

A Comparison of Single-, Two- and Three-Port Laparoscopic Myomectomy

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ABSTRACT

Background and Objective: A recent FDA safety communication has discouraged the use of a power morcellator for myoma extraction and has called for a change in surgical techniques for myomectomy. The objective of this study was to compare surgical outcomes of laparoscopic single-, two-, and conventional three-port myomectomy and to evaluate the feasibility of contained manual morcellation for uterine myoma.

Methods: This retrospective study was a review and analysis of data from 191 consecutive women who underwent single-, two-, or three-port myomectomy for the management of uterine myoma from January 1, 2009, through December 31, 2014.

Results: The 3 study groups did not differ demographically. Apart from operative time, the single- and two-port groups showed operative outcomes comparable to those of the multiport group. The single-port group had significantly longer operative times ($P = .0053$) than the two- and three-port groups. However, in the latter half of the single-port cases, the operative time was similar to those in the three-port group. The two-port surgery group showed a consistent operative time without a learning period.

Conclusion: Single- or two-port myomectomy with transumbilical myoma morcellation is feasible and safe, with outcomes comparable to those of three-port myomectomy. These results suggest the potential for minimally invasive management of symptomatic uterine myoma, without the use of a power morcellator.

Key Words: Morcellator, Myomectomy, Laparoscopy, Trocar, Uterine myoma

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INTRODUCTION

Uterine myoma is one of the most common benign gynecologic tumors, and despite the availability of various nonsurgical treatment modalities, surgery is still the treatment of choice for symptomatic myoma.¹ Myomectomy is a common surgical procedure for affected women desiring to retain fertility. Since the reporting of the first laparoscopic myomectomy, modern techniques and increased demand for less invasive treatment have led to the transition from laparotomy to laparoscopy in myomectomy.² Laparoscopy has clear advantages over laparotomy, including decreased pain, reduced recovery time, shortened length of hospital stay, and avoidance of large operative scars.³ Although laparoscopic myomectomy is one of the most frequently performed gynecological surgeries, the procedure has not been standardized due to its technical difficulty. Various minimally invasive myomectomy techniques, including single-port and robotic surgery, have been reported to result in clinical outcomes that are comparable to those of standard abdominal surgery.^{4–11} However, the optimal minimally invasive technique for myomectomy remains controversial, prompting researchers to investigate the differences between the current operative techniques.^{9,12,13} In addition, recent U.S. Food and Drug Administration (FDA) safety communications have discouraged the use of the power morcellator for leiomyoma extraction, necessitating the development of another method of extraction and a change in the surgical approach to myomectomy.^{14,15}

Therefore, we conducted a retrospective study comparing the surgical outcomes of laparoscopic single-, two-, and conventional three-port myomectomy for the treatment of uterine myoma. We evaluated the operative outcomes of each procedure and the feasibility of contained manual morcellation of uterine myomas.

MATERIALS AND METHODS

Patients

A retrospective study was conducted with a review of medical records of women who underwent laparoscopic myomectomy at Dae-Jeon St. Mary's Hospital in Korea,

from January 1, 2009, through December 31, 2014. Included in the study were 191 consecutive patients who underwent laparoscopic myomectomy for symptomatic uterine myoma; the research protocol was approved by our institutional review board. This study was performed in accordance with the ethical standards set forth in the Declaration of Helsinki. All surgeries were performed by 1 of 3 gynecologic surgeons (YSL, EKP, or ICJ). Laparoscopic myomectomy has been performed at our institution since 1998. The 3 gynecologists are highly experienced in minimally invasive surgery, including various single-port surgeries. A three-port technique for myomectomy was used at our institution until 2011; however, the hospital changed to the use of fewer ports in early 2012. Two surgeons (EKP and ICJ) started using a single port, and 1 surgeon (YSL) used two. As a historic control, all eligible patients who underwent three-port laparoscopic myomectomy starting in January 2009 were included. The surgical indications were categorized as menorrhagia, compression, pain, and infertility. In cases of suspected malignancy or with a large myoma (≥ 12 cm), open myomectomy was performed. The largest myoma was categorized based on the greatest diameter of the single largest myoma reported on preoperative imaging with ultrasonography, computed tomography (CT), or magnetic resonance imaging (MRI). The weight of the myoma was determined by a pathologist.

