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Advanced Laparoscopic Adenomyomectomy Technique for Focal Uterine Adenomyosis by Three-step Approach

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ABSTRACT

Background and Objective: Owing to the increasing trend of preserving fertility in adenomyomectomy, the need for laparoscopic adenomyomectomy has increased. This study aimed to introduce a new surgical technique, an advanced laparoscopic adenomyomectomy technique, and to evaluate its efficacy, benefits, and safety in focal uterine adenomyosis.

Methods: From February 1, 2019 to February 29, 2020, 47 patients who underwent laparoscopic adenomyomectomy using the new surgical technique were enrolled in the study. The inclusion criteria were: (1) Focal-type adenomyosis, diagnosed by ultrasound or magnetic resonance imaging that was refractory to medical treatments. (2) A strong desire to preserve the uterus. All the operations were performed by a single surgeon with a uniform technique.

Results: The mean patient age was 40.53 ± 5.93 years (median 38.5, range 32–47). The mean diameter of the adenomyoma lesions was 4.57 ± 1.21 cm and the mean weight of the excised lesions was 40.53 ± 35.65g (range, 15–209 g). The mean total operation time was 70.11 ± 15.05 minutes. The mean estimated blood loss was 88.88 ± 20.0 mL (20 – 500 ml). There was no conversion to laparotomy or major complications requiring reoperation. At the seven-month follow-up, there was complete remission of dysmenorrhea and menorrhagia in 97.4% and 88.9% of the patients, respectively.

Conclusions: The new advanced laparoscopic adenomyomectomy technique with a three-step approach could be a safe and effective therapeutic method.

Key Words: Adenomyomectomy, Laparoscopy, Technique, TOUA (Transient Occlusion of Uterine Arteries), Uterine adenomyosis.

INTRODUCTION

Uterine adenomyosis is defined as a myometrial invasion of the endometrial glands. It may present with dysmenorrhea, chronic pelvic pain, abnormal uterine bleeding, and subfertility.[1] Uterine adenomyosis can be classified into focal and diffuse types according to the extent of the lesion.[2] Owing to the increasing trend of preserving fertility in benign gynecologic diseases like uterine myoma or adenomyosis, the demand for uterus-conserving surgeries has been increasing worldwide. A few studies reported that conservative surgery for adenomyosis was effective in controlling symptoms and improving pregnancy rates, and various conservative surgery methods have been suggested to overcome unclear boundaries and the risk of bleeding.[3–10] However, there is no established standard adenomyomectomy technique. To further evaluate the efficacy and safety of the surgical adenomyomectomy techniques, a large number of surgical cases and comparison among the diverse surgical techniques are required.

For the surgical treatment of focal uterine adenomyosis, laparoscopic adenomyomectomy by transient occlusion of the uterine arteries (TOUA) was reported.[3] To minimize blood loss, we applied the TOUA method instead of using vasopressors. Based on that result, we developed an advanced method aimed to achieve better outcomes with shorter operating time, more complete excision without intraoperative complications and less postoperative bleeding, and easier performance of conservative uterine surgery.[4,11] The purpose of this study was to introduce our new surgical laparoscopic adenomyomectomy

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technique and assess its efficacy by analyzing the recent outcomes in a single center.

METHODOLOGY

From February 1, 2019 to February 29, 2020, 47 patients who underwent adenomyomectomy using the new surgical technique were enrolled in this study. The inclusion criteria were: (1) focal-type adenomyosis diagnosed by ultrasound or magnetic resonance imaging (MRI) that was refractory to noninvasive treatment such as oral pills, gonadotropin-releasing hormone (GnRH) agonists, progestins, and levonorgestrel-releasing hormone devices. (2) A strong desire to preserve their uterus. Focal adenomyosis, was defined as an adenomyosis lesion surrounded by normal myometrium, and the mean diameter of the pre-operative focalized lesion was approximately less than five cm.[12] Clinical diagnoses of the focal adenomyosis were done with ultrasound and when further imaging was required, an MRI was performed. All the patients underwent bimanual pelvic examination by a single surgeon to detect pre-operatively severe pelvic adhesion, which was excluded in this study.

