6 Intraoperative Management of FIGO Type 2 Fibroids

Zaraq Khan

Leiomyoma/myomas or commonly referred to as fibroids are benign uterine tumors that are present in up to 70–80% of premenopausal women by age 50 [1]. The prevalence in symptom-free women is as high as 40% in white and more than 60% in black patients of the same age group [1]. Even though 1 out of 3 women in the United States have a hysterectomy by age 60, more than 90% of these are performed for non-life-threatening indications [2]. The most common indication for hysterectomy in the United States remains leiomyoma at around 40% [3]. Most common symptoms caused by fibroids include abnormal uterine bleeding (AUB) – specifically heavy menstrual bleeding, bulk related symptoms due to the mass effect of the lesion, and an association with sub/infertility.

Approximately 40% of premenopausal women who seek evaluation for heavy menstrual bleeding are found to have intracavitary lesions like polyps or fibroids [4]. Submucosal fibroids are more likely to cause issues with AUB and are primarily lesions that have the potential to impair fertility. For these intracavitary lesions, myomectomy is more often recommended – especially for women seeking fertility in the future, and a hysteroscopic myomectomy is considered the gold standard for women who have symptomatic submucosal disease burden [5].

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Classification

Categorization of fibroids is very useful when evaluating the need to intervene in an otherwise asymptomatic patient with infertility. Location of the lesion within the uterus is most useful in such cases. It is also paramount when considering therapeutic options and surgical approach for patients with symptoms. There are primarily three different systems used to classify fibroids.

The ESGE (European Society of Gynecologic Endoscopists) classifies fibroids based on its location in relation to its location in one of the three basic layers of the uterus: the endometrium (submucosal fibroids), the myometrium (intramural fibroids), and the visceral peritoneum or serosa (subserosal fibroids). The submucosal fibroids are further divided into type 0, 1, and 2 [6, 7] (Fig. 6.1a) (Table 6.1).

The FIGO (International Federation of Gynecology and Obstetrics) utilizes the same classification for submucosal fibroids but adds several other categories (type 3–7) [8]. The FIGO classification system provides information on the myoma's outer boundary within the uterine wall/serosa. This is much needed information for a surgeon planning route of surgery. For example, a fibroid that has 20% cavitary component is

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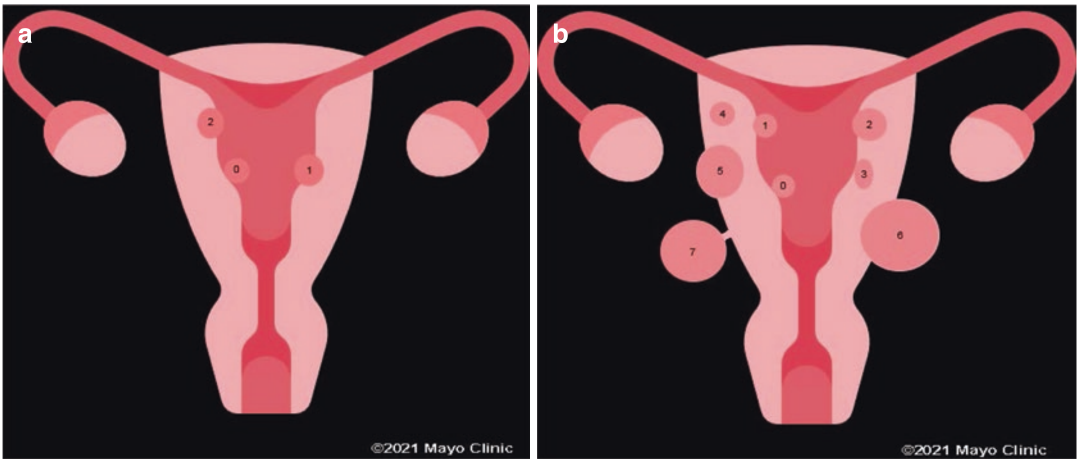

Fig. 6.1 Classification of uterine fibroids based on location is key for preoperative planning. Two most widely accepted classifications systems are shown (**a**) European Society for Gynecological Endoscopy (ESGE) classification of uterine fibroids. (**b**) International Federation of Gynecology and Obstetrics (FIGO) classification of uterine fibroids

Table 6.1 ESGE classification of submucosal fibroids

Type 0	Entirely within the endometrial cavity
	No myometrial extension (pedunculated)
Type 1	<50% myometrial extension
	<90° angle of myoma surface to uterine wall
Type 2	≥50% myometrial extension
	≥90° angle of myoma surface to the uterine wall

classified as a type 2 fibroid by both ESGE and FIGO classification systems. If this fibroid however is large enough to occupy the entirety of the uterine wall and has a subserosal portion as well, it will still be a type 2 fibroid on ESGE system where as it would be a type 2–5 lesion per FIGO classification and therefore not a candidate for hysteroscopic surgery (Fig. 6.1b).

Lasmar classification of submucosal myomas addresses many limitations in the previous two systems and takes into account: (a) the penetration of the myoma into the myometrium (same as ESGE/FIGO submucosal lesion classification), (b) the size of the largest myoma, (c) proportion of the endometrial surface area occupied by the base of the myoma, and (d) topography of the lesion – the location of the myoma with the uterus (upper, middle, or lower body and whether it is present in lateral walls as opposed to anterior or posterior uterine wall) [9]. The classification system provides a point system to calculate a score. The final score can predict the likelihood of completing a hysteroscopic myomectomy and the amount of fluid deficit during the procedure. The system was however not analyzed for its prediction of other important outcomes like successful treatment of AUB or fertility.

Fibroids and Fertility

The impact of fibroids on fertility is not well understood and is not without significant controversy. Whether removal of myomas in asymptomatic women improves fertility remains unknown and overall, there is insufficient evidence that uterine fibroids (all types) reduce the likelihood of pregnancy [10]. Data evaluating reproductive outcomes related to fibroids are generated from observational studies with many biases. Most studies have a heterogenous study design, insufficient patient recruitment and follow-up as well as lack of ideal controls (women without fibroids). Most reports have no means to control for size and location of the fibroids, have inappropriate primary outcomes (clinical pregnancy rates rather than live birth rates) and there is no accounting for major confounders for fertility like age in most studies [10].

However, there is consensus to intervene when there is presence of cavity-distorting myomas for women with sub/infertility [11]. Pritts and colleagues observed lower fertility in women with cavity distorting fibroids and noted improvements in fertility after removal of these lesions [12]. The American Society of Reproductive Medicine (ASRM) committee opinion also states that there is fair evidence that hysteroscopic myomectomy for submucosal fibroids improves clinical pregnancy rates [10]. This improvement in pregnancy rates is, however, not seen after removal of subserosal or intramural fibroids that are not distorting the uterine cavity [10, 12, 13].

It is widely accepted that type 2 fibroids up to 4 cm in diameter and type 0–1 fibroids up to 5 cm in diameter can be safely excised with hysteroscopic approach [5]. Prior to proceeding with hysteroscopic surgery, there are several preoperative issues to keep in mind.

