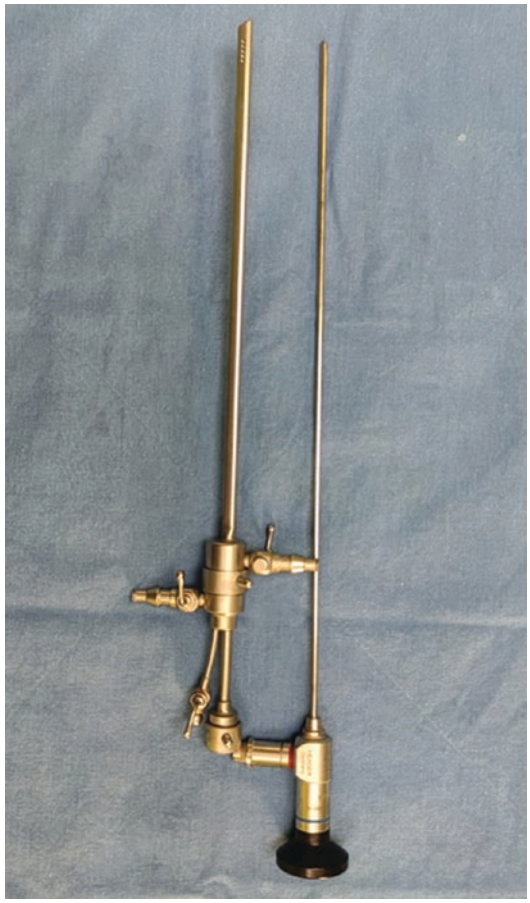


Fig. 20.1 Rigid Hysteroscope

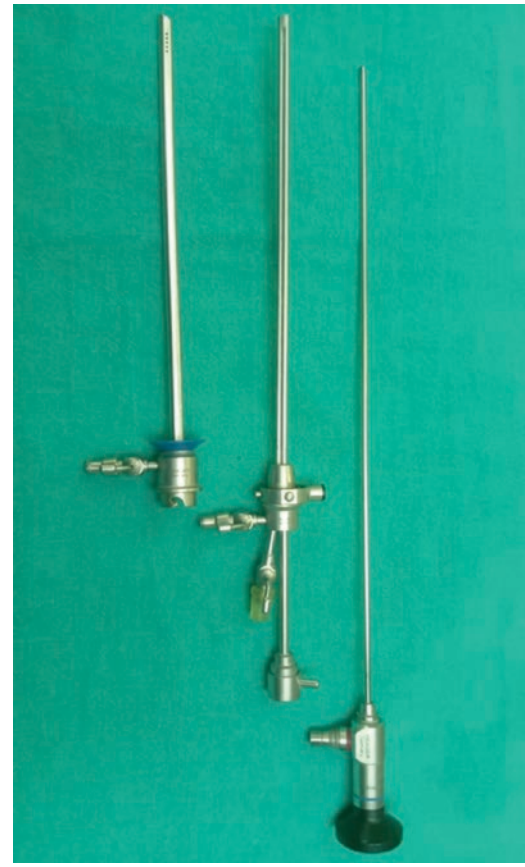


Fig. 20.2 Rigid Hysteroscope

The components of an endoscope are as follows:

1. Magnifying eyepiece.
2. Transmitting lens system.
3. Objective lens.

A range of hysteroscopes are available from the 1.2 mm flexible hysteroscope with a 2.5 mm diagnostic sheath to the standard 4 mm scope with 5 mm diagnostic sheath.

20.2.1 The Rigid Hysteroscope

The standard used rigid hysteroscope (Hopkins hysteroscope) is 4 mm with a 5 mm diagnostic sheath. This scope provides a very good image. It is available with varying directions of view: 0°, 12°, and 30° (Fig. 20.1). Normally, a 30° scope is used for diagnosis, while a 12° for operative work such as endometrial resection. However, a 30° scope can also be used for endometrial resection. In a case of operative procedures, the 4 mm scope needs to be combined with an operative sheath with a diameter of 7–8.5 mm, necessitating anesthesia and cervical dilatation [3] (Fig. 20.2).

20.2.2 Bettocchi Hysteroscope (Karl Storz & Company)

The standard Bettocchi hysteroscope with Hopkins-based rods-lens system is a miniature version of the famous Hamou 2 hysteroscope (Fig. 20.3).

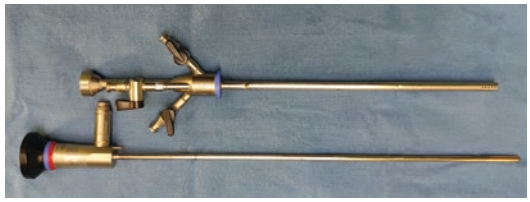


Fig. 20.3 Bettocchi Hysteroscope

20.2.3 Flexible Hysteroscope

Versascope system (Johnson & Johnson Gynecare Division) is a flexible telescope and has an external diameter of 1.8 mm and a length of 28 cm.

20.2.4 Contact Hysteroscope

The modern contact hysteroscope is a refined and precise instrument compared with its primitive ancestor. The quality of image obtained is excellent. It can discriminate between two points that are just 20 mm away.

20.2.5 Panoramic Telescopes

Telescope is the most important component of the endoscopic system. The optical features of the telescope include lenses, prisms, glass windows, and fiber optics. Three different optical systems are used: the bead-lens system, the rods-lens system, and the graded index system. Beads-lenses are made of glass no thicker than their diameter, whereas in the rods-lens system designed by Hopkins, 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 [3].

A new system using fiber-optic imaging technology has been introduced that permits better use of light, thus permitting a decrease in the size of the telescopes without impairing resolution. The higher the refractory index, the smaller the field of view.

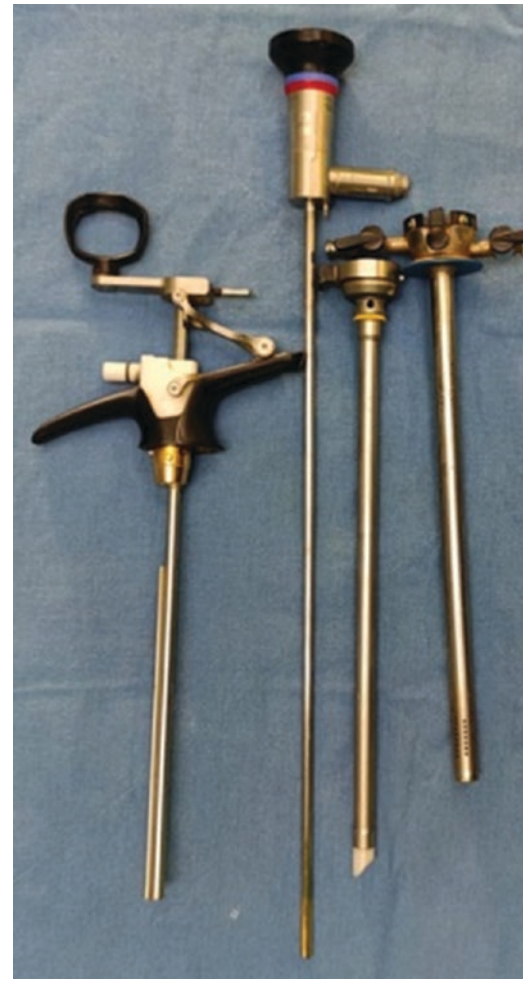


Fig. 20.4 Sheaths

20.3 Sheaths (Fig. 20.4)

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 distension for panoramic viewing [3].

Diagnostic sheaths are 3.3 mm to 5 mm, and operative sheaths are usually 7 mm to 8 mm.

The typical sheath measures 5 mm in diameter to accommodate the 4 mm telescope. The new small-diameter continuous flow hysteroscopes with a 5-French operative channel have been introduced. Diagnostic sheath have only single port for installation of distending medium and no port for accessory instruments.

Fig. 20.5 Light Source - Xenon

Most modern continuous flow systems have isolated inflow and outflow channels and provide excellent washing of the uterine cavity. The gold standard for 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 [4].

20.4 Light Source

There are various light sources which one can use for illumination. A high-quality light source such as a xenon source gives the best result (Fig. 20.5).

- **Halogen:** This 150 to 250 W cold light source is sufficient for vision and gives reddish tinge to image.
- **Xenon:** A 175 W light source provide outstanding illumination. This can cause thermal injury to the patient or burn paper drapes or clothing with prolonged contact.

20.5 Distention Systems

Hysteroscopy involves examination of the endometrial cavity, a potential space, which therefore requires distension for panoramic examination. Common agents used for distension includes gas and liquids.

20.5.1 Fluid Distention Systems

1. Gravity.
2. Pressure cuff (Fig. 20.6).

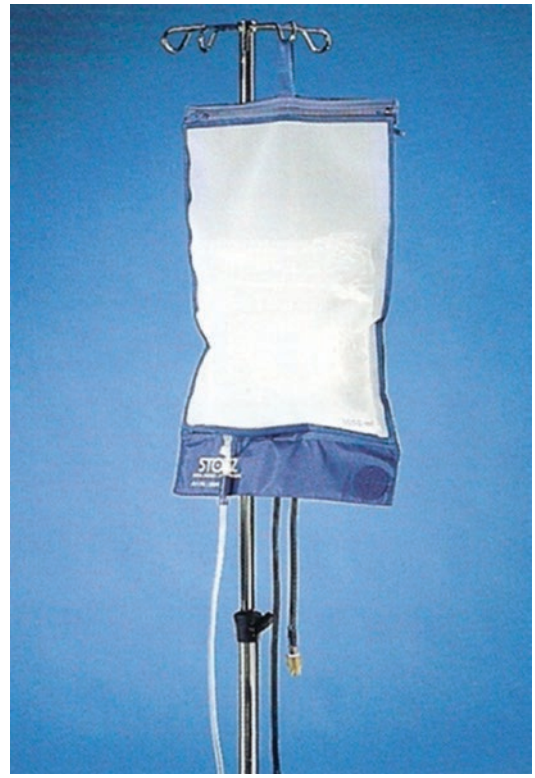


Fig. 20.6 Pressure cuff

Fig. 20.7 Hysteromat

Electronic Suction and Irrigation Pump This includes:

(a) Hysteromat (Fig. 20.7).
(b) Endomat.
(c) Total inflow-outflow system (Fig. 20.8).
(d) Endomet 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, it is very costly.

Fig. 20.8 Hysteromat

20.5.2 Gas Distention Systems

CO_2 hysteroflator can be used.

20.5.3 Types of Distention Media

The different types of media available are as follows:

(a) Gas—CO_2 gas.
(b) Fluids → Low viscosity/high viscosity.

20.6 Low-Viscosity Fluids

Low viscosity fluids are mainly used during operative hysteroscopy as they permit uterine-quality lavage of the blood clots and tissue debris formed during the operation [5, 6].

20.6.1 Electrolytes/Ionic Distention Media

The most commonly used ionic media are:

- Normal saline (0.9% NaCl, sodium chloride).
- 5% and 10% dextrose
- 4% and 6% dextran solutions
- 50% saline (0.45% NaCl)
- Ringer's lactate solution.
- Nonelectrolytes/nonionic distention media:
- 3% sorbitol
- 1.5% glycine
- 5% mannitol
- Combination of sorbitol 2.8% and mannitol 0.5%.

20.7 High-Viscosity Fluids

Most commonly used is Hyskon—32% HMW dextran solution (70,000 Da).

- Being highly viscous, provides excellent visualization due to its high refractory index and as it does not mix with blood.
- Expensive and tends to "caramelize" on instruments.

20.8 Energy Sources

- Mechanical energy: These are in the form of 2 mm semirigid sharp/blunt scissors, biopsy forceps, and myoma screw.
- Monopolar energy (Fig. 20.9).
- Bipolar standard electrode (Fig. 20.10).
- Bipolar Versapoint: bipolar cautery (Fig. 20.11).
- Laser.

The main laser delivery systems available for hysteroscopy are the ND:YAG and KTP532.

Fig. 20.9 Energy Sources

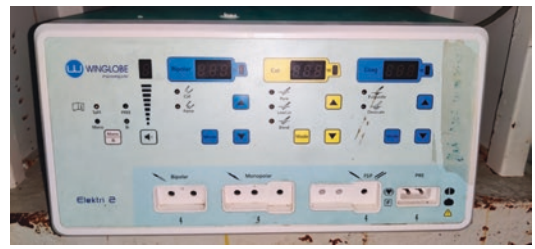


Fig. 20.10 Monopolar

Fig. 20.11 Biporal Standard electrode

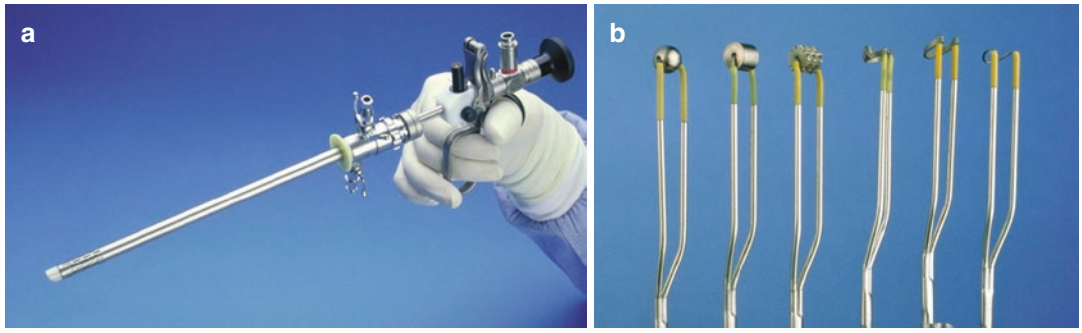


Fig. 20.12 Resectoscopes

20.9 Electrodes

1. Monopolar electrodes.
2. Bipolar electrode.
3. Bipolar Versapoint electrodes.

20.10 Resectoscopes

Specially designed for the resection and retrieval of abnormal intrauterine tissue as well as endometrial ablation and septal dissection. It consists of a classic 4 mm telescope preferably with a 120° angle to keep 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 [6] (Fig. 20.12).

20.11 Preparation of the Patient

- Detailed history and complete physical examination of both partners.
- It is preferable to do the procedure in the first part of the menstrual cycle.
- Informed consent.
- Patient is placed in lithotomy position.
- Accurate bimanual examination to assess the uterine (position, morphology, volume).

20.12 Technique

- Clean cervix with antiseptics.
- Cervical forceps is placed on the front labia.
- Light source and CO_2 gas supply are connected to the instrument.
- Insert scope into operative or resectoscope sheath.
- Flush sheath with distending media.
- Remove air by constant flow of media.
- Insert hysteroscope into uterus under direct vision.
- Scan uterine cavity **and note landmarks,** that is, tubal ostia, depth of cornua, location of lesion, and proximity to internal cervical os.
- Obtain clear view of cavity—**panoramic view.**
- Introduce operating device, and make contact with endometrium for spatial orientation.
- Simultaneous laparoscopy is done if required.

20.13 Best Time to Do a Hysteroscopy

- First half of menstrual cycle.
- Isthmus hypotonic.
- Endometrium is proliferative.
- There is less cervical mucus.
- There is less risk of unexpected pregnancy.
- Positioning: low dorsolithotomy.
- Preparation of cervix should always be done.

20.14 Indications of Hysteroscopy [3, 4]

The indications are broadly divided into diagnostic and therapeutic groups.

20.14.1 Indications for Diagnostic Hysteroscopy

1. Evaluation of abnormal uterine bleeding.
   (a) Endometrial polyp.
   (b) Endometrial hyperplasia.
   (c) Submucous myoma.
   (d) Adenomyosis.
   (e) Endometrial carcinoma.
   (f) Uterine synechiae (intrauterine adhesions).
   (g) Endocervical polyp.
2. Along with laparoscopy as a part of routine infertility workup especially with abnormal SSG or ultrasound.
3. Prior to IVF/ICSI cycle.
4. Diagnosing Mullerian anomalies.
5. For evaluation of recurrent miscarriage.
6. Postoperative evaluation: following hysteroscopic myomectomy, polypectomy, and septum resection.
7. Misplaced intrauterine device (IUD).
8. Chronic pelvic pain.
9. Hemangioma and arteriovenous malformation diagnosis.

20.14.2 Indications for Operative Hysteroscopy

(a) Location and removal of lost IUCD and intrauterine foreign bodies.
(b) Polypectomy.
(c) Submucous myomectomy.
(d) Hysteroscopic adhesiolysis.
(e) Endometrial ablation.
(f) Endometrial resection.
(g) Hysteroscopic metroplasty.
(h) Biopsy of suspected endometrium under direct vision.
(i) Tubal cannulation.
(j) Sterilization.
(k) Laser coagulation of endometrial hemangioma and AV malformation in cases with unresponsive bleeding.

20.15 Method of Intrauterine Device Removal

Localization of missing intrauterine device is the first thing to be ascertained using ultrasound. If found in uterine cavity, ultrasonic-guided removal can be attempted. Blind procedures are usually traumatic and unsuccessful. Hysteroscopy can be a method of choice or as a last resort in removing intracavitary devices, depending upon feasibility and surgeon's expertise. In case where IUCD is not located inside the uterine cavity, a pelvic x-ray is recommended [7, 8].

The ACOG committee (2016) makes the following recommendations:

1. When IUCD string is not visualized, pregnancy must be excluded, and a backup contraceptive measure must be advised until IUCD is confirmed.
2. Management of nonfundal IUCD depends on position of device and symptoms of patients.
3. If a women is pregnant with IUCD, it should only be removed if strings are visible in the cervix.
4. Whenever an implant is not visualized, removal should not be attempted till location is confirmed (Fig. 20.13).

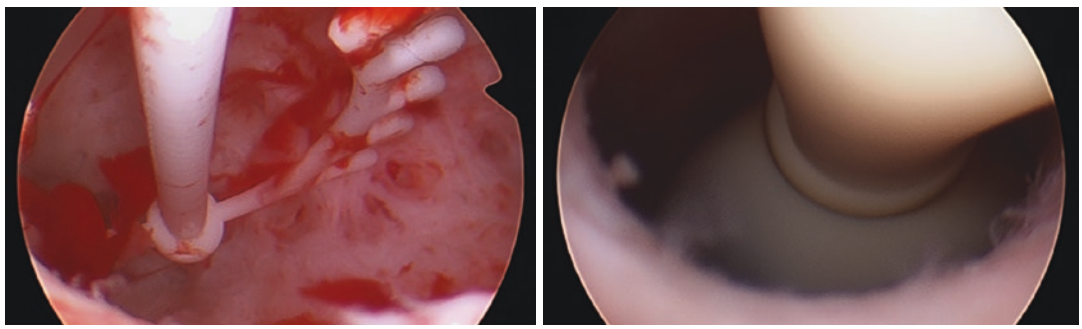
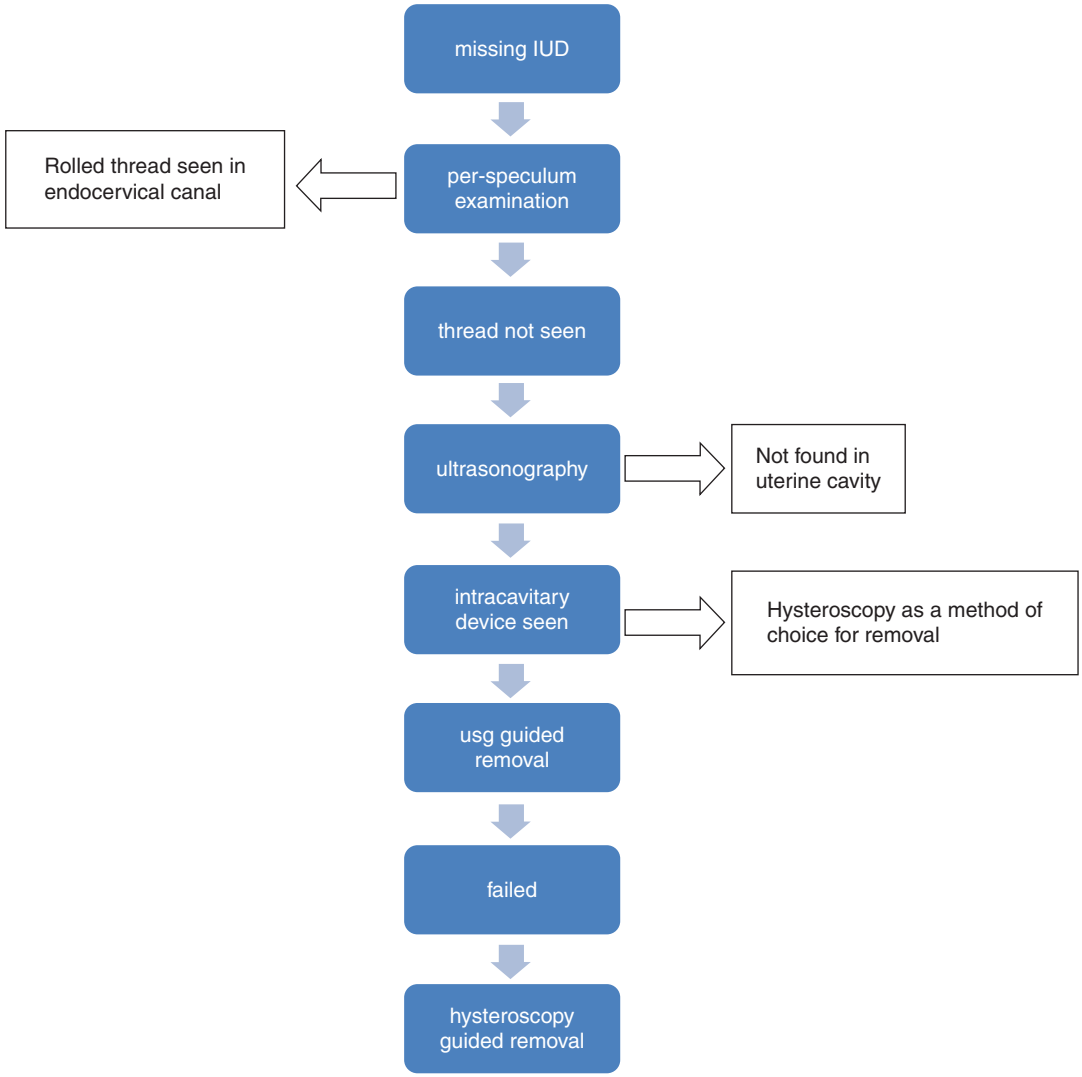


Fig. 20.13 IUCD



20.16 Hysteroscopic Polypectomy

Polyps are localized hyperplasic overgrowths of endometrial glands and stroma which form projections from the surface of the endometrium in the uterine cavity. The cause is unknown. Polyps can be benign and malignant [9, 10].

Although risk of malignant transformation in a polyp is very low, still polyps should be removed when detected as excision allows for both histological diagnosis and effective treatment of abnormal uterine bleeding patterns and excessive menstrual loss. Removal also is a must in postmenopausal women who are more likely to have a malignant transformation of polyp when symptomatic (Fig. 20.14).

The AAGL practice guideline was produced with the following search methodology; electronic resources including Medline, PubMed, CINAHL, the Cochrane Library (including the Cochrane Database of Systematic Reviews), Current Contents, and EMBASE were searched for all publications in relation to endometrial polyps (Fig. 20.15).

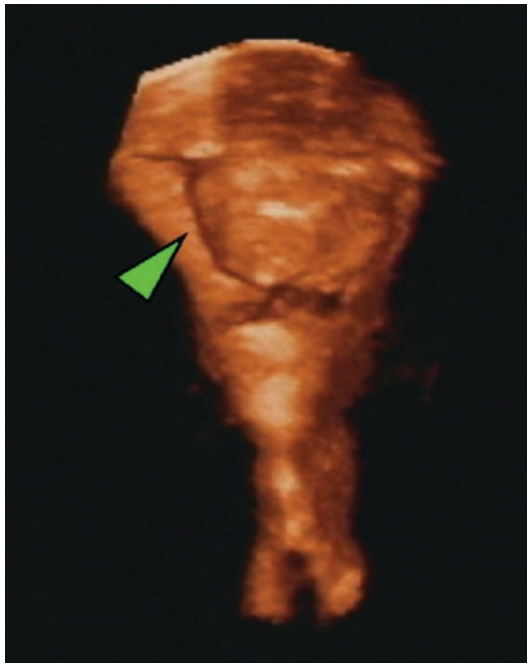


Fig. 20.14 3D image of the endometrial polyp

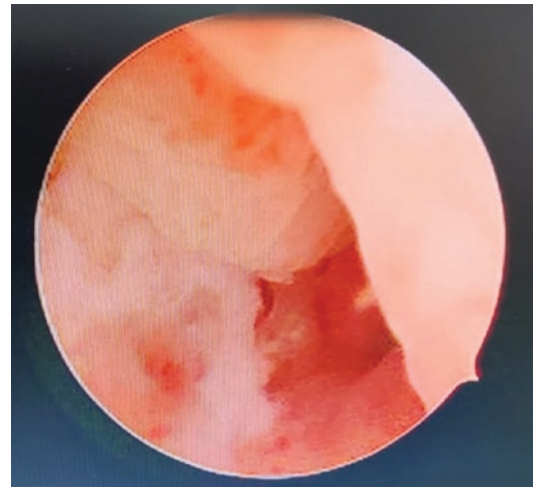


Fig. 20.15 Hysteroscopic polyp

Guidelines for the Management of Endometrial Polyps (AAGL) [8].

1. Conservative management is reasonable, particularly for small polyps and if asymptomatic (Level A).
2. Medical management of polyps cannot be recommended at this time (Level B).
3. Hysteroscopic polypectomy remains the gold standard for treatment (Level B).
4. There does not appear to be differences in clinical outcomes with different hysteroscopic polypectomy techniques (Level C).
5. Removal for histologic assessment is appropriate in postmenopausal women with symptoms (Level B).
6. Hysteroscopic removal is to be preferred to hysterectomy because of its less-invasive nature, lower cost, and reduced risk to the patient (Level C).

Key Points

1. A rigid hysteroscope is superior to flexible for outpatient procedures.
2. Vaginal misoprostol prior to hysteroscopy reduces the resistance.
3. Hysteroscopy has a major role among women undergoing INFERTILITY, and it has both diagnostic and therapeutic utilities.
4. Correction of anomalies distorting uterine cavity by hysteroscopy could have benefit on the outcome but needs more relevant data.
5. Intracavitary lesions such as polyp and fibroid not only distort endometrium but cause inflammatory and immunologic reactions that may affect embryo implantation. Polypectomy should always be done under vision, that is, hysteroscopically.
6. Relevant data indicates that hysteroscopy previous to IVF increases outcome.
7. Hysteroscopy is an extremely safe and efficient method to remove foreign bodies from the uterine cavity.

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Retained Products of Conception

21

Alonso Pacheco Luis, Aserlind Alexandra, and Carugno Jose

When evaluating abnormal uterine bleeding in a reproductive-aged woman after early pregnancy loss, termination, preterm or full-term vaginal delivery, or cesarean section, retained products of conception (RPOC) should be routinely considered in the differential diagnosis. RPOC is defined as the presence of persistent trophoblastic tissue within the uterine cavity. Bleeding caused by RPOC can present on a spectrum ranging from slight bleeding to hemorrhage leading to instability. It is important to consider the patient's obstetric history (both immediate and remote), symptomatology, clinical status, and diagnostic workup including imaging and hysteroscopy. While these cases were traditionally managed via sharp and suction dilation and curettage (D&C), there has been a gradual shift in paradigm toward hysteroscopic management in certain patients.

21.1 Introduction

Retained products of conception is the term used to describe the presence of placental and/or fetal tissue—also known as trophoblastic tissue—remaining in the uterus after any gestation. This includes spontaneous abortion, termination, and preterm and full-term pregnancies delivered by vaginal delivery or cesarean section. As the retained tissue undergoes necrosis with fibrin deposition, an eschar forms, which may be referred to as a placental polyp [1]. Additionally, the term "residual trophoblastic tissue" may be used. This is defined by the persistence of trophoblastic tissue that remains after the first menstruation (Fig. 21.1).

Other terms also frequently used to reference RPOC include "retained placental fragment" and "residual trophoblastic tissue."

When examining medical termination of pregnancy, a meta-analysis of the efficacy of medical abortion revealed decreasing success rates inversely correlated with increasing gestational age. This study suggested that medical abortion may have decreasing efficacy at 50 days of gestation [2]. Contrastingly, surgical termination of pregnancy results in a lower rate of RPOC and has been observed in approximately 0.5% of surgical abortions performed in the first trimester [3]. Approximately 1% of term pregnancies are complicated by retained trophoblastic tissue [4].

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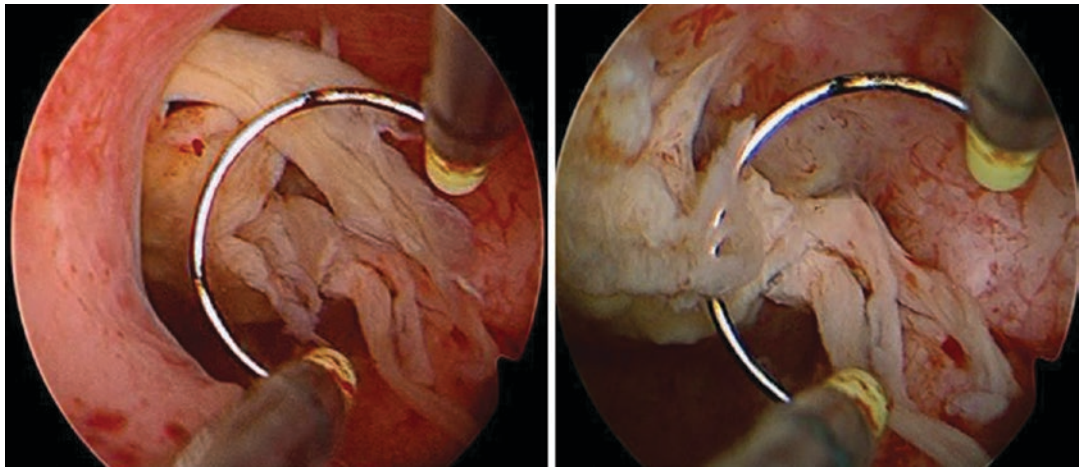

Fig. 21.1 Hysteroscopic view of RPOC

Table 21.1 Gutenberg classification of ultrasonographic patterns of retained products of conception

Type	Intrauterine echogenic mass	Intracavitary vascularization	Myometrial vascularization
Type 0	Homogeneous	No	No
Type I	Heterogeneous	Minimal	No
Type II	Heterogeneous	Highly	No
Type III	Heterogeneous	Highly	Present

21.2 Risk Factors

Second-trimester fetal demise, abnormal uterine cavities, morbidly adherent placentation, and pregnancies using assisted reproductive technology (ART) are among the risk factors that have been cited for RPOC [5]. The earliest literature describing RPOC dates back to 1884, when Baer documented case of placental polyp discovered 12 years after pregnancy [6].

In a prospective observational study evaluating the prevalence of residual trophoblastic tissue after miscarriage or delivery, RPOC was found more frequently after second-trimester demise or delivery (40%) than first-trimester miscarriage (17.8%) and a third-trimester delivery (2.7%) [7]. Moreover, there is a well-documented relationship between RPOC and abnormal uterine cavities, with such anomalies found in 10% of the patients with retained products [8]. This may be caused by difficulties during the D&C evacuation or by an abnormal uterine contractility during a spontaneous miscarriage. Lastly, an important risk factor for the development of RPOC is placenta accreta. This is a severe pregnancy complication that occurs when all or part of the placenta grows into the myometrium. It carries a high maternal morbidity and mortality rate and is associated with previous uterine scars, multiparity, prior uterine infections, and placenta previa.

21.3 Pathogenesis

As previously mentioned, RPOC are mostly comprised of trophoblastic tissue. During early pregnancy, the trophoblast is organized into a multitude of branching projections from the chorionic villi; these villi allow for the passage of respiratory, metabolic, and other products between maternal and fetal blood systems.

Two different mechanisms, although unproven, have been suggested to describe pathogenesis behind RPOC. Ranney's theory proposes a direct relationship between the

thickness and tone in various regions of the myometrium and the presence of RPOC. The belief is that areas such as the fundus and uterotubal region of the uterus have decreased tone in the second stage of labor and may lead a higher rate of RPOC in comparison to regions with increased tone [9]. This suboptimal uterine contractility can be the culprit of RPOC in abnormal uterine cavities.

Alternatively, Eastman and Hellman propose that focal regions of unrecognized placenta accreta may be the culprit behind retained trophoblastic tissue. Their belief is that placental attachment to areas inside the uterus with diminished decidua formation such as the cornua, fundus, and lower uterine segment may lead to direct implantation into the myometrium [10].

21.4 Clinical Presentation

RPOC can present with a spectrum of intensity and severity depending on the size, vascularization, and duration of retained tissue. The most prevalent clinical symptom is vaginal bleeding, which ranges from light bleeding to life-threatening hemorrhage. Although there is always uterine bleeding after an early pregnancy loss, termination, or delivery, no concrete criteria have been established to define when bleeding should be considered abnormal. Prolonged or heavy bleeding after a pregnancy must raise suspicion for RPOC. Other clinical findings include uterine tenderness, pelvic pain, fever, and foul-smelling discharge.

Time elapsed after miscarriage, termination, and delivery affects symptomatology and presentation. Dyer and Bradburn divided placental polyps into acute and chronic types. They found that acute placental polyps presenting a few days to 6 weeks post abortion or delivery were more likely to present with postpartum hemorrhage. These acute polyps were suspected to be remnants of placenta with blood and clots. Contrastingly, chronic placental polyps may persist for years with mild or no clinical symptoms [11].

RPOC may also present as persistent amenorrhea, or absence of menses, for more than 6 weeks after abortion or delivery. Although this entity may be appropriate in the setting of exclusive breastfeeding, it may be found in relation to presence of trophoblastic tissue [11].

There are some reports of retained products persisting for years despite return of menses. For example, Swan discovered trophoblastic tissue 21 years after the last documented pregnancy in a patient with normal menstrual cycles [11].

21.5 Workup and Diagnosis

Components used in the diagnosis of RPOC include history, physical exam, labs, and imaging. The diagnosis of RPOC can pose a challenge to clinicians as it is normal to have some bleeding and discomfort after miscarriage, abortion, or delivery. It is important to obtain a thorough clinical history in this specific population as significant clinical sequelae can stem from RPOC. A history of previous pregnancy with persistent, abnormal, or heavier-than-usual bleeding should raise suspicion.

Importantly, one must evaluate and quantify the degree of bleeding. In cases of massive bleeding, large clots can be seen protruding through the cervix causing dilation of the cervical os. On bimanual exam, it is crucial to assess cervical dilation, uterine size, and tenderness. One may also see products of conception protruding through the external cervical os causing the patient pain and discomfort; this usually allows for extraction with ring forceps [12, 13].

