Review Article

Hysteroscopic Myomectomy for Submucosal Myoma: Literature Review

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Uterine myomas are usually asymptomatic, although, most women with submucous myoma have severe symptom including abnormal uterine bleeding and infertility. Hysteroscopic myomectomy is a minimally invasive surgery and is a key benefit to patient care. Patient with submucous myoma no longer requires hysterotomy. Hysteroscopic myomectomy became the gold standard treatment in women who desire to preserve fertility. Complete removal of myoma in one-step procedure should be considered. Pre-operative optimization with cervical ripening agents including osmotic dilators such as laminaria tents and prostaglandin such as misoprostol and dinoprostone is important and decrease the risk of cervical trauma as well as uterine perforation. During the procedure, low viscosity isotonic conductive media such as normal saline are recommended to use with bipolar resectoscope and mechanical morcellator, and fluid deficit should be closely monitored at a minimum of 10-minute intervals. Resectoscope is usually used with slicing technique for resection of myoma. Morcellator can be used as it is easy to use, reduces risk of perforation, and reduces non-electrical currents. However, there is a limited utility in type 2 myoma. In addition, hyaluronic acid and polyethylene oxidesodium carboxymethylcellulose gel may reduce intrauterine adhesion after hysteroscopic myomectomy.

Keywords: Hysteroscopy; Morcellation; Myoma; Uterine myomectomy

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Myomas, also known as uterine fibroids or leiomyomas, are monoclonal tumors arising from the smooth muscle cell of the myometrium. These benign tumors are usually asymptomatic, but submucous myoma is the one type of uterine fibroid that correlated with severe symptom resulting from the distortion of the endometrial cavity caused by the lesion. Submucous myomas are categorized into three subtypes by the International Federation of Gynecology and Obstetrics (FIGO). The type 0 myoma is a pedunculated intracavitary mass. The type 1 myoma is a mass distorting the uterine cavity with myometrial extension less than 50%, while the type 2 myoma is a mass distorting the uterine cavity with myometrial extension more than 50%[1,2]. Women with abnormal uterine bleeding, pain, and infertility are found in approximate 5% to 10% from submucous myoma[3]. Surgical management is the definite treatment of symptomatic submucous myoma. Hysteroscopic myomectomy is the gold standard treatment in women who desire to preserve fertility[4]. However, hysteroscopic myomectomy procedure require good training and experience of the surgeon for satisfactory outcomes and minimizing complications. The objective of this review was to update the evidence on the techniques of hysteroscopic myomectomy.

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Principles of consideration in hysteroscopic myomectomy

The ideal goal of hysteroscopic myomectomy is to complete resection within a single surgical step. Therefore, the concerned principles include pre-operative optimization, good surgical technique, minimization of complications, and good surgical outcomes.

Pre-operative optimization

Patient selection: Achievement of completing hysteroscopic myomectomy requires proper patient selection. The size and type of myomas play significant roles in the success of the procedure. Evidence demonstrated that myomectomy via hysteroscopic approach is acceptable on myoma with the size up to 4 cm in diameter for type 2 myoma, or up to 5 cm for type 0 or 1 myoma[5-7]. Type 2 myomas are more difficult to completely resect especially in diameter greater than 3 cm resulting in increasing risk of repeated procedure[8]. Laparoscopic myomectomy provides more advantages than hysteroscopic myomectomy for type 2 myoma greater than 4 cm in diameter[9].

Pre-operative medication: Gonadotrophin releasing hormone (GnRH) analogue and selective progesterone receptor moderator such as ulipristal acetate or mifepristone, are alternative therapies for pre-operative myomectomy. The purposes of pre-operative medication include reducing myoma size, reducing operative time, and providing better visualization during the procedure. The recent meta-analysis demonstrated no statistically significant differences in the use of GnRH-a, in terms of completing hysteroscopic myomectomy, operative time, fluid absorption, or complications, in comparison with the control group[10]. While ulipristal acetate use for myoma was currently suspended due to the associated risk of hepatic failure[11], the clinical evidence of mifepristone for pre-operative hysteroscopic myomectomy was limited. Pre-operative medication for hysteroscopic myomectomy is not recommend routinely; however, there is a role of GnRH analogue for rising hemoglobin levels before the surgery[4,12].