Preoperative Considerations

Imaging

Even though a thorough history and physical examination is the first step in evaluation of any patient, the importance of preoperative imaging especially in women with submucosal fibroids cannot be overemphasized. The three most important things to consider are (a) location, (b) size, and (c) number of fibroids present. Imaging can hence dictate the route of surgery (abdominal vs. laparoscopic vs. hysteroscopic myomectomy). Additionally, imaging will help determine if asymptomatic patients need a myomectomy for enhancement/optimization of fertility. An asymptomatic patient with a type 1 myoma may require hysteroscopic surgery for fertility enhancement compared to an asymptomatic patient with a type 4 myoma that otherwise does not distort the cavity. Likewise, a patient with multiple (>10), large (largest >18 cm) fibroids that range from type 2–6 might require an abdominal approach compared to a patient with a solitary type 2 myoma who would benefit from hysteroscopic excision. Likewise, women with larger type 2 myomas may need a multi-step hysteroscopic resection (mostly because of fluid deficit limits being hit in these cases with larger lesions) versus a single laparoscopic myomectomy, An individualized discussion with the patient and weighing risk and benefits of hysteroscopy versus laparoscopy is necessary.

Ultrasonographic evaluation is typically the first imaging modality used in most patients however, ultrasound imaging has operator-dependent variability, limited field of view (especially when evaluating large myomas), and can have difficulty in accurately classifying a submucosal fibroid [3]. Other imaging modalities include 3D-ultrasonography, saline sonohysterography, magnetic resonance imaging (MRI) and office hysteroscopy [2] (Fig. 6.2a–d).

Imaging of submucosal myomas can also help predict the likelihood of completing a hysteroscopic myomectomy in one sitting based on the Lasmar classification system [9]. Additionally, depth of penetrance of submucosal fibroids in the wall of uterus and myoma size can help guide a surgeon in picking appropriate hysteroscopic instruments as well as help counsel the patient for the need of preoperative therapy to help reduce myoma volume and size for optimal surgical conditions. Finally, imaging with gadolinium-enhanced MRI in combination with elevated lactate dehydrogenase isoenzyme-3 may be helpful in preoperatively diagnosing leiomyosarcoma and may help appropriate management [14].

Evaluation of Hemoglobin/Iron Stores and Other Possible Causes of Heavy Menstrual Bleeding

Screening for anemia and assessment of iron stores prior to surgical intervention is critical in women who present with heavy menstrual bleeding. A complete blood count and ferritin levels might be useful prior to surgery in patients with long-standing heavy menstrual bleeding. Although most hysteroscopic myomectomy procedures have limited blood loss, normalizing

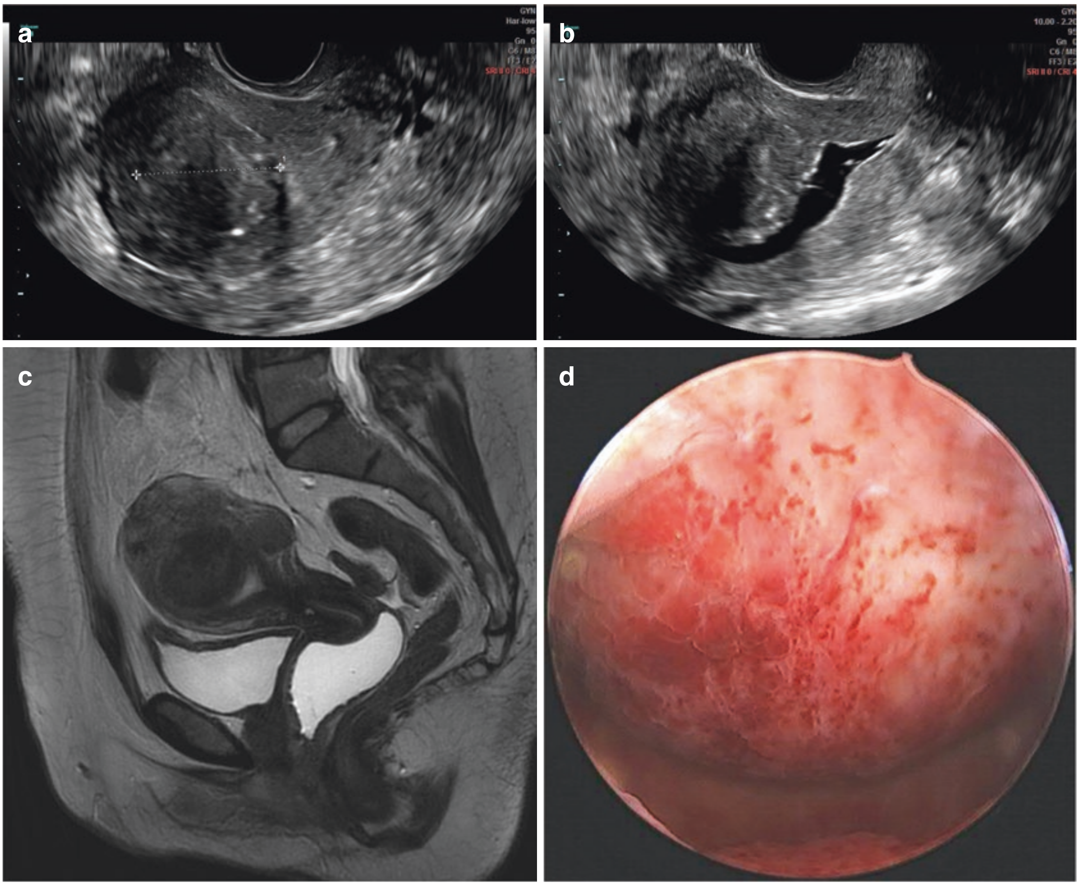

Fig. 6.2 Imaging for submucosal fibroid of the same patient with different techniques. (**a**) Ultrasonography is the most used imaging modality for the diagnosis of uterine fibroids. A sagittal view of the uterus is shown here with a fundal submucosal myoma. (**b**) Saline sonohysterography can further highlight the boundaries of the myoma. After saline infusion the myoma can be classified as FIGO type 1 as more than 50% of it is seen in the endometrial cavity. (**c**) Magnetic resonance imaging (MRI) is another accurate way to assess a uterine fibroid. Here a sagittal T2-weighted image is shown of the same patient where the myoma can be classified as FIGO type 1 as more than 50% of it is seen in the endometrial cavity. (**d**) A hysteroscopy can help identify submucosal lesions as shown in this image. An anterior wall FIGO type 1 myoma is noted consistent with sonohysterogram and MRI

hemoglobin and iron stores prior to surgery reduces overall risk and can prevent unnecessary post-operative blood transfusions that can otherwise lead to morbidity after myomectomy [15]. Oral, and intravenous iron, epoetin (a recombinant form of erythropoietin) and gonadotropin releasing hormone (GnRH) analogs and antagonists have all been used for improving hemoglobin and iron stores in otherwise anemic patients [16–18]. In general, the author utilizes oral iron therapy as first line and offers intravenous iron and GnRH analogs to induce amenorrhea if anemia is not corrected with first line measures.

Assessing other common metabolic causes for heavy bleeding like thyroid dysfunction and abnormalities in prolactin is essential to rule out causes of abnormal bleeding other than the myoma.