A GnRH agonist (3.75 mg of leuprolide acetate) was administered at least once two to three weeks prior to the surgery to achieve hypoestrogenic status for making the endometrial margin clear and minimizing blood loss.[13]

The operating time was defined as the period from the skin incision to closure. The size of the adenomyoma was the maximum diameter of the adenomyoma on ultrasound or MRI. The weight of the adenomyoma was estimated by the total weight of the excised lesion during surgery and the blood loss was estimated by subtracting the rinse volume from the blood volume that was collected in the suction apparatus. This study was reviewed and approved by the Institutional Review Board and informed consent was obtained before the surgery.

The questionnaire that was presented to the patients to assess symptomatic improvement used an 11-point numeric scale (0 = no pain, 10 = worst pain imaginable) and menorrhagia was evaluated using the Mansfield-Voda-Jorgensen menstrual bleeding scale. Symptom improvement was determined as the decline ratio (%) of the difference between initial and postoperative symptoms seven months after each surgery. We defined complete remission (CR) as 100% symptom improvement, partial remission (PR) as ≥ 30% improvement, and stable disease as ≤ 30% improvement. Parameters for predicting surgical outcomes included the weight of excised lesion, operation time, estimated blood loss, any injury to nerves or uterine vessels, and laparotomic conversion.

Surgical Technique for Laparoscopic Adenomyomectomy

Step 1. Transient Occlusion of Uterine Arteries (TOUA)[3,4]

The patient was placed in a dorsal lithotomy position under general anesthesia with endotracheal intubation. The RUMI system with a disposable uterine manipulator tip (Cooper Surgical Inc., Trumbull, CT, USA) was placed in the uterine cavity to allow optimal positioning of the uterine during excision. Intra-abdominal pressure was maintained at 13 mm Hg with carbon dioxide gas. Once a pneumoperitoneum was created, a video-laparoscopic system (Olympus Medical Systems Co., Tokyo, Japan) with a 10-mm trocar was introduced through the umbilicus. Three trocars were used during the operation, a 12-mm trocar for placement of the instruments (endoscopic vascular clips and morcellator) on the left side, a 5-mm trocar on the right side of the lower abdomen as an assistant, and a 5-mm trocar on the median line just above the pubic hairline. First, the uterine arteries were identified and TOUA was performed. Approaching through the retroperitoneal space, the uterine artery branching from the internal iliac artery can be detected on the lateral side of the ureter. The bilateral uterine arteries were isolated and transiently occluded with temporary atraumatic endovessel clips using the DeBakey tooth system (Aesculap, Inc. Center Valley, PA, USA) and a fixed bulldog applier/remover (Aesculap, Inc.).

Step 2. Resection of Adenomyosis as Completely as Possible

Using a hook-shaped, monopolar cutting instrument, the uterus was incised transversely on the lesion until the ballooned uterine manipulator and endometrial line were exposed. Another incision was made below the first transverse lined incision transversely along the upper and lower margin of the endometrial line. These two incisions allowed deep excision of the adenomyosis lesion while identifying the endometrial cavity. In the aspect of the endometrium direction, an incision line alongside the endometrial line and a plane were evenly apart, approximately 5 mm from the basal layer of the endometrium (**Figures 1A**, **1B**, and **2A**).

Step 3. Reconstruction of the Uterus; a Three-Layer Suture Technique

1) Suturing endometrial line. The suturing process involves three components. First, the endometrial cavity is