Timing for hysteroscopic myomectomy: Early proliferative phase of endometrium, day 4 to 10 of the menstrual cycle, is the optimal timing for hysteroscopic myomectomy because of the thinnest endometrial lining[13].

Cervical preparation: The difficulty involving cervical entry is the most common cause of hysteroscopic complications, such as cervical tear, creation of a false passage, and perforation. Cervical ripening agents including osmotic dilators such as laminaria tents, prostaglandin such as misoprostol[14] and dinoprostone, and intracervical vasopressin may be beneficial to reduce these complications.

Moderate-quality evidence from five randomized controlled trials (RCTs) demonstrated that the use of 200 to 400 mcg vaginal misoprostol 12 to 24 hours before the surgery is more effective than placebo for cervical ripening (OR 0.08%, 95% CI 0.04 to 0.16) and more effective than dinoprostone from a low-quality evidence of one RCT (OR 0.25, 95% CI 0.11 to 0.57)[15]. However, there is low-quality evidence from three RCTs suggesting that misoprostol is less effective than laminaria (OR 5.96, 95% CI 2.61 to 13.59) for insertion difficulty[15]. The author's previous data is comparable to the current meta-analysis, demonstrating that misoprostol provides significantly easier hysteroscopic entry, greater cervical dilatation, and short operative time. However, adverse effects including genital tract bleeding, abdominal pain, and gastrointestinal symptoms are significantly more common[16]. Intracervical injection of 10 to 20 mL of a dilute vasopressin at 3.00 and 9.00 of cervix may be used for cervical ripening with limited evidence from only one RCT[17].

Prophylactic antibiotics preparation: The incidence of infection after hysteroscopic myomectomy is very rare. Antibiotic prophylaxis is not routinely recommended for hysteroscopic surgery[18,19].

Anesthesia: Hysteroscopic myomectomy is usually performed under general anesthesia but either spinal anesthesia or local anesthesia, such as paracervical block and intrauterine injection with intravenous sedation can be utilized as well[20]. In patients with difficulty of cervical dilatation, emergency condition, or multiple comorbidities that increase the risk of hypervolemia, general anesthesia should be considered. Over the years, hysteroscopic myomectomy has been increasingly performed in an office setting, which can avoid the risk of anesthetic procedures.

Good surgical technique

The systems for hysteroscopic myomectomy consist of distension media system, telescope with video imaging system, operative instruments, and energy sources.

Distension media systems: Distension media is required to create sufficient intrauterine pressure that allows adequate visualization to accomplish hysteroscopic myomectomy. Fluid distension media is usually used, while gas (CO_2) is not recommended in hysteroscopic myomectomy due to the risk of embolism and unclear visualization. Fluid distension media can be classified according to the viscosity, osmolality, and electrolyte content as shown in Table 1.

High viscosity media such as dextran, exerts the advantage of good visualization of the uterine cavity. However, telescope and instruments may be damaged if they are not suitably cleaned immediately and high viscosity media can lead to disproportionate intravascular expansion, leading to cardiac failure even with a small volume of absorption[21].

Low viscosity media can be classified as hypotonic or isotonic media and non-conductive and conductive media, based on osmolarity and electrolyte content, respectively. Excessive absorption

Table 1. Type of fluid distension media and their properties

Distension media	Viscosity	Osmolality	Electrolyte content	Suitable energy sources	Comments
Normal saline	Low	Isotonic	conductive	Bipolar, morcellator, laser	
Ringer's lactate	Low	Isotonic	conductive	Bipolar, morcellator, laser	More physiologic than normal saline
Mannitol 5%	Low	Isotonic	Non- conductive	Monopolar	
Glycine 1.5%	Low	Hypotonic	Non- conductive	Monopolar	
Dextrose 5%	Low	Hypotonic	Non- conductive	Monopolar	
Sorbitol 3%	Low	Hypotonic	Non- conductive	Monopolar	
Dextran 70	High	Hypertonic	Non- conductive	Monopolar	Associated with anaphylaxis

of hypotonic media potentially leads to serious and life-threatening complications from dilutional hyponatremia, cerebral edema, and even death(22). Isotonic media does not cause hyponatremia; therefore, it is safer than hypotonic media. Non-conductive media can be used only with monopolar resectoscope while conductive media is applicable for either bipolar resectoscope, mechanical morcellator, or laser.