Quantitative values of human chorionic gonadotropin (hCG) are of limited value in the diagnosis of RPOC because the hormone can remain at a level of >5 mIU/mL in the immediate period after labor or abortions. One must suspect RPOC if hCG levels decline more slowly than expected (<21–35%) over a 48-hour period [14]. Moreover, a negative hCG result does not exclude RPOC. It has been established that retained trophoblastic tissue maintains capability of generating hCG and maintaining a low level in the blood after miscarriage, termination, and delivery [15].

Ultrasound with or without color Doppler is the mainstay in diagnosis of RPOC and remains the imaging modality of choice. There are differ-

ent factors that affect the accuracy of diagnosis via ultrasound such as the ultrasonographer's experience, the technology and protocols at the specific institution, and the use of color Doppler. The visualization of a mass inside the endometrial cavity is the most important finding on ultrasound. Contrarily, the visualization of a thin endometrial stripe without excess debris virtually excludes this pathology with a predictive value of close to 100% [16]. After a miscarriage, abortion, or delivery of viable fetus, the endometrium undergoes a series of changes that are part of the mechanism of evacuation of the uterus. At 8 weeks postpartum, the endometrium is visualized as a linear echogenic structure and returns to its pregravid size after this initial period of bleeding [17, 18]. Furthermore, up to 10% of women may have residual fluid in the endometrial cavity at 5 weeks postpartum [19]. In a retrospective study of patients who underwent uterine re-evacuation for suspected RPOC, it was found that an endometrial thickness of 13 mm or more by transvaginal ultrasound was suggestive of RPOC [20].

While some literature suggests that the use of color Doppler is accurate for confirming or excluding residual trophoblastic tissue, others have shown that its use is not helpful in the diagnosis of RPOC [7–21]. Retained clots may present with similar ultrasound findings during the postpartum period as normal uterine involution occurs. This is why there is a great variability in the sensitivity (44–93%) and specificity (74–92%) for the diagnosis of PROC with ultrasound according to different studies [16]. Usually, retained tissue is highly vascularized demonstrating a high rate of positive flow with color Doppler. Durfee postulates that the implantation site may remain vascular during the involution period leading to increased color Doppler in the endometrium and subsequent misleading diagnoses [16].

Kamaya and colleagues studied the Doppler ultrasonographic characteristics of RPOC. This retrospective study evaluated suspected RPOC based on vascularity as suggested by Doppler appearance and stratified these findings into four different types. Type 0 was defined as an avascular color Doppler with no detectable vascularity in the endometrium, whereas Type 3 was defined as marked vascularity that is greater in the endometrium than the myometrium. Interestingly, Type 3 Doppler appearance of RPOC can represent an undiagnosed arteriovenous malformation (AVM), and clinicians should plan ahead as hemorrhage can ensue with instrumentation [21, 22].

A more prominent system, the Gutenberg classification, differentiates ultrasonographic versus hysteroscopic findings of RPOC. The four described ultrasound patterns are based on retained tissue echogenicity as well as intracavitary and myometrial vascularization. This classification system may be used to correlate ultrasound patterns with the hysteroscopic appearance of RPOC. Using these two related classifications may aid clinicians in anticipating the complexity and degree of difficulty that may be encountered at the time of uterine evacuation via hysteroscopy (Fig. 21.2).

Hysteroscopy is now considered the gold standard for the diagnosis of intrauterine pathology including RPOC. The hysteroscopic appearance of retained trophoblastic tissue is different depending on the involution of the trophoblast and the chorionic villi, the necrosis of the nonviable tissue, and the fibrin deposition. The ultrasound patterns above are directly related to the hysteroscopic patterns observed in these patients. Thus, the Gutenberg classification also distinguishes four hysteroscopic patterns based on the structure of chorionic villi, vascularity of tissue, and attachment (Fig. 21.3).

Table 21.2 Gutenberg classification of hysteroscopic patterns of retained products of conception

Type	Chorionic villi structure	Vascularity	Attachment
Type 0	Not defined	Normal	Loose
Type I	Well defined avascular (white)	Normal	Focally
Type II	Well define vascular (red)	Mild vascular dilatation	Focally some loose and dense attachment
Type III	Well define vascular (red)	Severe vascular dilatation, aneurysms and AV shunt	Densely attached

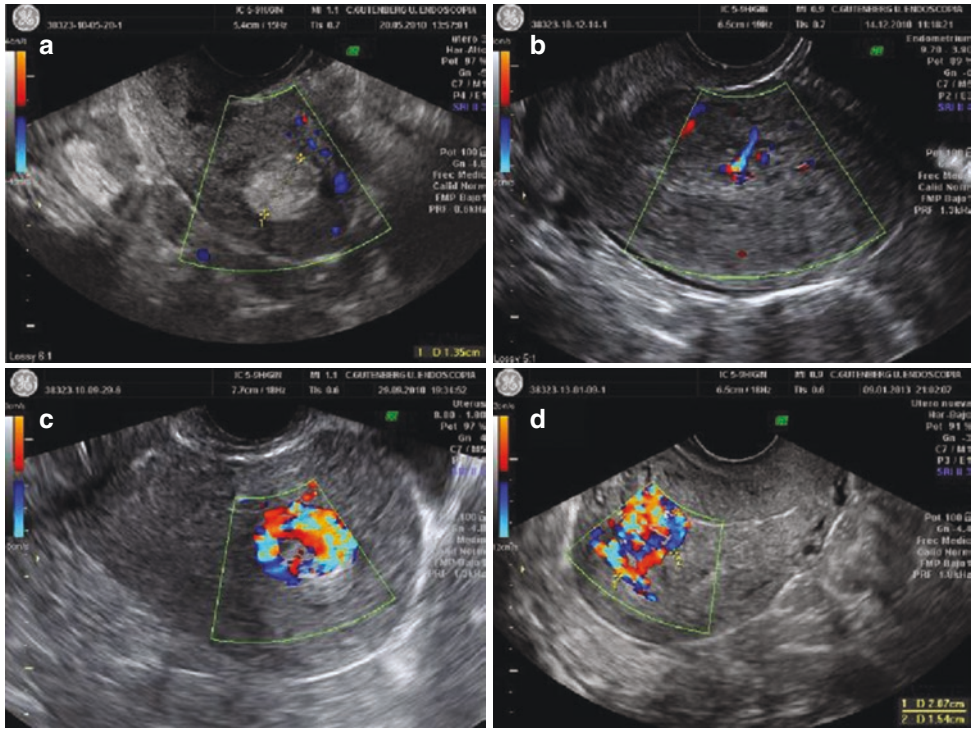

Fig. 21.2 Ultrasonographic appearance of RPOC (Gutenberg classification)

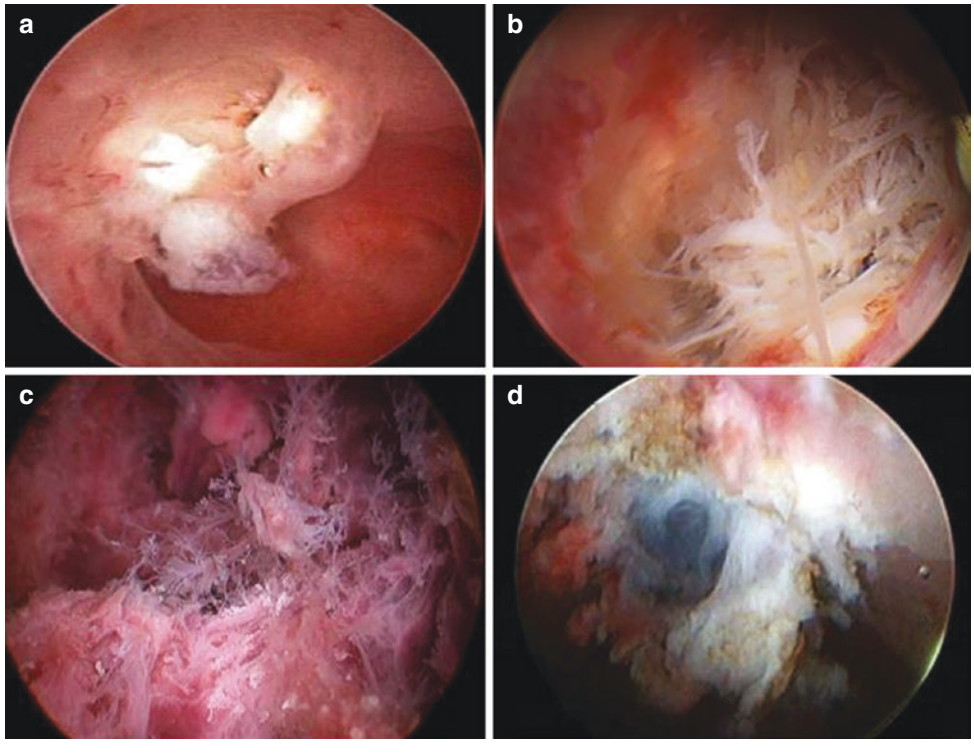

Fig. 21.3 Hysteroscopy patterns of RPOC (Gutenberg classification)

Although not as sensitive as ultrasonography or hysteroscopy, MRI may be used to aid in the diagnosis of RPOC. Classic MRI findings are intracavitary uterine soft tissue mass with variable degrees of myometrial thinning and disruption of the junctional zone. Additionally, there may be heterogeneous signal intensity on T1 and T2 imaging and variable enhancement on gadolinium-enhanced T1W images [23].

Definitive diagnosis is histological. Definitive diagnose is determined by the presence of chorionic villi indicating the existence of placental tissue. Chorionic villi with a rim of normal syncytiotrophoblasts or necrotic and hyalinized villi may be observed as well. The base usually contains highly vascularized decidualized stroma [24].

21.6 Differential Diagnosis

When evaluating for RPOC, there are entities that must be considered in the differential diagnosis such as placental site trophoblastic tumor, choriocarcinoma, and acquired arteriovenous malformation (AVM).

Placental site trophoblastic tumor is a rare form of gestational trophoblastic disease (GTD) arising from intermediate trophoblast. This typically occurs after delivery but can also occur after abortion, ectopic pregnancy, or molar pregnancy. In cases where a polypoid structure is seen growing from the myometrium into the endometrial cavity, GTD must be considered. The placental site trophoblastic tumor is characterized by low levels of hCG and some production of human placental lactogen (hPL) [25]. The key point in the diagnosis is the proliferation of trophoblastic cells without chorionic villi in the histopathological study. Treatment for placental site trophoblastic tumor is usually hysterectomy [26].

Choriocarcinoma is a highly invasive neoplasm affecting women of reproductive age with hematogenous metastasis appearing in early stages of the disease. This common neoplasm follows an early pregnancy loss or term gestation. One-third of cases result from a molar pregnancy, but it has also been identified after ectopic pregnancies [27, 28]. On ultrasound, these tumors are often seen invading the myometrium and cause hemorrhage and necrosis [1]. hCG levels are usually high and can be useful in guiding diagnosis. Histopathological examination is required to determine the diagnosis. The treatment is often chemotherapy.

An acquired uterine arteriovenous malformation (AVM) is a rare condition that may be caused by the incomplete involution of the placental implantation site [29]. Most cases of AVM develop over uterine lesions that resulted from uterine instrumentation such as curettage, thus calling them acquired arteriovenous malformations. Distinguishing between RPOC and AVM on ultrasound can be difficult; however, the vascular component in an AVM is confined to the myometrium with a turbulent pattern of arterial and venous flow. AVMs usually demonstrate high peak velocities and low resistance [30], whereas it is important to differentiate RPOC from AVM because the treatments of the two are vastly different. AVMs are treated with selective arterial embolization.

21.7 Treatment

The approach to treating RPOC is contingent on a multitude of factors such as hemodynamic stability, gestational age of antecedent pregnancy, available resources, and operator's experience. Traditionally, the management for RPOC has been dilatation and curettage; this is still the most common treatment. There are alternative treatments such as expectant management, medical management, and hysteroscopic selective resection. The main objective of these alternative treatments is to reduce the risks associated with the classical D&C.

Evacuation of retained products of conception with sharp metal or suction curettage is a widely used method for the management of RPOC. A recent review evaluating vacuum aspiration versus sharp metal curettage found that the vacuum aspiration was safer, quicker, less painful, and resulted in less blood loss than sharp curettage

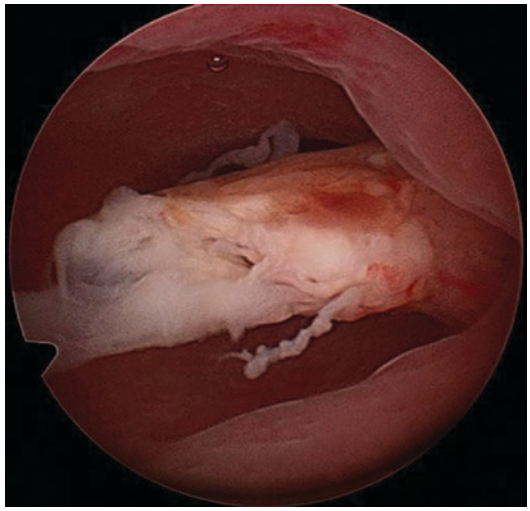

Fig. 21.4 The retained products of conception are often focal

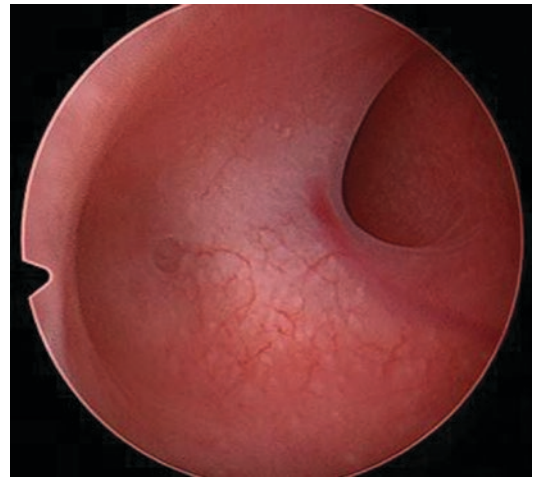

Fig. 21.5 Intrauterine adhesion

[31, 32]. This procedure can lead to several complications such intrauterine adhesions (IUA), Asherman syndrome, uterine perforation, and incomplete evacuation.

The retained products of conception are often focal, and the blind nature of curettage carries a risk of incomplete evacuation (Fig. 21.4). There are limited data on the incidence of repeat evacuation for suspected retained products. In a retrospective study on patients who underwent suction curettage for RPOC, the rate of repeat evacuation was 3.1% [28]. Another retrospective analysis comparing selective curettage of RPOC by hysteroscopy with conventional blind curettage reported higher rates after blind evacuation of the uterus with 20.8% of persistence of residual tissue [29]. In a study by Schenker, it was reported that 88% of women with Asherman syndrome previously underwent a D&C during the postpartum or post-abortion period [33].

The use of blind curettage can also cause trauma to the basal layer of endometrium that can lead to the development of IUA or even Asherman syndrome (Fig. 21.5). The incidence of IUA following one curettage for missed abortion is around 30% as diagnosed by hysteroscopy [34]. Interestingly, the incidence of IUA in women undergoing repeated evacuation is 40%. Of those women, 75% of them have grade II–IV adhesions as diagnosed by hysteroscopy performed within 3 months of the procedure [35].

Uterine perforation is the most common complication of curettage and can lead to bleeding, injury of internal organs, and peritonitis. It is estimated that this complication affects to 5.7% of patients who underwent evacuation of RPOC for postpartum hemorrhage [36]. Operator inexperience, prior cervical surgery, adolescence, multiparity, and advanced gestational age increase the risk of perforation [37]. D&C for RPOC carries a substantial risk due to a decrease in the resistance of the uterine wall.

To avoid these aforementioned complications, different therapeutic tactics have been proposed. Such alternatives include expectant management, medical treatment, ultrasound-guided evacuation, and hysteroscopic management of RPOC.

Expectant management is an option for women with RPOC with mild or no symptoms. Wijesinghe et al. conducted a randomized clinical trial (RCT) comparing surgical versus expectant management in patients with incomplete miscarriage. All subjects had amenorrhea for <14 weeks and RPOC measuring <50 mm on ultrasound. The study found a success rate of 90.1% at 1 week and 94.4% at 2 weeks [38]. One may also favor expectant management because prolonging interval to surgery may decrease intra-polyp blood flow which may lead to decrease operative blood loss during subsequent

procedure [39]. Therefore, expectant management of retained products of conception should be the first choice in patients who are mildly symptomatic or asymptomatic.

Different medical treatments have been used for the management of RPOC. Although various medications have been used, misoprostol is the most common agent. Treatment with misoprostol has shown to be effective in more than 90% of cases of first-trimester incomplete miscarriages, but some women need multiple doses, and usually oral analgesia is needed. Compared with expectant management, use of medication has been shown to decrease the time to expulsion of POC and increase the rate of complete expulsion [40]. There is no consensus about the correct dosage and route of administration. A literature review found evidence supporting misoprostol as a safe and effective treatment for uterine evacuation and recommended a dose of 600 micrograms oral for the treatment of incomplete abortion [41].

Comparing the effectiveness of curettage versus misoprostol, curettage is superior in achieving a complete evacuation of RPOC. Additionally, severity of pain, bleeding, and emergency evacuation was higher in those women treated with misoprostol [42]. Women who are hemodynamically unstable, hemorrhaging, or infected should undergo prompt surgical uterine evacuation. Although suction and sharp curettage are available, studies show that suction is superior to sharp curettage [43].

Lastly, RPOC may be managed surgically using hysteroscopy to determine the exact location of the tissue, to evaluate the need of uterine evacuation, and to diagnose associated uterine anomalies. In 1977, Goldberg published the first account of surgical removal of RPOC with a resectoscope with a cutting loop [7]. He reports successful removal of the retained material in all patients using the cutting loop as a curette while avoiding trauma of the remaining tissue. In all cases, the postoperative ultrasound revealed a cavity free of residual tissue. This excision under direct visualization allowed for higher accuracy of evacuation, complete removal of all products in one surgical procedure, and a reduction in risk of intrauterine adhesions related to the injury of the healthy uterine tissue. No complications during or after the surgery were reported with this technique.

The use of the hysteroscopy in the management of ROPC was also published by Tchabo in 1985 in a series of 95 patients in which a contact hysteroscope was used for the visualization RPOC in women presenting with postpartum and post-abortion bleeding. In this study, polyp forceps were used to remove tissue [7].

Years later, a panoramic hysteroscope was used as an auxiliary method for uterine surgical evacuation. A diagnostic hysteroscopy was performed before the curettage to identify where the RPOC were attached to the uterine cavity. This is a form of guided surgical evacuation where the surgeon is able to visualize the cavity before curettage. In a study over 287 women, Goldfarb concluded that there was significant evidence to support the routine use of hysteroscopy as an adjunct to D&C [44].

There are no conclusive studies indicating the optimal time to perform the evacuation of the retained material in those cases in which there is no life-threatening vaginal bleeding. In a study by Smorgick et al., operative hysteroscopy was performed in 50 women with RPOC at a mean of 1.7 months after first-trimester abortion. Pathology confirmed RPOC in 90% of patients. On follow-up diagnostic hysteroscopy 6–8 weeks post-procedure, none of the patients had intrauterine adhesions [45]. In a study comparing different parameters such as rate of conception and mean time to conception in women with early (within 3 weeks of delivery or terminal of pregnancy) versus late surgical intervention, no differences were found between the groups [46].

Conversely, a delay of surgical timing may be beneficial to a certain extent as it is associated with a decrease in the vascularization of both the placental polyp and the implantation area. Those changes in vascularity of the RPOC are correlated with less surgical bleeding during operative evacuation. This decrease in vascularity can be explained by a time-dependent disappearance of AVF within polypoid mass and a time-dependent vasospasm caused by the release of local prostaglandins [39].

Different instruments have been used for the hysteroscopic extraction of RPOC. Instruments

range from simple forceps and hysteroscopic scissors to intrauterine morcellators. It is important to take into account some factors that can increase the difficulty of this technique. In a hemodynamically stable patient, there are two very important factors to consider during surgical planning: the size and vascularity of the products and the implantation zone. The size limitations for hysteroscopic removal of RPOC are comparable to those limits used in hysteroscopy myomectomy. Tissue masses greater than 5 cm may cause substantial accumulation of debris, preventing adequate removal of specimen.

In cases of highly vascularized retained fragments, the use of electrocoagulation with a wire loop is usually required; however, coagulation of the implantation site may increase the risk of myometrial damage and development of intrauterine adhesions. Takeda proposed the use of preoperative uterine artery embolization (UAE) in patients with neovascularization in the placental polyp tissue as evaluated by computed tomographic angiography before the hysteroscopic resection. This measure is thought to decrease bleeding during surgical procedures (Fig. 21.6) [47].

Our therapeutic protocol is based in the result of both Doppler ultrasound and hysteroscopy. As mentioned above, the ultrasonographic appearance of RPOC can be different depending on the echogenicity and vascularization of the retained tissue and the surrounding endometrium.

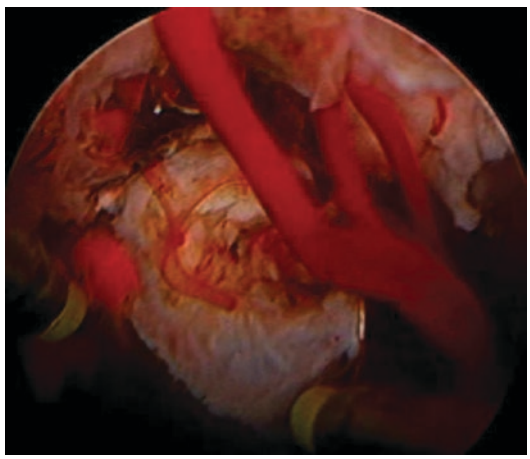

Fig. 21.6 Bleeding during surgical procedure

In cases with a hyperechogenic avascular pattern (Type 0) or varying echogenicity but minimal vascularization inside the RPOC (Type 1), we use the resectoscope as a curette after failed medical treatment in a similar manner proposed by Goldenberg [48]. This is usually a safe and quick procedure with little to no bleeding in which the retained tissue is easily detached from the uterine wall. The use of electrosurgery is not required.

Contrastingly, in cases with but highly vascularized (Type 2) RPOC, electrosurgery is commonly used to fulgurate the vascular implantation area after the excision of the tissue.

A selective fulguration is mandatory to avoid injury the healthy surrounding tissue. Lastly, in cases with a highly vascularized intracavitary mass, a highly vascularized myometrium can be dangerous. This occurs as a result of destructive invasion of the myometrium by the trophoblast, impairing uterine vasculature. After excision of the retained tissue, a concomitant superficial resection of the myometrial tissue and a fulguration of the actively bleeding vessels are needed. In some cases, an intrauterine catheter is left in place to the myometrial blood vessels.

We also perform systematic second-look hysteroscopy in all patients 1–2 months after the evacuation to evaluate the cavity and the presence of intrauterine adhesions.

21.8 Reproductive Outcomes

The treatment of patients with RPOC brings to the forefront concerns about the impact this pathology and treatment will have on future fertility. As management of RPOC evolves from dilation and curettage to hysteroscopic management, it is important to examine the manner in which this paradigm shift affects reproductive health.

As discussed above, uterine curettage can lead to development of intrauterine adhesions (IUA) or even Asherman syndrome due to the blind nature of the procedure. Hysteroscopy has shown lower rates of intrauterine adhesions after the evacuation of RPOC. Different recently pub-

lished studies found low rates of IUA after hysteroscopic evacuation with an incidence of <5% [49]. In addition, hysteroscopy has also been associated with fewer surgical complications, significantly reducing the risk of uterine perforation. Additionally, hysteroscopy affords the physician the ability to diagnose intracavitary abnormalities that can also be associated with recurrent abortions or higher incidence of RPOC.

Although further studies on long-term obstetric outcomes in women following RPOC treatment are lacking, the data available to date show acceptable posttreatment pregnancy rates varying across studies between 50% and 88% [11]. These rate are influenced by patient age and technique used for uterine evacuation. Most studies favor of hysteroscopy. The rates of live births range from 70 to 80%, and the mean time to achieve pregnancy is around 7–8 months. One study revealed that the probability of abnormal placentation in a subsequent pregnancy is 18% which is markedly increase compared to 0.19% in the general population. Abnormal placentation is seen more frequently in women treated with curettage than with hysteroscopy.

Ben-Ami et al. studied a total of 177 women who underwent either blind D&C or hysteroscopy for evacuation of pathologically confirmed RPOC. Mean time to conception is approximately 5 months in those who underwent hysteroscopy. Additionally, newly diagnosed infertility was more common among the D&C group than the hysteroscopy group [50].

21.9 Conclusion

The preferred management of RPOC differs with a patient's symptomatology, presentation, clinical status, and findings on imaging. While dilation and curettage used to be the gold standard for surgical management of RPOC, hysteroscopic resection is increasing in popularity. Hysteroscopic evacuation of RPOC is a feasible, safe, and effective technique that prevents many of the adverse outcomes seen with D&C. With this shift toward removal of tissue under direct visualization, there is a reduction in complications such as intrauterine adhesion formation, incomplete evacuation of products of conception, and uterine perforation. There is also a decrease in injury to surrounding endometrium. While hysteroscopy has proven to be effective in multiple studies, the result is often user-dependent. While hysteroscopic technique is useful for the extraction of intrauterine RPOC, we recommend the use of the resectoscope with energy in cases where there is high degree of vascularization. This allows the surgeon to selectively cauterize blood vessels and the tissue base when needed. Special care should be taken with Type 3 RPOC as bleeding can be profuse and can increase the chance of severe complications. Finally, data to date demonstrates promising posttreatment pregnancy rates and shorter interval to conception with hysteroscopic removal of tissue than with dilation and curettage.

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22 Hysteroscopy: Endometrial Hyperplasia and Endometrial Malignancies

Krishnendu Gupta and Bhaskar Pal

Hysteroscopy is commonly used to evaluate abnormal uterine bleeding, offers direct visualization of the endometrial cavity [1], has the capacity of detecting malignant pathologies such as endometrial cancer, and, in addition, permits an endometrial sampling or removal of the lesion during the same procedure. However, there is a continuing debate about the value of this technology in the diagnosis of serious endometrial disease.

Abnormal uterine bleeding (AUB) [earlier referred to as "dysfunctional uterine bleeding/DUB"] is a common gynecological complaint, and it may involve females at any age group. Thirty-three percent of women referred to gynecology clinics have AUB, and the figure rises to 69% in perimenopausal and postmenopausal women.

Regular cyclic menstruation indicates normal functioning hypothalamo-pituitary ovarian axis and its target organs. AUB is a common problem of adolescent girls and perimenopausal and postmenopausal women. In the perimenopausal age, most of the menstrual cycles are irregular, prolonged, and most often anovulatory. Pregnancy, although uncommon in perimenopausal women, can rarely occur due to infrequent ovulation seen during the transitional period to menopause. Hence, the possibility of pregnancy-related complications (threatened or incomplete miscarriage or an ectopic) should always be considered and excluded. An international expert consensus from the "FIGO Working Group on Menstrual Disorders" has proposed a standardized classification system for AUB to facilitate greater understanding of the complexities of this common yet intriguing clinical entity [2]. After menopause, progesterone production ceases, but peripheral conversion of adrenal and ovarian androgen to estrogen continues with cessation of ovarian function. The estradiol level may be as high as 100 pg/mL, exposing the progesterone-deprived endometrium to high levels of unopposed estrogen, which may lead to endometrial hyperplasia and carcinoma. Most of the endometrial hyperplasia remains benign, but when associated with cellular atypia, there is 8–29% chance of endometrial carcinoma. Endometrial carcinoma can also develop without the endometrial hyperplasia, usually in the background of atrophic endometrium. In the past, when few diagnostic options were available, endometrial carcinoma was routinely diagnosed following an endometrial curettage. However, with the availability of transvaginal sonography (TVS) and hysteroscopy,

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the diagnostic accuracy of endometrial carcinoma has vastly improved. TVS provides far more accurate information when compared to abdominal USG with respect to diagnosing pelvic organ pathology. TVS has been found to be the most cost-effective initial test in women with abnormal uterine bleeding especially in perimenopausal age group [3]. TVS can accurately measure endometrial thickness and detect any organic lesion in uterine cavity. Endometrial biopsy must be performed if the endometrial thickness is ≥12 mm and should be considered if endometrial thickness is ≥5–12 mm to exclude any endometrial pathology. Diagnostic hysteroscopy is now possible to be performed as an outdoor office procedure with or without minimum anesthesia. It provides a direct observation of endometrial cavity. Hysteroscopic examination is superior to other methods in evaluation of endometrial cavity [4]. However, hysteroscopic diagnosis should in no way replace histological diagnosis of the endometrium. Hysteroscopy is complementary to histological analysis as it permits a panoramic evaluation of the endometrial mucosa and provides directed biopsy from abnormal areas.

Endometrial hyperplasia (EH) is a pathological condition characterized by hyperplastic changes in endometrial glandular and stromal structures lining the uterine cavity [5]. Most cases of EH result from high levels of estrogens, combined with insufficient levels of progesterone [6, 7]. Unopposed estrogenic stimulation of the endometrium causes proliferative glandular epithelial changes, including glandular remodelling, resulting in variably shaped, irregularly distributed glands. Risk factors for the development of endometrial cancer (EC) include obesity, unopposed estrogen therapy, diabetes mellitus, tamoxifen treatment, PCOS, and nulliparity [8].

EH is common in women aged 50–54 years with body mass index (BMI) over 30 [9]. The average age for EH is 52 years, which is nine years lower than the average age for EC. The increased risk of endometrial cancer among overweight (BMI > 25) and obese women appears to be greater in postmenopausal than in younger women [10]. Accordingly, the growing epidemic of obesity, in conjunction with an aging cohort, has the potential to result in a significant increase in EC and its precursors.

Endometrial hyperplasia is one of the most frequent causes of abnormal uterine bleeding, which leads to EC if left untreated. In 10% of premenopausal women with abnormal uterine bleeding, histological findings show endometrial hyperplasia, and in 6% of postmenopausal women with uterine bleeding, EC is found [8]. The primary role of endometrial sampling in patients with AUB is to determine whether carcinomatous or premalignant lesions are present by evaluating histological samples [11, 12]. A study conducted by the Gynecological Oncology Group on biopsy-based diagnosis of atypical hyperplasia found 42.6% of concurrent endometrial carcinoma in hysterectomy specimens [13]. The most useful tool to assess endometrium and make preliminary diagnosis is ultrasound imaging: transvaginal sonography (TVS). Tissue sampling should be performed in women with risk factors of EC, who present symptoms of abnormal vaginal bleeding or pathological vaginal discharge.

Classification of Endometrial Hyperplasia:

Old World Health Organization 1994 (WHO 1994) classification [5, 14, 15]:

1. Simple hyperplasia.
2. Complex hyperplasia.
3. Simple hyperplasia with atypia.
4. Complex hyperplasia with atypia.

New World Health Organization 2014 (WHO 2014) classification [16]:

1. Non-atypical endometrial hyperplasia (benign hyperplasia).
2. Atypical endometrial hyperplasia or endometrial intraepithelial neoplasia (EIN)/well-differentiated carcinoma.

In 2016, the joint guidelines of two committees were published, the Royal College of Obstetricians and Gynaecologists (RCOG) and the British Society for Gynaecological Endoscopy (BSGE), regarding hyperplasia treatment and

classification [17]. They recommended the WHO 2014 classification, which divides endometrial hyperplasia into two groups: hyperplasia without atypia and atypical hyperplasia. The guidelines also state the algorithms for managing endometrial hyperplasia. They detail the treatment options that are preferred and give advice on the time for endometrial biopsy for patients after conservative treatment. Clinical management of atypical hyperplasia and EIN is the same.

22.1 Evidence

Numerous original research articles have been published in this field of interest both in India and internationally. A few such studies with their outcomes are discussed below.

22.1.1 Abnormal Uterine Bleeding and Endometrial Pathology

Barman et al. [18] did a comparative evaluation of TVS and diagnostic hysteroscopy in 85 women with AUB in perimenopausal age with their histopathological correlation and found that the most common bleeding pattern in patients with abnormal uterine bleeding was menorrhagia (30.59%) followed by metrorrhagia (22.35%). Sensitivity, specificity, positive predictive value, and negative predictive value of TVS in comparison to gold standard histopathology (HP) report for diagnosis of hyperplastic endometrium were 43.75%, 95.65%, 70%, and 88%, and for polyp were 50%, 89.16%, 10%, and 98.67%, respectively. Sensitivity, specificity, positive predictive value, and negative predictive value of hysteroscopy for diagnosis of hyperplastic endometrium were 50%, 95.78%, 70%, and 90.67%, and for polyp were 71.43%, 100%, 100%, and 94.67%, respectively.

Audimulapu and Sudeepti [19] in their original research article studied the comparative diagnostic evaluation of hysteroscopy, transvaginal ultrasonography, and histopathological examination in 50 cases of abnormal uterine bleeding and found that the most common bleeding pattern observed was heavy flow with regular cycles (menorrhagia) which was observed in 42% of the patients followed by heavy flow with irregular cycles (menometrorrhagia) which was observed in 26% of the patients in the study. With respect to parity of subjects, maximum incidence of abnormal uterine bleeding was seen in the parity of two (36%) followed by parity of three (32%). Majority of patients presented with one to six months duration of AUB. Most common histopathology finding was proliferative endometrium. Out of 50 cases, in 38 cases (76%), hysteroscopy findings correlated with histopathology, and discrepancy in findings was noted in 12 cases (24%). In 26 cases (52%), TVS findings correlated with histopathology findings, and the results differed in 24 patients (48%). Sensitivity and specificity for TVS were 62.8% and 86.6% in comparison with sensitivity and specificity of hysteroscopy which were 74.3% and 93.3%, respectively. Positive predictive value was 96.3% and negative predictive value was 60.8% for hysteroscopy, whereas for TVS, positive predictive value was 91.6% and negative predictive value was 50%. According to these findings, hysteroscopy was found to be superior to TVS in evaluating abnormal uterine bleeding because of higher sensitivity, specificity, positive predictive value, and negative predictive value. TVS is noninvasive and relatively cheap, causes minimal discomfort to the patient, and can be used as the initial modality in patients with abnormal uterine bleeding. However, it has inferior diagnostic value when compared to hysteroscopy. The authors concluded that although TVS represents a practical approach for the initial evaluation of uterine pathologies, a hysteroscopy examination would be necessary in most of the suspicious cases. Hysteroscopy remains the best option for the assessment of AUB owing to its diagnostic performance when compared to TVS. It allows direct visualization of the cavity and also sampling for histopathological examination.