Surgical Procedures

Single- and Two-Port Surgeries

All patients received general anesthesia and preoperative antibiotic prophylaxis. The surgeons did not use any articulating instruments for single-port surgery. After partial eversion of the umbilicus, a 1.5–2.0-cm vertical transumbilical skin incision was made. Subsequently, a rectus fasciotomy and peritoneal incision were performed. The fascial and peritoneal edges were sutured for traction before installation of the port system. A transumbilical single-port system was fashioned with Octoport (Dalim, Seoul, Korea), consisting of a retractor component and a cap component with a harbor mounted on the retractor component and multiple channels permitting introduction of a scope and laparoscopic instruments. After installation of the single-port system, carbon dioxide was infused to induce pneumoperitoneum. A rigid 0° or 30° 5-mm laparoscope was used at the surgeon's discretion. For two-port surgery, an additional 5-mm trocar was placed in the right lower quadrant of the abdomen, because the surgeon stood on the left side of the patient. The operative procedures did not differ beyond port placement (**Figure 1A**).

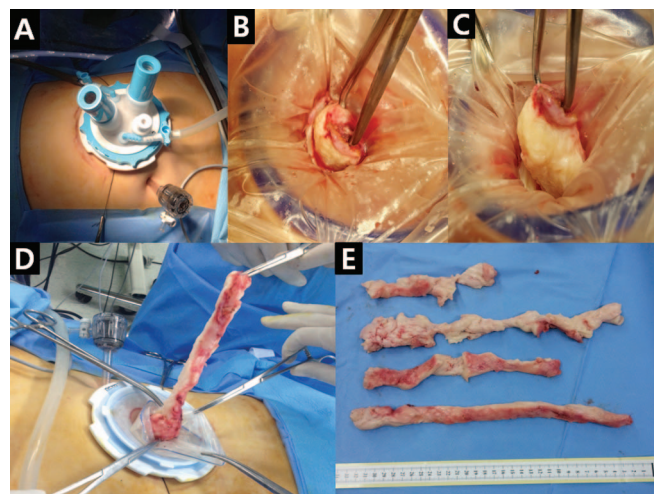


Figure 1. (A) Two-port entry system with a transumbilical single-port technique and an additional 5-mm trocar (B–E) for extraction of the myoma through the transumbilical single-port site. A contained manual morcellation technique was used.

When surgical preparation was completed, a dilute solution of vasopressin (10 IU/100 mL normal saline) was injected into the tissue adjacent to the base and the capsule of the uterine myoma. A monopolar scissor or an ultrasonic cutting device (Harmonic Scalpel; Ethicon Endo-Surgery, Cincinnati, Ohio) was used to make a vertical or horizontal incision to the myometrium, depending on the surgeon's preference. For extraction of the myoma through the transumbilical single-port site, contained manual morcellation was performed, using the following technique. Once the myoma was detached, it was placed in a specimen retrieval bag that was exteriorized at the umbilicus. Through the umbilical incision, the center of the myoma was grasped with a tenaculum and a V-shaped incision was made underneath the pinched portion (**Figure 1B**). As the myoma was pulled, a V-shaped incision was made continuously (**Figure 1C**). The myoma was rotated in the bag, and the tissue was pulled from the umbilicus in a continuous string-like form (**Figure 1D, 1E**). The specimen bag used was a 10-mm lapbag (Sejong Medical Co., Seoul, Korea). After enucleation of the myoma, the uterine muscle was closed intracorporeally, with either 1 or 2 layers of interrupted or continuous suturing with 1-0 polyglactin 910 sutures (Vicryl; Ethicon, Inc., Somerville, New Jersey). In some cases, large defects were repaired with interrupted sutures with extracorporeal knots formed with a knot pusher.

Three-Port Myomectomy

One 5-mm trocar was inserted at the umbilicus; another was inserted in the left or right lower quadrant of the

abdomen depending, on the surgeon's preference; and one 11-mm trocar was placed on the other side of abdomen. Myomas were extracted through the 11-mm trocar site with a 12-mm electromechanical power morcellator (X-Tract; Ethicon Inc.) without a bag. All other procedures were similar to the single-port surgery, except for port placement and extraction.