An alternative of suitable distension media less likely to cause complications should be used. Low viscosity isotonic conductive media such as normal saline is recommended with bipolar resectoscope and mechanical morcellator. Nevertheless, fluid deficit should still be closely monitored at a minimum of 10-minute intervals because of the risk of hypervolemia(4,23). If monopolar resectoscope is inevitable, isotonic non-conductive media, such as mannitol, is preferable than glycine or sorbitol, which are hypotonic media(4).

Simple gravity, pressure bags, and infusion pumps are safe and effective methods for distension media delivery. Infusion pumps are recommended to use in hysteroscopic myomectomy because of the constant intrauterine pressure and accurate fluid deficit surveillance. The distension pressure is usually set at 80 to 100 mmHg, maintained as low as possible to allow good visualization and kept below the mean arterial pressure(23). The pressure setting of 150 mmHg and flow setting of 450 mL/minute are the maximum rate(24).

Operative hysteroscopic instruments: There are two types of hysteroscopes, rigid and flexible ones. The rigid type is commonly used for hysteroscopic myomectomy. The rigid hysteroscope consists of various sizes of telescope, operative channel, and outer sheath providing inflow and outflow.

Scissors or grasper introduced, through the operative channel of the rigid 30o hysteroscope, can be used for hysteroscopic myomectomy but their applications are limited to the small type o submucous myoma with less than 1 cm in diameter(25).

Resectoscope is more widely used for hysteroscopic myomectomy. Telescope in the Forbique fashion (12° to 15°) may be more beneficial for the resection. The traditional telescope has about 3.5 to 4 mm outer diameter with the 8 to 9 mm diameter outer sheath. Bipolar resectoscope with the 9 mm external sheath is commonly used. U-shaped wired electrode should be used and operated with a cutting current of 130 to 170 W to remove 3 to 5 mm strips of myoma each time. A mini-resectroscope is developed for the office setting by decreasing the size of the hysteroscope as presented in Table 2.

Hysteroscopic tissue removal systems (HTRs), also known as hysteroscopic mechanical morcellator, is gaining in popularity because it can morcellate myoma and extract the tissue fragments without electrical requirement. TruClear® (Medtronic, USA) and MyoSure® (Hologic, USA) were approved by the Food and Drug Administration (FDA) in 2005 and 2009, respectively. Each TruClear® and MyoSure® have two sizes and several associated devices. Moreover, intrauterine BIGATTI shaver: IBS® (KARL STORZ, Germany) has been developed for the office setting with a 4 mm diameter outer sheath, but it is still not approved by the FDA. It comprises 6º angled telescope. The detail of mechanical morcellator is shown in Table 2. The advantages of the mechanical morcellator include a reduced risk of perforation due to the reduction of instrument insertion, fluid overload, gas embolism, and thermal injury from electrical currents. On the other hand, myoma bed bleeding may potentially increase because of the lack radiofrequency energy sources. Nevertheless, bleeding rate from the use of mechanical morcellator is reported to be very low, at approximately 0.003%(26). But even so, there is a limited utility in type 2 myoma.