Use of Gonadotropin Releasing Hormone (GnRH) Analogs and Antagonists

The use of GnRH analogs is adopted by many to reduce myoma size prior to surgery. Typically, submucosal myomas >4 or 5 cm could benefit from size reduction so the lesion could be amenable to hysteroscopic removal in a single sitting. The use of GnRH analogs does make dissection of the myoma from its bed harder and the author in his practice prefers not to use this. The data supports the use of GnRH analogs for 3–4 months prior to surgery to decrease fibroid size, uterine volume, and postoperative anemia; however, its use has not been shown to improve rates of complete myoma removal [19–21]. Most recently GnRH antagonist use has shown to reduce heavy bleeding in women with fibroids [49]; however, the specific use of GnRH antagonists in the perioperative period is still understudied.

Use of Cervical Ripening Agents

Most complications during hysteroscopy occur with entry of the hysteroscope [22]. Cervical ripening with the use of prostaglandin E1 analog (Misoprostol 200–400 μg) taken vaginally or orally 12–24 h before surgery may facilitate cervical dilation, reducing the risk cervical lacerations and uterine perforations with stenotic cervices. A Cochrane review supports the routine use of ripening agents which lead to reduction in cervical lacerations and creation of false cervical passages [23]. Some intracavitary lesions can prolapse further into the cavity due to uterine contractions following administration of Misoprostol making them more amenable to hysteroscopic excision [2].

Timing of Hysteroscopic Surgery

Timing of hysteroscopic surgery in relation to the menstrual cycle is key for adequate visualization. Most surgeons perform hysteroscopic procedures in the mid proliferative phase of the menstrual cycle after cessation of menses. A thin endometrial lining can be beneficial in adequate intracavitary visualization. Alternatively, patients can be placed on combined oral contraceptives or GnRH analogs to induce amenorrhea to allow for scheduling surgery.

Intraoperative Considerations

Use of Preoperative Antibiotics

The overall risk of an infection after hysteroscopy is very low (0.01–1.42%) [24, 25]. The role of preoperative antibiotics in this scenario has not been well established. Given the low risk of infection the author does not use preoperative antibiotics, an approach that is supported by the American College of Obstetricians and Gynecologists [26]. An exception to the rule includes resectoscopic surgery in women with a history of pelvic inflammatory disease (PID) [27].

Choice of Distension Medium for Hysteroscopy

The uterine cavity is a potential dead space that needs to be distended by a medium for visualization during surgery. Classically the distension medium used has either been carbon dioxide or some form of fluid [28]. The former is only used for diagnostic hysteroscopy and the latter for operative procedures. While distension of the cavity is key for surgical visualization, it also causes a common issue of fluid deficit in hysteroscopic procedures. Absorption of large volumes of fluid can occur during hysteroscopy leading to serious complications arising from fluid overload [29]. Distension fluids are characterized by viscosity and osmolality. The type of distension medium used for operative hysteroscopy is mainly dependent on surgeon preference and is dictated by the type of surgical instrument being used. (Table 6.2).

High Viscosity Distension Medium

Dextran 32% is an example of high viscosity solution. This fluid produces excellent visualization, especially in cases of bleeding as the solution is immiscible with blood, however, can cause anaphylactic reactions and also lead to crystallization within the hysteroscope [30]. The use of high viscosity fluids is hence not common at all. The recommended fluid deficit with high viscosity medium is as low as 300–500 mL [31].

Table 6.2 Details of common distension media and their applicability in operative hysteroscopy

Distension medium	Classification	Osmolality (mOSm/L)- normal plasma 285 mOsm/L	Electrolyte free	Compatibility of energy source
Glycine 1.5%	Hypotonic	200	Yes	Monopolar
Sorbitol 3%	Hypotonic	165	Yes	Monopolar
Mannitol 5%	Isotonic	274	Yes	Monopolar
Normal saline	Isotonic	285	No	Bipolar
Ringer's lactate	Isotonic	279	No	Bipolar

Low Viscosity Distension Medium

Low viscosity distension media can be divided into isotonic or hypotonic solutions in relation to the osmolality of plasma which is typically around 285 mOsm/L. (Table 6.2).

Hypotonic Distension Medium

Low viscosity hypotonic solutions can be used when utilizing monopolar energy devices during operative hysteroscopy. Common examples are: Glycine 1.5%, Sorbitol 3%, and Dextrose 5%. When the fluid deficit reaches 750 mL, the entire team including the anesthesiologist and nurse should be aware and surgery may be continued with caution. Strong consideration should be given to stopping the procedure when a fluid deficit of 1000 mL is reached. Going over the recommended deficit can lead to serious complications that include hypervolemia, hyponatremia, and in severe cases cerebral edema and increased intracranial pressure [29]. Excessive absorption of sorbitol can lead to hyperglycemia and hypocalcemia [32].

Isotonic Distension Medium

Isotonic solutions may contain electrolytes such as normal saline solution and Ringer's lactate solution, whereas some may be electrolyte free like mannitol 5% solution. Isotonic solutions containing electrolytes are used when bipolar energy devices are available. The use of isotonic fluid is considered safer as fluid absorption causes volume overload but not hyponatremia. When the fluid deficit reaches 1500 mL, the entire team including the anesthesiologist and nurse should be aware and surgery may be continued with caution. Strong consideration should be given to stopping the procedure when a fluid deficit of 2500 mL is reached. Complications of fluid overload include flash pulmonary edema, which can usually be reversed with careful use of diuretics [29].

The ideal distension solution should be isotonic, nontoxic, cheap, readily available, hypoallergenic, and should be able to be rapidly cleared by the body. For these reasons the author supports the use of normal saline or lactated Ringers solution for almost all operative hysteroscopies, provided bipolar instruments are available.

Choice of Hysteroscopic Surgical Instruments

The first description of hysteroscopic myomectomy utilized a urologic monopolar energy resectoscope [33]. Since then major advancements have been made in the field and these days gynecologic surgeons have a list of instruments to pick and choose from. As a rule, hypotonic fluid with electrolytes is utilized when monopolar energy devices are used, whereas isotonic electrolyte fluid with bipolar energy devices [29].

Overall surgeons have a choice of the following three types of devices for hysteroscopic myomectomy:

A. Hysteroscopic resectoscope (monopolar or bipolar)
B. Tissue retrieval systems/hysteroscopic morcellators
C. Hysteroscopic vaporization probes

A. *Hysteroscopic Resectoscope*

   This technique requires a wire loop that can resect almost all type 0 and 1 and selected type 2 fibroids. The cutting current for monopolar devices is generally sufficient between 60 and 80 Watts; however, denser and calcified fibroids might require higher energy in the range of 120 Watts. Bipolar devices use a default setting for both cutting and hemostasis [2]. Resectoscopes have an added advantage of being able to excise myomas with more uterine wall penetration when compared to morcellators. These devices are also more helpful than morcellators when bleeding is encountered at the time of myomectomy. Bleeding typically obscures visualization (especially when using isotonic fluid). Loop resectoscope devices are helpful in the cauterization of a bleeding vessel which not only helps visualization but can also decrease fluid deficit. Briefly, the electrode is activated with low voltage current to allow repetitive creation of strips of the myoma. The loop should only be activated when target tissue is in contact and once all landmarks within the cavity (both tubal ostia) are assessed to confirm correct placement of the scope within the uterine cavity (rather than a false passage). There is periodic interruption needed for removal of tissue fragments, which can be removed one at a time or all at once [6] (Fig. 6.3a–c).