Choudhary et al. [20] in their published article on the evaluation of abnormal uterine bleeding with transvaginal sonography and hysteroscopy in 50 perimenopausal women found that on TVS, 50% of patients showed normal endometrial

finding, 24% of patients showed endometrial hyperplasia, 14% endometrial polyp, 8% submucosal fibroid, and 4% adenomyosis. On hysteroscopy, 28 (56%) had normal endometrial finding. 20% of cases had endometrial hyperplasia, 16% had endometrial polyp, and 8% had submucosal fibroid. Sensitivity, specificity, PPV, and NPV for endometrial hyperplasia were 81.81%, 92.3%, 75%, and 94.73%, respectively. The authors concluded that TVS has a moderate diagnostic accuracy in detecting endometrial hyperplasia and other intrauterine pathology. TVS is safe, acceptable, and easily available and is noninvasive. It should be used as the first-line diagnostic tool in patients with AUB in perimenopausal women. Hysteroscopy is an important tool in the diagnosis of various endometrial and intrauterine lesions. TVS and hysteroscopy should be employed hand in hand in evaluation of AUB.

El-Gamal [21] et al. studied the role of diagnostic hysteroscopy and histopathology in evaluation of abnormal uterine bleeding in 114 patients and found that hysteroscopy had a sensitivity of 91.9%, specificity of 86.5%, positive predictive value of 93.2%, negative predictive value of 84.2%, and diagnostic accuracy of 90.1% for diagnosing the etiology of abnormal uterine bleeding. The authors thus concluded that hysteroscopy has a definitive role in evaluating patients with abnormal uterine bleeding especially in patients with thick endometrium, in any age group. Hysteroscopy is a safe and reliable procedure in the diagnosis of cases with abnormal uterine bleeding with high sensitivity, specificity, positive predictive value, and negative predictive value, and the results of hysteroscopy are immediately available. Hysteroscopy and histopathology complement each other in evaluating patients with abnormal uterine bleeding for accurate diagnosis and further treatment.

Goyal et al. [22] studied the role of transvaginal sonography versus hysteroscopy in evaluation of abnormal uterine bleeding in 100 women and concluded that TVS is recommended as first-line investigation in AUB. If TVS shows normal cavity, further evaluation can be omitted and patient started directly on medical treatment for her symptoms.

Krishnamoorthy and Shanthini [23] studied the role of TVS and hysteroscopy in abnormal uterine bleeding in 61 women and concluded that the combination of TVS, hysteroscopy, and directed biopsy was found to increase the diagnostic yield in patients with abnormal uterine bleeding. As the diagnostic accuracy increased by combining the three modalities, an effective and appropriate management can be planned.

22.1.2 Endometrial Cancer

Endometrial cancer is the most common malignancy of the female genital tract in developed countries. Hysteroscopy is used extensively in the evaluation of common gynecologic problems, such as menorrhagia and postmenopausal bleeding.

The systematic quantitative review of Clark TJ et al. [24] is the classical and most often cited study in this field. The objective of the study was to determine the accuracy of hysteroscopy in diagnosing endometrial cancer and hyperplasia in women with abnormal uterine bleeding. The data sources were relevant articles identified through searches of the Cochrane Library, MEDLINE, and EMBASE (1984–2001), manual searches of bibliographies of known primary and review articles, and contact with manufacturers. The studies were selected blindly, independently, and in duplicate if accuracy of hysteroscopy was estimated in women with abnormal uterine bleeding, using histopathologic findings as a reference standard. The search identified 3486 articles; 208 of these were deemed to be potentially eligible and were retrieved for detailed data extraction. Sixty-five primary studies were analyzed, including 26,346 women. Data were abstracted on characteristics and quality from each study. Results for diagnostic accuracy were extracted to form 2 × 2 contingency tables separately for endometrial cancer and endometrial disease (cancer, hyperplasia, or both). Pooled likelihood ratios (LRs) were used as summary accuracy measures. The results showed that the pretest probability of endometrial cancer was 3.9% (95% confidence interval

[CI], 3.7%–4.2%). A positive hysteroscopy result (pooled LR, 60.9; 95% CI, 51.2–72.5) increased the probability of cancer to 71.8% (95% CI, 67.0%–76.6%), whereas a negative hysteroscopy result (pooled LR, 0.15; 95% CI, 0.13–0.18) reduced the probability of cancer to 0.6% (95% CI, 0.5%–0.8%). There was statistical heterogeneity in pooling of LRs, but an explanation for this could not be found in spectrum composition and study quality. The overall accuracy for the diagnosis of endometrial disease was modest compared with that of cancer, and the results were heterogeneous. The accuracy tended to be higher among postmenopausal women and in the outpatient setting. The authors concluded that the diagnostic accuracy of hysteroscopy is high for endometrial cancer, but only moderate for endometrial disease.

Oliveres-Amor et al. [25] evaluated the efficiency of outpatient hysteroscopy for the diagnosis of intrauterine pathology in a retrospective study with 891 outpatient hysteroscopies and eye-directed biopsy, according to the hospital protocol. Patients were divided into four diagnostic categories for the endometrium classification: normal, benign pathology, suspected hyperplasia, and suspected malignancy. Twenty-six patients were diagnosed of endometrial cancer with the histologic study, 24 of them suspected on hysteroscopy (92.3%). The mean age was 65.27, 88.5% of patients being postmenopausal. The most common symptom was postmenopausal bleeding (PMB) in 86.9% of the postmenopausal patients. All the patients had abnormal findings on TVS. They concluded that hysteroscopic examination presents excellent specificity for endometrial cancer (99.1%) and good sensitivity for endometrial cancer (92.3%).

22.2 Conclusion

Abnormal uterine bleeding (AUB) is a commonly encountered gynecologic problem. Eliciting a proper history along with physical and pelvic examinations with appropriate diagnostic tests is essential for an early diagnosis and proper treatment of the patients. A wonderful detailed review with current recommendations on "Heavy menstrual bleeding: assessment and management" has recently been published by the National Institute for Health and Care Excellence (NICE) on 14 March 2018 for further advancing one's knowledge on the very common yet intriguing clinic problem called AUB [26]. Endometrial hyperplasia is of clinical significance because it is often a precursor lesion to adenocarcinoma of the endometrium. Making the distinction between hyperplasia and true precancerous lesion or true neoplasia has significant clinical effect because their differing cancer risks must be matched with an appropriate intervention to avoid undertreatment or overtreatment. TVS is a very important tool to exclude any anatomical lesion in uterus and adnexal region. It is also important for the measurement of endometrial thickness and selecting patients for additional testing. Hysteroscopy is a very important procedure for proper evaluation of the endometrial cavity, particularly for diagnosis of a polyp, which is likely to be missed by TVS. Hysteroscopy is most specific and sensitive for diagnosis of polyp but less specific for diagnosis of endometrial hyperplasia, probably due to lack of specific diagnostic criteria. It is worthwhile to mention that hysteroscopy will never be a replacement to a histopathology report but is complementary to histopathological examination since it permits a global evaluation of endometrial mucosa for directed biopsy. The high diagnostic accuracy with minimal trauma renders hysteroscopy to be an ideal procedure for global evaluation of endometrial cavity and directed biopsy and for follow-up of cases with abnormal uterine bleeding [27]. Hysteroscopy with directed biopsy is more sensitive than dilatation and curettage in the diagnosis of uterine lesions [28].

Key Learning Points

1. Endometrial hyperplasia is often a precursor lesion to adenocarcinoma of the endometrium.
2. The joint guidelines of RCOG and BSGE in 2016 recommended the WHO 2014 classification, which divides endometrial hyperplasia into two groups: hyperplasia without atypia and atypical hyperplasia, for managing endometrial hyperplasia.

3. TVS is a very important tool to exclude any anatomical lesion in uterus and adnexal region and for the measurement of endometrial thickness and selecting patients for additional testing.
4. Hysteroscopy is a very important procedure for global evaluation of the endometrial cavity, particularly for diagnosis of a polyp, which is likely to be missed by TVS.
5. Hysteroscopy is less specific for diagnosis of endometrial hyperplasia.
6. Hysteroscopy with directed biopsy is more sensitive than dilatation and curettage in the diagnosis of uterine lesions.
7. Hysteroscopy will never be a replacement to a histopathology report but is complementary to histopathological examination.

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Isthmocele: A Cesarean Scar Consequence

23

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23.1 Introduction

In recent years, the rate of cesarean section has drastically increased in developed countries. This has had a parallel effect on the economic expenses of obstetrics due to the nature of surgical intervention. With this increase in surgery, there has been a surge in the dangerous known sequelae of uterine surgery including placenta previa, abnormal placental implantation, and uterine rupture. Patients more frequently complain of abnormal uterine bleeding, dyspareunia, and abdominal pain that are believed to be related to cesarean section.

Another ramification of cesarean section can be seen on ultrasound. Imaging occasionally reveals a hypo-echogenic area at the level of the cesarean section scar known as an "isthmocele." The area is variable in size and triangular, with the vertex directed toward the bladder just in the area of the scar of the previous cesarean section.

This chapter is directed at the discussion of the significance, diagnosis, and treatment of this late complication of the cesarean section.

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23.2 Isthmocele

After cesarean section, the myometrium at the site of the uterine scar should heal together to reform an interrupted muscle layer. However, approximately 24–56% of the time, the incision can close incompletely and cause a cesarean scar defect (CSD) [1]. If incomplete healing occurs, there is a disruption in the myometrium with endometrium protruding to the level of the serosa. This break in the myometrium is known as an "isthmocele" or a surgical scar "niche" that was first described by Morris in 1995. Morris coined the term "cesarean scar syndrome" to describe the scar and oft-associated clinical symptoms such as menorrhagia, abdominal pain, dyspareunia, and dysmenorrhea [2]. There is a clear relationship between the anatomical defect and the presence of different degrees of postmenstrual bleeding and other gynecological symptoms such as dysmenorrhea, chronic pelvic pain, and infertility.

The combination of clinical symptoms, ultrasound evaluation, and hysteroscopy allows for a diagnosis of CSD. Transvaginal ultrasound and hysteroscopy both have high correlation for diagnosing the disorder.

Treatments for the condition range from medical therapy to surgery. Medical therapy with the use of oral contraceptives allows for reduction in heavy abnormal uterine bleeding. Surgery with hysteroscopy can help facilitate appropriate

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evaluation, diagnosis, and correction of the defect to facilitate drainage of menstrual blood. Laparoscopic and vaginal surgery are also utilized to correct the defects causing CSD.

23.2.1 Pathogenesis

According to the CDC, approximately 32% of deliveries in 2017 were via cesarean section. This begs the question, Why are there not more women with CSD? The reason why the defect does not appear in all women undergoing cesarean section is unknown. The pathogenesis of the isthmocele is also not well understood, but some factors have been identified.

Some theories focus on the uterus itself. In one, the defect arises from the mismatch in myometrial contraction between the thicker superior edge of the incision and the thinner inferior edge. Approximation of incision edges with variable thickness can contribute to the development of CSD. With more cesarean sections, the difference in thickness usually becomes more pronounced. Increasing number of cesarean sections is clearly associated with increased risk for CSD per a study performed by Ofili-Yebovi [3]. They also endorse an association with uterine retroflexion.

Another factor aside from the tissue itself is thought to be due to surgical technique with closure of hysterotomy. The method of closure might affect the healing process. Yazicioglu found that a group treated with full-thickness suturing had significantly lower frequency of incomplete healing and subsequent isthmocele [4]. Ischemic suturing technique and a slow absorbable suture are also thought to produce abnormal healing [5]. However, a recently published meta-analysis found no significant difference in the risk of uterine scar defect with single-layer versus double-layer closure [6].

Theories due to the state of the uterus after labor are also considered. There is an association between the degree of cervical dilatation and duration of labor with an increase in the risk of CSD if the duration of labor is greater than 5 h or if cervical dilation is greater than five centimeters [7]. In late labor, the modified cervix becomes part of the lower uterine segment. A low transverse hysterotomy is the most common if performed late in labor, and cervical tissue may be included in the closing sutures, causing interference with the healing of the scar.

23.2.2 Clinical Manifestation

There are well-documented obstetric and gynecologic complications of cesarean section that present long after the surgery itself. Gynecologic complications are often found in patients with CSD including postmenstrual abnormal bleeding, chronic pelvic pain, and secondary infertility. The classic symptom of CSD is postmenstrual abnormal bleeding. This bleeding usually lasts approximately 2–12 days after menstruation. It is usually scarce and dark in color. In Morris' description of CSD, he described a relationship between this postmenstrual bleeding and the presence of anatomic and histologic changes at the site of the cesarean scar.

Postmenstrual bleeding occurs in approximately 1/3 (33.6%) of women with a cesarean scar niche. There is a direct relationship between the size of the defect and the quantity and duration of the bleeding. Retroverted uteri are also especially prone to this postmenstrual bleeding. Three factors are likely directly related to this postmenstrual bleeding: First, the disruption in the continuity of the endometrium due to the uneven myometrial layers acts as a reservoir pouch. This "niche" collects menstrual blood and debris, and the slow and irregular outflow of this retained blood is what causes the postmenstrual bleeding (Fig. 23.1). Second, the myometrium contains fibrotic tissue, which prevents normal contractility of the musculature at the site of the scar. This also prevents the collected blood from being properly expelled during the menstrual cycle. Finally, there are aberrations in the cellular material at the level of the scar. There is congestion of the endometrial tissue above the

scar, lymphocytic infiltration, and the presence of small polyps (Fig. 23.2) at the level of the cesarean scar defect [2].

Other clinical symptoms of CSD include dysmenorrhea, chronic pelvic pain, and dyspareunia. Disruption of the myometrial layer of the uterus results in chronic inflammation and lymphocytic infiltration within the scar. These reactive changes are likely what causes the aforementioned symptoms. Of these symptoms, dysmenorrhea is the most common with an incidence of 53% followed by chronic pelvic pain (39.6%) and dyspareunia (18.3%) [8].

CSD is also a cause of secondary infertility. Retrograde passage of menstrual blood into the uterine cavity, especially in retroverted uteri, can affect the quality of the endometrium with consequences during embryo implantation (Fig. 23.3).

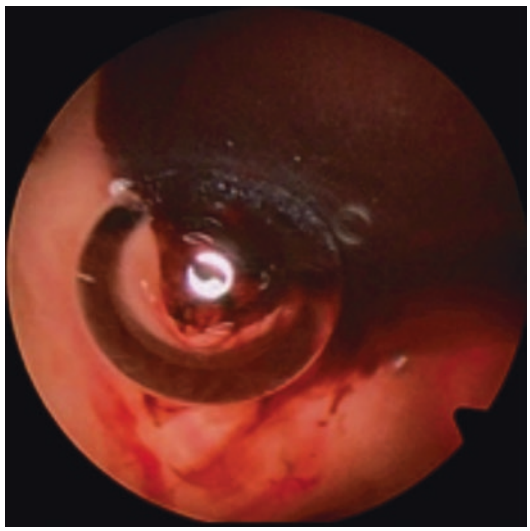

Fig. 23.1 Blood and clots collected in the scar defect

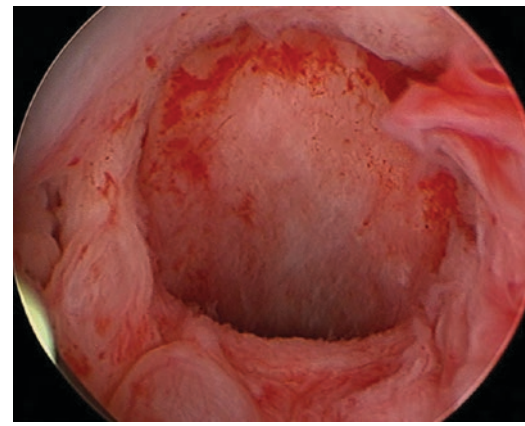

Fig. 23.2 Local inflammation at the level of the cesarean scar defect

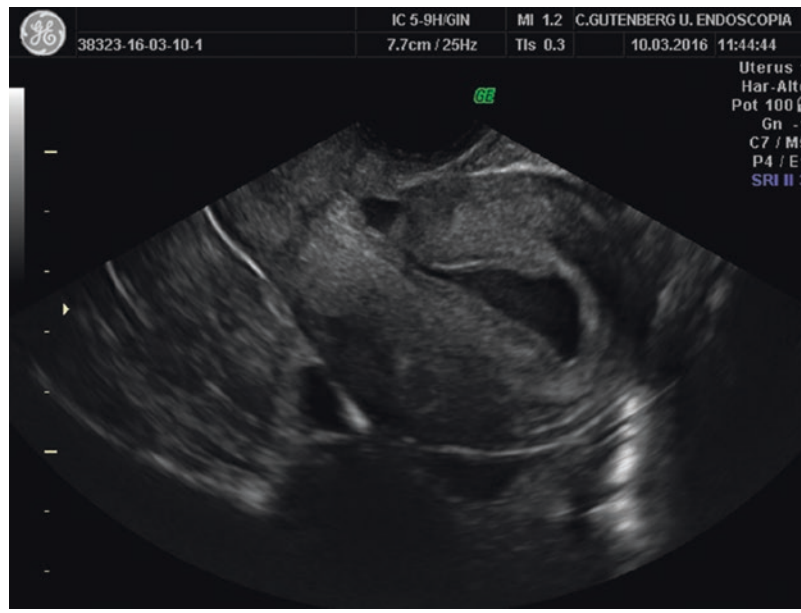

Fig. 23.3 Retrograde passage of menstrual blood into the uterine cavity

Also, the endometrial congestion within the niche can affect cervical mucus, thus prohibiting sperm transportation to the uterine cavity.

23.2.3 Diagnosis

The diagnosis of CSD begins with a history of cesarean section and a high clinical suspicion due to symptomatology or secondary infertility. Diagnostic imaging tools such as various forms of ultrasound, hysteroscopy, and hysterosalpingography are useful in confirming suspicions. However, currently, there is a lack of consensus on the definition of cesarean scar defect with regard to imaging studies. One study defined a niche as defect with a depth of at least 1 mm when visualized with gel infusion sonogram [9]. This study acknowledged that there are different shapes and sizes of the defects including triangular and semicircular, but they did not feel this was relevant to the definition as it had no effect on symptomatology in their study. Another published article sought to create a classification system to aid in standardization of CSD classification. Their definition was a "triangular hypoechoic defect in the myometrium at the site of the previous hysterotomy" [10]. Clearly, there is need for further study in order to adequately define and classify these defects.

The imaging modality of choice when evaluating a patient with postmenstrual bleeding, dyspareunia, and chronic pelvic pain is transvaginal 2D or 3D ultrasound. Therefore, CSD is usually initially visualized with this imaging modality. However, saline infusion sonohysterogram (SIS) or gel infusion sonohysterogram (GIS) have also been utilized as they fill the niche and allow for more thorough imaging of the defect. Hysterosalpingography, hysteroscopy, and MRI have also been used for diagnosis.

23.2.4 Ultrasound

Transvaginal ultrasound is overall very accurate in detecting cesarean scar defects. The niche is defined by the presence of an anechoic area at the site of a previous cesarean section (Fig. 23.4). This niche is usually triangular shaped with the vertex toward the isthmus. Some diagnostic criteria state that presence of fluid within the incision site is necessary to deem it a CSD [10]. The prevalence of an isthmocele on evaluation with conventional 2D ultrasound is 24% [7]. The use of 3D ultrasound facilitates the study of the defect in multiple planes and can offer more information than conventional ultrasonography. The best time to image the uterus is during the late proliferative phase of the menstrual cycle. At that time, the cervical mucus can fill the niche and help make the diagnosis of CSD (Fig. 23.5).

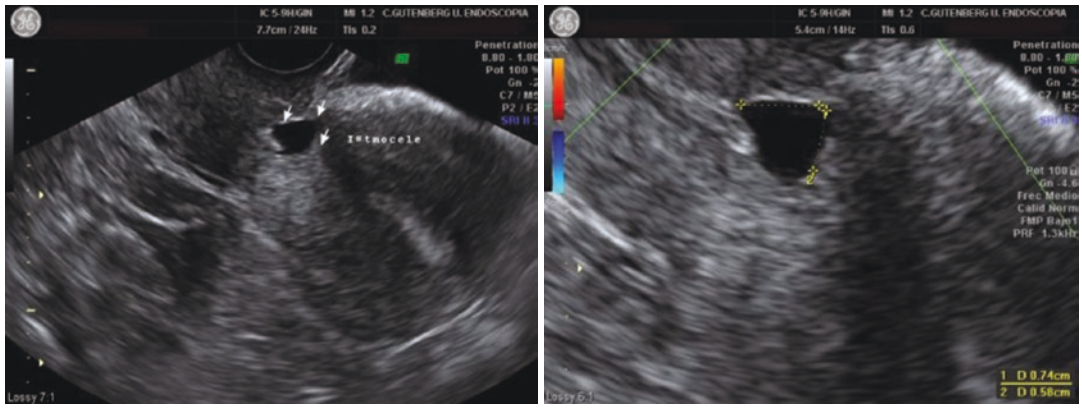

Fig. 23.4 Typical triangular shaped of the isthmocele with the vertex toward the isthmus

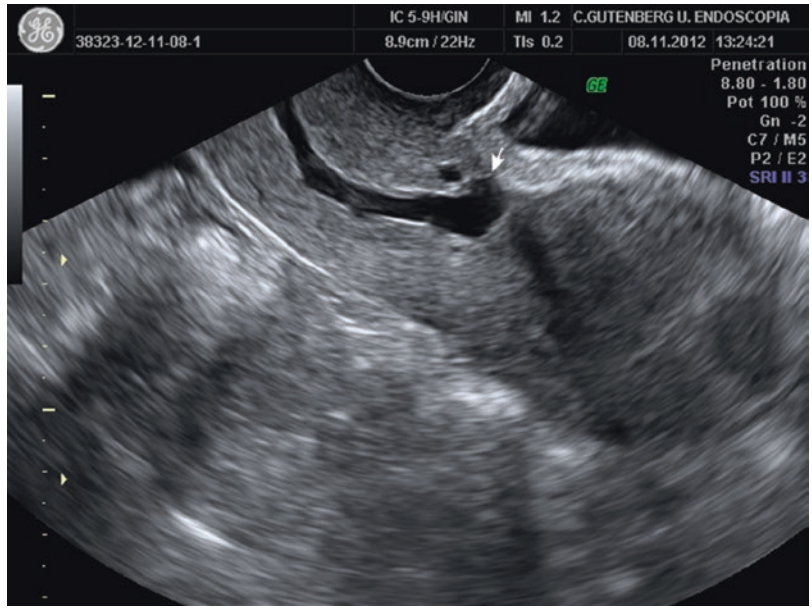

Fig. 23.5 Mucus filling the defect

23.2.5 Hysterosalpingography

Hysterosalpingography is another imaging modality used to diagnose CSD. This is usually an incidental finding during other workup. The presence of an anatomical defect is found in about 60% of patients. The defect usually appears as a diverticulum in the uterus or a thin linear defect in the lower uterine cavity and is commonly seen in patients with a previous cesarean section.

23.2.6 Sonohysterography

The use of saline infusion sonohysterogram (SIS) or gel infusion sonohysterogram (GIS) provides a clear visualization of the CSD due to the filling of the niche with liquid. Once expanded with the distention medium, the niche is more apparent which facilitates the diagnosis. More defects are detected using sonohysterography than traditional ultrasonography, and the defects are classified as larger overall [11]. The instillation of saline/gel inside the uterine cavity also allows for the clinician to describe different shapes and sizes of the defects. The prevalence of an isthmocele on evaluation with gel is around 56% [7]. GIS has an added advantage over SIS because the gel remains in the cavity and defect longer, which allows for more thorough imaging and evaluation of the CSD.

23.2.7 Hysteroscopy

Hysteroscopy allows for direct visualization of the scar defect inside the uterus. It is considered the "gold standard" for diagnosis of isthmocele. During hysteroscopy, a pseudo-cavity is visualized in the anterior wall of the lower uterine segment or in the upper third of the cervical canal. Traditionally, this is identified as a "double arch" of fibrous tissue with a dome between those fibrous layers representing the niche itself (Fig. 23.6). The dome of the isthmocele is covered by endometrium with various grades of inflammation. In the early proliferative phase, blood and some clots are usually visualized filling the anatomical defect and the cervical canal.

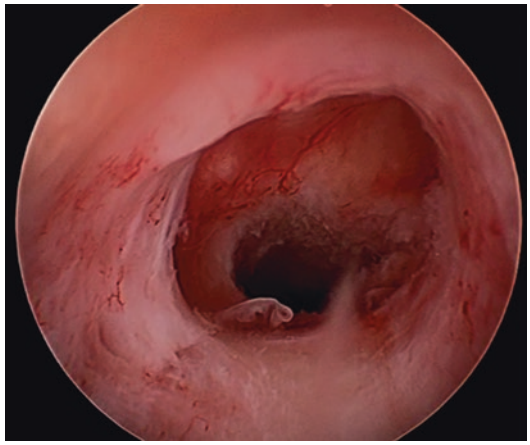

Fig. 23.6 "Double arch"

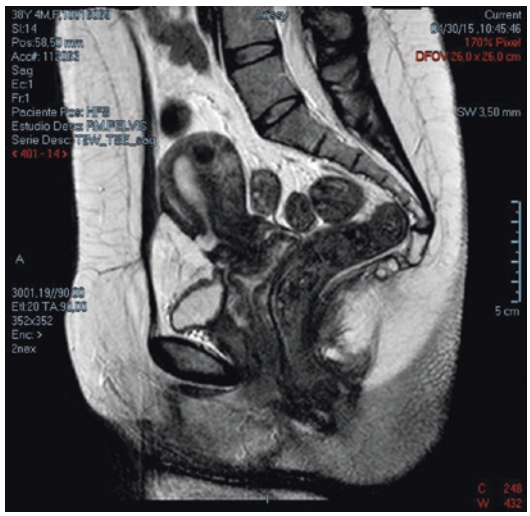

Fig. 23.7 Myometrial defects as seen with MRI

23.2.8 Magnetic Resonance Imaging

Magnetic resonance imaging (MRI) can also detect myometrial defects in the lower uterine segment. It is utilized for visualization of distinct layers of the tissue and to identify tissue planes. The MRI displays a linear low-signal area, sometimes filled with fluid (Fig. 23.7). MRI can be useful for surgical planning if the clinician is interested in a corrective procedure as well as to rule out other intrauterine conditions.

23.2.9 Classification of Cesarean Scar Defects

There are two main classification systems used to grade CSD. Gubbini proposed the first classification system in 2011 [12]. In this system, the depth and the base of the isthmocele are measured, and the area of the triangular isthmocele is calculated using (base × height)/2. The size of the calculated area was then used to separate the isthmoceles into three grades: grade 1 with an area <15 mm^3, grade 2 with an area between 16 and 25 mm^3, and grade 3 with an area >26 mm^3. Gubbini and colleagues found that more than 55% of cases were grade 1.

Yebovi classified the isthmoceles according to the endometrial thickness at the level of the CSD. The thickness was defined by the ratio between the myometrial thickness at the level of the defect and the thickness of the adjacent myometrium. If the ratio was >50%, it was considered to be large [3]. The researchers also determined that a scar defect was large if the thickness of the remaining myometrium over the defect was <2.2 mm or if during SIS/GIS the thickness of the remaining myometrium over the scar was <2.5 mm. The concern of their study was uterine dehiscence, and a ratio equal to or greater than 80% was considered to be concerning for this sequelae.

23.2.10 Medical Treatment

The use of oral contraceptives can be a conservative alternative for the management of postmenstrual bleeding. Oral contraceptives can be utilized to decrease and regulate menstrual bleeding if there are contraindications to surgery or the patient is minimally symptomatic and/or does not wish to undergo surgery. Published results on the efficacy of medical management are conflicting. Some studies conclude that medical therapy fails to eliminate the bleeding [13]. Others support the use of oral contraceptives for treatment of inter- and postmenstrual bleeding in patients with defects in the lower uterine segment with decrease in the quantity of bleeding [14]. At this time,

there are no consistent studies about the use of the hormonal intrauterine device.

23.2.11 Surgical Treatment

Definitive treatment of cesarean scar defect is performed with surgery. Various surgical options have been proposed to treat CSD including laparoscopy, resectoscopic and hysteroscopic surgery, and vaginal surgery. Surgery should be reserved for symptomatic patients with postmenstrual bleeding, chronic pelvic pain, or secondary infertility.

The surgical treatment of isthmocele aims to avoid retention of menstrual blood at the level of the defect with the goal of eliminating postmenstrual spotting. The laparoscopic and vaginal approaches seek to eliminate the defect altogether in a reparative surgery. Hysteroscopic surgery can also be performed for improvement of symptoms. As a general rule, it is accepted that in cases in which the residual myometrial thickness at the level of the isthmocele is greater than 3 mm, the hysteroscopic approach is an adequate and safe option. However, if the endometrial thickness at that level is less than 3 mm, the laparoscopic approach should be employed because it will more adequately restore the anatomy and avoids the risk of uterine perforation [15].

After hysteroscopic surgery, between 59.6% [16] and 64% [17] of patients reported a postoperative improvement of postmenstrual bleeding. This improvement was more evident in patients with anteflexed uterus.

23.3 Resectoscopic Surgery

Fernandez [18] was the first clinician to reference the use of the resectoscope in the treatment of CSD. The procedure removed the fibrotic tissue of the inferior part of the scar or "double arch" previously mentioned in order to facilitate drainage of the menstrual blood collected in the niche, thus reducing postmenstrual bleeding. Since then, multiple articles have been published about the efficacy of resectoscopic surgery, and it has become the most applied approach for the treatment of symptomatic CSD. Fabres [19] went a step further and used local fulguration of the dilated blood vessels and endometrial glands in the isthmocele to avoid in situ production of fluid or blood that might again fill the defect even with adequate drainage (Fig. 23.8). The risk most associated with resectoscopic surgery is the possibility of uterine perforation and secondary bladder injury. In order to prevent this complication, some authors recommend avoiding use of the resectoscope if the remaining myometrium at the level of the niche is <2 mm [17].

23.3.1 Laparoscopic Surgery

As aforementioned, the purpose of laparoscopic surgery is restoration of the myometrium and complete resolution of the CSD. The reduction or elimination of the niche will result in improvement of the related symptoms. The main advantage of this approach is that it is considered a definitive treatment with restoration of the thickness of the uterine wall, which cannot be done with the hysteroscopic or resectoscopic approaches [20]. Donnez [21] described a laparoscopic approach with excision of the fibrotic tissue around the scar and laparoscopic suture to re-bridge the healthy myometrium on either side of the thinned-out scar. Klemm used a combined laparoscopic and vaginal approach to repair the defect [22]. Laparoscopic surgery offers a clear visualization of the surgical area after dissection of the bladder with low risk of damage and reparative treatment (Fig. 23.9).

23.3.2 Vaginal Surgery

The vaginal approach to the repair of CSD is also considered to be reparative; it restores the continuity of the myometrial layer and increases the thickness of the entire anterior uterine wall. This was initially performed by Klemm in combination with laparoscopy [22]. A newer vaginal repair technique has recently been proposed; the cervico-vesical space is opened, and the bladder is

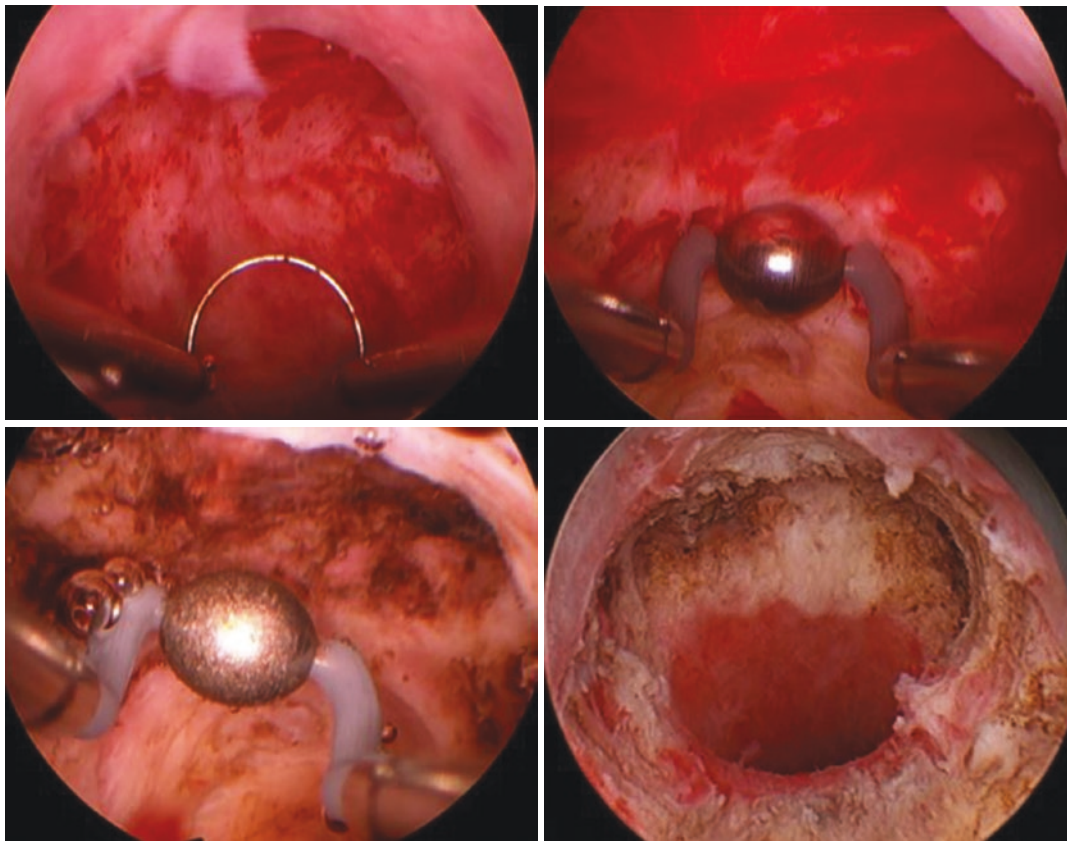

Fig. 23.8 Resectoscope in the treatment of CSD. Step-by-step

dissected off of the cervix at which time the scar is opened and the fibrotic tissue removed. The opened scar is closed with two layers of suture to once again approximate the tissue [23]. This approach is a minimally invasive way of repairing the myometrium and removing the CSD.

23.3.3 Surgical Considerations

With the advent of surgical intervention, a new question has arisen as to whether a spontaneous vaginal delivery is safe after completion of isthmoplasty. The current recommendation of the Global Congress of Hysteroscopy Research Committee is to perform an elective cesarean section no later than week 38 of gestation due to risk of uterine rupture [15].