Electrosurgical vaporization is introduced with a

Table 2. Properties of operative hysteroscopic instruments for myomectomy

	Bipolar resectoscope	Mini-bipolar resectoscope	TruClear®	MyoSure®	IBS®
Size of external sheath	7 to 9 mm (22 to 26 Fr)	5 mm (15 Fr)	- Elite plus 7.25 mm (22 Fr) - Elite mini 6 mm (18 Fr) - 5C scope 5.7 mm (17 Fr)	- Classic 6.25 mm (19 Fr) - XL 7.25 mm (22 Fr)	8 mm (24 Fr)
Working channel outer diameter	4 mm	1.7 mm	4 mm	3 mm, 4 mm	4 mm
Telescope angle	12°	12°	0°	0°	6°
Telescope size	4 mm	2.9 mm	5 mm	N/A	N/A
Vacuum setting (mmHg)	N/A	N/A	150 to 300	180 to 475	100 to 240
Associated devices	N/A	N/A	- Incisor plus 4.0 for myoma ≤3 cm - Ultra plus 4.0 for myoma ≤5 cm	- MyoSure Reach for myoma ≤3 cm - MyoSure XL for myoma ≤5 cm	N/A

N/A=not available

large surface-area electrode activated with low voltage current. The main purpose is to reduce the myoma volume until it is feasible to extract the residual mass with grasping forceps. Its main advantage is to diminish systemic absorption of distension media. However, the degree of adjacent thermal injury is greater, along with the increasing risk of dispersive pad skin burn[27].

Myomectomy procedure: Hysteroscopic myomectomy is performed in a patient in lithotomy position. Trendelenburg position should be avoided. The cervix should be gently dilated by Hegar dilators. The size of Hegar dilators should be gradually step up by one step until it is compatible with the outer sheath of the hysteroscopy. Size 9 to 10 of Hegar dilator are suitable for the 9 mm outer sheath of a standard resectoscope or morcellator.

The principle of hysteroscopic myomectomy is to completely remove the myoma and minimize the damage to an adjacent healthy endometrium. The operative instruments, either the resectoscope or the morcellator, should not contact the normal tissue adjacent to the lesion.

The slicing technique is commonly used to remove submucous myoma by the resectoscope. It is recommended to start current of the electrosurgical loop with as low voltage as possible to easily resect the myoma. The current is usually set at 100 to 120 W in coagulation mode and 60 to 75 W in cutting mode[28,29]. The electrosurgical loop is advanced beyond the myoma and cut over the lesion in a backward direction. Myoma resection starts from the top of the mass and meshes the way down to its base. To reduce the times of hysteroscope insertion and trauma risk, the fragments of resected myoma can be pushed into a fundal cavity and removed at the end of the procedure. Bleeding can be coagulated, with concern of minimizing the trauma of surrounding normal endometrium.

The cold loop technique is performed by blunt section at the junction between myoma and myometrium by a non-electrosurgical loop. This technique is effective and minimized the damage to the healthy endometrium. Therefore, the cold loop technique can be safely performed in the patients with pregnancy desire.

Satisfactory outcomes

Complete removal of myoma: The rate of complete resection depends on the type and size of myoma. Type 2 myoma especially with a greater than 3 cm in diameter, increases the risk of multiple procedures[8]. No single technique has proved superior to the others for hysteroscopic myomectomy. There is conflicting evidence of success rate when comparing bipolar resectoscope with morcellator. There is no significant difference in the success rate between each brand of the morcellator (TruClear® vs MyoSure®)[30,31]. Additionally, the recent meta-analysis reveals that the feasibility rate of a one-step hysteroscopic myomectomy by resectoscope is significantly lower than the morcellator technique in type 0-1 myoma at 86.5% versus 92.3% ($p<0.001$) and in type 0 myoma at 70.6% versus 88.4% ($p<0.001$)[32].

Operative time: Over the years, there is no significant difference in operative time of hysteroscopic myomectomy in the comparison of resectoscope and conventional resectoscope[33].

Infertility: Submucous myoma is a cause of infertility because of decreasing implantation, decreasing clinical pregnancy rate, and increasing miscarriage rate. However, the current meta-analysis found uncertain data to improve clinical pregnancy rate after hysteroscopic myomectomy procedure by resectoscope (OR 2.04, 95% CI 0.62 to 6.66). Moreover, this study did not report on live birth or ongoing pregnancy rate(34). Hysteroscopic myomectomy may help restore uterine cavity, but it may increase the risk of intrauterine adhesion. Therefore, pre-operative counselling should be concerned.