The use of loop resectoscope requires surgical skill and experience. The risk of perforation can be high with deeper myometrial penetration [34]. Moreover, the risk of formation of intrauterine scar tissue is higher with use of electrocautery especially if energy is was used on opposing surfaces within the endometrial cavity. When targeting deeply seated type 1 (>40% in wall of the uterus) and type 2 fibroids, the author finds loop resectoscopes to be most useful for a hysteroscopic approach. Several techniques can be used to enucleate deeply seated type 1 and type 2 myomas (see tips and tricks below).

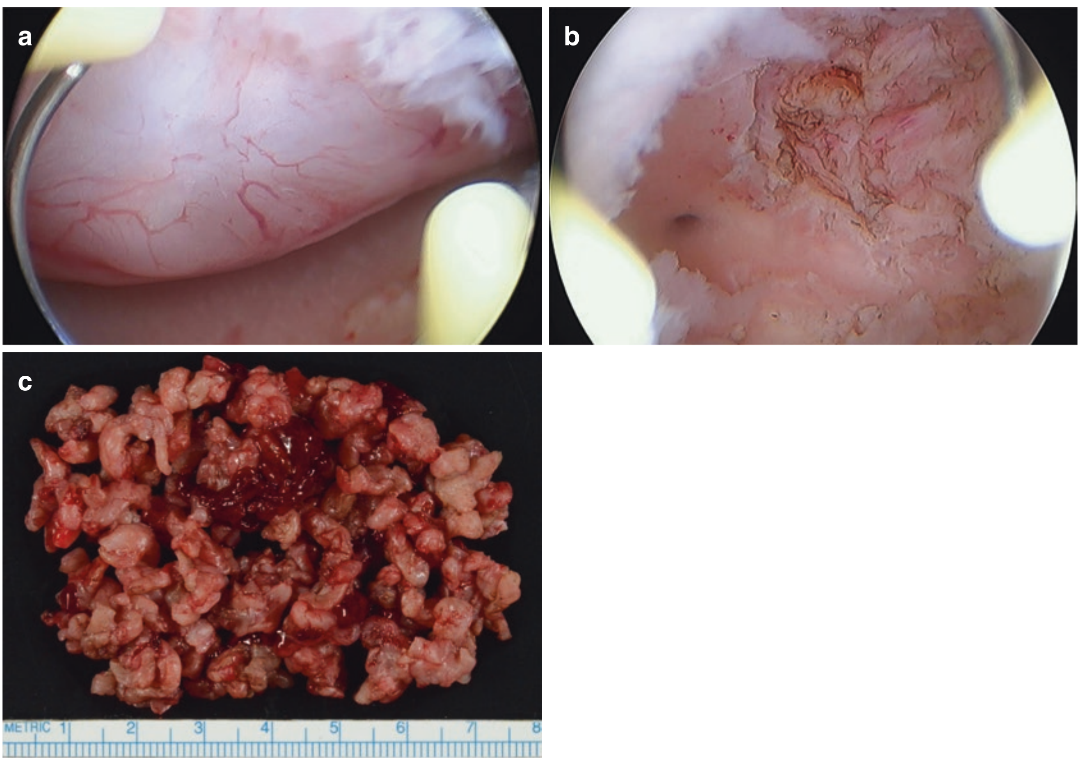

Fig. 6.3 Hysteroscopic myomectomy utilizing loop resectoscope. The loop resectoscope is helpful in removal of deeply seated myomas within the uterine wall. (**a**) Image of myoma prior to resection with the loop resectoscope. (**b**) The myoma bed can be seen after completion of the myomectomy. All myoma fragments were removed hysteroscopically. (**c**) Gross pathology picture of myoma fragments removed at the time of hysteroscopic myomectomy. Large amounts of tissue can be removed efficiently with loop resectoscopic devices as shown here

B. *Tissue Retrieval Systems/Hysteroscopic Morcellators*

Newer techniques have utilized a tissue retrieval system which mechanically shaves and suctions out tissue into a trap or "sock" permitting adequate removal and histologic evaluation. The hand piece of a hysteroscopic morcellator has a window at the tip to feed target tissue into and a rotary-style morcellator that is housed within the window. As the window is opened, the tissue is suctioned into it due to negative pressure. The rotary-style morcellator is then able to shave the tissue as it is being fed into the window, with the tissue fragments being suctioned into the trap or sock [2, 3, 6, 35] (Fig. 6.4a–c).