Surgical Outcomes

Patient age, body mass index (BMI), parity, history of abdominopelvic surgery, and indication for myomectomy were recorded. Total blood loss was calculated from the blood collected in suction, gauze, and drapes. The operation time was recorded from the first incision until final skin closure. The length of hospital stay was calculated by subtracting the admission date from the discharge date, with a same-day stay coded as 1 day. The operative complications were major vessel injury, incision herniation, intra-abdominal bleeding, wound infection, or damage to the bowel, bladder, or ureter.

Statistical Analysis

All statistical analysis was performed with SPSS Version 18 for Windows (SPSS, Inc., Chicago, Illinois). All tests were conducted with statistical significance assumed at $P < .05$. The data are expressed as the mean \pm SD for continuous variables and as the number of cases and percentage of occurrences for categorical variables.

Differences between groups were analyzed with the χ^2 test and Fisher's exact test for categorical data and analysis of variance (ANOVA) for continuous variables. When the ANOVA revealed a difference among the 3 treatment groups, a *post hoc* comparison was performed with the Scheffé test.

RESULTS

Clinicopathologic Characteristics

The records of 191 patients who underwent elective myomectomy were reviewed in this study. The patients were divided into 3 groups, based on number of laparoscopic ports. In total, 93 (48.7%) patients underwent three-port myomectomy, 37 (19.3%) underwent two-port myomectomy, and 61 (31.9%) underwent single-port myomectomy. Among the three-port group, surgeon A performed 28 cases, surgeon B performed 31 cases, and surgeon C performed 34 cases. In the single-port group, surgeon B performed 26 cases and surgeon C 35 cases. All cases in

the two-port group were performed by surgeon A. There were no cases of operative failure, defined as the need for an additional port or conversion to laparotomy. During the period reviewed, open myomectomy was performed in 6 patients with myomas 12 cm. One additional open myomectomy was performed in a case in which there was high suspicion of malignancy. The patient characteristics are presented in **Table 1**. There were no significant differences in age, BMI, parity, history of abdominopelvic surgery, or indication for operation among the 3 groups. As shown in **Table 2**, the size of the largest myoma in the three-port group was smaller than the largest ones in the single- and two-port groups ($P < .05$). There was a greater prevalence of myomas in an anterior location in the three-port group than in the single- and two-port groups ($P < .05$). There was a significantly higher prevalence of fundal myomas in patients who underwent single-port surgery than in those who had two- or three-port surgeries. The presence of adhesions in the single-port and two-port groups was significantly higher than in the three-port group ($P < .05$).

Operative Outcomes

Surgical outcomes are summarized in **Table 2**. The patients in the single-port group experienced a significantly longer operative time than those in the three-port and two-port groups ($P < .05$). Blood loss during surgery, transfusion rate, and length of the postoperative hospital stay were not significantly different between the 3 groups. There was one case of small bowel herniation through the 5-mm trocar site in connection with drain removal after three-port myomectomy, necessitating an additional laparoscopic operation for reduction.

In our study, the length of hospitalization was notably higher in all groups compared with rates in other reports. This outcome is associated, not only with the medical conditions of the patients, but also with the unusual culture of hospitalization in Korea, where even patients who have laparoscopy without complications have prolonged hospital stays. It may also be associated with the relatively low cost of medical care in Korea. On the first postoperative day, most patients who underwent laparoscopic surgery could ambulate and eat meals with little difficulty.

Table 3 shows the comparison of surgical outcomes between the single-port group and the two-port group divided into 2 periods based on when the operation was performed. In the single-port group, the operative time of procedures performed in the latter part of the study period was significantly lower than it was in the early part of the