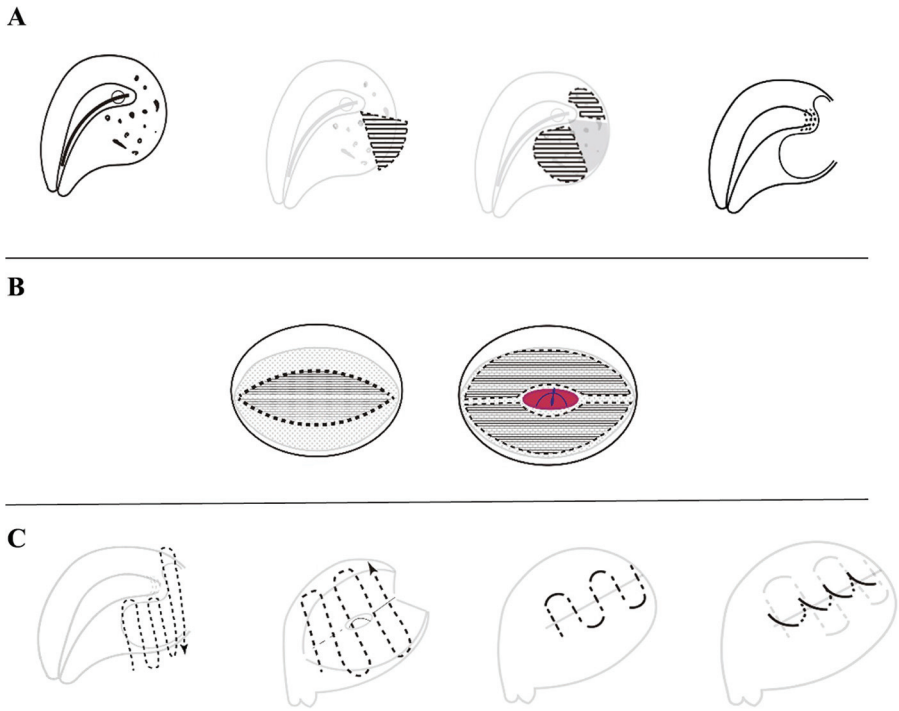

Figure 1. Schematic images of TOUA laparoscopic adenomyomectomy. **A**) Step 1. Transient Occlusion of Uterine Arteries (TOUA). **B**) Step 2. Resection of adenomyosis - as complete as possible. **C**) Step 3. Reconstruction of the uterus; Three-layer suture technique.

sutured with a 3-0 barbed suture material. The operator should be carefully close the tip of the cavity to prevent endometrial lining synechiae. Notably, when pulling the string and needle, to avoid tearing the tissue, the tension should not be strong, but just enough to approximate the endometrial line (**Figures 1A**, **1B, and 2B**).

2) Suturing myometrial cavity. After closing the endometrial cavity, the myometrial defects were sutured. First, the dead space of the myometrial defect was closed by the suture pattern of continuous anchoring of the serosa layer to the remaining myometrium consisting endometrial cavity. This suture technique was continued to completely close the defect dead space using a 1-0 barbed suture material (**Figures 1C and 2C**). This kind of suture is similar to the continuous horizontal and vertical suture technique. The suture material goes through the serosal and endometrial flaps to compress the vacant myometrial space vertically, while the needle moves horizontally.

3) Suturing outer incision line made on the uterus. After closing the myometrial space, the last step was an approximation of both of the excised serosa layers. The outer myometrium was finally sutured by a continuous running suture (**Figures 1C and 2C**). When the repair of the uterus was finished, the temporary vessel clamps were removed to monitor the blood perfusion status and leakage of the injured vessels. Anti-adhesion barrier gels including hyaluronic acid were applied to the endometrial cavity to prevent intra-uterine adhesions and a membrane-type barrier was used to cover the sutured serosal surface of the uterus. After finishing the reconstruction, the tissue was taken out through the port and one closed drain (Jackson-Pratt drain) was routinely inserted before the end of surgery.

Three cycles of GnRH agonist injections were given at monthly intervals. Five months after the last GnRH agonist injection, approximately seven months after the surgery, we assessed whether there was an improvement in the symptoms, including dysmenorrhea and menorrhagia, through standardized questionnaires and evaluating the normal uterine architecture recovery using transvaginal ultrasound. Then, the patients were followed at the outpatient clinic at six-month intervals to monitor their well-being, pregnancy status, and recurrence.

RESULTS

From February 1, 2019 to February 29, 2020, 47 patients underwent laparoscopic adenomyomectomies by a single surgeon. The mean patient age was 40.53 ± 5.93 (median