Key Points

- It is important to bear in mind that postmenstrual bleeding in patients with a previous caesarean section may be related to the presence of an isthmocele.
- Isthmocele is significantly linked to abnormal uterine bleeding (usually postmenstrual), as well as to secondary infertility.
- The diagnosis of isthmocele is based on clinical signs and complementary/confirmatory tests such as ultrasound, SIS/GIS, and hysteroscopy.
- Hysteroscopy is the "gold standard" technique for the diagnosis of isthmocele.
- There are two classification systems for isthmocele. Gubbini proposed using the area of the triangular defect to grade the isthmocele, while Yebovi focused on the thickness of the myometrium at the level of the defect.

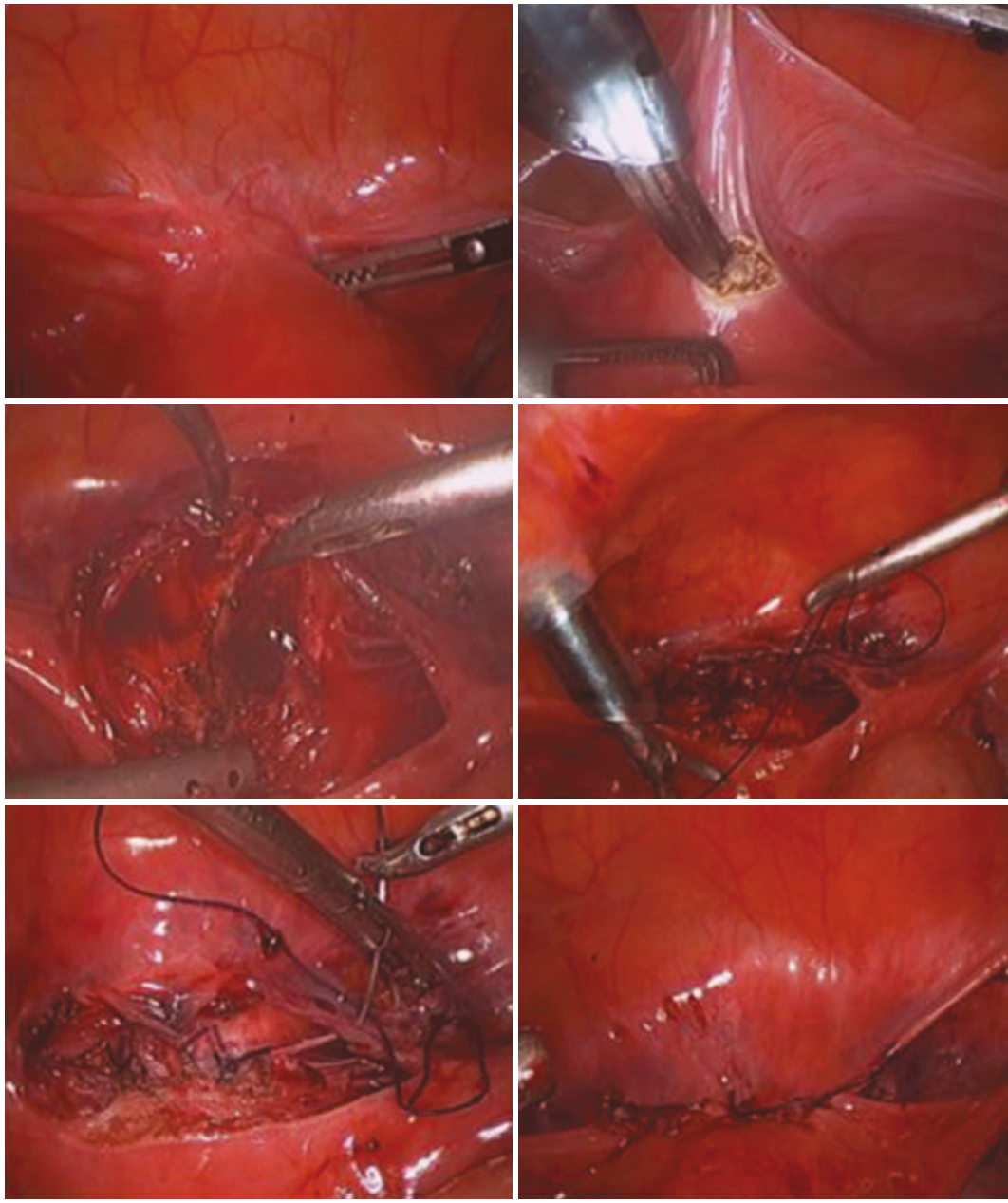

Fig. 23.9 Laparoscopic management of CSD

- There are several proposed treatments aimed at resolving the symptomatology associated with the isthmocele, especially bleeding and secondary infertility.
- The hysteroscopic and resectoscopic approaches are for symptomatic treatment, while laparoscopic and vaginal surgeries aim to repair the defect, making them a restorative treatment.
- As a general rule, it is accepted that in cases in which the residual myometrium thickness at the level of the isthmocele is greater than 3 mm, the hysteroscopic approach is an adequate and safe option.

- If the endometrial thickness at this level is less than 3 mm, the laparoscopic approach should be preferred because of the risk of uterine perforation and the likely need for more definitive management to ensure restoration of the uterine wall myometrium at the scar.
- After the correction of the scar defect, the recommendation of the Global Congress of Hysteroscopy Research Committee is to perform an elective cesarean section no later than week 38 of gestation due to the risk of uterine rupture.

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Hysteroscopic Management of Cervical Ectopic Pregnancy

24

Mala Raj

24.1 Introduction

Implantation of blastocyst in the intracervical canal is called cervical ectopic pregnancy. The incidence is found to be 1:1000–95,000 [1]. It is a high-risk condition where the women will present with severe bleeding due to erosion of the cervical blood vessels, which can occasionally lead to even hysterectomy. It is more common in ART pregnancies (Ginsburg, 1994). With high index of suspicion and early diagnosis with the help of biochemical and imaging techniques, we are able to provide conservative medical management and surgical management, thereby avoiding hysterectomy and thereby retaining their fertility. Hysteroscopy is the gold standard in the diagnosis and management of cervical ectopic pregnancy. It not only allows direct visualization but also allows control of hemorrhage and complete resection of the ectopic pregnancy, thereby avoiding prolonged follow-up.

24.2 Diagnostic Criteria

Most of the times, cervical ectopic pregnancy can be misdiagnosed. There are various criteria to diagnose. They are:

24.2.1 Rubin Pathological Criteria (1911) [2]

- Cervical glands must be present opposite the placental attachment.
- Attachment of the placenta to the cervix must be intimate.
- The whole or portion of the placenta must be situated below the entrance of the uterine vessels or below the peritoneal reflection of the anterior and posterior surface of the uterus.
- No fetal elements must be present in the corpus uteri.

24.2.2 Raskin Criteria (1978)

(a) Enlargement of the cervix.
(b) Uterine enlargement.
(c) Diffuse amorphous intrauterine echoes.
(d) Absence of intrauterine pregnancy.

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24.2.3 Timor Tritsch et al. (1994)

Timor refined Raskin Criteria:

(a) Placenta and entire chorionic sac containing the pregnancy should be below the internal cervical os.
(b) Cervical canal must be dilated and barrel shaped.

24.2.4 Ushakov's Sonographic Criteria (1996)

- GS in the endocervical canal.
- Presence of some intact cervical tissue between the GS and the internal orifice.
- Trophoblast invasion of the endocervical tissue.
- Embryos or fetal structures, in particular the pulsating heart in the ectopic gestational sac.
- Empty uterine cavity.
- Sandglass-shaped uterus.
- Endometrial decidualization.
- Doppler detection of peritrophoblast arterial flow.

24.2.5 Paalman and McElin (1959) Criteria [3]

- Uterine bleeding without cramping pain following a period of amenorrhea.
- A soft, enlarged cervix equal to or larger than the fundus.
- Products of conception entirely confined within and firmly attached to the endocervix.
- A closed internal cervical os.
- A partially opened external cervical os.

24.3 Diagnosis

Many a times, cervical ectopic pregnancy can be confused with an aborting intrauterine pregnancy, which can be differentiated by "sliding sign" on transvaginal ultrasound (Turkotic et al., 1996). When gentle pressure is applied on the cervix with the probe, the gestational sac of an abortus slides against the endocervical canal unlike an implanted cervical pregnancy.

In cervical ectopic pregnancies, we can visualize a pseudo gestational sac in which there will be only a single echogenic layer (instead of two concentric echogenic rings of a true gestational sac) surrounding an intra-endometrial fluid collection. Color Doppler (especially transvaginal) will demonstrate focal "peritrophoblastic" flow that demonstrates a low resistance pattern in pulsed Doppler waveform analysis. It tends to show a focal area of arterial flow adjacent to the sac that is more intense than other color flashes in the uterus. Because of low diastolic resistance, this area of color flow will appear continuous or nearly continuous during real-time examination. Before 1980, cervical pregnancy was diagnosed when dilation and curettage for presumed incomplete abortion resulted in unexpected hemorrhage. However, now it can be easily diagnosed by a first-trimester ultrasound examination.

24.4 Risk Factor

Risk factors for cervical ectopic include any compromise in the capacity of the uterine cavity that prevents nidation in the endometrium. These include structural uterine anomalies, intrauterine adhesions, myomas, rapid transport of fertilized ovum due to non-receptive endometrium, abnormal timing of fertilization in relation to menstrual cycle, postsurgical trauma, as well as in vitro fertilization [4, 5]. Higher the implantation more is its capacity to grow, but chances of hemorrhage also increase due to its close proximity to uterine blood vessels and the proteolytic enzymes released by the trophoblast on the walls of these large blood vessels which can potentially be life-threatening [4].

24.5 Differential Diagnosis

Cervical aborting intrauterine pregnancy is trapped in the endocervical canal because of resistance from the external cervical os. In recent times, in vitro fertilization and other assisted reproductive technique have been reported to be associated with increased risk of cervical pregnancy, and the etiology is attributed to the rapid transport of fertilized ovum into the endocervical canal because of an unreceptive endometrium. According to one review, the incidence of cervical pregnancy is 0.1% among in vitro fertilization pregnancies [4].

24.6 Treatment

The most effective treatment of cervical pregnancy is unclear.

24.6.1 Medical Treatment

Single or multidose intramuscular methotrexate is effective in 80–90% of cases of early cervical pregnancy. Criteria for successful methotrexate therapy are:

1. Patient should be hemodynamically stable.
2. No fetal cardiac activity.

Introduction of methotrexate with or without intra-amniotic potassium chloride represents a major advance in terminating cervical ectopic pregnancy especially in early stages [6]. Among the various routes for methotrexate administration, intramuscular route is usually preferred. The patient should be hemodynamically stable and must comply with posttreatment monitoring [4].

In case of cervical pregnancy, usually the multidose methotrexate regimen, i.e., 1.0 mg/kg body weight on days 1, 3, 5, and 7 interspaced by leucovorin 0.1 mg/kg body weight, is preferred. Posttreatment decline in weekly serum beta hCG level shows the successful therapeutic intervention.

24.6.2 Surgical Treatment

According to the available literature, the most effective treatment of cervical ectopic in early weeks of gestation is conservative management by means of methotrexate. Ineffectiveness of this cytotoxic drug has been observed with serum HCG level higher than 10,000 IU/mL, presence of cardiac activity, and a crown-rump length of >10 mm on ultrasound. Methods of fertility preservation in a case of failed medical management include uterine artery embolization and intra-amniotic instillation of potassium chloride and/or methotrexate. Methods of management of intractable hemorrhage include insertion of Foley catheter for tamponade effect post curettage, cerclage suture at the level of internal os, ligation of descending cervical branches of the uterine artery, and internal iliac artery ligation [7]. Because of the risk of massive life-threatening hemorrhage, cervical pregnancy is in most cases treated by surgical removal of the uterus. However, there has now been a shift in management from aggressive surgical procedures to more conservative management strategies focusing on uterine preservation and fertility maintenance, and the need for hysterectomy has declined from 89.5% in 1979 to 21.7% in 1994 [8]. Uterine artery embolization (UAE) emerged as an extremely effective technique owing to risk of excessive hemorrhage if intra-amniotic instillation had been performed. It can be performed prior to suction and evacuation to prevent the catastrophic hemorrhage. It has high clinical effectiveness and a low complication rate. However, despite all the benefits of UAE, it still remains an underutilized procedure. This is mainly due to limited availability of modern angiography units and lack of a trained skilled team. Regardless of the conservative approaches, cervical ectopics must be followed up until complete resolutions, i.e., serum HCG values 10 IU/mL, and one must not rely on ultrasound findings alone. But the main problem with UAE is that it would compromise the ovarian reserve so not apt for fertility patients.

24.7 Hysteroscopic Management

Hysteroscopic removal of ectopic pregnancy is the latest option in the management of cervical ectopic pregnancy where the products of conception can be identified within an enlarged area of concavity of the cervical canal, the product of conception can be removed using bipolar resectoscope, and the blood vessels can be ablated simultaneously. Complete resection through hysteroscopy under direct visualization helps in preventing hemorrhage, promotes resolution, and avoids prolonged follow-up. The visualization of normal uterine cavity with the entire gestational sac embedded in the wall below the internal os is considered superior and more definitive diagnosis. Hemorrhagic mass is visualized with or without active bleeding to the adherent tissue demonstrating chorionic villi on the surface to a well-formed gestational sac with or without a live embryo.

Distension in the limited space in the cervical canal is a challenge. The Karl Storz bipolar resectoscope with inflow-outflow system is helpful with occlusion of the external os with a vulsellum. The procedure needs to be completed quickly and plane of cleavage need to be identified between the mass and the cervix. Bleeders can be identified and coagulated. But if it persists, then it can be controlled with balloon tamponade with a Foley bulb distended to control bleeding. Best approach would be uterine artery ligation laparoscopically along with hysteroscopic removal of ectopic pregnancy which would also preserve the fertility potential of the patient.

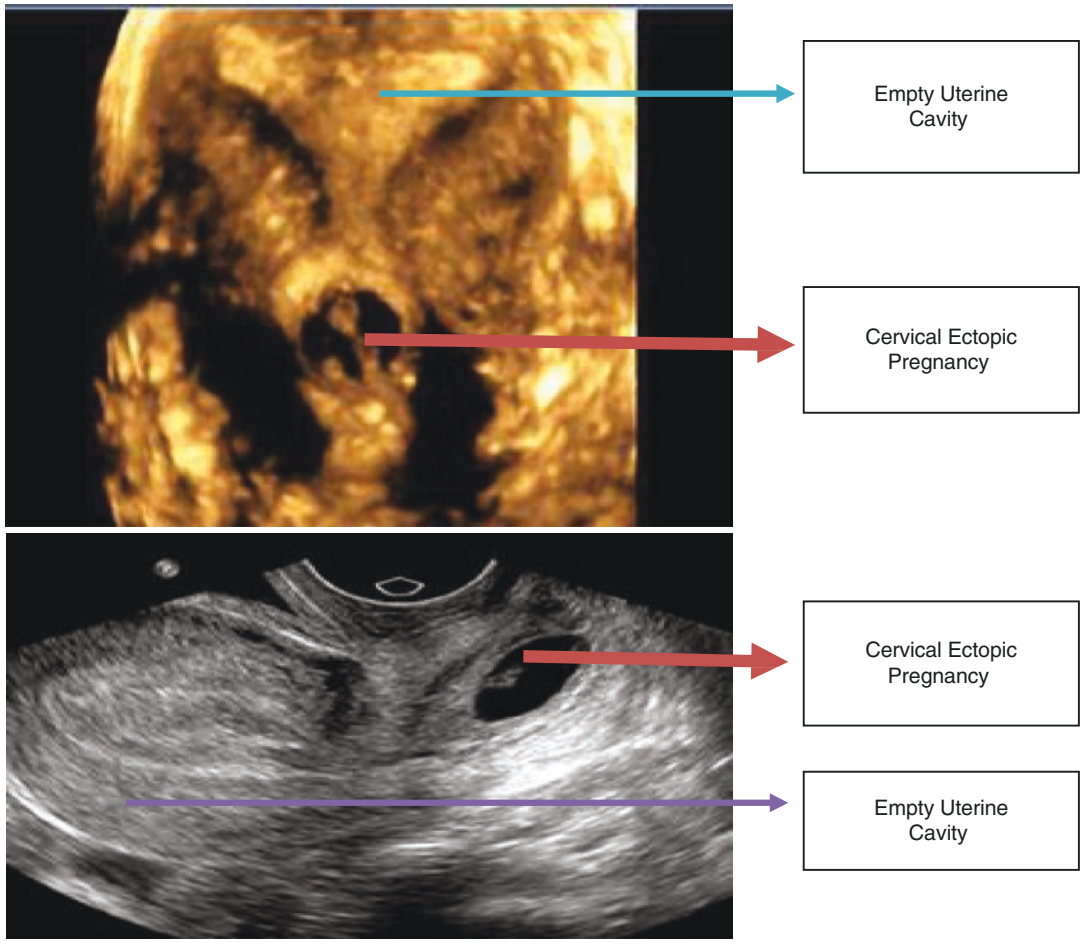
In 1992, Roussis et al. described the first case in which hysteroscopy was used to visualize a cervical ectopic pregnancy and suction evacuation was done but resulted in incomplete resolution in spite of multiple dose of methotrexate [9]. Four years later, Ash and Farrell published the first case of operative hysteroscopy without prior chemotherapy to completely resect a viable cervical pregnancy [10].

In 2004, Kung et al. performed laparoscopic-assisted uterine artery ligation along with hysteroscopic endocervical resection in six patients, thereby avoiding methotrexate prior to hysteroscopy, and menstruation resumed in two months period and patient achieved pregnancy spontaneously in 14 months postoperatively.

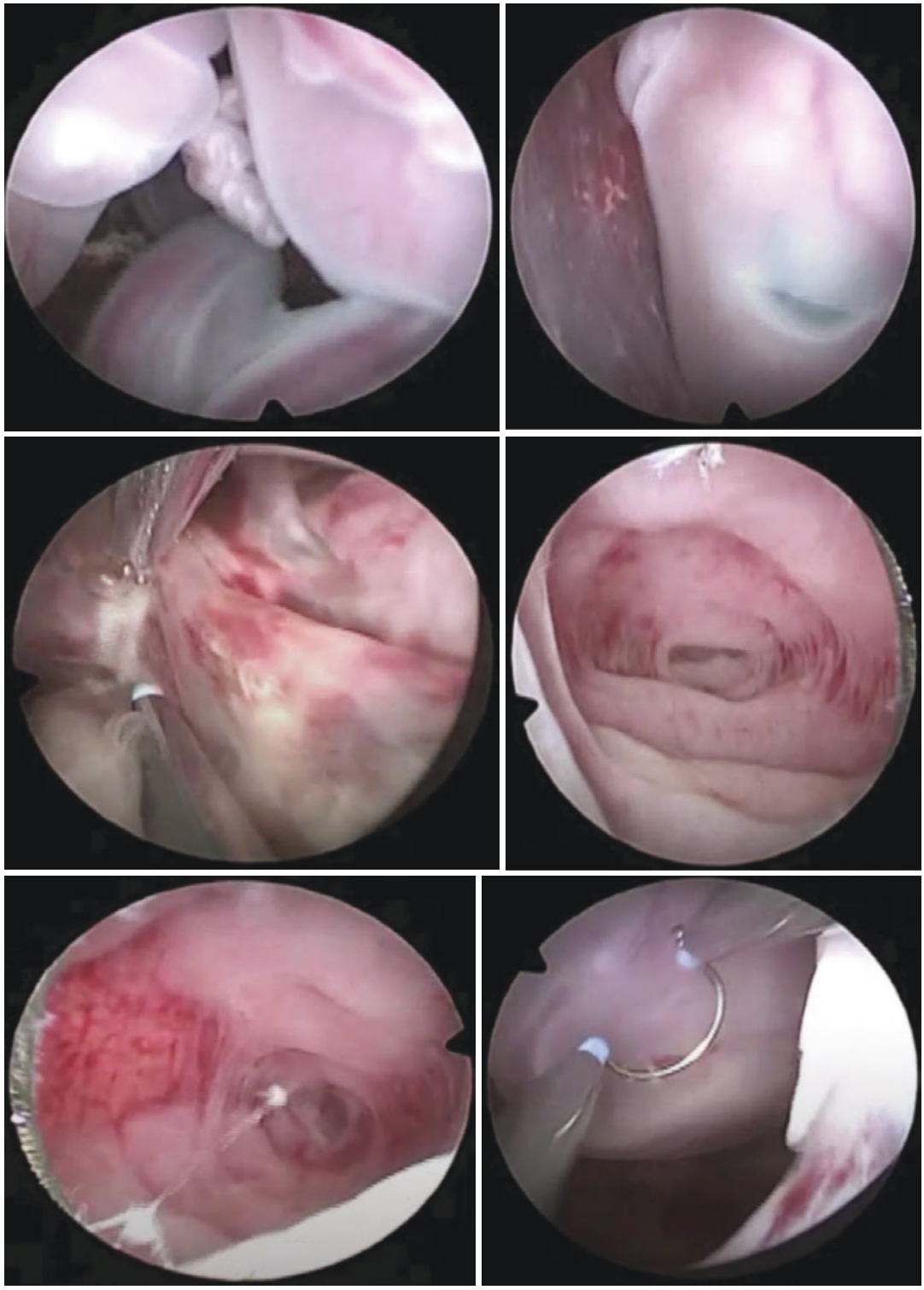
24.8 Conclusion

Cervical ectopic pregnancies are easy to miss and difficult to treat. Early diagnosis and medical management with systematic or local administration of methotrexate are the treatments of choice. Conservative approaches in late stages have proven beneficial in preserving a women's fertility. Hysteroscopic resection is a potentially safe and effective option for fertility-sparing management of cervical ectopic pregnancy.

Sonographic View of Cervical Ectopic Pregnancy



Hysteroscopic Management of Cervical Ectopic Pregnancy



Key Points

1. Cervical ectopic pregnancy is a rare condition.
2. Diagnosed by ultrasound and biochemical parameters.
3. The most significant ultrasound finding is sandglass-shaped uterus with empty uterine cavity.
4. Can be misdiagnosed with incomplete abortion.
5. Early line of management is methotrexate injection.
6. If diagnosed late, laparoscopic uterine artery ligation with hysteroscopic evacuation is best.
7. Uterine artery embolization is not advised if the patient wants to conceive.

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Hysteroscopy in Postmenopausal Group

25

S. Krishnakumar, Rohan Krishnakumar, Rachana Kaveri, and Aditi Joshi

25.1 Introduction

Menopause is the permanent cessation of menstrual cycle due to natural depletion of ovarian oocytes. The exact time interval to define menopause is difficult since many women have anovulatory cycles leading to episodes of amenorrhea preceding actual menopause. However, an interval of 12 months or more is taken as the arbitrary value. Women in this age group present with certain specific conditions which can pose a diagnostic challenge. The management protocols applied are typically in line with the etiology. Hysteroscopy is the technique utilized for inspecting the uterine cavity with an endoscope via the cervix. It is one of the newer modalities for diagnosis as well as treatment and is currently the gold standard.

25.2 Indications

Increased longevity of life has led to presentation of certain characteristic conditions in women of this age group. Hysteroscopy helps make a precise diagnosis in these patients. Some of the common indications of hysteroscopy for these patients include:

Table 25.1 Differential diagnosis of postmenopausal bleeding

Causes	Percentage
Atrophic endometrium	60–80
Hormone replacement therapy	15–25
Endometrial hyperplasia	5–10
Endometrial carcinoma	7–10
Endometrial polyp	2–12
Others (leiomyoma, cervicitis, atrophic vaginitis, trauma, anticoagulation)	<10

American Cancer Society Figures 2012 [1]

- Postmenopausal bleeding.
- Recurrent leucorrhea.
- Forgotten IUD.
- Incidental uterine pathology detected on screening.

Postmenopausal bleeding is defined as the bleeding occurring after permanent cessation of menstruation, and it is the commonest indication of hysteroscopy in clinical practice (Table 25.1).

25.3 Evaluation

The workup of these patients comprises of a detailed history taking, thorough examination, and specific investigations to arrive at a diagnosis. Risk factors like nulliparity, chronic anovulation, early menarche, late menopause, diabetes, hypertension, obesity, tamoxifen usage, etc. can predispose to endometrial carcinoma. A history

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Fig. 25.1 Illustrating the setup for an office hysteroscopy

of medications especially anticoagulants and hormonal replacement therapy is vital. Evaluation should encompass a per-speculum examination initially to rule out local causes of bleeding such as vaginal atrophy, cervical erosion, polyp, or any mass. Other sources of bleeding like urethral caruncle, hemorrhoids, etc. must be ruled out. Per-speculum examination should be performed in patients presenting with recurrent leucorrhea since it may be an indicator of underlying pyometra or forgotten IUD.

Apart from routine blood investigations, it is mandatory to perform a Pap smear for cervical cytology and a transvaginal ultrasonography to look for intrauterine pathology and to measure the endometrial thickness. According to ACOG guidelines, an endometrial thickness of 4 mm and above warrants the need for a histopathological evaluation by means of an endometrial biopsy. Various techniques of acquiring an endometrial sample are:

1. Pipelle biopsy.
2. Dilatation and curettage.
3. Fractional curettage.
4. Hysteroscopy-directed biopsy.

Previously, the gold standard for diagnosis was an institution-based dilatation and curettage. However, with advent of minimal access surgery and sophisticated instruments, an office-based hysteroscopy and biopsy have replaced the above procedure (Fig. 25.1).

25.4 Hysteroscopy in Postmenopausal Women

In this era of minimal access surgery, hysteroscopy has revolutionized the outlook toward management of patients with localized pathology in the uterus especially in the postmenopausal age group. Elderly patients are at a greater risk for anesthesia and other comorbid conditions which can pose as a challenge in surgery. With the advent of newer telescopes, the art of hysteroscopy is shifted from the operative room to an office setting. In many cases, the need for anesthesia is completely obliterated. The findings noted on hysteroscopy are broadly classified as normal (proliferative, secretory, or atrophic endometrium) and abnormal (polyp, submucous fibroids, retained products of conception).

Traditionally considered as a gold standard, pipelle biopsy has now been replaced by hysteroscopic biopsy as the investigation of choice. Hysteroscopy offers the advantage of visualization of the endometrium and directed biopsy in the same setting.

Endometrial polyp is a benign outgrowth of the endometrium. They may be pedunculated or sessile, single or multiple, and at times vascular (Fig. 25.2). In some cases, they may even be malignant; hence, obtaining a tissue biopsy is important. The prevalence of carcinoma or atypical hyperplasia in symptomatic postmenopausal patients with endometrial polyp is 3.2% [2]. Hysteroscopy aids in localizing the site of lesion and obtaining a targeted biopsy. Furthermore, in patients with endometrial hyperplasia, certain characteristic features can be markers for malignancy (Fig. 25.3). Typical features of endometrial carcinoma noted on hysteroscopy include:

1. Marked distortion of endometrial cavity attributed to focal or extensive nodular, polypoid, papillary, or mixed patterns of neoplastic growth.
2. Focal necrosis.
3. Friable consistency.
4. Atypical neovascularization.

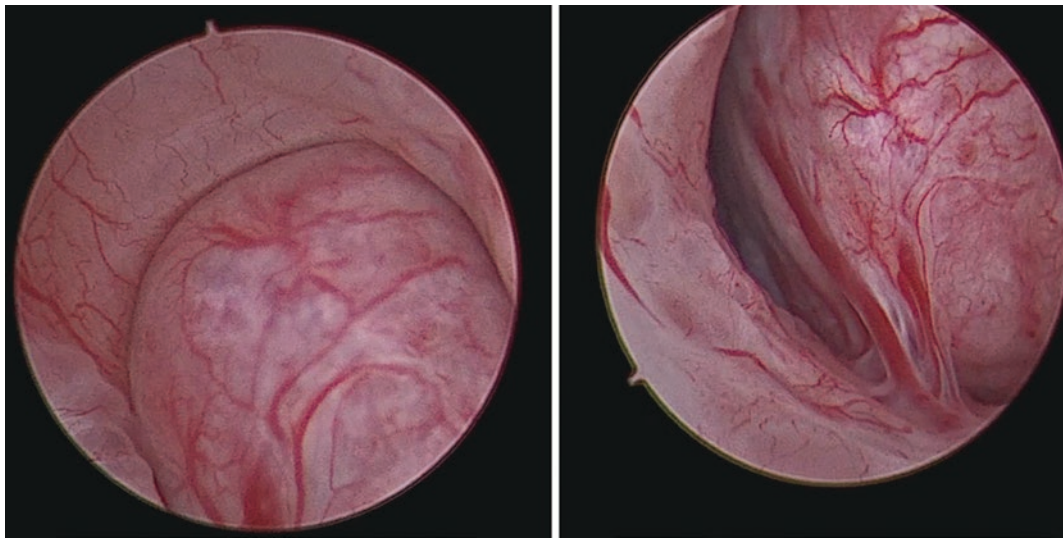

Fig. 25.2 Large endometrial polyp in a postmenopausal patient

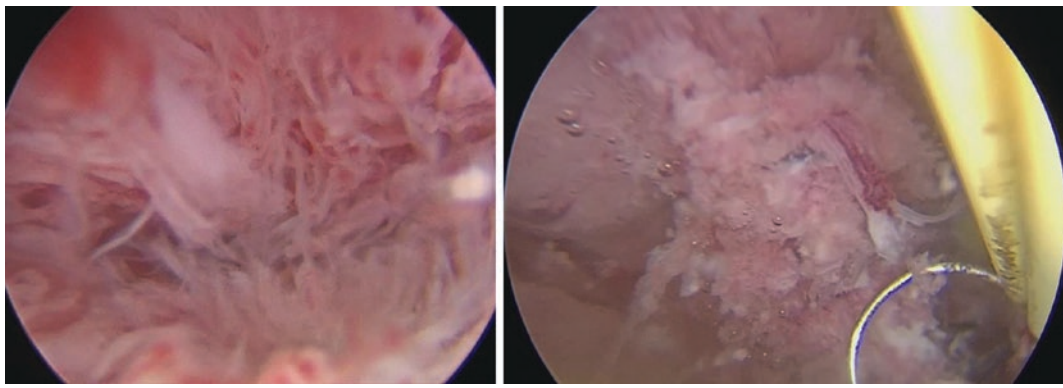

Fig. 25.3 Illustrates various appearances in carcinoma of endometrium

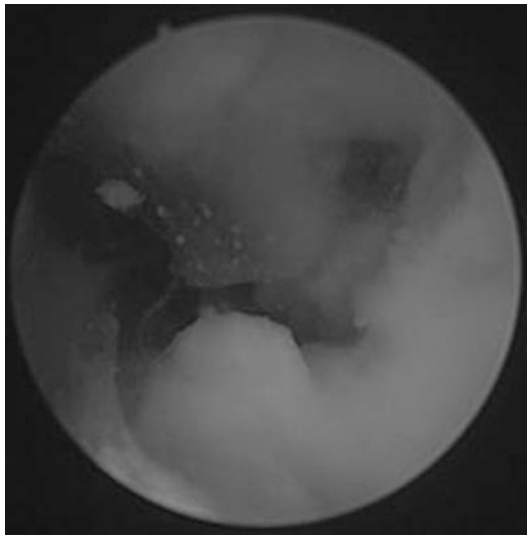

Fig. 25.4 Hysteroscopic appearance in pyometra

The primary concern with hysteroscopy in suspected endometrial carcinoma is the spread of malignant cells into the peritoneal cavity [3]. Evidence in regard to this has conflicting results. There is no particular set pressure above which transtubal reflux is known to occur. However, precaution can be exercised by maintaining the intrauterine pressure below 70 mmHg [4].

Besides postmenopausal bleeding, one of the important indications of hysteroscopy in postmenopausal women is pyometra. These patients may present with chronic pelvic pain, foul-smelling vaginal discharge, and at times fever. Pyometra may be suggestive of an underlying malignancy in elderly women (Fig. 25.4).

25.5 Challenges in Postmenopausal Women

1. Manipulation of cervix—With advanced age, often the cervix gets atrophic and becomes flushed with the vaginal walls; hence, holding the cervical lips with an instrument is often difficult. Also, the tissue is fragile, and hence overzealous attempts at holding the cervical lips can lead to bleeding. These problems can be overcome using the vaginoscopic approach of hysteroscopy in atraumatic way of entry especially in postmenopausal women.
2. Stenotic external os—With estrogen deficiency, there are various atrophic changes that have taken place in the genital system. Stenotic os is one of the common difficulties encountered in women with menopause (Fig. 25.5). Forceful dilatation of the cervical os can many times lead to formation of a false passage and at times cause perforation in these women. The BETTOCCHI model of hysteroscope (Fig. 25.6) which has an oval shape configures with the anatomy of the cervix perfectly, hence facilitating entry. In addition, the new mini-hysteroscopes (Fig. 25.7) with 1.9 mm diameter make entry even easier.
3. Atrophic uterus—Chronic estrogen deficiency leads to hypotrophy and weakening of the uterine musculature. This causes the distensibility of the uterus to decrease. The temptation to increase pressure for better visibility should be resisted. The pressure should be always kept below 70 mmHg for safety.
4. Increased chances of perforation—The operating surgeon should be cautious during entry or if excessive distention pressure is being used. Since the uterine walls are thin in these patients, unrestrained surgical maneuvers should be avoided.
5. Intravascular syndrome—Often, women in this age group have several comorbidities, and hence, even a minimal fluid deficit can have deleterious consequences.