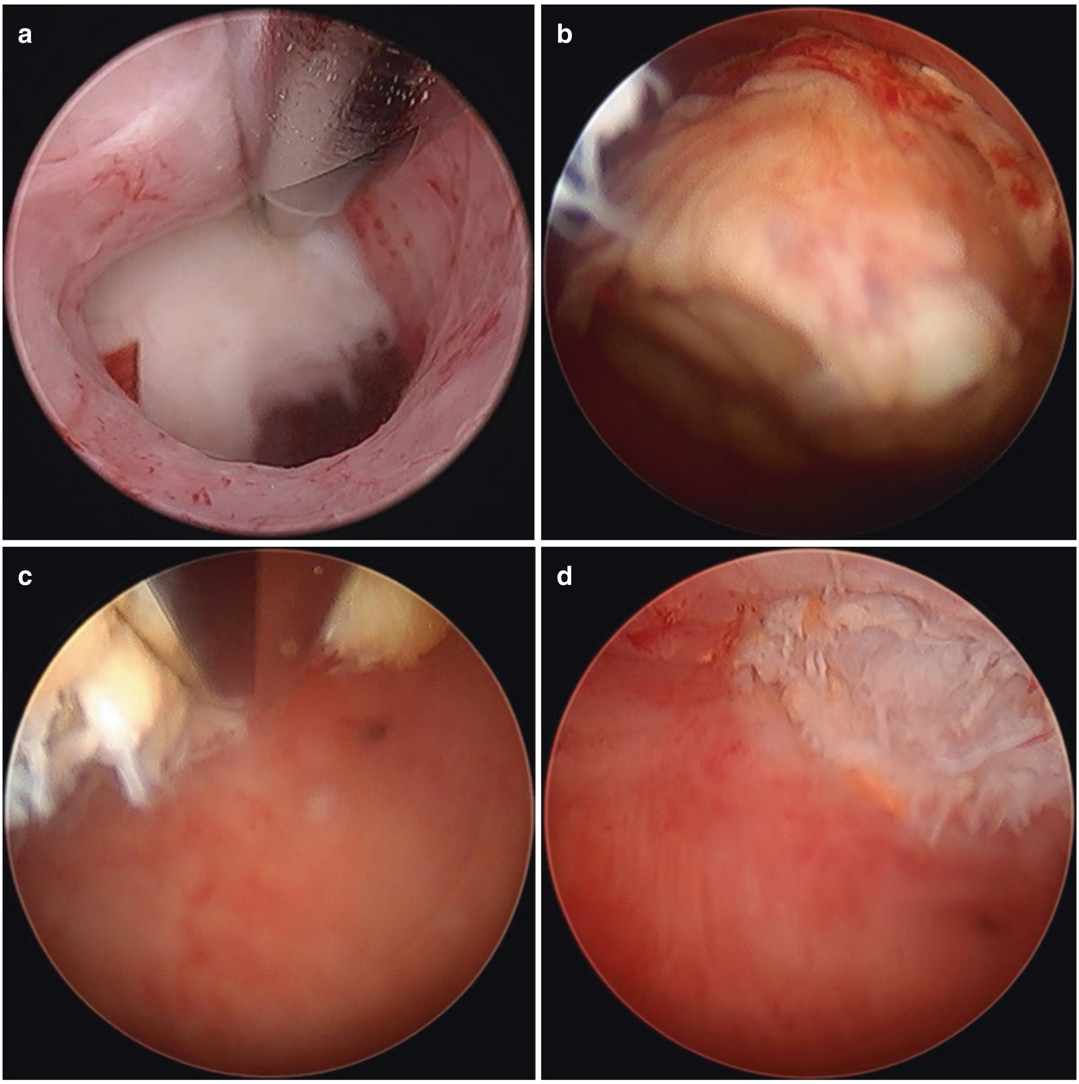

Fig. 6.4 Hysteroscopic morcellator can be used for FIGO type 0 and type 1 myomas that are not deeply seated within the wall of the uterus. In these images, a case of a previously incomplete resected type 2 myoma with loop resectoscope is shown. Most of the myoma had extruded into the cavity and for the second surgery a hysteroscopic morcellator was used. (**a**) This image shows the end of the morcellator with the window and blade within the window noted just above the black mark. (**b**) The previously partially resected myoma can be seen with the lesion extruded into the uterine cavity- changing it from a FIGO type 2 to a FIGO type 0 myoma. (**c**) The specimen is fed into this window. Activation of the morcellator creates a suction and causes the blade to rotate within this window, resulting in shaving of the lesion. (**d**) The myoma bed can be appreciated after completion of myomectomy with a morcellator

Hysteroscopic morcellators are user-friendly and several reports have described fewer complications and less risk of intra-uterine scar tissue. New trainees acquire adept skills quicker than with the resectoscope [2]. Conversely, these devices tend to work mostly for type 0 and type 1 lesions where a significant amount of the fibroids is within the endometrial cavity. Compared to loop resectoscopes these devices also don't work as well when fibroids are hard and calcified based on pre-operative imaging. Finally, any bleeding during the procedure makes it much harder to visualize as the device does not have the ability to pin-point cauterize a bleeding vessel. The author utilizes hysteroscopic morcellation for all endometrial polyps and type 0 fibroids as well as type 1 myomas with <40% wall encroachment.

C. *Hysteroscopic Vaporization Probes*

A multiple edge density electrode can be used to desiccate larger leiomyomas hysteroscopically. Vaporizing electrodes are available for mono and bipolar hysteroscopic devices [2]. This technique is beneficial for larger myomas that are not deeply seated in the uterine wall. Vaporization of the tissue makes it smaller and more amenable to removal with loop resectoscope. Although this technique has its advantages, its use precludes tissue for histopathology.

This technique should specifically be avoided at the cornua and isthmus since these anatomical areas are the thinnest and at highest risk of perforation and intraperitoneal injuries.

Many reports have compared outcomes from hysteroscopic morcellation to hysteroscopic resectoscope use for myomas [5] (Table 6.3). Generally the deeper the extent of the lesion the lower the success rate of complete excision with both morcellation and loop resectoscope; however, a systematic review concluded that both modalities had similar resection rate [36]. Long-term outcomes are also seen to be very similar between the two modalities [5].

Table 6.3 Comparison of hysteroscopic resectoscope to tissue retrieval systems/hysteroscopic morcellator

Hysteroscopic loop resectoscope	Tissue retrieval systems/ hysteroscopic morcellator
Utilizes electric energy (mono or bipolar devices)	Utilizes mechanical force of rotary blade
Suited of deeply seated lesions (deep type 1 and type 2 myomas)	Ideal for type 0 and most type 1 myomas
Has capacity to coagulate bleeding vessels	Visualization can sometimes be more challenging
Requires surgical expertise and skill	Can be easily adopted by newer trainees
Risk of formation of postop scar tissue is higher	Lower risk for scar tissue formation
Specimen pathology is preserved	Specimen pathology is preserved

Miscellaneous Tips and Tricks for Deeply Seated Type 1, and Type 2 Fibroids

It is recommended that deeply seated type 1 and type 2 submucosal fibroids be addressed by expert and experienced surgeons as the excision of these fibroids is technically difficult and these procedures are associated with higher risk of complications. Conventionally type 1 fibroids should not exceed 5–6 cm, whereas a safe proposed cut off for type 2 fibroids is 4–5 cm for hysteroscopic excision [37]. Several techniques have been described that can assist with safe removal of deeply seated myomas. The common shared objective for all hysteroscopic resectoscope techniques is to expose the fibroid capsule as to extrude as much of the fibroid tissue into the cavity so it can be safely excised without mechanical or thermal injury to adjacent endometrium. Some of these tips and tricks are:

- *Cold Loop Technique*

  This technique is carried out by repeated and progressive passage of the loop electrode resectoscope up to the capsule of the fibroid. Once the plane between the fibroid and myometrial bed is identified, a suitable cold blunt loop is used to roll the fibroid and mobilize it from surrounding myometrial by traction and counter-traction rather than energy. Once a significant portion of the fibroid has delivered to the cavity, a loop resectoscope can be used to enucleate any remaining disease [38] (Fig. 6.5a–e).