Minimized complications

Excessive fluid absorption: Volume overload can cause pulmonary edema and congestive cardiac failure. If hypotonic media is used, the excessive fluid absorption dose not only result to hypervolemia, but also lead to hyponatremia, cerebral edema, and even death.

Core of fluid management is choosing suitable fluid media, minimizing systemic absorption during procedure, and early detection these complications. Isotonic conductive media such normal saline is recommend for use with either bipolar resectoscope or morcellator to avoid risk of hyponatremia. Close monitoring of fluid deficit is necessary. The procedure should be stopped when fluid deficit is more than 1,000 mL for hypotonic media, and 2,500 mL for isotonic media. The cutoff of fluid deficit is lower to 750 mL for hypotonic media, and 1,500 mL for isotonic media in elderly and women with cardiovascular, renal, or other comorbidities(23).

Trauma: Hysteroscopic myomectomy can cause cervical trauma and uterine perforation. Uterine perforation can occur during cervical dilatation, multiple insertion of hysteroscope, and resection of myoma with mechanical grasping tools or resectoscope. Cervical ripening should be prepared before the procedure to reduce these complications.

If perforation occurred, bowel injury should be evaluated. If perforation occurred when the electrical tool was activated, bowel injury may occur. When either bowel injury or heavy bleeding is present, laparoscopy or laparotomy must be performed. On the other hand, if bowel injury was not suspected, the patient should closely be observed in hospital for 24 hours.

Bleeding: The incidence of heavy bleeding from uterine cavity is low. Medication such as tranexamic acid, prostaglandin E2 analogues such as misoprostol and dinoprostone, and ascorbic acid can be used for reducing blood loss. Moreover, uterine tamponade can be performed using Foley catheter with saline infusion until the bleeding settles. Balloon may be deflated after one hour and removed.

Thermal burn: Thermal burn may be caused by current diversion that occured during the use of monopolar resectoscope. Therefore, monopolar resectoscope is not recommended to reduce the risk of dispersive electrode. Another cause of thermal burn is unintentional activation of electrosurgical tools. These complications can be prevented by delaying attachment of the electrosurgical cables to the resectoscope until the surgeon is ready to place it in the endometrium.

Intrauterine adhesion (IUA): The incidence of IUA following hysteroscopic myomectomy is 31% to 40% for single myoma resection and 45.5% for multiple myoma resection(35, 36). Hyaluronic acid gel, polyethylene oxidesodium carboxymethylcellulose gel, oral estrogen, intrauterine balloon, intrauterine device, and human amnion are used for intrauterine adhesive prevention. The recent meta-analysis in 2016 and 2000 found that hyaluronic acid and polyethylene oxidesodium carboxymethylcellulose gel significantly reduce IUA(37,38). Moreover, repeating hysteroscopy one week after hysteroscopic myomectomy may decrease IUA when combined with estrogen and intrauterine device(39). There is no evidence demonstrating that estrogen, intrauterine device, or human amnion can be used for effective IUA prevention(38).

Conclusion

Patients with submucous myoma usually have symptoms of abnormal uterine bleeding and infertility. Hysteroscopic myomectomy is a minimal invasive surgery and the gold standard treatment in women who desire to preserve fertility. The purpose of the operation is to completely remove the myoma in one-step procedure. The principles to be concerned with are pre-operative optimization, good surgical technique, minimized complications, and good surgical outcomes. Resectoscope is commonly used for conventional hysteroscopic myomectomy, thus, morcellator is used because it is easy to use, reduces the risk of perforation, and has no electrical currents. Hysteroscopic myomectomy in office setting is more popular in smaller size of hysteroscope. The important technique performed during hysteroscopic myomectomy is to minimize damage to adjacent healthy endometrium.

Conflicts of interest

The author declares no conflict of interest.

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