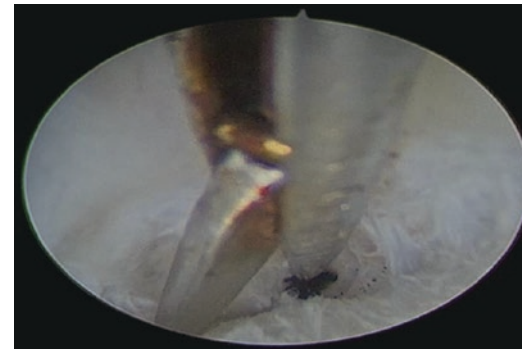

Fig. 25.5 Stenotic cervical os with entry under vision using hysteroscopic scissors

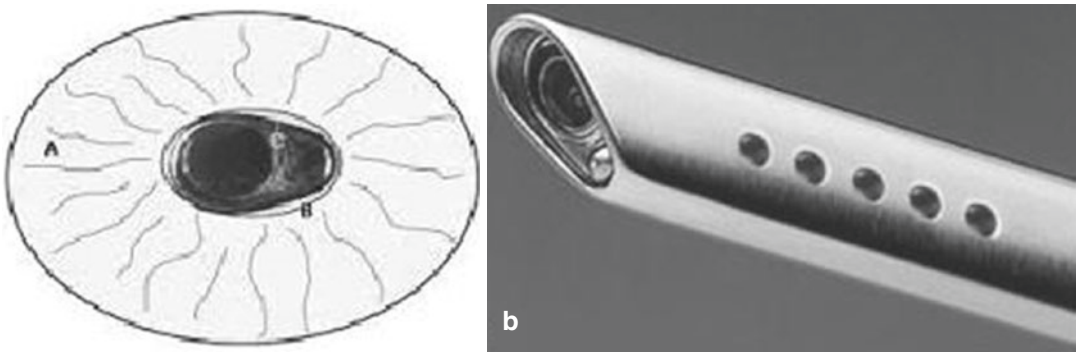

Fig. 25.6 BETTOCCHI hysteroscope with an oval shape

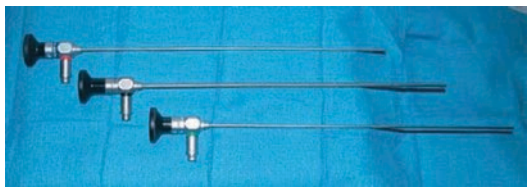

Fig. 25.7 Mini-hysteroscopes with diameter of 2 mm

25.6 Complications of Hysteroscopy

As described previously, hysteroscopy in the elderly patients is challenging owing to various anatomical factors and physiological changes of menopause. The complications commonly encountered can be classified as following:

1. Anesthesia related.

   Anesthesia-related complications are similar to any operative procedure. The choice of anesthesia may be general or regional depending upon the fitness of the patient. A chest X-ray, ECG, and 2D ECHO are a must for evaluation of the cardiopulmonary status prior to surgery.
2. Improper patient positioning.

   This can lead to various nerve injuries. Hyper-abduction of the arm can lead to brachial plexus injury. Excessive pressure by assistant surgeon or improper placement of stirrup may damage peroneal nerve leading to paresthesia. Also, these patients are more prone to fractures owing to reduced bone density and reduced mobility of joints.
3. Surgery related.
   - Uterine perforation.

     This may occur commonly due to cervical stenosis or an acutely anteverted or retroverted uterus. Excessive pressure during mechanical dilatation is also a causative factor. Apart from that, forceful dilatation can increase chances of creating a false passage which can lead to hemorrhage (Fig. 25.8).
   - Hemorrhage.
   - Intravascular absorption syndrome.

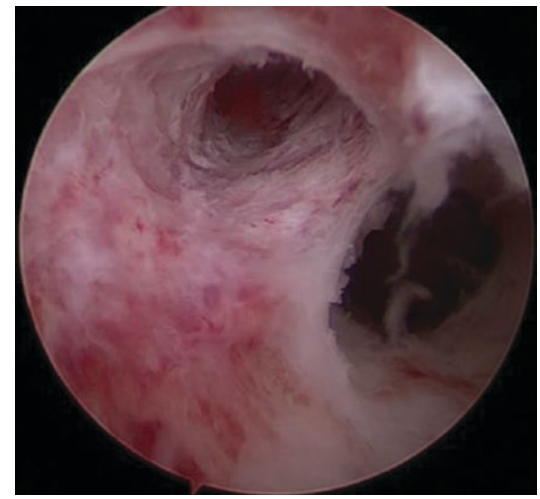

Fig. 25.8 False passage created during blind dilatation diagnosed on hysteroscopy

4. Delayed complications like infection and vaginal discharge.

   Pelvic infection is a rare complication. It may occur due to an underlying infection, undetected perforation, prolonged operative time, and repeated introduction of the instruments into the uterus. This can be avoided by administering a prophylactic antibiotic and identifying any comorbidities pre-procedure.

25.7 Prevention Strategies

- Ripening of the cervix.
  - The use of pre-procedure misoprostol is still a matter of debate. There is no standard protocol yet; however, there are a few reports in literature advocating the usefulness of misoprostol in patients with cervical stenosis. Oppegaard et al. conducted a small double-blind, placebo-controlled trial with 1000 μg vaginal misoprostol administered 24 h prior to procedure, in combination with vaginal estradiol (25 μg daily) administered in the preceding 2 weeks [5]. They reported significant cervical dilatation in postmenopausal patients given this regimen. This can help prevent uterine perforation due to overzealous force during introduction of the hysteroscope.
- Intravascular absorption syndrome.
  - This is one of the most dreadful complications and poorly tolerated in the elderly. In order to avoid this complication, some simple steps can be taken.
  - A meticulous account of the amount of inflow and outflow channels is mandatory. An automated fluid management system may be ideal in such circumstances. Prophylactic administration of a diuretic agent like furosemide should be done in cases where the deficit is >1 L for nonelectrolyte media like glycine or >1.5 L for electrolyte media like normal saline.
  - Limit the operating time to the minimum.
  - Excessive inflow pressure should be avoided as it can lead to sudden increase in intrauterine pressure which can lead to excessive fluid absorption.
  - In cases where nonelectrolyte distension media is utilized, an evaluation of serum electrolytes is a must.
  - Controlled and careful cervical dilatation in patients with cervical stenosis is important. Traumatic cervical dilatation can increase the fluid absorption rate due to opening of vascular channels.
  - Use of vasoconstrictor agents like vasopressin for intracervical instillation prior to the procedure is still controversial.
  - In patients with large submucosal fibroids, preoperative use of GnRH analogues has been reported to decease the fibroid size and vascularity. However, it may increase the risk of uterine perforation due to softening of the myometrial fibers.
- Use of mini-resectoscopes.

Fig. 25.9 GUBBINI mini hystero-resectoscope system

Initially introduced as 26-Fr resectoscopes, the newer mini-resectoscopes (Fig. 25.9) are of 18, 16, and 14.9 Fr. These offer less traumatic surgical interventions owing to the smaller diameters. These resectoscopes enable surgery to be performed with a lesser dilatation.

25.8 Conclusion

Hysteroscopy is a simple, effective, and valuable technique for diagnosis in patients with postmenopausal bleeding. The procedure is also safe if one exercises caution and is vigilant in monitoring the vital parameters. It aids in obtaining targeted tissue biopsy and hence prevents unnecessary major operative procedures, which may be poorly tolerated in patients of this age

group and especially those with other medical comorbidities.

ACOG recommends that in cases of postmenopausal bleeding, we should be vigilant for cases of endometrial carcinoma [6]. In cases with transvaginal sonography revealing an endometrial thickness of 4 mm or less, the negative predictive value for carcinoma is 99%. Other modalities of diagnosis like sonohysterography, endometrial sampling, or office hysteroscopy are also vital in cases of query. If, however, after initial investigations and negative histopathology report for carcinoma the symptoms do persist, a hysteroscopy-directed biopsy is a must. An incidental finding of endometrial thickness greater than 4 mm in asymptomatic postmenopausal women does not warrant any investigations.

Key Notes

1. Postmenopausal bleeding is the commonest clinical presentation in menopausal patients.
2. Hysteroscopy is the modality of choice for evaluating any intrauterine pathology in the postmenopausal women.
3. Advent of mini-hysteroscope has obviated the need for dilatation of the cervix. Hence, it is highly useful for patients especially with cervical stenosis.
4. A thorough preoperative workup, efficient intraoperative anesthesia, and meticulous calculation of fluid deficit is mandatory.
5. The new age mini-resectoscopes like GUBBINI resectoscope have enabled safe surgery in patients with large intrauterine pathologies like polyp or myoma.
6. Atrophic changes characteristic to menopause pose challenges during hysteroscopy which may lead to complications. Hence, a high index of suspicion is necessary.
7. In expert hands, hysteroscopy is a safe and effective tool for diagnosis as well as treatment.

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26 Complications of Hysteroscopy and Management

Rahul Manchanda and Richa Sharma

Diagnostic and operative hysteroscopy are relatively safe procedures. Majority of complications occur due to ignorance of contraindications, poor surgical techniques, inadequate knowledge, and wrong application of instruments (Table 26.1). Diagnostic procedures have lower complications than the operative procedures (0.13% vs. 0.95%). Overall complication rate for operative hysteroscopy is 2% (AAGL 1993). The greatest risk of complications occurs with adhesiolysis (4.48%), followed by endometrial resection (0.81%), myomectomy (0.75%), and polypectomy (0.38%) [1].

Table 26.1 Complications [1–3]

	Type of complications	Specific complication
1.	1.Perioperative complications	Failed hysteroscopy
		Cervical laceration
2.	Complications related to improper positioning of patient	Nerve injuries, foot drop, deep vein thrombosis, and back injuries
3.	1.1.Intraoperative	False passage
		Uterine perforation
		Hemorrhage
4.	Distension media-related complications (intraop or postoperatively)	Fluid overload and hyponatremia Hyperglycemia, hypocalcemia and myoclonus, and air embolism Dextran syndrome—Hypotension, hypoxia, coagulopathy, and anemia Dextran-induced anaphylactoid reaction (DIAR)—Bronchospasm, severe hypotension, and cardiorespiratory arrest
5.	1.Postoperative	Infection
		Vaginal discharge
6.	Delayed complications	Adhesion formation
		Failure of resolution of the presenting symptoms

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26.1 Failed Hysteroscopy

When hysteroscope cannot be negotiated through the cervical os and the procedure is abandoned. Office hysteroscopy accounts for 4.2% of all failures. Majority of failures occur due to acutely flexed uterus and cervical stenosis (61.7% due to external os stenosis and 23.3% due to internal os stenosis). Cervical stenosis often leads to creation of false passage (Figs. 26.1 and 26.2).

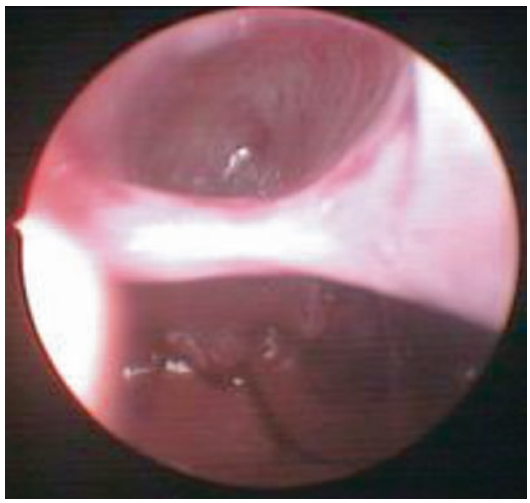


Fig. 26.1 False passage

26.1.1 Management [2]

- **Acutely anteflexed uterus**: Place a long-bladed, open-sided Graves speculum deep in the anterior or posterior fornix; it pushes the fundus to the midposition and can facilitate dilation. Speculum can be removed once hysteroscope is inserted.
- **Acutely retroflexed uterus:** Place a tenaculum on the posterior lip of the cervix, and apply traction; it straightens the cervical canal.
- **Cervical stenosis** (Fig. 26.3): Preoperative cervical priming with agents [4]
  - Misoprostol 400 mg either orally or vaginally 6–8 h prior to surgery or 400 mg sublingually 2–4 h prior to surgery.
  - Hygroscopic dilators—Laminaria tents or Dilapan-S (3 × 55 mm or 4 × 55 mm) 12 h before procedure
  - Intracervical injection of vasopressin solution (4 IU in 100 cc sodium chloride) injected at the 4 and 8 o'clock positions

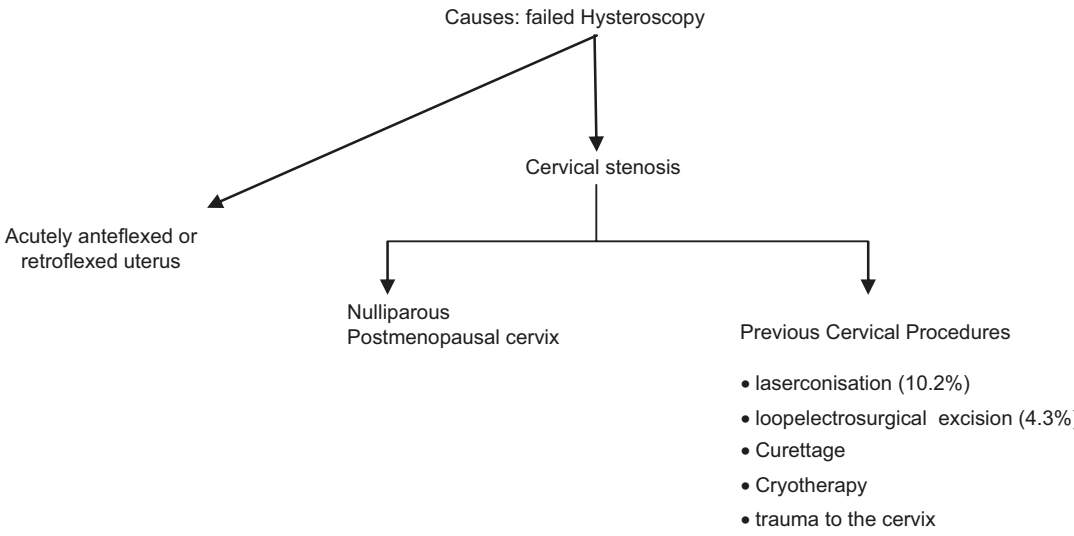


Fig. 26.2 Causes: failed hysteroscopy

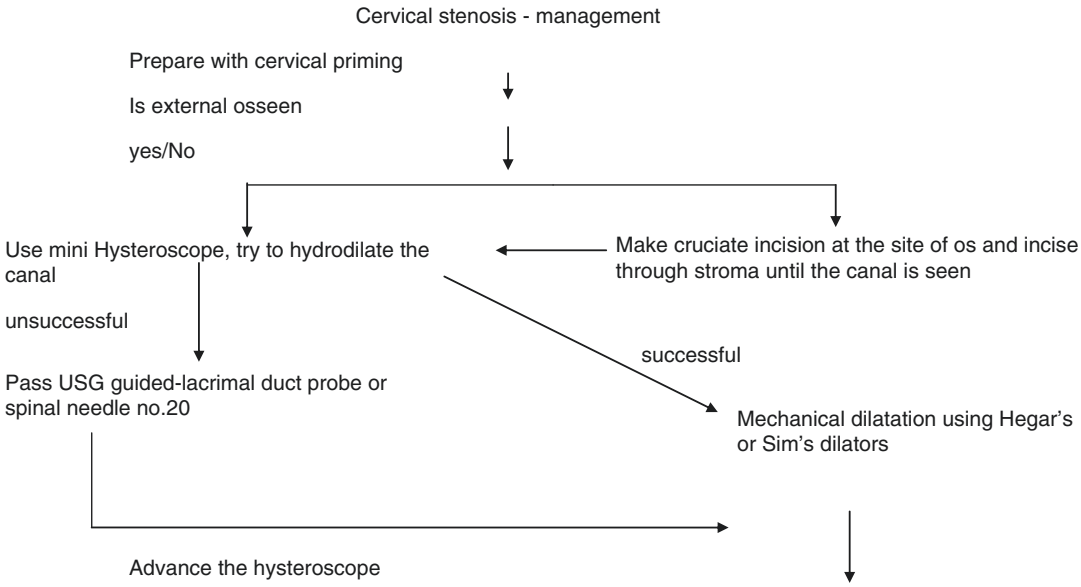


Fig. 26.3 Cervical stenosis management

26.2 Cervical Laceration

May occur due to holding with tenaculum or volsellum. Recommendation is to perform vaginoscopy by "no-touch technique" or use two tenacula at 3 and 9 o'clock positions to hold the cervix and Pratt's dilator for mechanical dilatation.

26.2.1 Management

- Suturing the laceration
- Touching with roller ball cautery at 20–30 W
- Silver nitrate sticks or ferric subsulfate (Monsel's) paste application

26.3 Complications Due to Positioning of the Patient

- **Nerve injuries**: Brachial plexus injury may result from incorrectly placed shoulder restraints. A nonslip mattress must be preferred.
- **Foot drop and deep vein thrombosis**: Due to pressure on the peroneal nerve by lithotomy stirrups. Legs should be adequately padded and supported.
- **Back injuries:** Legs should always be lifted simultaneously and kept together until they are at the appropriate height when they should be abducted gently and placed in the supports. Over-abduction may cause damage to the sacroiliac joints.

26.3.1 Prevention [2]

- Modified lithotomy position is the most ideal position—moderate hip flexion, limited abduction, and external rotation.
- Use padded Allen stirrups or candy cane stirrups that avoid any kind of trauma to the nerves, joints, and soft tissues (Fig. 26.5a, b).

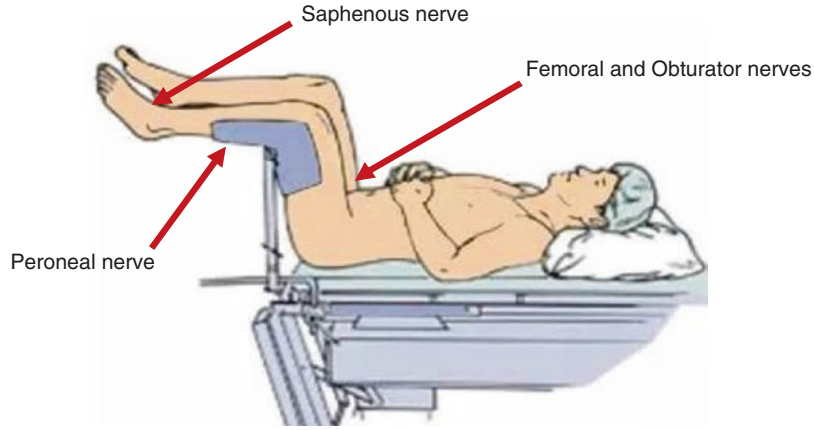


Fig. 26.4 Nerves at risk—lithotomy position

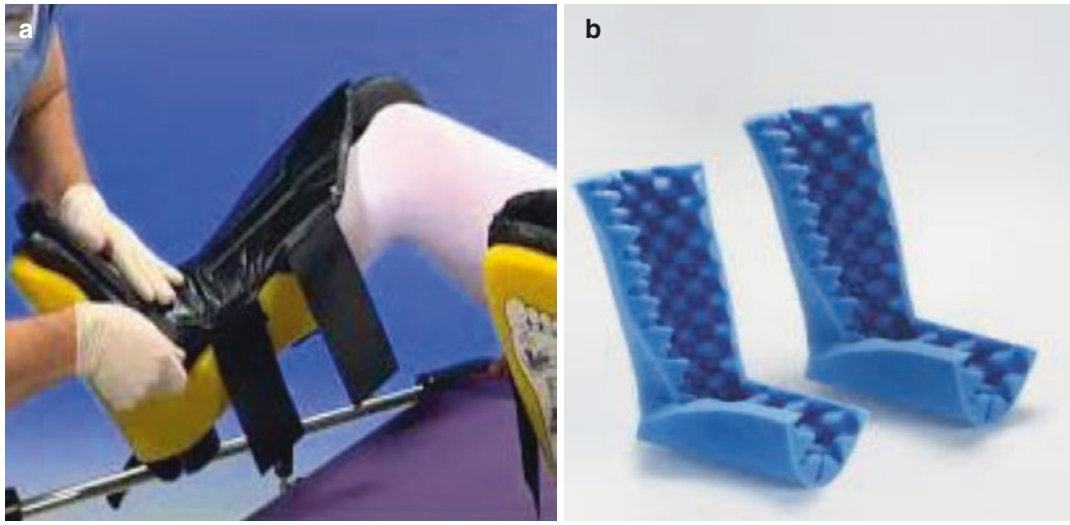


Fig. 26.5 (**a**) Allen stirrups. (**b**) Candy cane stirrups

26.4 Uterine Perforation

Incidence of perforation is 14 per 1000 (AAGL survey). Perforation is more likely in repeat procedures (9.3% vs. 2.0%). Electrosurgical devices cause thermal injuries following perforation and can lead to peritonitis, sepsis, and death.

Tips to Avoid Creating a False Passage or Perforation:

- Dilate the cervix with slow, steady pressure and stop when internal os opens; dilators should not be pushed to the fundus.
- Hydrostatic dilatation with inflow "on" and outflow "off" must be preferred.
- Always insert the hysteroscope or resectoscope under direct vision, keeping the "dark circle" in the center of the field and slowly advancing until the cavity is reached (Fig. 26.6).
- Morcellators should never be activated outside the uterine cavity, and clear exposure by adequate expansion of the uterine cavity is mandatory while using this device.

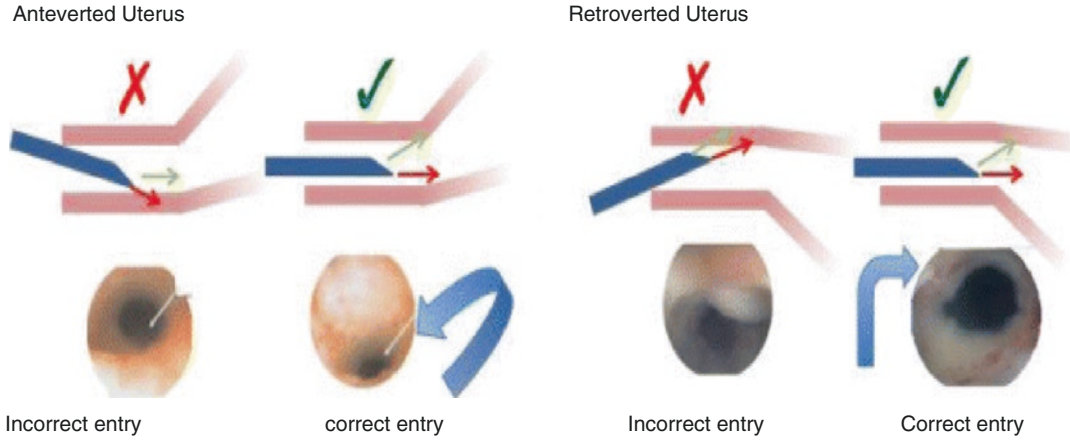
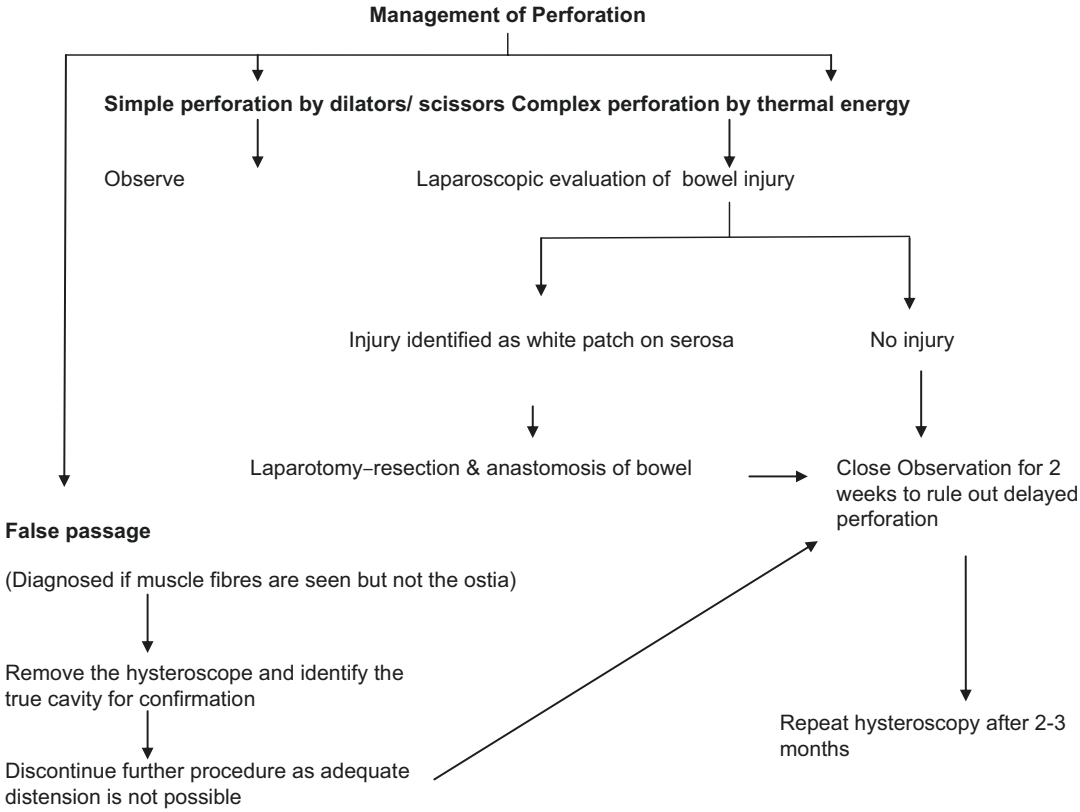


Fig. 26.6 Insertion of 30° hysteroscope

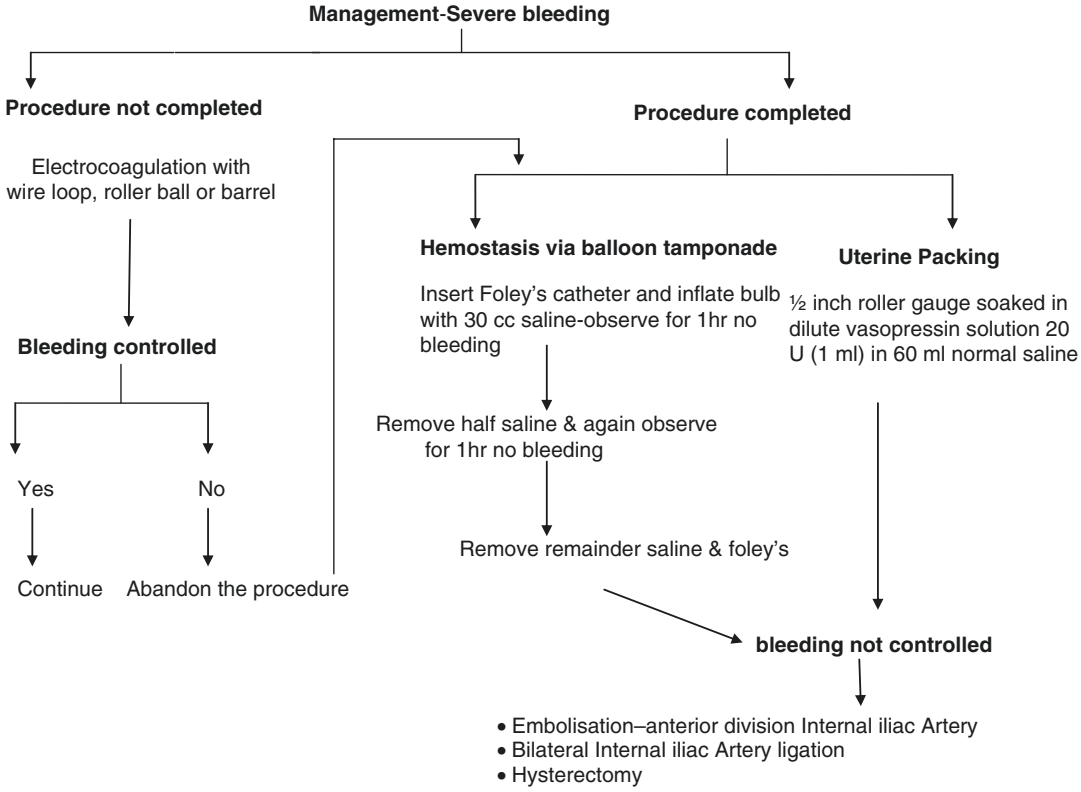


26.5 Hemorrhage

Severe bleeding requiring intervention occurs at a rate of 0.5–1.9%. Mainly observed during forceful dilatation, deep ablation, and vaporization

Preoperative measures to reduce the amount of bleeding during operative hysteroscopy:

- Prefer vaporizing electrodes for myoma resection (seals blood vessels as tissue is vaporized)
- Injection of very dilute vasopressin 4 U (0.2 mL) in 60 mL normal saline directly into cervix −2 mm deep at 4 and 8 o'clock positions
- Danazol or GnRH agonists decreases the thickness and vascularity of the endometrium and shrinks leiomyoma, thereby resulting in shorter operative time, less blood loss, and less intravasation of distending fluid.



26.6 Fluid Overload [5–7]

Incidence of fluid overload and dyselectrolytemia during operative hysteroscopy is less than 5% (Table 26.2).

BSGE/ESGE 2018 Defines Fluid Overload as [8, 9]:

- **Hypotonic** solution overload—fluid deficit threshold of **1000 mL** in healthy women of reproductive age and **750 mL** for elderly

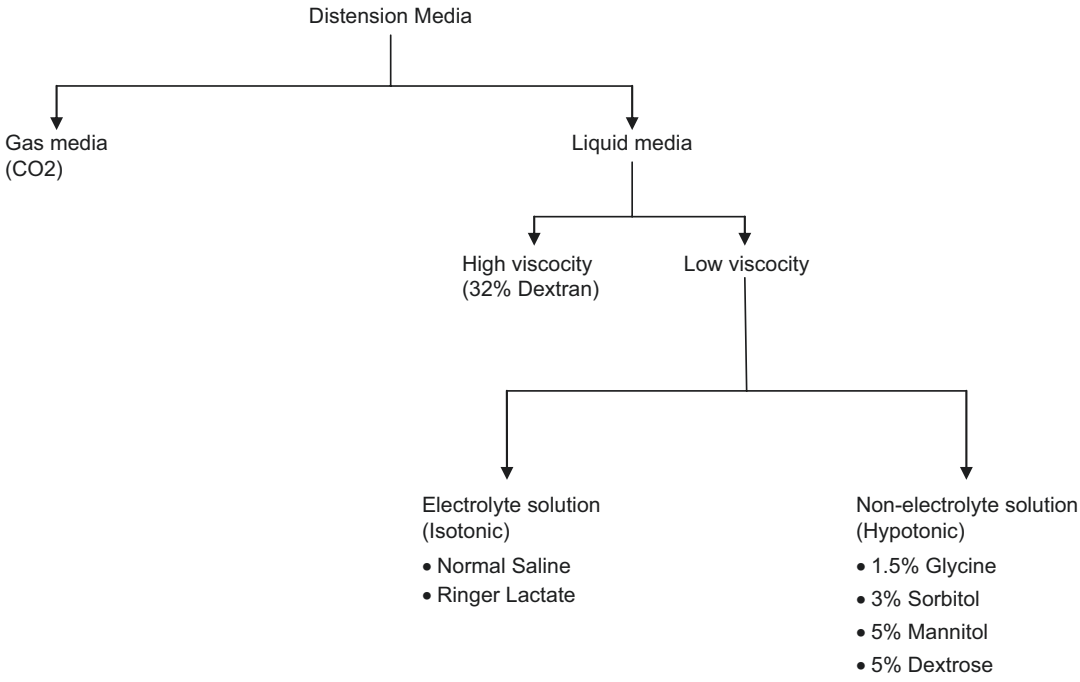


Table 26.2 Hypotonic fluid overload: clinical features and management

Fluid overload	Sodium concentration	Symptoms	Management
Asymptomatic hyponatremia	125–135 meq/L Osmolality normal: 280 mOsm/L	–	Fluid restriction <1 lit/day and loop diuretics, e.g., furosemide
Symptomatic hyponatremia	125–120 meq/L	Headache, nausea, vomiting, and weakness Signs of cerebral irritation: Agitation, apprehension, confusion, weakness, visual disturbances, and blindness If significant, leads to coma and death	Multidisciplinary approach[a]
	< 120 meq/L	Confusion, lethargy, seizures, coma, arrhythmias, bradycardia, and respiratory arrest	
	Recommended target increase of the serum Na^+ is 6 mmol/L over 24 h until 130 mmol/L is reached.		

[a]Management of symptomatic hyponatremia
- Multidisciplinary involvement—anesthetists, physicians, and intensivists in an intensive care unit
- Strict fluid balance during intraoperative and postoperative period
- Urinary catheterization and input-output charting
- Frequent (hourly) oxygen saturations, electrolytes, calcium, urea, and creatinine monitoring
- Echocardiogram and chest X-ray (if signs of cardiac failure or pulmonary edema)
- 100 mL bolus of 3% saline over 10 min and repeat up to three times followed by slow iv infusion of 3% hypertonic sodium chloride infusion (typically 1–2 mmol/L/h to prevent pontine myelinolysis) until serum $Na^+ > 125$ mmol/L

women or with cardiac and renal comorbidities
- **Isotonic** solution overload—fluid deficit threshold of **2500 mL** in healthy women of reproductive age and **1500 mL** for elderly women or with cardiac and renal comorbidities

Factors Influencing Absorption of Distension Fluid:
- **Hypotonic electrolyte-free solutions** like glycine, mannitol, and sorbitol cause serious fluid overload.
- **Intrauterine pressures** > 75 mm Hg increases the volume of media entering the peritoneal cavity via fallopian tubes.
- If intrauterine pressures > mean arterial pressure (normal 70 to 110 mmHg) especially in elderly and cardiac-renal comorbidities
- **Depth of myometrial penetration**—Large blood vessels breached and large myometrial surface area exposed (e.g., myomectomies) facilitate the absorption of fluid under pressure.
- **Duration of surgery**—The longer the procedure, the more time for fluid to accumulate within the body.
- **Size of uterine cavity**—Larger cavities provide a greater endometrial surface area for fluid absorption.

Risk Factors for Accelerated Systemic Fluid Absorption:
- Premenopausal patients have a higher risk of developing neurological complications.
- Cardiovascular and renal disease and elderly women are less likely to adapt to sudden significant increases in intravascular fluid.

Sorbitol 3% (hypotonic sugar) can lead to hyperglycemia, hypocalcemia, and myoclonus within an hour. Monitor the blood sugars and give insulin according to sliding scale. Hypocalcemia must be corrected with 3 g of calcium gluconate over 10 min.

Monitoring Fluid Deficit
- Closed systems should be used as they allow more accurate measurement of the fluid output.
- Drapes that contain a fluid reservoir or the devices that suck fluid from the ground should be used (Figs. 26.7 and 26.8).
- Automated fluid measurement systems are more accurate (Fig. 26.9a–d).
- Theater team should keep fluid deficit balance **every 10 min** and at the end of each fluid bag used.