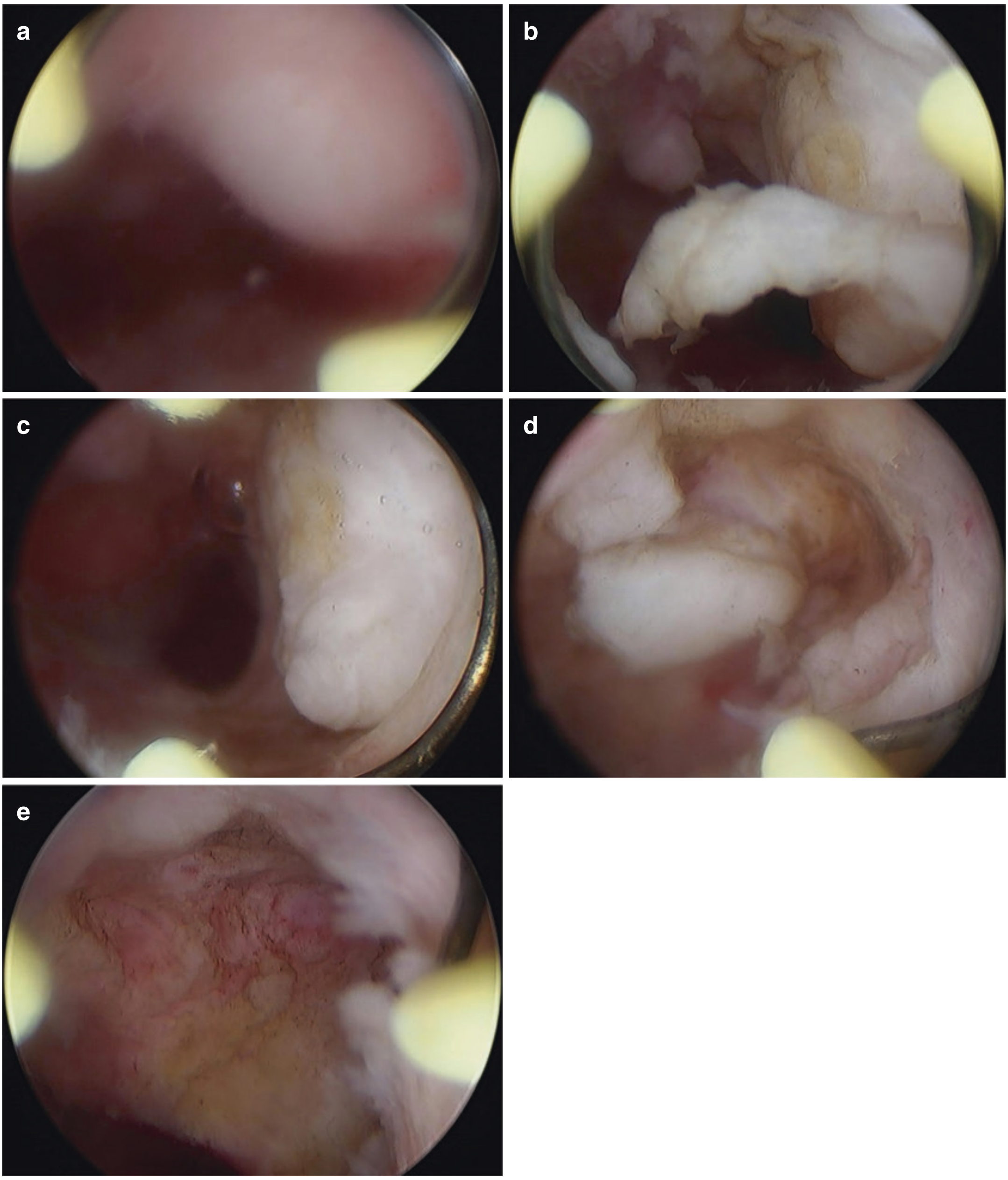

Fig. 6.5 Hysteroscopic removal of difficult, deeply seated submucosal fibroid. (**a**) A deeply seated lateral wall FIGO type 2 myoma is noted on hysteroscopy. (**b**) The loop resectoscope is used to enter the myoma capsule as shown. This allows for some of the myoma to be extruded into the uterine cavity. (**c**) The plane between the myoma and the myometrium is identified, and a cold loop is used to roll the fibroid from the surrounding myoma bed as is seen. (**d**) Once most of the myoma is mobilized from the myometrial bed, the loop resectoscope is used to excise the extruded portion of the lesion. This process is repeated until the entire lesion is successfully excised. (**e**) The large, deep myoma bed is noted here after complete removal of a large type 2 fibroid

- *Enucleation* in Toto (*Litta's Technique*)

  This method utilized a 90° Collins electrode to make an elliptical incision on the endometrial mucosa that covers the fibroid. The incision is continued till the plane between the myoma and surrounding myometrium is noted. Connecting tissue between the fibroid and myometrium is taken down with electrocautery. This maneuver leads to extrusion of the myoma into the cavity, which can then be excised in the traditional method with loop resectoscope [39].
- *Lasmar Technique*

  Very similar to Litta's technique where the Collins electrode is used to make an "L" shaped incision (instead of an elliptical) to get into the myoma capsule [9].
- *Hydromassage*

  Reducing intracavitary fluid pressure aids the myoma to be extruded toward the cavity. This principle was first explored by Hamou, who was the first to propose a rapid cyclic change in intrauterine pressures using an electronically controlled irrigation and suction device [40]. This "hydromassage" could help the partially resected myoma to further deliver toward the endometrial cavity for conventional excision with loop resectoscope.
- *Manual Massage*

  A manual massage of the uterus has also been proposed to help a partially resected myoma in the uterine wall [41].
- *Circumferential Incision into the Capsule*

  A circumferential incision around the protrusion of a deeply seated myoma can also be another way of entering the capsule from all sides and allowing the myoma to deliver more toward the endometrial cavity [42].
- *Use of Pharmacologic Agents*

  Most hysteroscopic procedures are terminated primarily for safety and to reduce excessive fluid deficit. Intracervical injection of dilute vasopressin at 3 and 9 0'clock can help with vasoconstriction of endometrial vessels. This helps with reduced fluid deficit and allows for better visualization as bleeding can be minimized [3].

  Intracervical (at hysteroscopy) or intramyometrial injection (at laparoscopy) of Carboprost (a methyl analog of prostaglandin F (PGF) 2α) can cause uterine contractions and facilitate in excision of deeply seated lesions [43, 44].

  Finally, as described previously, GnRH analogs can be used to reduce the size of the myoma and could help in reducing the risk of incomplete removal of a deeply seated myoma [19].
- *Safely Completing the Procedure in Two Sittings*

  While the goal should always be to completely excise a myoma, some patients with larger, deep lesions can reach the fluid deficit safety sooner than later. In these cases, it might be best to schedule a second procedure 20–30 days after the initial surgery. The observation of rapid migration of residual disease toward the endometrium with parallel increase in myometrial thickness at the time of hysteroscopic resection clarifies that once the myoma capsule is breached, it will typically deliver toward the cavity [45, 46]. An interval procedure will allow for more of this migration to occur, which could allow complete excision at the second surgery.
- *Convert to a Laparoscopic Approach*

  If the myoma is much larger than anticipated and completing the surgery in one sitting is key, the procedure could be converted to a laparoscopic myomectomy which can facilitate the removal of the deeply seated lesion. Having surgical expertise and laparoscopic suturing skills are essential in being successful.

Intra- and Postoperative Complications

Hysteroscopic myomectomy is generally considered a safe outpatient procedure with overall low complication rates at 0.1–5% [2]. A few common complications from the procedure are listed below:

Uterine Perforation

The most reported complication during hysteroscopy is uterine perforation. This commonly occurs at the time of entry into the cavity or occasionally with uterine sounding. A sudden loss of visualization or drop in intrauterine pressure and a rapidly rising fluid deficit are some signs of perforation. If perforation occurs the procedure must be terminated. If increased bleeding is noted or if perforation occurred with a sharp object or with cautery, a laparoscopy is recommended [6].

Acute Bleeding/Cervical Trauma

Bleeding is rare but occurs more frequently after hysteroscopic myomectomy than other hysteroscopic procedures. Localizing the site of bleeding is most important. If a cervical laceration or trauma is noted, it should be addressed with pressure, chemical cauterization with silver nitrate or suturing. If bleeding is from within the cavity and perforation has been ruled out, a hysteroscopic evaluation may be beneficial. A bleeding vessel can be cauterized with pin-point cautery. If bleeding continues, an intrauterine foley bulb can be placed to tamponade bleeding. Pharmacologic agents that aid in uterine contraction like prostaglandin E1, PGF 2α, methergine, etc., can be used as well to aid with hemostasis [2, 3, 6].