Table 1.
Demographic Characteristics of Each Group

	Single-port (n = 61)	Two-port (n = 37)	Three-port (n = 93)	<i>P</i>
Characteristics of patients				
Age (years)	39.6 ± 7.1	38.5 ± 7.7	39.6 ± 7.7	0.724
BMI (kg/m ²)	24.1 ± 4.2	23.0 ± 3.6	23.5 ± 3.7	0.357
Parity	0.9 ± 1.0	0.6 ± 0.9	0.9 ± 1.0	0.193
Previous abdominopelvic surgery, n (%)				
Tubal operation	3 (4.9)	2 (5.4)	1 (1.1)	0.277
Adnexal operation	4 (6.6)	1 (2.7)	2 (2.2)	0.341
Myomectomy	0 (0.0)	2 (5.4)	3 (3.2)	0.234
Appendectomy	5 (8.2)	2 (5.4)	10 (10.8)	0.610
Cesarean section	4 (6.6)	1 (2.7)	7 (7.5)	0.589
Cesarean section * 2	0 (0.0)	0 (0.0)	0 (0.0)	
Cesarean section * 3	5 (8.2)	1 (2.7)	9 (9.7)	0.407
Other	1 (1.6)	1 (2.7)	0 (0.0)	0.338
Previous surgeries	0.4 ± 0.7	0.3 ± 0.5	0.5 ± 0.8	0.527
Indication for operation, n (%)				
Menorrhagia	16 (26.2)	12 (32.4)	30 (32.3)	0.695
Compression	12 (19.7)	5 (13.5)	11 (11.8)	0.394
Pain	24 (39.3)	14 (37.8)	37 (39.8)	0.979
Infertility	16 (26.2)	12 (32.4)	30 (32.3)	0.695

N = 191. Data are expressed as the mean ± SD, unless otherwise specified. *2 = two times; *3 = three times.

period (197.5 ± 107.3 min vs 136.5 ± 58.0 min, respectively; *P* < .05). In the two-port group, there was no significant difference in operative time, depending on study period (129.5 ± 54.6 min vs 129.6 ± 43.0 min for the earlier and latter periods, respectively; *P* = .488), and the average operative time in both periods in the two-port group was not longer than that in the three-port group. As compared to the earlier period, there was a significant decrease in blood loss in the latter period in the single-port group (338 ± 415.5 mL vs 114.8 ± 89.2 mL, respectively; *P* < .05). However, in the two-port group, no significant change was noted between the 2 periods (207.2 ± 21.84 mL vs 164.2 ± 145.0 mL; *P* = .488). **Figure 2** shows the operative times of the single- and two-port myomectomies performed by each surgeon (A–D). The single-port operative time of surgeons B and C was longer in the early period and decreased as the number of operations increased. Meanwhile, the two-port operative time of surgeon A was stable throughout the period, and the

average operative time was not longer than that of the three-port group.

DISCUSSION

Challenges in performing laparoscopic myomectomy include traction of the myoma, suture repair of the defect after myoma enucleation, the possibility of complications in future pregnancies, and loss of tactile sensation.^{6,8,13} These difficulties may be associated with prolonged operative time and the risk of perioperative morbidity, and these technical problems could be severe in those undergoing surgery with fewer ports. There have been few reports comparing single- and two-port myomectomy with the conventional three-port procedure. Some authors have reported no significant differences in operative outcomes, including operative time, between three- and single-port myomectomy, whereas other investigators have found differences in operative outcomes.^{5,12,13} Kim et al suggested that the main rea-

Table 2.
Characteristics of Myomas and Surgical Outcomes of Each Group

	Single-Port (<i>n</i> = 61)	Two-port (<i>n</i> = 37)	Three-port (<i>n</i> = 93)	<i>P</i>
Characteristics of myomas				
Myomas (n)	2.1 ± 1.5	2.2 ± 2.0	2.1 ± 1.6	0.950
Size of largest myoma (cm)	7.5 ± 3.2	7.8 ± 2.6	6.5 ± 2.8	0.027
Weight of specimen (g)	144.4 ± 134.6	211.0 ± 165.2	195.9 ± 233.9	0.169
Largest myoma type, n (%)				
Intramural	41 (67.2)	24 (64.9)	72 (77.4)	0.227
Subserosal	15 (24.6)	12 (32.4)	14 (15.1)	0.072
Submucosal	0 (0.0)	0 (0.0)	1 (1.1)	0.588
Intraligamentary	5 (8.2)	1 (2.7)	6 (6.5)	0.551
Location of largest myoma, n (%)				
Anterior	24 (39.3)	14 (37.8)	55 (59.1)	0.018
Posterior	17 (27.9)	13 (35.1)	28 (30.1)	0.748
Fundal	15 (24.6)	9 (24.3)	6 (6.5)	0.002
Broad ligament	4 (6.6)	0 (0.0)	3 (3.2)	0.234
Adhesion, n (%)	32 (52.5)	16 (43.2)	22 (23.7)	0.0009
Surgical outcomes				
Operative time (min)	165.8 ± 91.1	129.5 ± 48.6	132.1 ± 54.7	0.005 ^a
Blood loss (ml)	224.6 ± 320.9	185.1 ± 183.1	189.6 ± 201.8	0.628
Transfusion	4 (6.6)	1 (2.7)	3 (3.2)	0.529
Postop. hospital stay (days)	3.3 ± 0.8	3.1 ± 0.4	3.5 ± 1.1	0.091
Length of single port incision (mm)	17.2 ± 2.5	0.0 ± 0.0	0.0 ± 0.0	
Conversion, n (%)				
To laparotomy	0 (0.0)	0 (0.0)	0 (0.0)	
To an additional port	0 (0.0)	0 (0.0)	0 (0.0)	
Complications				
Intraoperative, n (%)	0 (0.0)	0 (0.0)	0 (0.0)	
Postoperative, n (%)	0 (0.0)	0 (0.0)	1 (1.1)	0.588
Total	0.0 ± 0.0	0.0 ± 0.0	0.0 ± 0.1	0.592