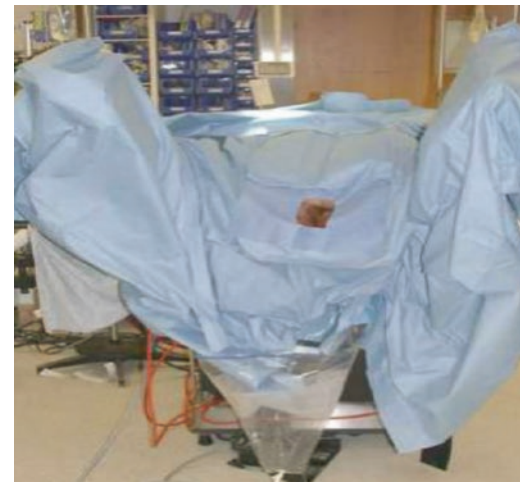


Fig. 26.7 Drapes with pouch collects fluid

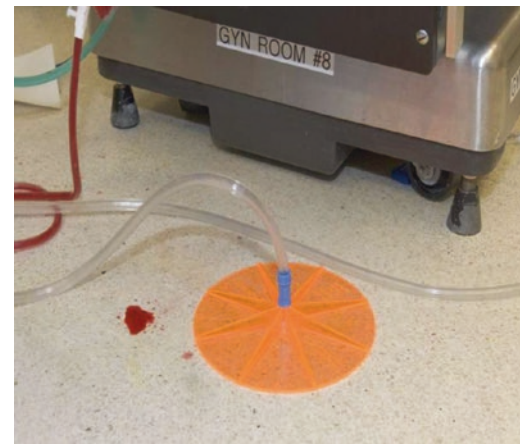


Fig. 26.8 PuddleVac aka "sucky ducky"

Fig. 26.9 (**a**–**d**) Automated fluid measurement system

BSGE/ESGE 2018 Executive Committee Safety Recommendations [8, 9]

- Isotonic, electrolyte-containing distension media such as normal saline should be used with mechanical instrumentation and bipolar electrosurgery because of low risk of hyponatremia and fluid overload.
- Hypotonic, electrolyte-free distension media such as glycine and sorbitol should only be used with monopolar electrosurgical instruments.
- Carbon dioxide gaseous media should be used for diagnostic hysteroscopy only.
- Automated pressure delivery systems provides constant intrauterine pressure and accurate fluid deficit surveillance, advantageous in prolonged operative procedures.
- Measurement of the fluid deficit should be done at a minimum of 10 min intervals.
- Local anesthesia with sedation should be considered for performing operative hysteroscopic procedures rather than general anesthesia.

26.7 Air Embolism

Clinically significant air embolism is rare but potentially a fatal complication of hysteroscopy. Signs of gas embolism are sudden fall in oxygen saturation, hypotension, hypercarbia, arrhythmias, tachypnea, or a "mill wheel" murmur (characteristic splashing auscultatory sound).

Management: Immediately abandon the procedure, ventilate the patient with 100% oxygen, and give supportive treatment. **Durant maneuver** is keeping the patient in left lateral position with head low and Trendelenburg position (Fig. 26.10). In severe cases, central venous catheter (CVC) insertion or direct needle insertion in right atrium to release the air may be necessary.

Fig. 26.10 Durant maneuver

26.7.1 Preventive Measures

- Place the patient in dorsal lithotomy and avoid Trendelenburg position because it keeps the uterus above the level of heart and creates a venous vacuum with each diastolic relaxation.
- Preoperative cervical priming must be considered and minimize the cervical trauma.
- Always keep the os occluded so as to prevent entry of room air. Keep the last dilator inside till resectoscope is assembled. Whenever electrode is to be changed, keep the obturator inside.
- Avoid repetitive removal and reinsertion of the resectoscope (often seen during myoma resection). Best alternative is to use **MyoSure device** that combines both resection and suction simultaneously.
- Anesthetist should closely monitor end-tidal CO_2 (expired CO_2 measurement of each breath amounts to noninvasive estimation of $PaCO_2$) and can diagnose air embolism early.
- Use of GnRH agonists preoperatively narrows venous sinuses and helps prevent this complication.
- Intracervical injection of dilute vasopressin prior to dilatation of the cervix creates vascular spasm and may help prevent gas from entering the circulation.
- Use vaginoscopic method and avoid using heavy-weighted speculums and dilatation.
- Flush system with fluid to remove air bubbles.
- Avoid using gas-producing electrosurgical equipment as far as possible.

26.8 Infection

Endometritis after hysteroscopic procedure is extremely rare 0.01–1.42%. Routine antibiotic prophylaxis is not recommended except for postmenopausal women requiring IUCD removal. ACOG and SOGC recommend antibiotic prophylaxis for women with history of pelvic inflammatory disease.

26.9 Postoperative Adhesion Formation (IUA) [9, 10]

Risk for IUAs depends upon the type of hysteroscopic surgery; those confined to the endometrium (polypectomy) having the lowest risk and those entering the myometrium or involving opposing surfaces have higher risk. Intrauterine adhesions can occur in 37.5% of patients after monopolar resection of a single submucous fibroids, 45% after resection of multiple fibroids, polypectomy 3.6%, and uterine septa 6.5%. Risk appears to be greater when electrosurgery is used in the nongravid uterus and for blind versus vision-guided removal in the gravid uterus.

26.10 AAGL-ESGE 2017 Guidelines [7]

26.10.1 Primary Prevention of Intrauterine Adhesions

Application of an adhesion barrier significantly reduces the development of IUAs in the short term, but limited fertility data are available (Level A).

26.10.2 Secondary Prevention of Intrauterine Adhesions [11]

1. The use of an IUD, stent, or catheter appears to reduce the rate of postoperative adhesion reformation (Level A).
2. Semisolid barriers, e.g., hyaluronic acid and auto-cross-linked hyaluronic acid gel reduce adhesion reformation (Level A).
3. Following adhesiolysis, hormone treatment using estrogen, with or without progestin, may reduce recurrence of IUAs (Level B).
4. The role of medications designed as adjuvants to improve vascular flow to the endometrium has not been established. Consequently, they should not be used outside of rigorous research protocols (Level C).

26.11 Failure of Resolution of the Presenting Symptoms

- Approximately 15% of women have an early pregnancy loss following metroplasty.
- In women undergoing myomectomy for menorrhagia or infertility, 20% have no immediate improvement and 80% fail to conceive.
- Endometrial ablation produces amenorrhea in 30% of cases and satisfactory improvement in about another 50%. Repeat ablation or hysterectomy is needed in 10%.
- Adhesiolysis for Asherman's syndrome is curative in about 30–40% of cases only.

Key Points

1. Diagnostic and operative hysteroscopy are relatively safe procedures. Overall complication rate for operative hysteroscopy is 2%.
2. Preoperative cervical priming with agents misoprostol and hygroscopic dilators, e.g., Laminaria tents or Dilapan, or intracervical injection of vasopressin must be considered.
3. Modified lithotomy position and use of padded Allen stirrups or candy cane stirrups is the most ideal.
4. Always insert the hysteroscope or resectoscope under direct vision, keeping the "dark circle" in the center of the field, and slowly advance until the cavity is reached.
5. Simple perforation requires observation, while complex perforation is caused by the thermal energy, so bowel exploration and subsequent repair are mandatory.
6. Balloon tamponade and uterine packing with vasopressin-soaked gauge is effective for controlling severe bleeding.
7. Automated fluid measurement systems provide constant surveillance on fluid deficit and pressure.
8. Fluid deficit balance must be recorded every 10 min and at the end of each fluid bag used.
9. Semisolid barriers, e.g., hyaluronic acid and auto-cross-linked hyaluronic acid gel, reduce adhesion reformation.
10. Following adhesiolysis, hormone treatment using estrogen, with or without progestin, may reduce recurrence of IUAs.

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Embryofetoscopy

27

Erin E. Reed and Aarathi Cholkeri-Singh

27.1 Background

Although often used interchangeably, the terms embryoscopy and fetoscopy describe technically and temporally different surgical procedures. In the historical literature and descriptions of early procedures, "embryoscopy" is commonly used to describe the transcervical approach and "fetoscopy" for its transabdominal counterpart [1]. In the more modern vernacular, "embryoscopy" is used to describe procedures between five and eight gestational weeks and "fetoscopy" after eight gestational weeks. In general, both terms are used to refer to direct, in utero, endoscopic visualization of the developing fetus and placenta [2, 3]. This minimally invasive surgical procedure can be used to evaluate a developing fetus and diagnose genetic and non-genetic conditions [3–7]. Since its inception in the mid 1950s, clinical use of endoscopic fetal evaluation has ebbed and flowed with the development of other methods for in utero evaluation of the fetus (i.e., ultrasound).

Advancement in ultrasonographic technologies lead to global use of this less invasive method to diagnose fetal abnormalities, making fetoscopy relatively obsolete in the 1980s. However, advancements in endoscopic technology in the fields of general surgery and medicine lead to a resurgence of the technique and development of specialized endoscopes for fetal therapy [2]. The growing trend toward minimally invasive therapies across medicine has provided fertile ground for the development of cutting-edge treatments of fetal abnormalities via transabdominal fetoscopy [8].

27.2 History

The first reported endoscopic visualization of a fetus was performed by Björn Westin, a Swedish obstetrician, in 1954. Using a 10 mm McCarthy panendoscope, he performed transcervical, direct hysteroscopic visualization of the fetus in three different pregnancies. Westin performed his procedures between 14 and 18 weeks of gestation just prior to medically indicated pregnancy terminations [9]. At the time, this novel procedure was diagnostic and not therapeutic. Thirteen years later in 1967, Bernard Mandelbaum was the first to perform endoscopic visualization of the fetus using a transabdominal approach. His application of this developing

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technique was attempted intrauterine fetal transfusion for hemolytic disease of the newborn.

The 1970s were a period of time during which the techniques of embryoscopy and fetoscopy rapidly developed and clinically diversified. Valenti, in 1972, modified a pediatric cystoscope into a smaller 5 mm "needlescope" to obtain fetal skin samples. He subsequently used this so-called endoamnioscope to perform the first in utero aspiration of fetal blood for diagnosis of hemoglobinopathies [5]. Scrimgeour, a contemporary of Valenti, used an even smaller (2.2 mm) needlescope to survey the amniotic cavity and fetuses at high genetic risk of open neural tube defects. During this time of limited methods for fetal diagnostics, development of specialized cannulas allowed Hobbins and Mahoney to obtain and evaluate fetal blood directly for sickle cell disease and other hemoglobinopathies with minimal risk to the fetus and mother [10]. As additional clinicians were trained in the technique, fetoscopy was used to obtain blood samples which diagnosed hemophilia (1979, Firsheim), chronic granulomatous disease (1979, Newburger), galactosemia (1979, Fensom), and Tay-Sachs disease (1979, Perry). Other groups used the technique to obtain fetal biopsy of the skin and liver leading to in utero diagnosis of congenital bullous ichthyosiform erythroderma ichthyosis, epidermolysis bullosa letalis, and ornithine carbamoyltransferase deficiency [11].

The 1980s ushered in a time during which fetoscopic techniques began to flourish again as the technique was adapted to facilitate fetal surgery and other interventions for a number of fetal diseases. Fetoscopy as a method to access the growing fetus, placenta, or umbilical vessels, via a minimally invasive approach, is essential to modern techniques of twin-to-twin transfusion syndrome (De Lia in 1988, Nicolaides in 1991), percutaneous umbilical blood sampling (Daffos in 1983, Hobbins in 1985), as well as tissue or organ sampling.

As new fetal therapies were developed using transabdominal fetoscopic approaches, the classic transcervical method became less commonly used but still remains a clinically relevant diagnostic tool in evaluation of the first-trimester fetus [12].

27.3 Transcervical Embryoscopy

Approximately one in five clinically recognized pregnancies result in a spontaneous miscarriage, and approximately 80% occur in the first trimester. Pregnancy loss at these early gestational ages may be the result of anatomic, genetic, or infectious causes [12]. More than one-half of these failed pregnancies are associated with an abnormal karyotype. As referenced previously, technological advances in ultrasound technology have allowed earlier and earlier detection of intrauterine pregnancies and pregnancy failure [2–4]. Unfortunately, the very early gestation ages at which these spontaneous pregnancy losses are diagnosed limit sufficient evaluation of the fetal phenotype via currently available imaging modalities [2].

Our current understanding of the early mechanisms that drive both normal and abnormal development is based on detailed observations of aborted human embryos as well as anatomic and genetic comparisons of high-order vertebrates. Developmental studies have shown evolutionary conservation of genes and molecules that underlie development of complex organs like the vertebrate brain, limbs, and heart [13]. These animal studies are possible because the developing embryo is able to be visually and molecularly evaluated at critical genetic and developmental milestones. Historically, these comparative studies have been the basis for our understanding of human embryonic development. However, human embryofetoscopy has the potential to be an indispensable tool for expanding and clarifying our knowledge of human embryonic development as it can be used to directly visualize the developing embryo at critical points in development [2].

Historically, transcervical embryofetoscopy has been performed prior to an intended pregnancy termination. However, Ghirardini in 1991 reported two patients with uncomplicated, full-term pregnancies after the transcervical procedure. This subsequently opened up its use for early embryonic diagnosis in high-risk populations [14, 15]. Dumez et al. were the first to perform the technique in a case series of 42 ongoing pregnancies at high risk for genetic conditions

with limb and/or facial abnormalities [16]. They reported an overall fetal visualization success rate of 97%, 12.3% miscarriage rate between 11 and 23 weeks gestation, and delivery of 31 normal babies.

Additional studies have proven the technique to be diagnostic for Van Der Woude syndrome at 11 weeks and Meckel-Gruber syndrome at 10 weeks [16, 17]. Application of the transabdominal approach has also allowed diagnosis of Smith-Lemli-Opitz syndrome and Pierre Robin syndrome and comprehensive evaluation of two fetuses with unexplained increased nuchal translucency and hydrops with normal karyotype [2, 18]. Despite the body of clinical literature which has proven the utility of transcervical embryofetoscopy in prenatal diagnosis, it remains an invasive procedure and carries with its inherent risk of miscarriage [1–3]. Embryofetoscopy has the potential to be used for visualization of the first-trimester embryo and aid in prenatal diagnosis but will most likely continued to be restricted to women opting to terminate a pregnancy or in continuing pregnancies that are high risk for genetic syndromes with classic phenotypic findings [2, 19].

Despite the aforementioned limitations in ongoing pregnancies, transcervical embryoscopy has the potential to be used in missed abortions. Additionally, there is emerging evidence which shows that traditional methods for surgical management of early pregnancy loss limit not only phenotypic evaluation but also evaluation of fetal chromosomes which is critically important in cases of recurrent pregnancy loss and infertility. More than 50% of early conceptus tissues are unable to be evaluated phenotypically after instrumental evacuation of the uterus.

Currently, the only method which allows direct visualization of the embryo in utero is embryoscopy (Figs. 27.1, 27.2, 27.3). Transcervical embryofetoscopy not only allows for phenotypic evaluation of the fetus but also allows direct sampling of the products of conception [20–22]. Consistent with previously reported data, Cholkeri et al. recently showed that embryofetoscopy and directed biopsy of chorionic villi allow (Figs. 27.4 and 27.5) for significantly improved fetal karyotyping with reduced maternal cell contamination compared with the standard suction dilation and curettage [23, 24].

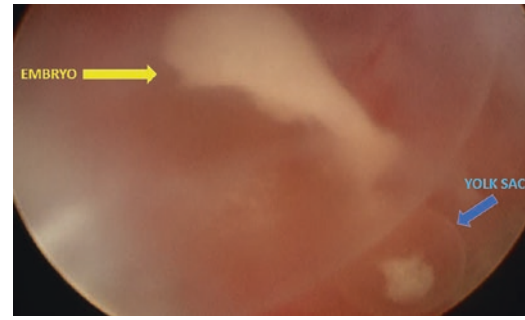

Fig. 27.1 Image of a 7-week embryo that failed to develop beyond 5 weeks gestational age pictured with its yolk sac

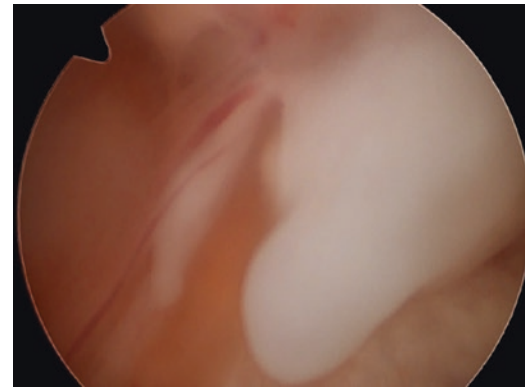

Fig. 27.2 Image of an 8-week embryo head with cranium, nasal, eye, and mouth features visualized

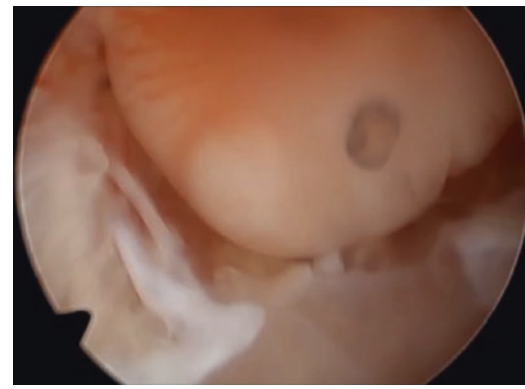

Fig. 27.3 Image of an 8-week embryo visualizing umbilical cord and its insertion site along with lower limb anatomy

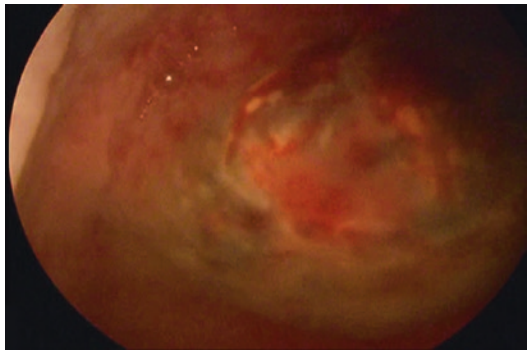

Fig. 27.4 Visualization of a gestational sac located on the fundus of the uterine cavity

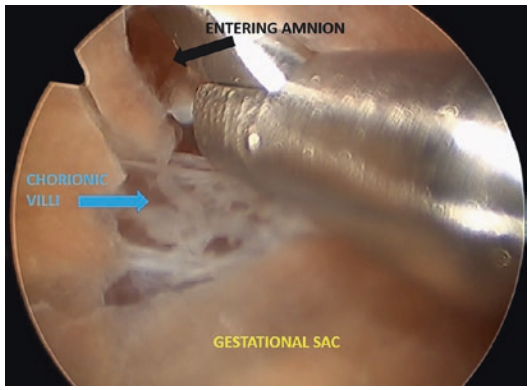

Fig. 27.5 Entry into gestation sac allows visualization of the chorionic villi and entry through the amnion

27.4 Preoperative Considerations

Informed consent should be obtained from patient, and full documentation of standard risks of hysteroscopy procedure is expected prior to proceeding with the procedure [3, 8, 25]. Discussion of what tissue samples will be collected and how those tissues will be evaluated should be had with the patient prior to procedure as collection medium and sterility of technique dictate how specimens are processed. Sterile tissue specimens, in normal saline, can be used for chromosomal analysis and determination of fetal genetics. Non-sterile curettage specimens, in formalin or normal saline, can only be used for pathologic evaluation. As is standard for vaginal surgeries, patients undergoing transcervical embryofetoscopy should be placed in dorsal lithotomy position after induction of anesthesia. Vaginal area can then be prepped, using sterile technique, according to institutional guidelines.

27.5 Intraoperative Considerations

The technique of transcervical embryofetoscopy involves introduction of a hysteroscope through the cervical canal and either into the extracoelomic space (between the amnion and chorion) or into the amniotic sac proper [1–3, 8]. If continuation of the pregnancy is intended, then the procedure needs to be performed between 5 weeks and 11 weeks gestation when the chorion and amnion are separate layers. The amnion is translucent, allowing for direct visualization of the embryo [2, 8]. After 11 weeks, these two layers fuse, making selective entry into the extracoelomic cavity technically impossible and would result in rupture of membranes [8]. If procedure is intended to selectively sample fetal tissue after anatomic survey, the chorion and amnion will both be intentionally breached with the hysteroscope.

After a sterile speculum is placed into the vagina, the anterior lip of the cervix is grasped with a single-tooth tenaculum, and the cervical canal is dilated to the appropriate size to allow passage of the hysteroscope. Early procedural descriptions of transcervical techniques used a 10 mm diameter McCarthy panendoscope, but innovation has allowed for creation of small endoscopic cameras and hysteroscopes with operative channels [8, 9, 24]. A variety of scopes have been documented in the literature ranging from outer diameter for 1.7 mm to 3.5 mm with a lens angle of 0 to 30° [8]. Modern operative hysteroscopes, ranging from 5 mm to 7 mm outer diameter sheaths and capabilities like continuous-flow and automated fluid pumps, have also been used for this technique. One recent paper described maintaining intrauterine fluid pressure of 60 to 80 mmHg to facilitate optimal visualization of the fetus while also clearing blood from cavity [24]. When the selected scope reaches the chorion, either it can be rapidly advanced into the

extracoelomic space or hysteroscopic scissors can be used to dilacerate the membranes and allow advancement of a large-diameter scope [2, 3, 8]. Photo documentation should be performed of the fetus and yolk sac. After anatomic survey, samples can be obtained from the chorionic villi and fetus with hysteroscopic scissors or a 5-French hysteroscopic grasper can be used to remove the fetus for genetic testing. After completion of the hysteroscopic portion of the procedure, suction or sharp curettage must be performed to remove the remaining products of conception in the cases of missed abortion [24].

If continuation of the pregnancy is planned, trauma to the fetal membranes may cause potential infectious complications, induced miscarriage, or bleeding that renders the procedure incomplete [3, 8]. Additionally, in the case of a severely retroverted or anteverted uterus, the fetus may be difficult to visualize via endoscopic methods. Complications like electrolyte imbalance and intravascular or pulmonary fluid overload are also possible during prolonged or complicated procedures.

27.6 Postoperative Considerations

Although the emotional recovery from a pregnancy loss or prenatal diagnosis of a phenotypic syndrome may be prolonged, the physical recovery time from this procedure is very short [25]. Women return to normal activities, with few limitations, within several days. Postoperative pain can be controlled with over-the-counter analgesics. Women who are Rhesus factor (Rh) negative should receive RhoGAM prior to discharge from the recovery room to prevent alloimmunization in future pregnancies [26].

Key Learning Points

- Embryofetoscopy is a minimally invasive surgical procedure and can be used to evaluate a developing fetus and diagnose genetic and nongenetic conditions.
- Human embryofetoscopy has the potential to be an indispensable tool for expanding and clarifying our knowledge of human embryonic development as it can be used to directly visualize the developing embryo at critical points in development.
- Diagnostic transcervical embryofetoscopy has mostly been described prior to an intended pregnancy termination or after diagnosis of missed abortion. However, there have been case reports of successful term pregnancies after transcervical procedures.
- Transcervical embryofetoscopy not only allows for phenotypic evaluation of the fetus but also allows direct sampling of the products of conception allowing for significantly improved fetal karyotyping with reduced maternal cell contamination compared with the standard suction dilation and curettage.
- Standard procedure for obtaining informed consent, patient preparation sterile technique, and administration of RhoGAM should be ensured for any hysteroscopic embryofetoscopy procedure.

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28 Vaginoscopy

Vimee Bindra

The introduction of hysteroscopy in gynaecology has revolutionized patient care and has helped advance minimally invasive approach of treating intrauterine pathologies. Hysteroscopy, which is the direct visualization of the uterine cavity, is the commonest test used in gynaecology for diagnosing abnormal uterine bleeding, endometrial cancer and reproductive problems. With advancements and miniaturization in designing of hysteroscopic instruments, now almost all procedures can be done in an office setting without anaesthesia. Conventional hysteroscopy involves introducing a speculum in the vagina and holding the cervix with a tenaculum to straighten the uterocervical canal for introducing the hysteroscope, but with the introduction of 'no-touch hysteroscopy' or 'vaginoscopy', there is no need of instrumentation, and it makes the procedure less painful and is better tolerated by patients [1]. Miniaturization of this technique has facilitated the development and acceptance of vaginoscopy because resistance to advancement of hysteroscope through the cervical canal is minimized. Additional advantage of doing vaginoscopy is that vaginal and cervical lesions can be identified under vision and can be treated which otherwise may be missed with conventional hysteroscopy. Vaginoscopy by 'no-touch technique' is a feasible and safe technique. It is recommended to adopt this painless, non-traumatic and innovative technique [2]. This technique is also used for women with intact hymen and adolescent girls with abnormal vaginal discharge and abnormal uterine bleeding without damaging the intact hymen [3, 4]. This no-touch technique is more acceptable to patients, and they are more comfortable getting this procedure done in an office setting. The recent guideline on heavy menstrual bleeding by National Institute of Health and Care Excellence (NICE) recommends the use of office hysteroscopy for diagnostic workup [5].

A common concern with regional or general anaesthesia is increased time to recovery, and it increases the cost of the procedure. And in clinic settings, doctors don't prefer to administer anaesthesia or even conscious sedation. Vaginoscopy allows such an approach to diagnostic as well as therapeutic hysteroscopy. This technique is used by few doctors because of lack of familiarity with the technique and concerns over the ability to identify and negotiate the cervical canal without any instrumentation. There is also an important concern that there is a higher likelihood of post-operative genital tract infections. To answer the concerns, the RCT Vaginoscopy Against Standard Treatment (VAST) has shown that vaginoscopy is more successful than standard hysteroscopy with lesser complications and failures [6]. The risk of infection associated with hysteroscopy is thought

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to be less than 1%, although few studies only have reported this outcome [7, 8]. The VAST study also did not find any difference in infection rates between the standard technique and hysteroscopy and vaginoscopy [6].

28.1 The Technique

28.1.1 Pre-Procedure

Explain to the patient that uterine distension will cause little discomfort and cramping pain. Simple analgesic like paracetamol or ibuprofen can be used pre-procedure if needed. Premedication for cervical softening in nulliparous and young patients facilitate easy entry into the cervix. Premedication in any form of analgesia or ripening of cervix is not mandatory and is based on case selection (Figs. 28.1 and 28.2).

28.1.2 Procedure

Prepare the vagina and cervix with a small-diameter swab dipped in Betadine or another antiseptic if patient is allergic to Betadine.

Visualization of vagina and cervix can be achieved by VAGINOSCOPY which is done by filling up the vagina with the distension media (which in most hysteroscopies nowadays are normal saline) and without the use of speculum and instruments or tenaculum to hold the cervix. The distension is maintained when assistant holds the labia together gently, and it helps visualizing the vagina and cervix properly. First, negotiate the scope to the posterior vagina so that you know you have reached the end, and then withdraw the scope while observing anteriorly and visualizing the external cervical os (Figs. 28.3, 28.4 and 28.5). After negotiating the external os, the pressure of distension media

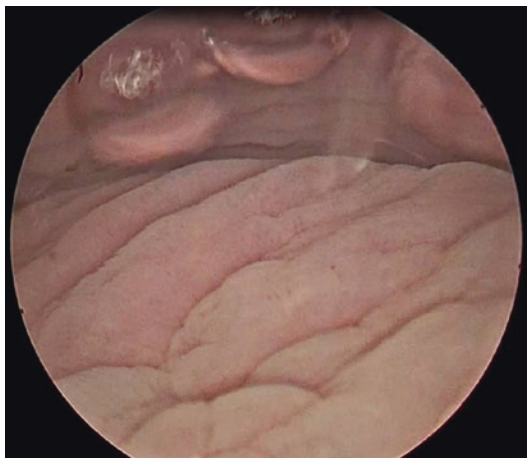

Fig. 28.1 Appearance of normal vagina on vaginoscopy (*pic courtesy Dr. Vimee Bindra)*

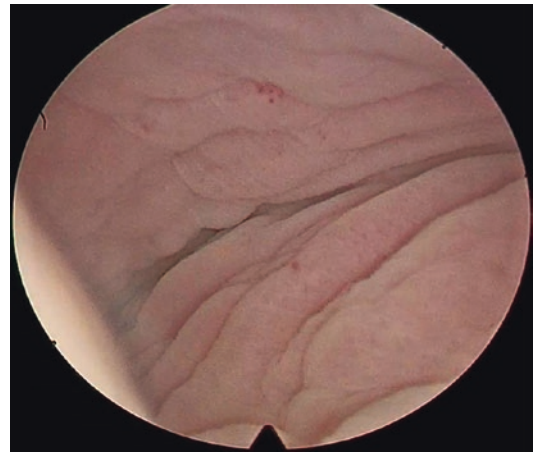

Fig. 28.2 Anterior and posterior vaginal wall on vaginoscopy (*pic courtesy Dr. Vimee Bindra)*

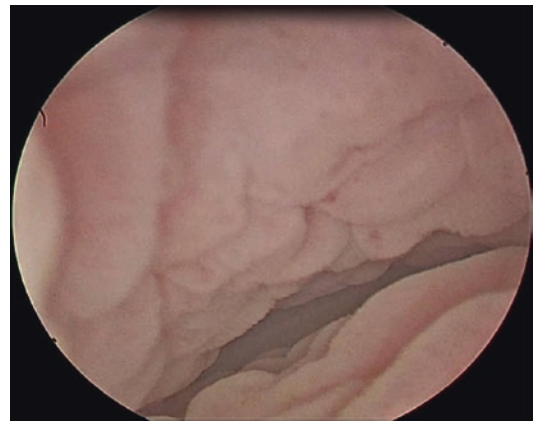

Fig. 28.3 Negotiating the scope till posterior fornix and withdrawing it to locate ectocervix (*pic courtesy Dr. Vimee Bindra*)

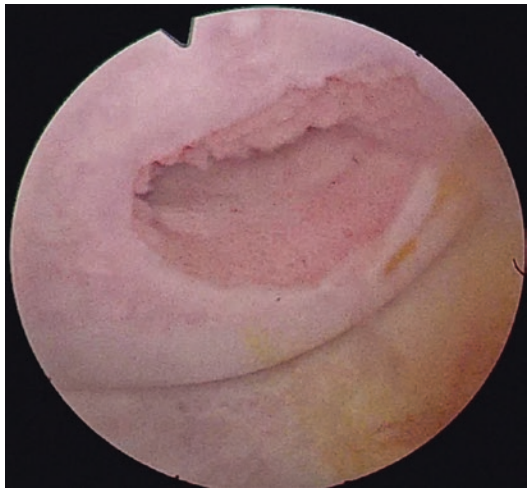

Fig. 28.4 Identifying the ectocervix (*pic courtesy Dr. Vimee Bindra*)

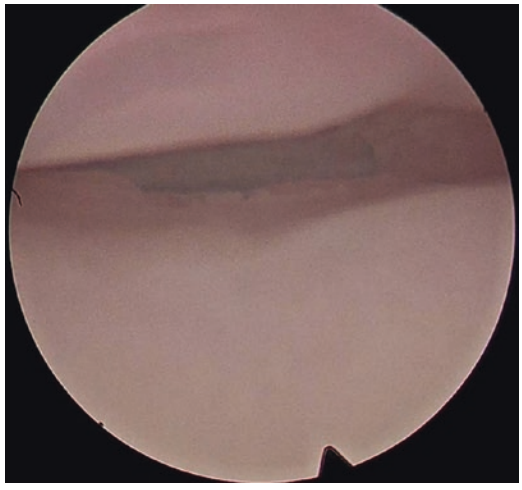

Fig. 28.5 Cervical lips on vaginoscopy (*pic courtesy Dr. Vimee Bindra*)

keeps dilating the cervical canal, and one can negotiate endocervical canal into the cavity easily (Fig. 28.6). The cavity must be fully and systematically inspected, and a surgical procedure can then be performed if necessary. A careful inspection of cervical canal and vagina must be done while withdrawing the scope.

Inserting the hysteroscope without using any instrument needs dexterity and comfort with the instrument.

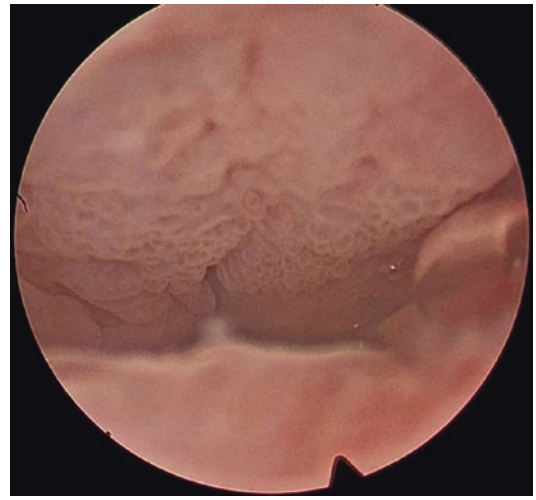

Fig. 28.6 Negotiating the endocervical canal (*pic courtesy Dr. Vimee Bindra*)

28.1.3 Post-Procedure

After the diagnostic or therapeutic procedure, vitals should be checked for the patient and make sure she is comfortable and ambulatory.

Advantages of Vaginoscopy

- Almost all hysteroscopies can be done in office setting.
- Quicker to perform.
- Safe.
- Less painful.
- More successful than standard hysteroscopy.
- Helps identify additional pathologies of vagina and cervix if any.
- Hysteroscopy is feasible without damaging the intact hymen and can be done in adolescent girls and women who are not sexually active and with intact hymen to rule out uterine pathologies.

Clinical Applications for Vaginoscopy

- Adolescent girls presenting with abnormal vaginal discharge.
- To rule out vaginal foreign body in adolescent girls with intact hymen, limited vaginal access or a narrow vagina.
- To diagnose vaginal wall laceration due to foreign body, sexual abuse and traumatic causes.

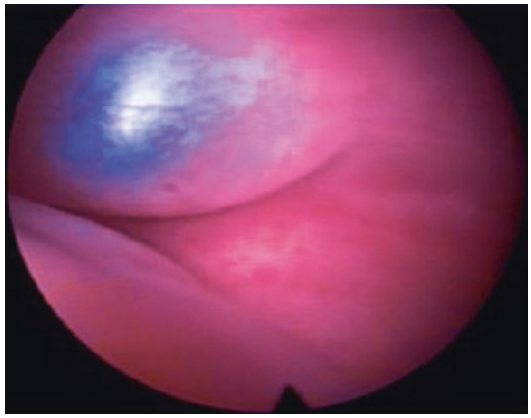

Fig. 28.7 Vaginal endometriosis (*pic courtesy Dr. Vimee Bindra)*

- Can be used in women with vaginismus or with history of previous vaginal surgery.
- For office hysteroscopy for diagnosis as well as therapeutic uses.
- For endometriosis patients to rule out vaginal endometriosis. Vaginal endometriosis is of two types: superficial and deep endometriosis. Superficial endometriosis are located in vaginal fornices and have no relationship with deep infiltrating endometriosis and can be found as isolated lesions. Deep vaginal endometriosis is more common, is usually located at posterior fornix between the uterosacrals and is associated with rectovaginal endometriosis. In conventional hysteroscopy, these lesions can be missed, but when combined with vaginoscopy, they can be picked up and treated better (Fig. 28.7).
- For morbidly obese patients, if visualization of cervix is not feasible by conventional instruments, vaginoscopy can be used.

Key Points

- Vaginoscopy should be the default method for outpatient hysteroscopy.
- Minimal training is required for doctors who are proficient in standard hysteroscopy.
- It potentially reduces pain associated with instrumentation in conventional hysteroscopy.
- It improves women's experience.
- It saves resources by reducing the need of procedure to be done under general anaesthesia.
- Women should be counselled having any mild pain in 2 weeks following the procedure is common and should be given verbal and written advice for the same.
- Low risk of genital tract infection should be explained, and if required, they may need antibiotic.