Air/Gas Embolism

Air embolism during a hysteroscopic excision of a myoma can occur secondary to absorption of room air or gas generated during the procedure. Trendelenburg favors gas absorption, most likely due to the pressure difference in operating field and right atrium [31]. A sudden decrease in end-tidal carbon dioxide is typically the first sign of gas embolism. Avoiding excessive cervical dilation, minimizing Trendelenburg position, and purging gas from fluid tubing can be helpful in prevention of this complication.

Fluid Overload

Fluid overload is a common complication of large myomas that are deeply seated in the uterine wall. Having an objective assessment of the fluid deficit is hence critical for operative hysteroscopy. This can be achieved using a closed loop/circuit fluid management system that can accurately determine the amount of fluid given to the patient through the hysteroscope and the amount of fluid returned.

Fluid overload can have serious health consequences especially when it results in hypervolemic hyponatremia as has been described earlier. Knowing the fluid deficit limits for each type of distention fluid (high vs. low viscosity and isotonic vs. hypotonic) is important. For high viscosity and low viscosity hypotonic media, the author recommends stopping the procedure at a deficit of 500 and 1000 mL respectively. When using isotonic solution like normal saline the fluid deficit should not exceed 2500 mL, unless the surgeon, anesthesia team, and nurse are aware. In certain select cases when the patient is young and has robust cardiovascular system, the author does exceed that amount only if the procedure is close to completion. In these scenarios the author will typically insert a foley catheter to record output closely and provide gentle diuresis with Lasix (10–20 mg).

Postoperative Intrauterine Adhesions

Formation of intrauterine adhesions has been reported specifically after hysteroscopic myomectomy that utilized the loop resectoscope and electrocautery. The rate of scar tissue was around 1.5% in women who underwent a single leiomyoma excision, compared to 78% in those who underwent resection of apposing lesions [47]. Multiple methods have been described to reduce the chance of formation of scar tissue. These include the use of postoperative hormone therapy with high dose estrogen for 1 month followed by progestin-induced withdrawal bleed, use of physical barriers like intrauterine stents, intrauterine devices, etc. Overall, none of these methods have shown superiority when compared with one another [48].

While the risk of postoperative scar tissue is low, liberal approach to an early "second" look hysteroscopy has been proposed by some which may help in reducing the formation of postop intrauterine scar tissue [31].

Summary

Hysteroscopy overall and hysteroscopic myomectomy in particular has made great advances in gynecologic surgery. Approaching submucosal fibroids is key as most of these lesions result in heavy menstrual bleeding and have an impact on fertility. Classification of these lesions is extremely important to select a surgical route. Preoperating imaging is essential in developing a surgical plan. Surgeons should be well versed with the various forms of distension media for hysteroscopy and different types of surgical instruments. Deeply seated myomas (some type 1 and all type 2 lesions) require surgical experience and expertise and in most cases, the use of loop resectoscope. Certain tips and tricks have been described in the literature to facilitate the excision of these tricky lesions. Finally, to safely perform surgery, one must be aware of the common complications that can occur during and after hysteroscopic myomectomy.

References

1. Baird DD, Dunson DB, Hill MC, Cousins D, Schectman JM. High cumulative incidence of uterine leiomyoma in black and white women: ultrasound evidence. Am J Obstet Gynecol. 2003;188(1):100–7.
2. Valentine LN, Bradley LD. Hysteroscopy for abnormal uterine bleeding and fibroids. Clin Obstet Gynecol. 2017;60(2):231–44.
3. Falcone T, Parker WH. Surgical management of leiomyomas for fertility or uterine preservation. Obstet Gynecol. 2013;121(4):856–68.
4. Maheux-Lacroix S, Mennen J, Arnold A, Budden A, Nesbitt-Hawes E, Won H, et al. The need for further surgical intervention following primary hysteroscopic morcellation of submucosal leiomyomas in women with abnormal uterine bleeding. Aust N Z J Obstet Gynaecol. 2018;58(5):570–5.
5. Friedman JA, Wong JMK, Chaudhari A, Tsai S, Milad MP. Hysteroscopic myomectomy: a comparison of techniques and review of current evidence in the management of abnormal uterine bleeding. Curr Opin Obstet Gynecol. 2018;30(4):243–51.
6. American Association of Gynecologic Laparoscopists: Advancing Minimally Invasive Gynecology W. AAGL practice report: practice guidelines for the diagnosis and management of submucous leiomyomas. J Minim Invasive Gynecol. 2012;19(2):152–71.
7. Wamsteker K, Emanuel MH, de Kruif JH. Transcervical hysteroscopic resection of submucous fibroids for abnormal uterine bleeding: results regarding the degree of intramural extension. Obstet Gynecol. 1993;82(5):736–40.
8. Munro MG, Critchley HOD, Fraser IS, Committee FMD. The two FIGO systems for normal and abnormal uterine bleeding symptoms and classification of causes of abnormal uterine bleeding in the reproductive years: 2018 revisions. Int J Gynaecol Obstet. 2018;143(3):393–408.
9. Lasmar RB, Barrozo PR, Dias R, Oliveira MA. Submucous myomas: a new presurgical classification to evaluate the viability of hysteroscopic surgical treatment--preliminary report. J Minim Invasive Gynecol. 2005;12(4):308–11.
10. Practice Committee of the American Society for Reproductive Medicine. Electronic address Aao, Practice Committee of the American Society for Reproductive M. Removal of myomas in asymptomatic patients to improve fertility and/or reduce miscarriage rate: a guideline. Fertil Steril. 2017;108(3):416–25.
11. Bosteels J, van Wessel S, Weyers S, Broekmans FJ, D'Hooghe TM, Bongers MY, et al. Hysteroscopy for treating subfertility associated with suspected major uterine cavity abnormalities. Cochrane Database Syst Rev. 2018;12(12):CD009461.
12. Pritts EA, Parker WH, Olive DL. Fibroids and infertility: an updated systematic review of the evidence. Fertil Steril. 2009;91(4):1215–23.
13. Casini ML, Rossi F, Agostini R, Unfer V. Effects of the position of fibroids on fertility. Gynecol Endocrinol. 2006;22(2):106–9.
14. Goto A, Takeuchi S, Sugimura K, Maruo T. Usefulness of Gd-DTPA contrast-enhanced dynamic MRI and serum determination of LDH and its isozymes in the differential diagnosis of leiomyosarcoma from degenerated leiomyoma of the uterus. Int J Gynecol Cancer. 2002;12(4):354–61.
15. Kim T, Purdy MP, Kendall-Rauchfuss L, Habermann EB, Bews KA, Glasgow AE, et al. Myomectomy associated blood transfusion risk and morbidity after surgery. Fertil Steril. 2020;114(1):175–84.
16. Kim YH, Chung HH, Kang SB, Kim SC, Kim YT. Safety and usefulness of intravenous iron