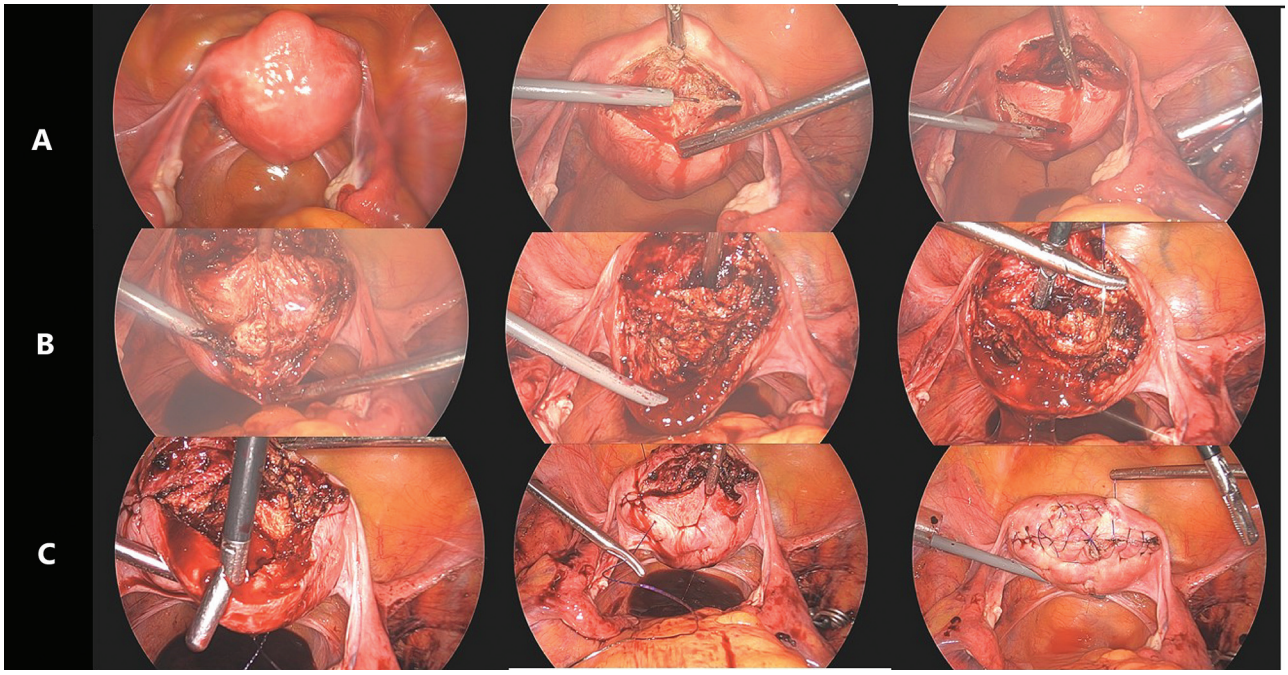

Figure 2. Intraoperative pictures of TOUA laparoscopic adenomyomectomy. **A**) Step 1. Transient Occlusion of Uterine Arteries (TOUA). **B**) Step 2. Resection of adenomyosis - as complete as possible. **C**) Step 3. Reconstruction of the uterus; Three-layer suture technique.

38.5, range 32 – 47) years. The major site of the adenomyoma was the posterior uterine body (41.7%) and the most common symptom associated with uterine adenomyoma was dysmenorrhea combined with menorrhagia (**Table 1**).

Table 1.
Clinical Characteristics of the 47 Patients

Characteristic	Value
Age (Year)	40.53 ± 5.93
Site of adenomyosis	
Anterior body of the uterus	13 (27.1%)
Posterior body of the uterus	20 (41.7%)
Fundal portion of the uterus	5 (10.4%)
Multifocal adenomyosis	10 (20.8%)
Main symptom	
Dysmenorrhea	17 (35.4%)
Menorrhagia	5 (10.4%)
Combined symptoms	22 (45.8%)
Others	4 (8.3%)

Data are expressed as the mean ± standard deviation or the absolute number (%).

The mean ± standard deviation (SD) diameter of the adenomyoma lesions was 4.57 ± 1.21 cm and the mean weight of the excised lesions was 40.53 ± 35.65 g (range, 15 – 209 g). The mean operation time was 70.11 ± 15.05 minutes. The mean estimated blood loss was 88.88 ± 200.0 mL (20 – 500) and there were no uterine arteries or pelvic nerve injuries.

The mean pre-operative hemoglobin (Hb) was 12.51 ± 10.3 g/dL and the mean postoperative day one Hb was 11.47 ± 1.68 g/dL. The mean total amount of drainage was 781.32 ± 387.87 (84 – 1792) mL. No patients had an intraoperative transfusion. The mean length of hospital stay was 3.34 ± 00.7 days (**Table 2**). There were no cases of conversion to laparotomy or major complications requiring re-operation or readmission during the mean follow-up period. At the seven-month follow-up, the main symptoms, including dysmenorrhea and menorrhagia, improved. Complete remission of dysmenorrhea and menorrhagia occurred in 97.4% and 88.9% of the patients, respectively (**Table 3**).