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29 Pain Management in Office Hysteroscopy

Ameya J. Sirsat

29.1 Introduction

Office hysteroscopy (OH) has the ideal conditions to qualify as the gold standard technique for the surgical treatment of intracavitary uterine pathology. The recent trend of reducing the diameter of hysteroscopes has largely contributed to the performance of hysteroscopy as an ambulatory procedure, effectively reducing the difficulties both for the surgeon as well as the patient [1].

29.2 Background

The problem of adverse events in health care is known since the 1950s. The subject remained largely neglected until early 1990s [2, 3]. Today, this is a well-known problem, and the WHO launched in 2004 the World Alliance for Patient Safety. Regarding office practice in gynecologic procedures, a task force was convened in 2008 by the American College of Obstetricians and Gynecologists (ACOG). The primary impetus to creating this task force was the steady migration of surgical procedures to the office that had solely been performed in the hospital, and this transition began with hysteroscopy in the 1980s [4]. In 2004, Bettocchi et al. reported on 4863 operative hysteroscopic procedures performed using a 5.0-mm-diameter operative hysteroscope and 5F instruments [5]. The procedures included the polypectomy along with adhesiolysis and repair of anatomic abnormalities by using a vaginoscopic technique without analgesics or anesthesia, and it was noted that patients reported little discomfort [6].

29.3 Anatomy

An adequate knowledge of uterine nerve innervation is essential to understand the physiology of pain in hysteroscopy (Fig. 29.1) (Table 29.1).

Munro and Brooks suggest that due to this complex innervation, successful anesthesia requires simultaneous targeting of more than one site, including paracervical and intracervical anesthesia and topical agents in the cervical canal and endometrial cavity [9].

The endometrium (other than basal layer) and any fibrotic tissue within the cavity are not sensitive due to no nerve supply. Thus, procedures can be carried out without the use of analgesia [10].

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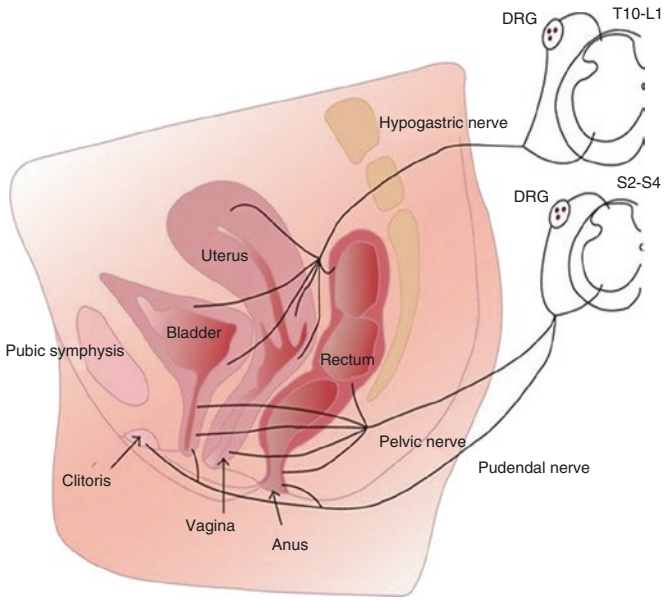

Fundus of uterus-sympathetic fibres T10 to L2, (ovarian plexus) via inf. Hypogastric plexus, enters by the utero-sacral & infundibulo-pelvic ligaments.

LUS, upper vagina & cervix-parasympathetic fibres S2-S4 (Frankenhauser plexus), enters following the cardinal ligament

Myometrium and endometrium are innervated by a plexus at the myome trial-endometrial interface. Only the basal third of the endometrium is innervated.

Fig. 29.1 Nerve supply of the female reproductive tract

Table 29.1 Pain-stimulating factors [7, 8]

• Wider hysteroscopes (>5 mm).	• Carbon dioxide as distention media.	• Endometrial ablation.
• Speculum/tenaculum.	• Resection of polyps (> 2.2 cm).	• Tubal sterilization.
• Cervical dilatation.	• Myomectomy.	• Long procedures (>15 min) [13, 15].

29.4 Pre-Procedure Preparation

Pain experienced throughout the procedure and various anatomical obstacles that challenge the access to the uterine cavity represent the main limiting factors to the widespread use of office hysteroscopy.

Adequate pain management requires using the right equipment and a multimodal approach to reducing pain by creating a calm and relaxing clinic environment.

Physicians must carefully select patients for office-based procedures.

The preoperative evaluation, including a complete history and physical examination, will help identify factors that would exclude patients from office-based surgery.

Reviewing a patient's menstrual and contraceptive history and appropriately scheduling her hysteroscopy are important because best visualization is obtained during the early proliferative phase of the endometrium. This assessment will also identify risk factors for higher pain with the procedure (Tables 29.2 and 29.3).

Table 29.2 Risk assessment for pain

• Nulliparity.
• Severe dysmenorrhea.
• Dyspareunia.
• Menopause.
• Chronic pelvic pain.
• Comorbid conditions.

Table 29.3 Protective factors [8, 11]

• Experienced surgeons.
• No-touch approach.

29.5 Techniques for Pain Management

Hysteroscopes with a diameter of 1.2 to 1.9 mm and a 2.5- to 3-mm external sheath are available in flexible or rigid frames. Reduction in outer diameter reduces the section of area of the instrument by 50–75% causing less pain. Flexible hysteroscopes make it easier to follow the canal pathway, although visibility is not guaranteed. Use of specially designed hysteroscopic 5F mechanical instruments (e.g., scissors, biopsy cup, graspers, and corkscrews) has long been the only way to perform office procedures [5].

Normal saline is the most common distension medium imparting excellent visibility and safer than carbon dioxide and glycine, [12] although it is thought that warming the distension fluid to physiological temperature (37.5 °C) decreases perceived pain as well as reduces incidence of vasovagal episodes [13].

Speculum placement can be uncomfortable. It is recommended using local anesthetic gel on speculum that can help reduce the discomfort.

Vaginoscopic approach or "no-touch technique" was introduced in 1997 by Bettocchi et al. for the atraumatic insertion of the hysteroscope without the aid of the speculum or the tenaculum [5]. To ensure a good vaginoscopic approach, the endoscopist starts to place the hysteroscope into the lower vagina and, with the introduction of the distension medium at a pressure of 30–40 mmHg to distend the vaginal cavity, progress up to the posterior fornix and then retract the hysteroscope until external os is visualized.

Acetaminophen (1 gm) also inhibits cyclooxygenase, acting in the central nervous system instead of the periphery. It is a good option in cases of allergy or intolerance to NSAIDs [14]. Mefenamic acid is also used as a prostaglandin synthesis inhibitor.

Misoprostol is a prostaglandin E1 analog used for cervical ripening in office hysteroscopy. It may facilitate the hysteroscopic procedure and lower the risk of cervical laceration because it dilates and softens the cervix. Misoprostol 400 ug is to be inserted per vaginally a night before the procedure [15].

Local anesthesia can help attenuate the pain of tenaculum placement and cervical manipulation. Different preparations of local anesthesia are used such as paracervical block or intracervical block and topical anesthesia such as lidocaine spray and intrauterine instillation.

Nitrous oxide may be helpful in reducing pain from hysteroscopy and especially hysteroscopic sterilization. Nitrous oxide has analgesic, anxiolytic, as well as amnestic properties and vasodilates smooth muscle. It is effectively used in short painful procedures.

Opioids have also been used for pain treatment in hysteroscopy. They produce analgesic effects through interaction with endogenous opioid mu receptors providing analgesic effects and causing euphoria. The most frequently used opioid for gynecologic procedures is fentanyl, which causes moderate sedation with a rapid onset and brief duration. It can be reversed by naloxone. Routine use of opiate analgesia before office hysteroscopy has to be avoided as it may cause adverse effects.

It reported 38.8% of adverse reactions, including 5% drowsiness, 2.5% nausea or vomiting, and 31.3% of both. The high incidence of these adverse effects limits the use of opioids in the outpatient setting [16].

Nonsteroidal anti-inflammatory drugs (NSAIDs). Double-blind placebo trial demonstrates significant reduction in postprocedure pain, although no significant benefit in discomfort during the procedure [17].

29.6 Methods of Analgesia

Patients with high-risk factors of suffering a painful procedure may be candidates for anesthesia. Although many studies have been performed about anesthesia in hysteroscopy, there is no ideal anesthetic agent, and on the contrary, anesthesia delivery could be more painful than not receiving any anesthesia.

Types of Analgesia

- NSAIDs.
- Opiates.
- Anxiolytics.
- Local.

Levels of Anesthesia

- Level 1: Local anesthesia with limited preoperative oral anxiolytic.
- Level 2: Moderate sedation.
- Level 3: Deep sedation.

NSAIDs

- Ibuprofen, ketorolac, paracetamol.
- Act like cyclooxygenase and PG synthesis inhibitor.
- To be used 1 h prior to surgery with a short treatment duration.
- Side effects: GI intolerance, acute renal failure.

Opiate

- Tramadol, fentanyl.
- Acts centrally on opioid receptors.
- 30 mins prior to surgery given intravenously
- Side effects: somnolence, respiratory depression, hypotension.

Anxiolytic

- Lorazepam 2 mg, alprazolam 0.5 mg.
- Bind to GABA receptors.
- 30 mins prior to procedure. Coadministration with opiates may potentiate sedation.
- Side effects: CNS depression, respiratory depression.

Local Anesthesia

- Lidocaine (1%), bupivacaine (0.25%).
- Combining with epinephrine (vasoconstrictor) slows the absorption and increases the duration.
- Lidocaine max dose 4.5 mg/kg, bupivacaine 2.5 mg/kg.
- Lidocaine with epinephrine—7 mg/kg.
- Bupivacaine with epinephrine do not exceed 225 mg.

- Topical sprays, gel.
- Paracervical—Start the paracervical block by placing the needle below the paravaginal mucosa, aspirate, and inject 1–2 mL. Next, advance the needle through the area you have already anesthetized, aspirate, inject an additional 1–2 mL, and keep going until approximately 9 mL have been injected.
- Once the procedure is started, if the patient is still having pain with cervical cannulation and dilation, consider injecting additional lidocaine until maximum dosing is attained and/or inject 10–15 mL of normal saline instead. This second injection can be given paracervically or intracervically at 10, 2, 4, and 8 o'clock. While it is not an anesthetic, the distension of nerve innervation with saline can reduce pain.
- Intracervical injection of 2–3 mL of 1% buffered lidocaine at the anterior cervix prior to placement of the tenaculum. Following placement of the tenaculum, the remaining can be injected in equal aliquots at 4 and 8 o'clock at the cervicovaginal junction as a PCB.
- Lidocaine toxicity: tingling around the mouth or face, tinnitus, and, in extremely rare cases, cardiac dysrhythmias and seizures.

29.7 Literature

The British Medical Journal meta-analysis by Cooper et al. found that intracervical and paracervical injections of local anesthetic significantly reduced pain in women undergoing outpatient hysteroscopy, whereas transcervical and topical application did not. Paracervical

injection was significantly superior to the other anesthetic methods. They also concluded that local anesthetics did not have a significant effect on the incidence of vasovagal episodes [18].

Munro and Brooks' review of local anesthesia for office hysteroscopy also supports that a consistent positive anesthetic effect is only demonstrated with paracervical anesthesia. Five of the six randomized clinical trials that their review included demonstrated reduced pain in patients who received paracervical anesthesia compared with placebo [9]. Paracervical anesthesia is also effective in hysteroscopic tubal sterilization, but only for passage of the hysteroscope through the cervical canal and for cervical manipulation, not for tubal insertion of the devices.

The Cochrane Review of paracervical local anesthesia for uterine intervention does not recommend the use of paracervical injection because it does not reduce intraoperative pain. This does not apply to office hysteroscopy as the review includes procedures that require cervical dilation. Exclusively local anesthesia is not recommended by the Cochrane Review if cervical dilation is needed [16].

Combined cervical block protocols have been studied by Lukes et al.'s randomized trial, and they found a statistically significant difference in pain score between a group receiving paracervical and intracervical block and a group only receiving intracervical block [19].

A Cochrane Review meta-analysis, Pain relief for outpatient hysteroscopy, did not demonstrate any significant reduction with NSAIDs or opioid analgesics during or after the procedure [16].

The RCOG Green-top Guideline Number 59 advises women without contraindications to take a standard dosage of NSAIDs 1 h before hysteroscopy to reduce pain in the immediate postoperative period [20].

According to Nagele et al., 184% of failed hysteroscopies are due to excessive discomfort [17]. De Iaco et al. state that 34.8% of patients who undergo anesthesia-free diagnostic hysteroscopy report severe pain [21]. Carvalho et al. report moderate to severe pain [measured by Visual Analog Scale (VAS) score of 5 or more immediately after examination] in 68.4% of patients [22].

The main conclusion of this revision is that, at present, injectable local anesthetics, particularly paracervical infiltration, are the methods that seem more effective, according to the revised literature [16, 20].

Key Learning Points

- To be consciously aware at each step of hysteroscopy where pain can be produced.
- Correct patient selection and appropriate analgesic method are the key to painless outpatient hysteroscopy.
- Risk and protective factors of suffering pain during outpatient hysteroscopy are important for identifying patients who are susceptible to receiving anesthesia.
- Combined analgesic methods are better option for office hysteroscopy.

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Hysteroscopy: Facts and Fictions

30

Archana Baser, Varsha Mahajan, and Anshu Baser

A hysteroscopy is a procedure of visualising and operating in the uterine cavity through a natural orifice cervix. Thus, it can be considered to be a minimally invasive method of intervening the uterine cavity in many benign pathologies.

The credit of performing first successful hysteroscopy goes to Pantaleoni in 1869. Subsequently, the advances took place, and use of different distension media and light source came into account. Over the decades, hysteroscopy has proven its efficacy and safety in diagnosing and treating a number of gynaecological conditions.

Success of hysteroscopy depends on better visualisation, physiologic distension media and good-quality instruments.

30.1 Procedure

Hysteroscopy involves the introduction of a rigid or flexible hysteroscope through the cervix into the uterus. It is attached to a camera and a channel to allow the distending media to enter in the uterine cavity. Conventionally, normal saline is used to distend the cavity. Saline is introduced in the cavity by pressure by either pressure cuff or hysteromat. Hysteromat allows the fluid to enter the cavity with a specific pressure to minimise the overload of fluid. The cavity is seen on the monitor connected.

The uterine cavity is visualised by contact hysteroscopy. Initially, both ostia are inspected, and their relation with the uterine cavity is also noted. Figure 30.1 shows normal uterine cavity in relation to ostia. Abnormal position of ostia can be noted in mullerian anomaly (Figs. 30.2 and 30.3). Cornual polyps (Figs. 30.4 and 30.5) are frequently encountered in subfertility patients. Many submucosal fibroids (Fig. 30.6), endometrial polyps (Figs. 30.7 and 30.8) and intrauterine adhesions (Fig. 30.9) can be very well diagnosed or confirmed in patients with abnormal uterine bleeding. Misplaced IUCD is best located by hysteroscopy. Also, missed fetal bone of previous second-trimester abortion are sometimes picked up (Fig. 30.10). Falloposcopy can also be done by flexible hysteroscope. Endometrial tuberculosis can be suspected when caseation seen in the cavity (Fig. 30.11) or tubercles are noted. Endometritis is one of the common finding. A rare endometriotic cyst with chocolate fluid coming can be best picked by hysteroscopy (Fig. 30.12).

Many more such indications of hysteroscopy has made it an important tool in the arsenal of all

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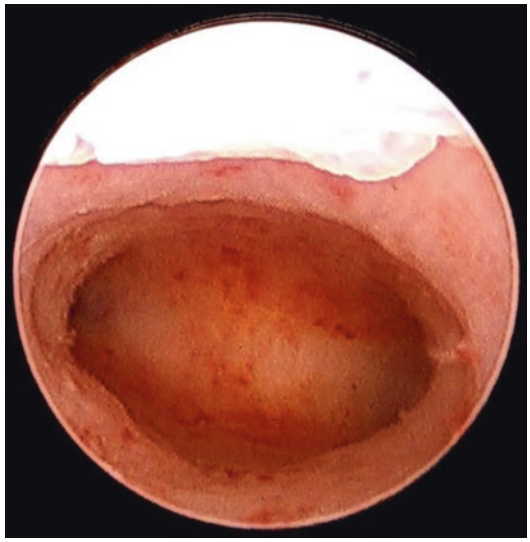

Fig. 30.1 Normal positioning of ostia with relation to uterine cavity

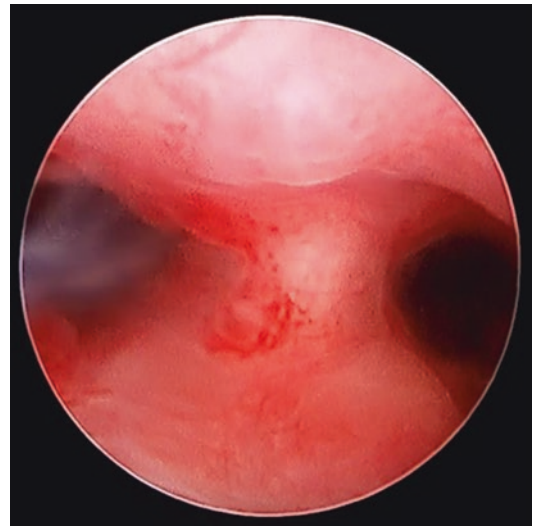

Fig. 30.3 Septate uterus showing thick uterine septum

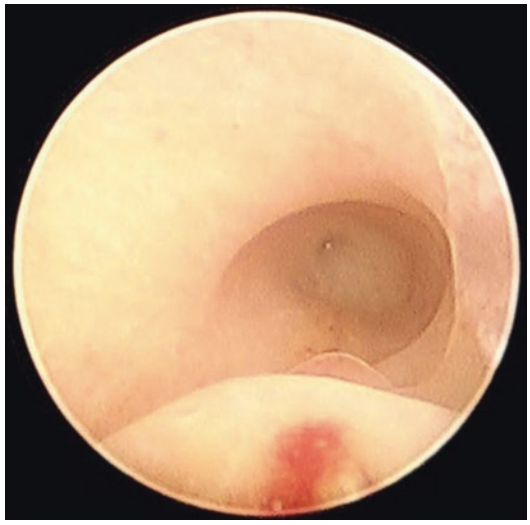

Fig. 30.2 Unicornuate uterus showing one ostia only

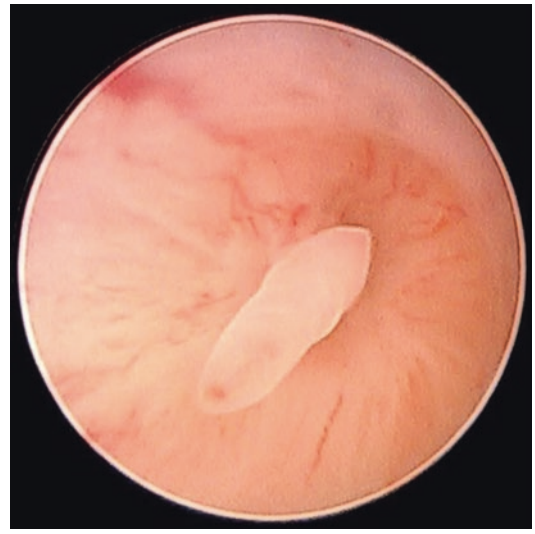

Fig. 30.4 Cornual polyp obstructing visualisation of ostia

gynaecologists. Concept of office hysteroscopy has rather increased its use owing to low cost, low-anaesthesia risk and less hospital stay, thus increasing acceptance. Office hysteroscopy can be done without any anaesthesia or sometimes local anaesthesia. Diagnostic hysteroscopic procedures have very low complication rates so are safe procedures to evaluate intrauterine pathology.

Outpatient hysteroscopy, whether diagnostic or operative, is successful, safe and well tolerated. However, as with any procedure requiring instrumentation of the uterus, outpatient hysteroscopy can be associated with significant pain and anxiety. To minimise pain and discomfort, variations in hysteroscopic equipment, use of local anaesthesia, adaptations to the technique and use of pharmacological agents have been advocated [1]. The preoperative use of misoprostol or laminaria decreases the risk of uterine perforation. Expert preoperative evaluation is essential in determining the surgical skill and expertise needed, the surgical time and the

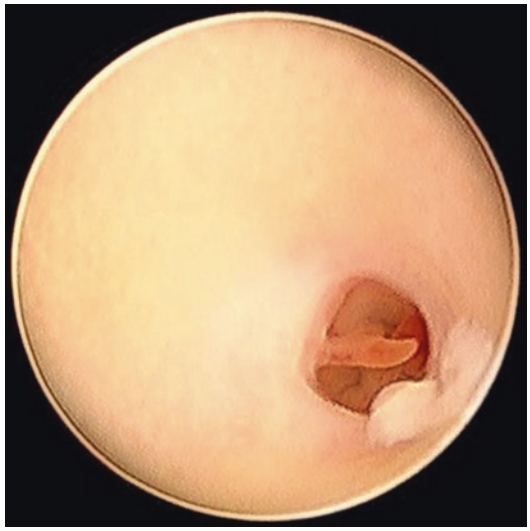

Fig. 30.5 Small cornual polyp

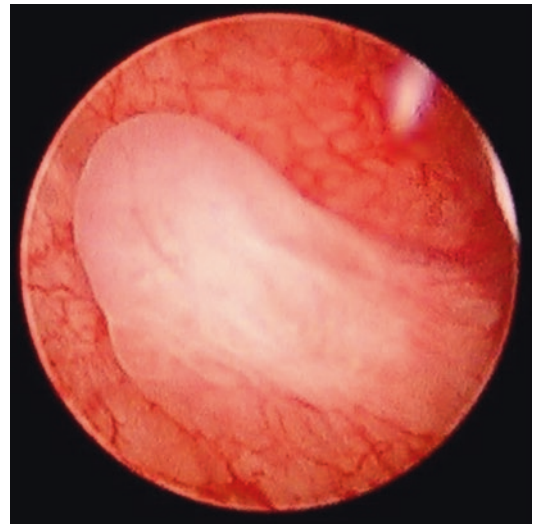

Fig. 30.7 Small endometrial polyp

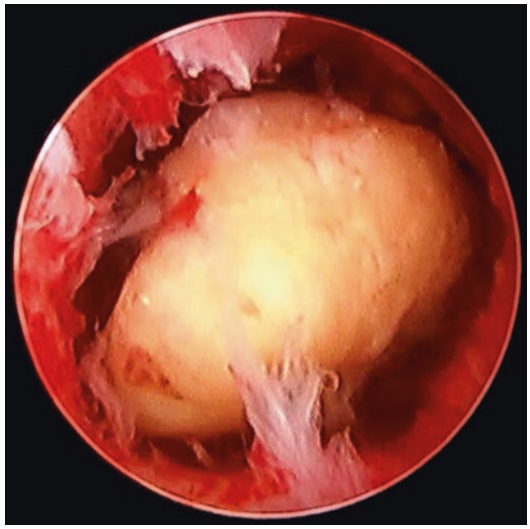

Fig. 30.6 Submucosal intracavity fibroid occupying the uterine cavity

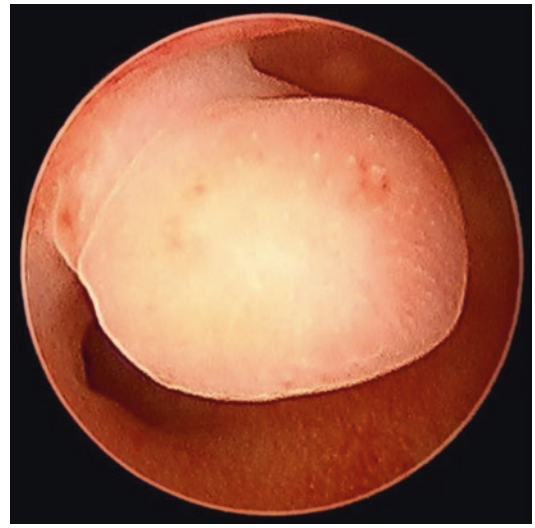

Fig. 30.8 Endometrial polyp

likelihood of completing the operative procedure. Overall, complications in outpatient hysteroscopy are infrequent. Sometimes, the office hysteroscopy procedure is failed due to cervical stenosis, pain and poor visualisation.

Operative hysteroscopy on the other hand is done under general anaesthesia with use of energy sources either monopolar or bipolar to remove fibroid myomas and submucosal polyps (Fig. 30.13) and for adhesiolysis (Fig. 30.14), etc. Operative hysteroscopic procedures require the need of glycine as distension media conventionally which is associated with fluid overload as a known complication, but with the advances in technology, even saline can be used as distension media if energy source is bipolar instead of unipolar so that glycine-related complications can be prevented. Thus, it is advisable for health-care provider to implement use of technologically advanced gadgets instead of conventional means wherever possible.

Many complications of operative hysteroscopy were entry-related, so attention has to be paid to the method of entry with the hysteroscope

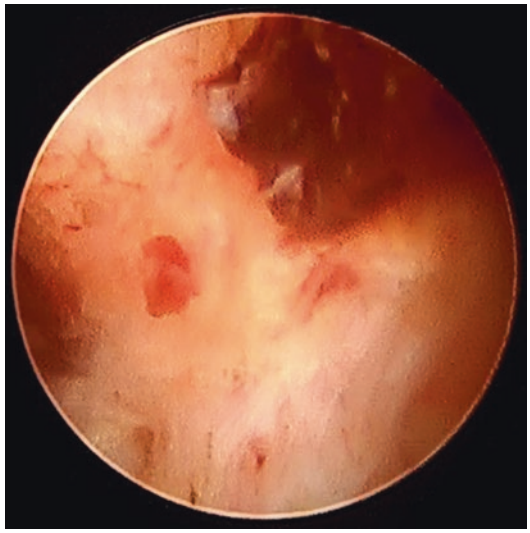

Fig. 30.9 Showing dense intrauterine adhesions

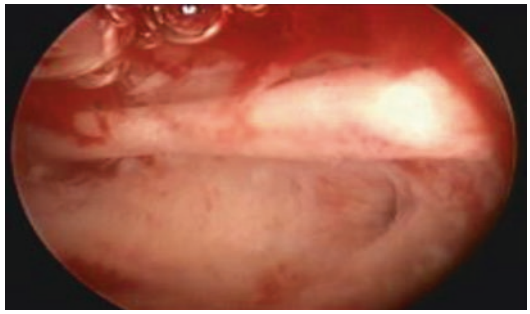

Fig. 30.10 Missed fetal bone acting as IUCD in a case of secondary subfertility and dysmenorrhea

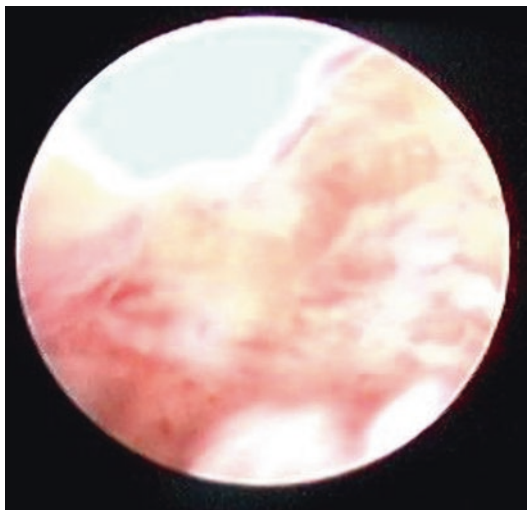

Fig. 30.11 Caseation noted in the cavity along with irregular endometrial cavity in a case of endometrial TB

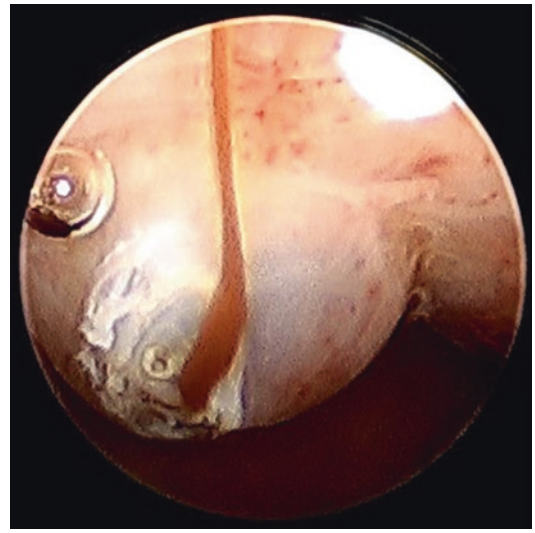

Fig. 30.12 Adenomyotic cyst with chocolate fluid coming out

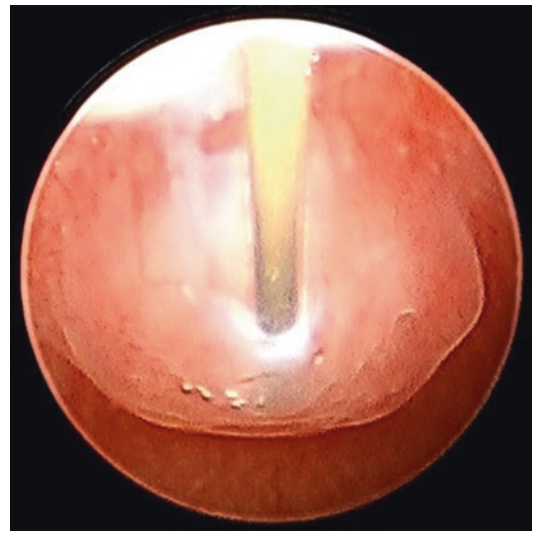

Fig. 30.13 Submucosal polyp resection using energy source

(no unnecessary dilation of the cervix and introduction of the scope under direct vision). The other complications were related to surgeon's experience and type of procedure.

Fortunately, gynaecologists are enthusiastically embracing diagnostic and operative hysteroscopy as a means to evaluate women with menstrual disorders, subfertility, postmenopausal bleeding, recurrent pregnancy loss, etc. In general, operative hysteroscopy is a safe procedure, is

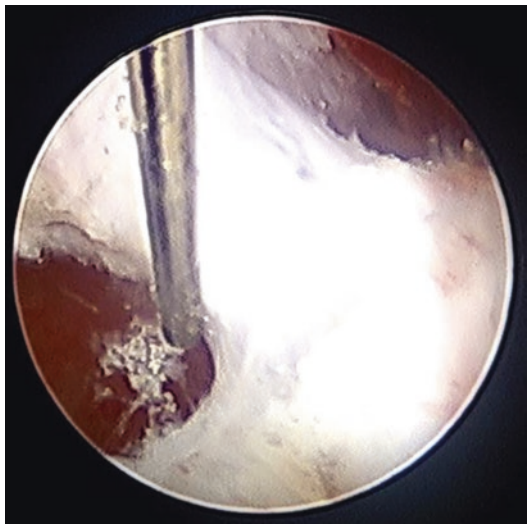

Fig. 30.14 Adhesiolysis done using energy source

easily learned and has excellent surgical outcomes. As more obstetricians/gynaecologists perform hysteroscopy, they must remain aware about the salient complications. The recognition of complications and prompt intervention will prevent adverse sequelae as well as minimise undesirable patient outcomes and reduce legal risks.

Fluid management is critical for intraoperative safety. Meticulous attention should be paid to fluid management, and a critical care specialist should be involved when fluid overload or hyponatraemia is suspected. Continuous pain, fever or pelvic discomfort after surgery requires prompt evaluation.

It is important that the procedure is stopped if a woman finds the procedure too painful for it to be continued. This may be at the request of the patient or nursing staff in attendance or clinician performing the investigation.

Advances in endoscopic technology and ancillary instrumentation have facilitated the development of operative hysteroscopic procedures in an outpatient setting with or without the use of local anaesthesia. Common procedures include endometrial polypectomy, removal of small submucous fibroids, endometrial ablation, removal of lost intrauterine devices and transcervical sterilisation.

Enthusiasm is a great asset one can have but knowledge remains the main power. Although with recent advances in fibre optics and technology along with surgeon's expertise, the complications in hysteroscopy are rare, but the proper knowledge of early and late complications should always be in the back of mind while performing the procedure as sometimes they can be life-threatening and can bring a long-time morbidity.

Operative hysteroscopy reported a complication rate of 0.22% [2].

Common complications are:

- Uterine perforation (0.12%).
- Fluid overload (0.06%).
- Intraoperative haemorrhage (0.03%).
- Bladder or bowel injury (0.02%).
- Endomyometritis (0.01%).

At the outset of the fact that hysteroscopy is easy to understand and perform, it should not be forgotten that any surgery either outpatient or indoor whether diagnostic or operative involves the risks and complications if not handled with utmost care pre-op, intra-op and post-op.

Key Points

- Hysteroscopy is a very common tool providing the gynaecologist the ability to diagnose and treat a variety of intrauterine disorders. This outpatient therapy has provided quick and effective relief for women worldwide. Although simple in concept, hysteroscopy is associated with minor and major complications. Awareness of these difficulties and methods of prevention and management is key to good surgical outcomes.
- Although complications with both diagnostic and operative hysteroscopy are rare, they can often be prevented with thorough preoperative evaluation and appropriate intraoperative decision-making.
- Understanding the patient, disorder and surgical process can assist the surgeon in providing the best outcome for the patient. With appropriate training and education, gynaecologists can safely incorporate hysteroscopy into their surgical practice.

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Further Reading

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Newer Advances in Hysteroscopy

31

Rahul Gore and Sunita Tandulwadkar

Hysteroscopy has witnessed numerous innovations over the years and has eventually become an integral part of the gynaecologist's armamentarium. Its role is vital not only for diagnostics but also for therapeutics, for the panoptic spectrum of gynaecological problems. The ultimate motive behind all these improvisations remains the same—minimal invasion with enhanced recovery, aiming towards highly efficient and cost-effective management. Thanks to miniaturisation of the hysteroscopes, many procedures can now be performed with minimum trauma and without general anaesthesia.

The modern gynaecologist's signature procedure, office hysteroscopy (OH), as an independent technique of the hospital circuit, has the ideal conditions to be qualified as the gold standard technique [1]. Professional bodies such as British Society for Gynaecological Endoscopists (BSGE) [2] and Royal College of Obstetricians and Gynaecologists (RCOG) [3] have recommended that the patients should be offered outpatient hysteroscopy as the first choice, whilst American Association of Gynecologic Laparoscopists (AAGL) [4] statement also regards hysteroscopy as the gold standard.