Data are expressed as the mean ± SD, unless otherwise specified.

^a2,3<1.

son for this difference is the surgeon's experience and inferred that a surgeon must perform 100 procedures to achieve a reasonable level of proficiency.¹³ Our study showed that single-port surgery initially involved longer operative times compared to three- and two-port surgeries; however, in later cases, the operative time for single-port surgery was shortened and became similar to the times of three-port surgery. Because our surgeons were already experienced with single-port surgeries such as hysterectomy, our data suggest that experienced surgeons do not face a

steep learning curve in performing single-port myomectomy. The operative times of the two-port surgeries did not show a learning curve and these surgeries were shorter than three-port procedures. One of the technical difficulties of single-port surgery is the lack of angulation. Our study showed that a two-port approach with an additional 5-mm trocar easily addressed this problem. A single-port procedure can be conveniently converted to a two-port one in difficult cases. Surgeons should not hesitate to use additional trocars if needed.

Table 3.
Comparison of Surgical Outcomes Between the Single-Port and Two-Port Groups Divided by Period When Operation Was Performed

	Single-Port		<i>P</i>	Two-Port		<i>P</i>
	Early Period (n = 31)	Latter Period (n = 30)		Early Period (n = 19)	Latter Period (n = 18)	
Surgical outcomes						
Operative time (min)	197.5 ± 107.3	136.5 ± 58.0	0.008	129.5 ± 54.6	129.6 ± 43.0	0.996
Blood loss (ml)	338.4 ± 415.5	114.8 ± 89.2	0.006	207.2 ± 218.4	164.2 ± 145.0	0.488
Transfusion, n (%)	3 (9.7)	1 (3.2)	0.612	1 (5.6)	0 (0.0)	>0.999
Postop. hospital stay (days)	3.6 ± 1.2	3.2 ± 0.5	0.200	3.1 ± 0.4	3.2 ± 0.4	0.411
Conversion						
To laparotomy	0 (0.0)	0 (0.0)	—	0 (0.0)	0 (0.0)	.
To an additional port	0 (0.0)	0 (0.0)	—	0 (0.0)	0 (0.0)	—
Complications, n						
Intraoperative, n (%)	0 (0.0)	0 (0.0)	—	0 (0.0)	0 (0.0)	—
Postoperative, n (%)	0 (0.0)	0 (0.0)	—	0 (0.0)	0 (0.0)	—
Total	0.0 ± 0.0	0.0 ± 0.0	—	0.0 ± 0.0	0.0 ± 0.0	—

Data are expressed at the mean ± SD, unless otherwise specified. The early operations in the study period were performed from 2009 through 2011; the latter operations were performed from 2012 through 2014.

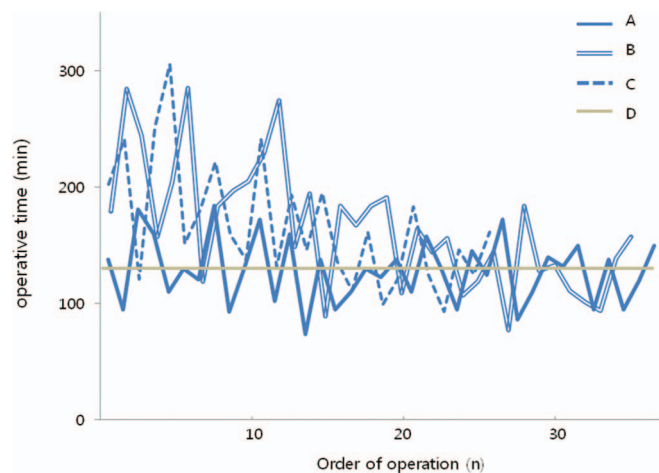


Figure 2. Operative time of single- and two-port myomectomies, by surgeon. Surgeon A, two-port; surgeon B, single-port; surgeon C, single-port; D, mean operative time of three-port myomectomy (132.1 min).