DISCUSSION

All the patients were diagnosed by ultrasound owing to its cost-effectiveness and feasibility rather than an MRI.

Table 2.
Surgical Outcomes of Laparoscopic Adenomyomectomy with Transient Occlusion Of Uterine Arteries

Outcome	Mean	Standard Deviation	Range
Maximal diameter (cm)*	4.57	1.21	2 – 8
Weight of excised lesion	40.53	35.65	15 – 209
Operative time (minutes)	70.11	15.05	45 – 110
Estimated blood loss (mL)	88.88	20.0	20 – 500
Pre-operative Hb (g/dL)	12.51	1.3	9 – 14
Postoperative day 1 Hb (g/dL)	11.47	1.68	7 – 14
Total amount of drainage (mL)	781.32	387.81	84 – 1792
Hospital stay (days)	3.34	0.7	2 – 5
Intraoperative transfusion	0		
Laparotomic conversion	0		

*Maximum diameter of the uterine adenomyoma.
Abbreviation: Hb, Hemoglobin.

Notably, deep infiltrative endometriosis (DIE) with focal uterine invasion could resemble pure focal adenomyosis. However, there are several differences including major symptoms, adjacent invasion, especially rectal invasion, and pelvic adhesion. It is very important to differentiate between the two diseases because their therapeutic modalities and prognostic value are different. In this study, an MRI was used to rule out DIE mimicking focal adenomyosis.

Adenomyosis has obscure boundaries making it challenging to excise the lesion completely. If there are remnant lesions, adenomyosis can recur. In addition, partial excision of an adenomyotic lesion might increase the need for continuing adjuvant treatment after surgery and result in a shorter symptom-free period and less improvement in infertility.

In our clinic, we use laparotomic or laparoscopic surgical approaches for uterine adenomyosis and we have reported results for a comparison between the two approaches.[12] Complete excision of an adenomyotic lesion through the laparoscopic approach for focal-type uterine adenomyoma relieves symptoms and improves fertility without adjuvant medical treatment. In addition, compared to diffuse-type adenomyosis, focal-type uterine adenomyoma can be easily and effectively treated surgically, mostly via the laparotomic approach.

Table 3.
Clinical follow-Up Seven Months After Advanced Laparoscopic Adenomyomectomy (n = 47)

Clinical Finding or Symptom	Complete Remission	Partial Remission	Persistent
Dysmenorrhea (n = 39)	38 (97.4%)	1 (2.6%)	0
Menorrhagia (n = 27)	24 (88.9%)	3 (11.1%)	0

Recently, the laparoscopic technique has advanced and is used worldwide in gynecologic disease-treating strategies. However, there are only a few reports of the excision methods of adenomyosis and uteroplasty via the laparoscopic approach.[3,4]

We previously published a paper on surgical laparoscopic adenomyomectomy technique and its clinical outcomes.[4] From the initial technique to the last published paper, our surgical techniques have matured and advanced to overcome surgical limitations. However, there are still some challenges including difficulties in the excisional procedure using laparoscopic scissors, and difficulties in suturing between the defected myometrium and uteroplasty to recover the uterine structure.

First, to improve the excisional process using endoscopic scissors, a monopolar cutting instrument with a hook-shaped tip (ENDOPATH® Probe Plus II Multi-Functional) and electrosurgery, piston grip handle with spatula-type and hook-type electrode (Ethicon, Johnson and Johnson, Cincinnati, OH, USA) were used in the current surgical procedure. Using a hook-shaped monopolar cutting instrument makes it easier to do the excisional procedure and obtain an even thickness of approximately 5 mm of the myometrium from the endometrial basal layer. It also safely saves the ascending branches of the uterine artery, which is important for maintaining endometrial architecture and function for future pregnancy. During the excisional procedure, needless vessel injury can be controlled using the coagulation mode of the monopolar electrode. In the previous report, the mean size of adenomyosis was 4.36 ± 0.99 (2.5 – 7.0) cm calculated by ultrasound. In the current study, the mean maximal diameter was 4.57 ± 1.21 (2.0 – 8.0) cm (**Table 4**). These results suggest that using a monopolar electrode leads to a wider excision.