31.1 New Hysteroscopy Devices

31.1.1 Bettocchi™ Integrated Office Hysteroscope (B.I.O.H)®

Photographs courtesy © KARL STORZ SE & Co. KG, Germany

This compact hysteroscope from KARL STORZ (Germany) is recent advancement of the traditional Bettocchi 'size 4' hysteroscope [5]. It has Hopkins® 2.0-mm scope like its predecessor; however, the new ergonomic design of the handle facilitates insertion and handling of the hysteroscope, with improved comfort for the patient. In the lower part of the grip, an assembly of connectors has been included that allows the connection of a fibre-optic light cable and a tubing set for irrigation and suction.

The operating channel is equipped with an automatic silicone valve inlet that prevents leakage and permits a rapid insertion of any mechanical instrument or bipolar electrode, up to 5 Fr in diameter.

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31.1.2 CAMPO TROPHYSCOPE® Compact Hysteroscope

Without working channel

With working channel

Photographs courtesy © KARL STORZ SE & Co. KG, Germany

This is another recent addition from KARL STORZ [5]. It has HOPKINS® telescope (30°) with size 2.9 mm. It is equipped with an irrigation connector and can be used with either examination sheath (Continuous-Flow Examination Sheath, size 3.7 mm, length 18 cm, with suction adaptor) or operating sheath (Continuous-Flow Operating Sheath, size 4.4 mm, length 16 cm, with channel for semi-rigid instruments 5 Fr., with 1 stopcock and 1 LUER-Lock adaptor). Its main innovative feature is the sheath with gliding mechanism which enables intraoperative changeover from single-flow to continuous-flow and/or operating sheath. Integrated irrigation channel also means greater stability.

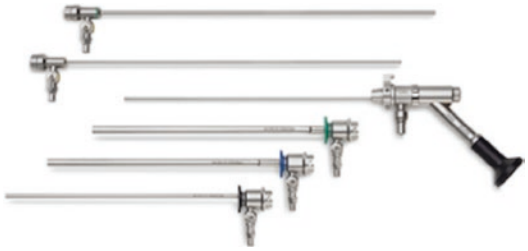
31.1.3 EndoSee®

Images provided by CooperSurgical, Inc.

The EndoSee® device (CooperSurgical, USA) (2013) is a handheld, battery-operated hysteroscopy system that consists of two main parts. The 'HandTower™' contains a small (LCD) monitor and a rechargeable battery. The hysteroscope is a single-use semi-rigid curved cannula with a diameter of 15 F (4.5 mm). The lens, camera and light source are placed at the tip, with a CMOS sensor, which has low-static power consumption. The LED light provides a high-intensity light, but without significant heat production, hence safe for the uterine cavity. There is a port at the proximal end for attachment of a syringe or inflow tubing for saline irrigation.

Observational studies using the device for diagnostic hysteroscopy, primarily in an office setting, have reported that adequate tissue samples were obtained with the device and with minimal need for cervical dilatation. Harris et al. [6] collected data for 13 patients, and Munro et al. [7] collected data for 24 women who underwent office diagnostic hysteroscopy with the device in one of nine medical centres in the USA. Procedure was reported easy to use with good patient tolerance. The findings of these investigators support use of the device in a non-specialised examination room as it has the potential to replace the more usual bulky monitor, camera and light source equipment, without the need for sterilisation facilities [8].

31.1.4 Hologic Three-in-One Omni™ Hysteroscope

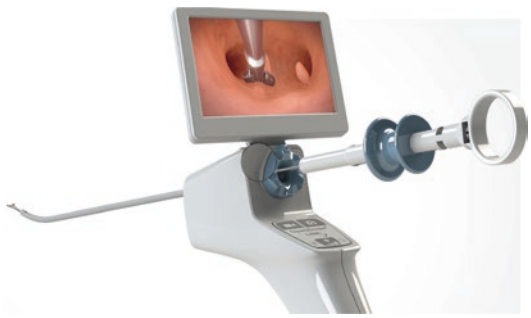


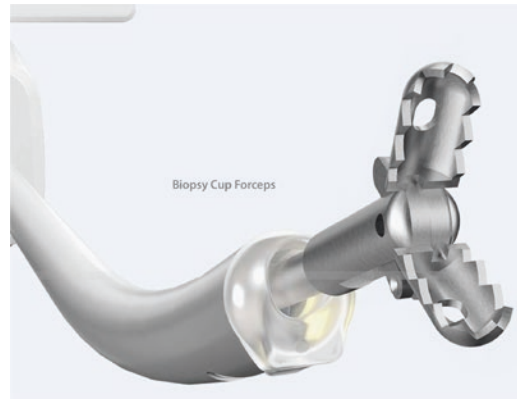
Photograph courtesy: Hologic Inc. & Affiliates

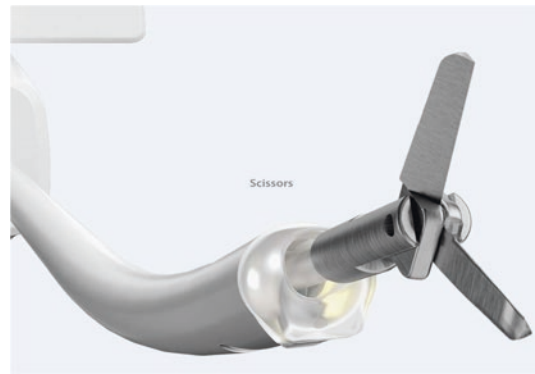
Omni™ hysteroscope (2018) is an innovative three-in-one modular scope with advanced visualisation capabilities designed for both diagnostic and therapeutic hysteroscopic procedures. MyoSure optics provide good-quality visualisation and sheaths designed with smaller diameters (3.7 mm diagnostic sheath, 5.5 mm operative sheath, 6 mm operative sheath) to reduce dilation and promote patient comfort and easy insertion.

These sheaths can be easily interchanged during the procedure. It is compatible with the MyoSure device (discussed later). Another advantage is its 200 mm working length facilitates easier access and treatment for obese patients [9].

31.1.5 LiNA OperaScope™ (LiNA Medical, Glostrup, Denmark)







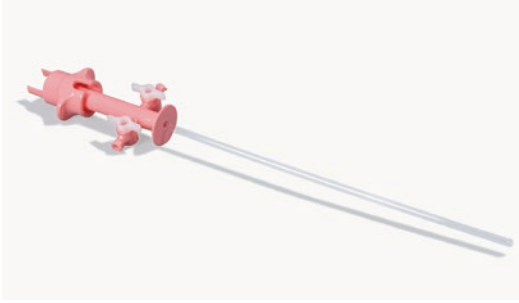
Photographs courtesy: LiNA Medical

This cordless single-use hysteroscope was recently launched (2018) and is a perfect addition to office hysteroscopy. It has high-definition LCD display and the scope itself is 4.2 mm thick. The scope has inbuilt battery for camera, LCD and the illumination system.

The scope has ports for fluid input and output and also the USB attachment for recording image/video. 360° steerable tip allows for precise control and manoeuvrability. It has great range of miniature operative tools such as forceps, graspers and scissors.

The main advantage of this system is to bypass the complexity of traditional hysteroscopy setup, hence reducing the cost of staffing, infrastructure and sterilisation procedures. It has shown superior picture quality and ease of use.

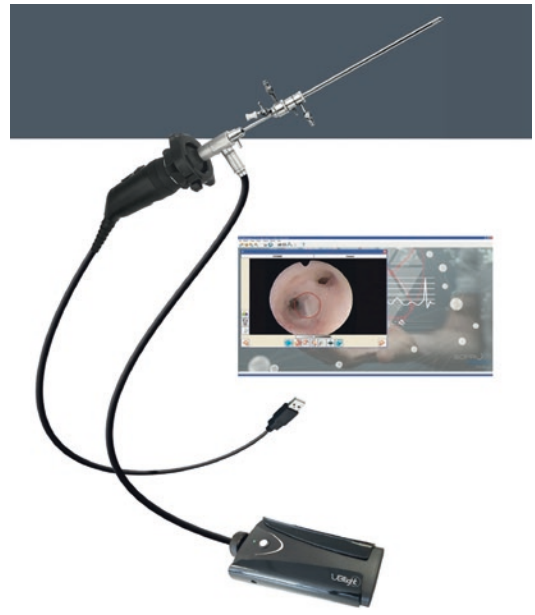
31.1.6 Endoshaft® Disposable Hysteroscopy Sheath (Italy)



Photograph courtesy: Endoshaft

An Italian company has developed a disposable sheath, Endoshaft® (Italy), that provides a barrier between the patient and the endoscope so that a single hysteroscope could be used for all patients without being re-sterilised. This may reduce preparation time, enabling more patients to be seen on a list and without the same capital expenditure. Irrigation fluid passes down the outer sheath, and the view at the hysteroscope tip is through a clear window at the distal tip of the sheath.

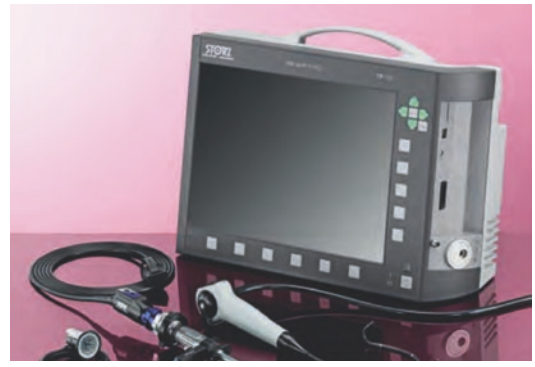
The sheath is reported by the company as having smooth rounded surfaces to allow it to easily pass through the cervical canal. Endoshaft can be used with the commonly available hysteroscopes [8].



Photograph courtesy: Comeg Med Tech

UBIPack (Comeg Med Tech) is an all-in-one system. It has SD camera with 2.7 mm scope with diagnostic sheath. The system can be used in outpatient clinic setting with good patient satisfaction and cost-effectiveness. LED light is equivalent to 100 W xenon light. It uses intuitive SOPRO imaging software, which can record image, video and audio to generate patient reports. The scope sheaths are autoclavable.

31.1.7 TELE PACK X LED System



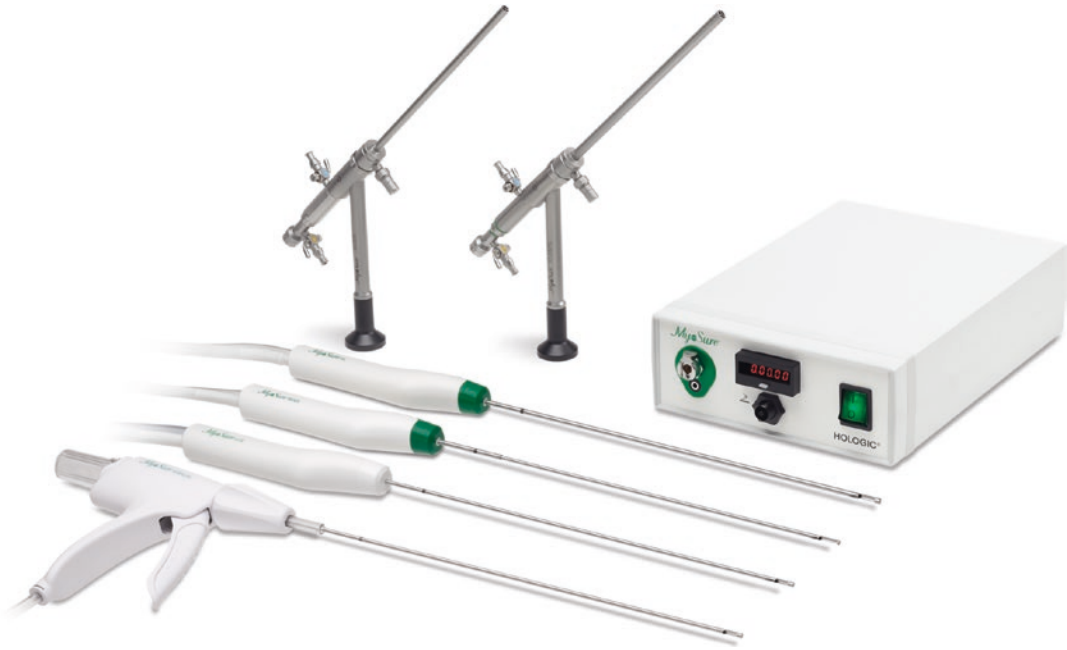
Photographs courtesy © KARL STORZ SE & Co. KG, Germany

The TELE PACK X LED system is another all-in-one unit that allows performance of high-quality outpatient hysteroscopies in minimum space with maximum comfort. This innovative device integrates a monitor, camera, documentation terminal and a powerful LED light source in one compact unit.

The TELE PACK X LED provides good visualisation of hysteroscopic findings on the brilliant 15″ flat-screen monitor with LED backlight. Six USB ports and one SD card slot enable the storage of images and videos as well as direct printouts in combination with compatible medical USB printers.

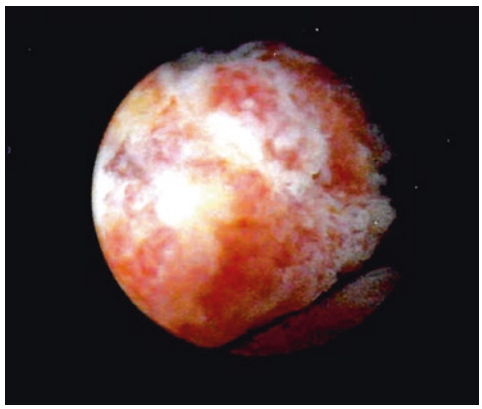
31.2 New Intrauterine Morcellation/Resection Devices

31.2.1 MyoSure

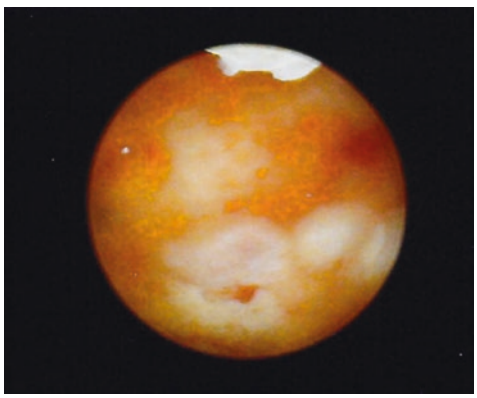


Photograph courtesy: Hologic Inc. & Affiliates

Pre op view of submucous myoma.



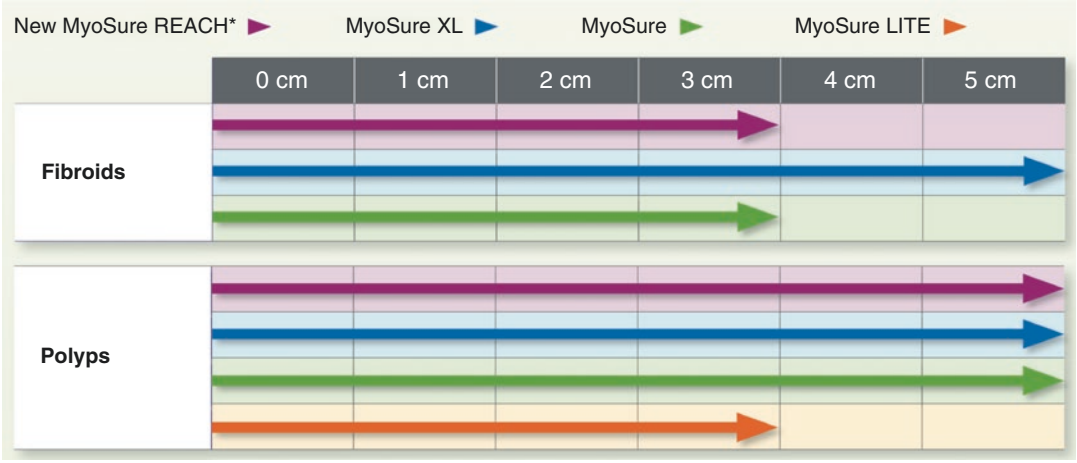
Post op view after Myoma resection



Photographs courtesy: Tunbridge Wells Hospital, UK

Hologic, Inc. launched MyoSure in 2011 and later introduced advanced versions in 2017 and 2018. The MyoSure system provides a fast, convenient way to hysteroscopically remove intrauterine pathology whilst maintaining uterine form and function—100% mechanical resection preserves tissue margins. The MyoSure system resects intrauterine pathologies whilst simultaneously removing resected tissue from the uterine cavity with suction.

The devices provide customised selection for fibroid and polyps as per the following :



Photographs courtesy: Hologic Inc. Inc. & Affiliates

Rotating cutting tip can be easily manoeuvred to access lateral, anterior and posterior wall.

31.2.2 Aquilex Fluid Control System

Photograph courtesy: Hologic Inc. & Affiliates

The main advantage of hysteroscopic morcellation with MyoSure is minimal disruption to procedural workflow. In conjunction with real-time fluid monitoring with systems like Aquilex, the risk of fluid absorption is significantly reduced [10, 11].

As the MyoSure tissue removal device simultaneously cuts and removes intrauterine tissue, the Aquilex fluid control system balances steady fluid inflow with active suction to optimise uterine distention and provide a clear field of view—free from tissue debris.

Large prospective studies and multicentric systematic reviews have already proven the safety and efficacy of MyoSure morcellation [12, 13]. Nevertheless, the type of submucous myoma still remains the biggest challenge: type 0 and 1, being easier to manage with respect to type 2, reflecting what is already known as "classic" hysteroscopic myomectomy [13].

31.2.3 TruClear™ Hysteroscopic Tissue Removal System

Photograph courtesy: Medtronic UK

Launched in 2016, this system can perform both diagnostic and operative hysteroscopy for range of conditions—fibroids, polyps, intrauterine adhesions, retained products and also tubal catheterisation for the evaluation and treatment of proximal tubal occlusion in conjunction with the use of the C arm.

100% continuous flow and suction help maintain a clear operative field.

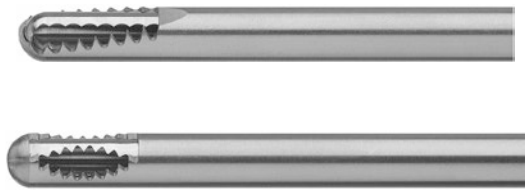
Localised treatment reduces endometrial damage which is important for future conceptions.

A recent scientific review of published data related to 1184 patients demonstrated that the TruClear 5.0 System outperformed conventional resectoscopy and conventional outpatient operative hysteroscopy on such issues as safety, efficacy, surgical complications, estimated learning curve and operating time [14].

A large multicentric RCT compared morcellation with electrosurgical resection and concluded that morcellation was significantly quicker, less painful, more acceptable to women and more likely to completely remove endometrial polyps [15].

31.2.4 DRILLCUT-X® II Shaver Handpiece GYN, for Use with UNIDRIVE® S III SCB

Two types of cutting tips, 4 mm, rectangular & oval cutting edge



Photographs courtesy © KARL STORZ SE & Co. KG, Germany

Handpiece with adjustable option.

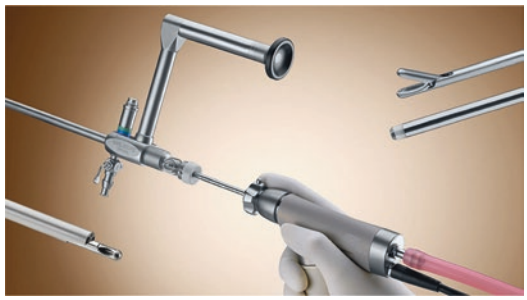
31.2.5 UNIDRIVE® S III SCB-Shaver Control Unit

Photographs courtesy © KARL STORZ SE & Co. KG, Germany

KARL STORZ, Germany, launched this recently for gynaecological use. It was originally designed for arthroscopic shaving procedure. It has adjustable ergonomic handle for simple handling. The tip provides powerful oscillating rotations for fast resection of submucous fibroids. It has an integrated suction channel for immediate

removal of tissue fragments out of the uterine cavity under direct vision. There are two different blades for individual use.

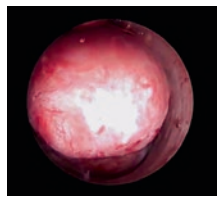
31.2.6 Intrauterine BIGATTI Shaver (IBS® System)

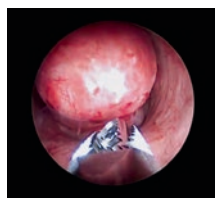


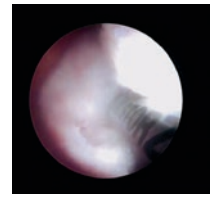
Mazzon Forceps (3 mm).

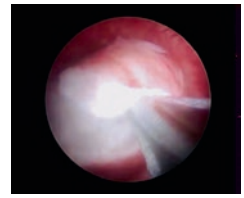
Photographs courtesy © KARL STORZ SE & Co. KG, Germany

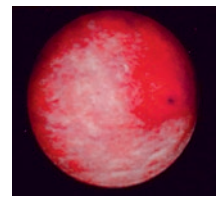
Illustration of submucous fibroid resection with Bigatti System











Photographs courtesy: Laura Kappusheva Russia and KARL STORZ

HYSTEROMAT E.A.S.I.® (discussed later) in conjunction with Drillcut shaver blades forms Bigatti shaver system. 6° Hopkins telescope is used for better vision.

This system allows use of recently modified instruments (Mazzon forceps) for septum resection and adhesiolysis. These also can be used for extraction of remaining fibroid tissues.

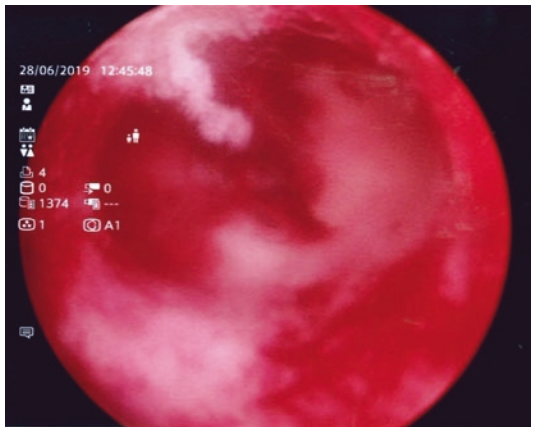
The studies have proven the efficacy and safety of the IBS shaver system, and also mean duration of procedure has been significantly reduced [16, 17]. It also can be used to safely extract the retained products of conception [18].

31.3 New Endometrial Ablation Devices

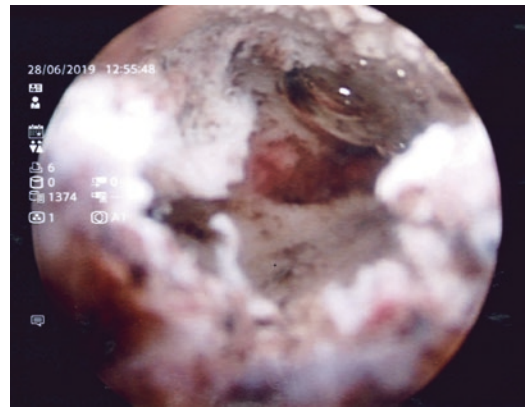
31.3.1 NovaSure™ Advanced

Photograph courtesy: Hologic Inc. & Affiliates

Illustration of NovaSure Advanced endometrial ablation for a 46-year-old patient with profuse DUB, intractable to nonsurgical options.



Pre op cavity.



Post op cavity

Photographs courtesy: Tunbridge Wells Hospital, UK

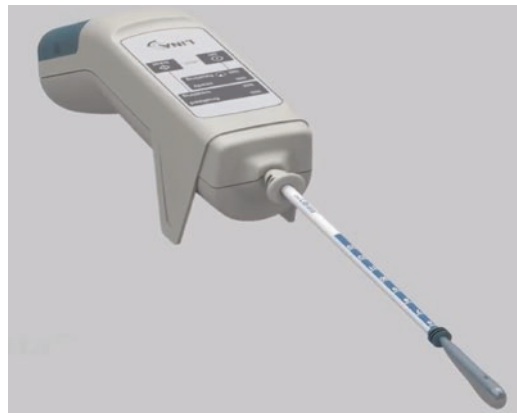
NovaSure™ *Advanced* is a recent modification (2017) to its predecessor which has been in clinical practice since 2001 and probably amongst the few devices with vast patient safety and efficacy data. It is a radiofrequency ablation device with 6 mm diameter compared to the 8 mm diameter of the previous version. It has rounded tips, making insertion easier, and improved cervical seal, reducing the failure rate. This also makes it suitable for outpatient procedures under local anaesthesia. Greater patient satisfaction score has been recorded with outpatient endometrial ablation [19].

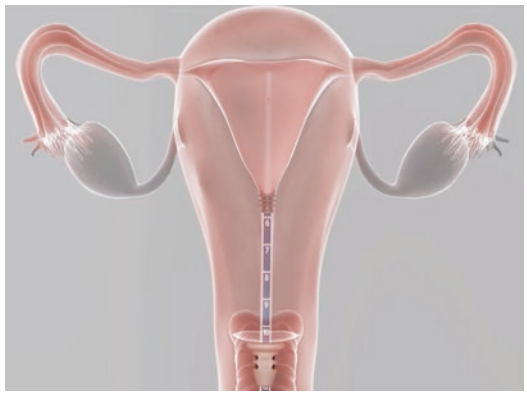
It is important to reiterate in patients counselling that her family should have been completed and that she will need post-procedure effective contraception because any pregnancy after this procedure is highly complicated.

The following chart explains the clinical comparison with other ablation devices.

	NovaSure® endometrial ablation	ThermaChoice III [20]	HTA [21]	Her Option [22]
Average treatment time	90 s	8 min	10 min	10–34 min
Average procedure time	4.2 min	27.4 min	26.4 min	N/A
Pretreatment required	No	Yes	Yes—Lupron depot®	Yes—Lupron depot®
Cycle dependent	No	Yes	Yes	Yes
Mechanism of action	Impedance-controlled, radiofrequency ablation	Balloon filled with heated fluid	Circulating heated saline	Cryotherapy (freezing) prove
Procedural distension	No	Yes (160—180 mmHg pressure)	Yes (50–55 mmHg pressure)	No
Perforation detection	Cavity integrity system (pre-procedure)	Pressure shut-off (during procedure)	Fluid alarm (during procedure)	Ultrasound for monitoring (during procedure)

31.3.2 LiNA-Librata Endometrial Ablation System (Denmark)





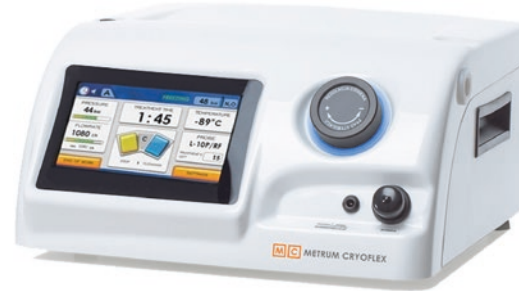
Photographs courtesy: LiNA- Librata

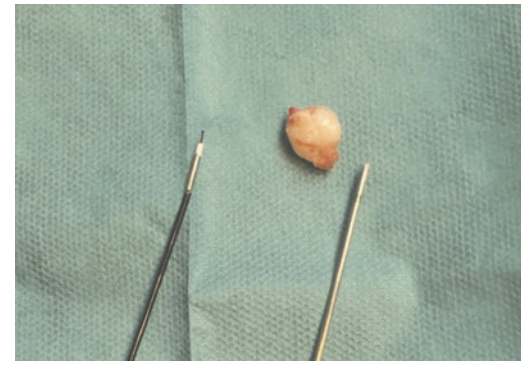
LiNA-Librata thermal balloon ablation device was launched in 2016. It is a disposable, handheld cordless device which operates on battery. The catheter has 5 mm diameter. It has insulated heating system which heats up glycerine to 150 °C which takes up to 6 min. The catheter is then inserted in the uterus and balloon is inflated by the system. It automatically maintains the pressure of approx. 175 mmHg, and then heated glycerine is circulated in the balloon for 2 min so that most of the endometrial area is treated. There is inbuilt safety check system to detect any perforation/leakage of fluid.

Recent studies have proven that it is an effective treatment for abnormal uterine bleeding and well tolerated in an outpatient setting [23] [24].

31.4 New Cryotechnology

31.4.1 Metrum Cryoflex Generator and Cryoprobes

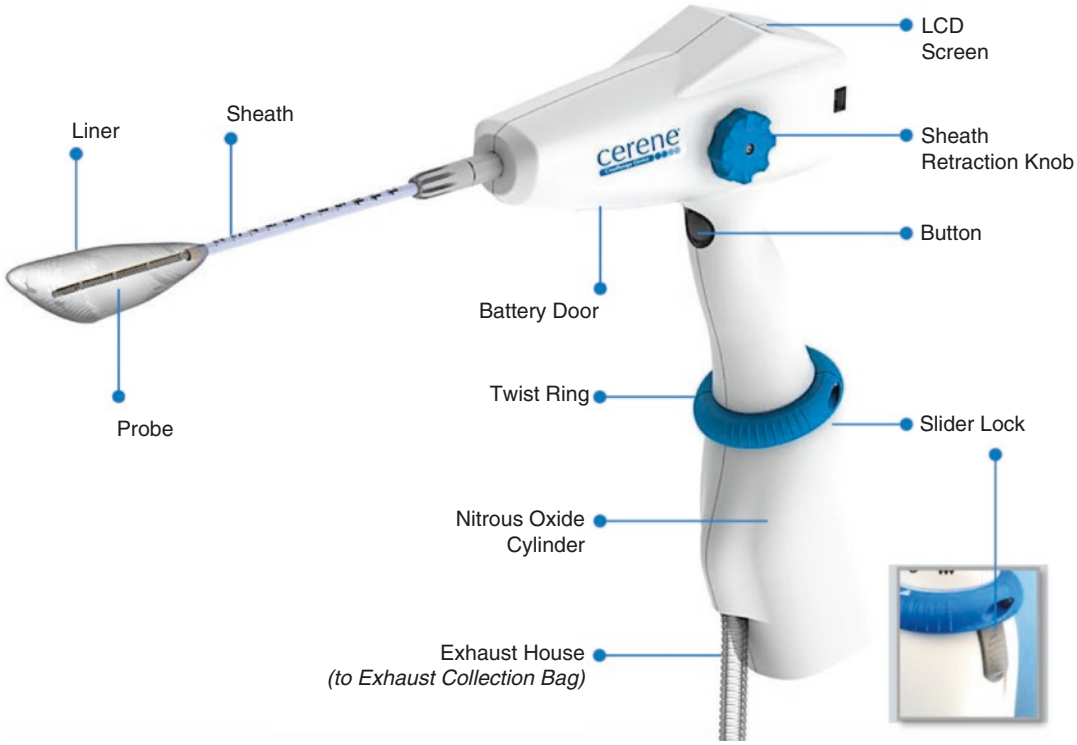




Photographs courtesy: Metrum Cryoflex

The cryoprobe and universal generator for cryotherapy is manufactured by Metrum Cryoflex. An adhesive force is created on the tip of the cryoprobe by reducing the temperature to −70 °C, according to the Joule-Thomson principle. During the procedure, the pathological structure is attached to the tip of the electrode, and as such, cryobiopsy allows extraction of larger fragments of tissue from the uterine cavity, both hard and soft. A lower risk of bleeding due to the haemostatic features of cryotechnology is another advantage. The procedure can be repeated until complete extraction of polyp or fibroid [25].

31.4.2 Cerene ™ Cryoablation Device (Channel MedSystems, USA)



Photograph courtesy: Channel Medsystems

FDA has recently (2019) approved Cerene cryoablation device for endometrial ablation. It has a nitrous oxide cylinder, and the probe is 5.8 mm thick, making it suitable for outpatient procedure. After the insertion in the uterine cavity, the probe is filled up with the air to ensure the liner is covering most of the endometrial surface.

The nitrous oxide gas is then released into the liner which creates the cryogenic effect lasting over 150 sec. The software in the device detects and maintains exact intrauterine pressure and also triggers off in the adverse event such as uterine perforation.

The pivotal CLARITY study has demonstrated safety and efficacy of this innovative device [26].

31.5 Intracavitary Distension Devices

31.5.1 KARL STORZ Hysteromat EASI®

© KARL STORZ SE & Co. KG, Germany

A more recent electronic system for intracavitary distension is the *E.A.S.I. Hysteromat*® (*Endoscopic Automatic System for Irrigation*).

The *E.A.S.I.* system ensures the maintenance of a preselected intracavitary pressure by an automated microprocessor-controlled continuous flow of the distension medium. The system allows predefined set values of pressure and flow to be stored in memory.

Hysteromat® (E.A.S.I.) can be operated in conjunction with other electronic systems for real-time monitoring of liquids. This system includes a pressure-controlled fluid infusion pump, integrated suction source, a fluid collection system and monitoring component to ensure accurate fluid deficit monitoring during operative hysteroscopy. The alarm sounds when the predefined critical fluid balance level is exceeded.

31.6 Recent Advances in Hysteroscopy Training–VR Simulation

Simbionix Hyst Mentor

Photograph courtesy: 3D SYSTEMS (SIMBIONIX)

HystSim, a new virtual reality simulator, has been tested for the training of hysteroscopic interventions. VirtaMed GynoS™ provides lifelike gynaecology training at no risk to live patients. It is the most realistic virtual reality simulator for uterine sounding, IUD insertion, embryo transfer and hysteroscopy. Trainees learn using original medical instruments, making their skill directly transferable to the clinical setting. Ghost tools demonstrate the correct movements, and the unique patient comfort scale makes sure the doctor gets the most realistic experience possible.

Virtual reality simulators have been assessed to be highly relevant to reality, and all surgeons attained significant improvements between their pretest and posttest phases, independent of their previous level of experience, demonstrating more improvement amongst novices than experts. Available evidence supports the effectiveness of virtual simulators in increasing the diagnostic and surgical skills of gynaecologists, independent from their starting level of expertise [27].

Key Learning Points

- The innovations should be targeted towards patient safety, satisfaction scores and clinical efficacy.
- Whilst focused on newer advanced technology, one should balance the cost-effectiveness of the treatment offered to the patient, and it should be adequately individualised to the patients and healthcare system.
- Regardless of any innovations, basic surgical principles remain the key for overall clinical success, i.e., appropriate case selection, preprocedural counselling, consent, adequate preparations and setup for the procedure, good anatomical knowledge and sound surgical skills such as respect to the tissues, precise and concise surgical manoeuvres, aseptic technique, post-procedural advise and follow-up advice.
- Good-quality documentation and larger studies are of paramount importance whilst new innovative devices are being used in routine practice especially endometrial ablation devices.
- Reflective learning and improvisation are still a vital part of medical innovation. This should be amalgamated with teaching and training.

Conflicts of Interest

None.

Resources: The article is based on the review of available published literature (international guidelines, medical publications, manufacturer's manuscript) and experts' opinions in various international meetings and conferences. Financial and marketing information of any device remain outside the scope of this article.

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