sucrose in the management of preoperative anemia in patients with menorrhagia: a phase IV, open-label, prospective, randomized study. Acta Haematol. 2009;121(1):37–41.
17. Wurnig C, Schatz K, Noske H, Hemon Y, Dahlberg G, Josefsson G, et al. Subcutaneous low-dose epoetin beta for the avoidance of transfusion in patients scheduled for elective surgery not eligible for autologous blood donation. Eur Surg Res. 2001;33(5–6):303–10.
18. Stovall TG, Muneyyirci-Delale O, Summitt RL Jr, Scialli AR. GnRH agonist and iron versus placebo and iron in the anemic patient before surgery for leiomyomas: a randomized controlled trial. Leuprolide Acetate Study Group. Obstet Gynecol. 1995;86(1):65–71.
19. Lethaby A, Puscasiu L, Vollenhoven B. Preoperative medical therapy before surgery for uterine fibroids. Cochrane Database Syst Rev. 2017;11(11):CD000547.
20. Favilli A, Mazzon I, Grasso M, Horvath S, Bini V, Di Renzo GC, et al. Intraoperative effect of preoperative gonadotropin-releasing hormone analogue administration in women undergoing cold loop hysteroscopic myomectomy: a randomized controlled trial. J Minim Invasive Gynecol. 2018;25(4):706–14.
21. Kamath MS, Kalampokas EE, Kalampokas TE. Use of GnRH analogues pre-operatively for hysteroscopic resection of submucous fibroids: a systematic review and meta-analysis. Eur J Obstet Gynecol Reprod Biol. 2014;177:11–8.
22. Bradley LD. Complications in hysteroscopy: prevention, treatment and legal risk. Curr Opin Obstet Gynecol. 2002;14(4):409–15.
23. Al-Fozan H, Firwana B, Al Kadri H, Hassan S, Tulandi T. Preoperative ripening of the cervix before operative hysteroscopy. Cochrane Database Syst Rev. 2015;(4):CD005998.
24. Aydeniz B, Gruber IV, Schauf B, Kurek R, Meyer A, Wallwiener D. A multicenter survey of complications associated with 21,676 operative hysteroscopies. Eur J Obstet Gynecol Reprod Biol. 2002;104(2):160–4.
25. Agostini A, Cravello L, Shojai R, Ronda I, Roger V, Blanc B. Postoperative infection and surgical hysteroscopy. Fertil Steril. 2002;77(4):766–8.
26. ACOG Practice Bulletin No. 195: prevention of infection after gynecologic procedures. Obstet Gynecol. 2018;131(6):e172–e89.
27. McCausland VM, Fields GA, McCausland AM, Townsend DE. Tuboovarian abscesses after operative hysteroscopy. J Reprod Med. 1993;38(3):198–200.
28. Brusco GF, Arena S, Angelini A. Use of carbon dioxide versus normal saline for diagnostic hysteroscopy. Fertil Steril. 2003;79(4):993–7.
29. Umranikar S, Clark TJ, Saridogan E, Miligkos D, Arambage K, Torbe E, et al. BSGE/ESGE guideline on management of fluid distension media in operative hysteroscopy. Gynecol Surg. 2016;13(4):289–303.
30. Witz CA, Silverberg KM, Burns WN, Schenken RS, Olive DL. Complications associated with the absorption of hysteroscopic fluid media. Fertil Steril. 1993;60(5):745–56.
31. Munro MG, Christianson LA. Complications of hysteroscopic and uterine resectoscopic surgery. Clin Obstet Gynecol. 2015;58(4):765–97.
32. Lee GY, Han JI, Heo HJ. Severe hypocalcemia caused by absorption of sorbitol-mannitol solution during hysteroscopy. J Korean Med Sci. 2009;24(3):532–4.
33. Neuwirth RS, Amin HK. Excision of submucus fibroids with hysteroscopic control. Am J Obstet Gynecol. 1976;126(1):95–9.
34. Murakami T, Hayasaka S, Terada Y, Yuki H, Tamura M, Yokomizo R, et al. Predicting outcome of one-step total hysteroscopic resection of sessile submucous myoma. J Minim Invasive Gynecol. 2008;15(1):74–7.
35. Emanuel MH, Wamsteker K. The intra uterine morcellator: a new hysteroscopic operating technique to remove intrauterine polyps and myomas. J Minim Invasive Gynecol. 2005;12(1):62–6.
36. Hamidouche A, Vincienne M, Thubert T, Trichot C, Demoulin G, Nazac A, et al. Operative hysteroscopy for myoma removal: morcellation versus bipolar loop resection. J Gynecol Obstet Biol Reprod (Paris). 2015;44(7):658–64.
37. Di Spiezio SA, Mazzon I, Bramante S, Bettocchi S, Bifulco G, Guida M, et al. Hysteroscopic myomectomy: a comprehensive review of surgical techniques. Hum Reprod Update. 2008;14(2):101–19.
38. Osorio W, Posada N, Cano J, Tamayo S, Giraldo J. Hysteroscopic myomectomy for submucosal type 2 fibroids with cold enucleation technique and complete fibroid extraction using a double-lumen intracervical cannula. Fertil Steril. 2021;115(2):522–4.
39. Litta P, Vasile C, Merlin F, Pozzan C, Sacco G, Gravila P, et al. A new technique of hysteroscopic myomectomy with enucleation in toto. J Am Assoc Gynecol Laparosc. 2003;10(2):263–70.
40. JH. Electroresection of fibroids. In: Sutton C, DM, editors. London: WB Saunders; 1993.
41. Hallez JP. Single-stage total hysteroscopic myomectomies: indications, techniques, and results. Fertil Steril. 1995;63(4):703–8.
42. Munro MG. Hysteroscopic myomectomy of FIGO type 2 leiomyomas under local anesthesia: bipolar radiofrequency needle-based release followed by electromechanical morcellation. J Minim Invasive Gynecol. 2016;23(1):12–3.
43. Murakami T, Tamura M, Ozawa Y, Suzuki H, Terada Y, Okamura K. Safe techniques in surgery for hysteroscopic myomectomy. J Obstet Gynaecol Res. 2005;31(3):216–23.
44. Indman PD. Use of carboprost to facilitate hysteroscopic resection of submucous myomas. J Am Assoc Gynecol Laparosc. 2004;11(1):68–72.

45. Loffer FD. Removal of large symptomatic intrauterine growths by the hysteroscopic resectoscope. Obstet Gynecol. 1990;76(5 Pt 1):836–40.
46. Yang JH, Lin BL. Changes in myometrial thickness during hysteroscopic resection of deeply invasive submucous myomas. J Am Assoc Gynecol Laparosc. 2001;8(4):501–5.
47. Yang JH, Chen MJ, Wu MY, Chao KH, Ho HN, Yang YS. Office hysteroscopic early lysis of intrauterine adhesion after transcervical resection of multiple apposing submucous myomas. Fertil Steril. 2008;89(5):1254–9.
48. Khan Z, Goldberg JM. Hysteroscopic management of Asherman's syndrome. J Minim Invasive Gynecol. 2018;25(2):218–28.
49. Schlaff WD, Ackerman RT, Al-Hendy A, Archer DF, Barnhart KT, Bradley LD, Carr BR, et al. Elagolix for heavy menstrual bleeding in women with uterine fibroids. N Engl J Med. 2020;382(4):328–40. https://doi.org/10.1056/NEJMoa1904351.