The use of an electronic monopolar instrument also resulted in shortened operation time (70.11 ± 15.05 min vs. 75.14 ± 20.56 min) despite the heavier weight of the excised adenomyotic lesions (40.53 ± 36.65 vs. 26.18 ± 8.33 g) and less estimated blood loss (88.88 ± 200.0 vs. 148.19 ± 101.69 mL). Consequently, the postoperative day one hemoglobin value was higher compared to that of the previous surgical technique[4] (11.47 ± 1.68 in the

Table 4.
Comparing Results of Previous Technique and Current Technique

	Previously Published (Kwack JY and Kwon YS, 2017)	New Technique (2021)
Operation time (min)	75.14 ± 20.56	70.11 ± 15.05
Weight of the excised adenomyotic lesions (g)	26.18 ± 8.33	40.53 ± 36.65
Estimated blood loss (mL)	148.19 ± 101.69	88.88 ± 20.0

current study vs. 10.49 ± 1.38 g/dL in the previous study) (**Table 4**).

Second, for suturing myometrial space, the suture material was changed from synthetic polymer absorbable suture material (Polysorb®, Covidien, Mansfield, MA, USA) to absorbable, barbed suture material, (V-LOCTM 180 Covidien, Mansfield, MA, USA). The barbed suture material made it easy to maintain the tension of the continuous sutures and tightly closed the dead space of the defected myometrium by anchoring it to the endometrial myometrium. Moreover, the barbed suture material enabled a shorter operation time. In the previous report,[4] the mean operation time was 75.14 (mean) ± 20.56 (SD) minutes while in this study the operation time was 70.11 (mean) ± 15.05 (SD) minutes.

Third, a wedge resection of the adenomyotic lesion was performed with the new technique (**Figure 1**). Through the wedge resection, less effort is exerted for the complete excision of the adenomyotic lesion and after the complete excision, a uteroplasty could be carried out with a good approximation of the resected myometrium and serosa of the uterus, returning the uterus to a near-normal shape and size (**Figure 2**).

However, the new laparoscopic adenomyomectomy technique has another limitation. First, the monopolar electrode produces surgical smoke during the excision of the adenomyotic lesion, this causes a visual interruption in the laparoscopic surgical field and postoperatively irritates the organs in the peritoneal cavity. To reduce the effects of the surgical smoke, frequent intraoperative gas-exchange through the port valve was needed and the air circulating system should be properly set in the operation room. Furthermore, a Jackson-Pratt drain was inserted postoperatively to monitor postoperative peritoneal inflammation processes.

Although the Jackson-Pratt drain was inserted to monitor postoperative bleeding, there was a large volume of postoperative serous-colored drainage fluid (781.32 ± 387.81 mL) instead of blood. We assumed that this was from the inflammatory process due to surgical fume that irritated the peritoneum and bowel serosa. To resolve this, sufficient intraperitoneal irrigation with normal saline was performed as a final procedure. This removes small burnt tissue materials that cause intra-abdominal irritation. Additionally, regular administration of nonsteroidal anti-inflammatory drugs (NSAIDs) decreased the amount of secretion. It seemed that NSAIDs controlled the inflammatory reaction that induced reactive peritoneal fluid.

The GnRH agonist injection was based on our experience because there is no reference to the numbers and duration of postoperative use. Follow-up ultrasound showed that the uterus recovered its shape after three months. The GnRH agonist treatment was not administered to treat the remnant lesion, but to promote the wound healing process; the three times injection block endometrial proliferation and menstrual blood flow into the uterine cavity to promote the complete healing process approximately three months after the surgery.

In the previous study, four patients who received the previously reported method[4] of laparoscopic adenomyomectomy delivered without complications.[14] In this study, the patients were advised to try conception at least three months after the operation. In addition, delivery through the cesarean section was recommended because there was a lack of data that the uterus could endure labor. For the evaluation of fertility and pregnancy outcomes of the newly revised method, long-term follow-up will be needed. Among the 47 patients, 17 patients were nulliparous and among them, 6 patients were not married or did not have a plan for a baby at the time they received the surgery. Accumulated data should be gathered throughout the extended follow-up period.

In conclusion, in patients with focal uterine adenomyosis or adenomyoma who want to preserve their fertility and uterus, a TOUA laparoscopic adenomyomectomy with the new technique could be a safe and more effective therapeutic method than the previous technique using endoscopic scissors without barbed suture material. However, a long-term follow-up analysis of the surgical outcomes of this technique is needed to assess the related recurrence rate and long-term complications and determine the benefits related to low recurrence and patient satisfaction.

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