The differences in size of the largest myoma, prevalence of adhesions, and location of the myoma among three-, single-, and two-port surgeries may reflect surgical indications and patient preference rather than differences in operative method. A surgeon's technical confidence with accumulated experience and the desire of a patient to

preserve her uterus may result in the decision to pursue a more conservative myomectomy instead of a hysterectomy, even with larger myomas, difficult locations, and more severe adhesions.

In addition, the extraction of the enucleated myoma has recently become a major issue. A recent FDA safety communication has discouraged the use of a power morcellator for myoma extraction and has called for a change in surgical techniques for myomectomy. Myomas can be removed from the peritoneal cavity by colpotomy or via one of the port sites. Actually, many expert laparoscopic surgeons prefer vaginal removal because most large myomas can be removed easily through a posterior colpotomy followed by vaginal morcellation.^{16–19} Other advantages of transvaginal morcellation include avoiding the use of expensive equipment including the electronic morcellator and avoiding large abdominal scars. This approach may also have some limitations, however, including the need for an additional incision in a contaminated field, the need for a second surgical approach, and the potential for dyspareunia after surgery.²⁰ In addition, even married Korean women tend to be more reluctant to have transvaginal procedures than their Western counterparts. Therefore, we do not use the vaginal morcellation technique routinely. After the release of the FDA safety com-

munication, many alternative procedures that include the use of bags have been proposed, such as contained manual morcellation, in-bag laparoscopic morcellation, and contained vaginal morcellation.¹⁴ The use of a bag in the contained morcellation could reduce rare morcellation-related complications such as direct morcellation injuries, and the spread of malignant particles and cells in the abdominal cavity.²¹ For laparoscopic in-bag morcellation, the morcellation procedure is still performed intra-abdominally. Therefore, the surgeon cannot completely avoid the risk of accidental dissemination of the morcellated tissues or cells. The morcellation method described in this report could minimize the potential risk of dissemination by pulling the opening of the bag to the outside of the abdomen and then completing the morcellation.

One of the clear advantages of single-port surgery is that the larger umbilical incision facilitates extraction of tumors from the abdominal cavity. In some reports of single-port myomectomy, authors have described the use of a power morcellator despite a large transumbilical single-port entry,^{6,8,13} which could cause unnecessary cost and risk of morcellation-related complications. On the other hand, others reported the use of manual morcellation with a scalpel through the umbilical incision, similar to our technique.^{4,12} Myoma morcellation with a knife though an umbilical wound retractor is safe and fast in the hands of an experienced surgeon and could explain the short operative time in the two-port cases in this study. The length of a single umbilical incision is usually 15 to 20 mm, which is similar to the length of the single incision used in other studies.^{4,6,8,12–13}

In this study, the cost of the trocars used for the single-, two- and three-port myomectomy was \$200, \$255, and \$208 (USD), respectively, and the cost of the bag was \$30. Reusable trocars may reduce cost; however, they were not used in this study. Because of the healthcare system in Korea, the patient cost associated with myomectomy is the same regardless of the method used.

Another issue in laparoscopic myomectomy is the use of barbed sutures. Using barbed suture material can speed up uterine closure.²² Although we have recently started to use barbed sutures in some cases, they were not used in the cases included in this study.

This study has some limitations. For one, it is a retrospective study and includes cases treated by 3 different surgeons, which means that the specifics of the surgical technique may have differed between providers. However, there is a need for wider discussion of minimally

invasive myomectomy technique in surgeons with variable experiences.

In conclusion, both single-port and two-port myomectomy, with transumbilically contained manual morcellation of the myoma, are feasible and could be alternative options for minimally invasive myomectomy without the use of a power morcellator. However, a large study is needed to standardize minimally invasive myomectomy procedures.

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