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Effect of semisimultaneous morcellation *in situ* during laparoscopic myomectomy

Hsiao-Wen Tsai ^{a, b, c}, Elizabeth Joan Ocampo ^{a, b}, Ben-Shian Huang ^{c, d}, Nae-Fang Twu ^{a, b}, Peng-Hui Wang ^{a, b}, Ming-Shyen Yen ^{a, b}, Yu-Shan Kung ^e, Yi-Jen Chen ^{a, b, c, *}

^a Department of Obstetrics and Gynecology, Taipei Veterans General Hospital, Taipei, Taiwan

^b National Yang-Ming University, School of Medicine, Taipei, Taiwan

^c Institute of Clinical Medicine, National Yang-Ming University, Taipei, Taiwan

^d Department of Obstetrics and Gynecology, National Yang-Ming University Hospital, Ilan, Taiwan

^e Department of Nursing, Taipei Veterans General Hospital, Taipei, Taiwan

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ABSTRACT

Objective: The conventional technique of laparoscopic myomectomy (LM) was performed by complete enucleation of the myoma followed by morcellation as described previously. However, the conventional technique of LM presented some inherent problems in the management of larger myomas. Our objective was to compare the surgical outcome of the semisimultaneous morcellation *in situ* (SSMI group) technique and conventional morcellation (Control group).

Materials and methods: In this prospective case–control study 122 patients with symptomatic uterine myomas treated with LM were recruited and divided into two groups. Patients in the Control group underwent LM using the conventional technique of completely enucleating the myoma followed by morcellation. In the SSMI group, morcellation was initiated from the upper half of the myoma and then the lower half was completely enucleated.

Results: Fifty-four women underwent SSMI, and 68 women served as controls. There was no difference in the baseline characteristics between the two groups. The SSMI technique significantly reduced surgical time (163.2 ± 46.8 minutes vs. 189.4 ± 56.7 minutes; $p = 0.007$), although the difference in the mean blood loss was not significant (178 ± 147 mL vs. 203 ± 185 mL; $p = 0.417$), compared with the control. Furthermore, SSMI technique and myoma weight contributed to longer surgical times in multivariate analysis.

Conclusion: The SSMI technique could shorten surgical time when a laparoscopic myomectomy is performed, but uterine size is also important.

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Introduction

Laparoscopic myomectomy (LM) is one of the powerful surgical procedures for the treatment of uterine leiomyoma. Laparoscopic myomectomy is more advantageous than abdominal myomectomy with less postoperative pain, a shorter hospital stay and less postoperative adhesions.^{1–5} However, LM is more technical, especially

while dealing with the larger myomas.^{6–8} In a limited space, the large dimension of the myoma makes the enucleation with the laparoscopy far more difficult.^{9,10} It not only takes time, but also increases blood loss. Therefore, it is necessary to modify the LM technique, especially while dealing with the larger myomas.

The conventional technique of LM was performed by complete enucleation of the myoma first, followed by morcellation, which was pioneered by Kurt Semm in 1973.^{11–13} Simultaneous morcellation *in situ* (SMI), a modified method proposed in recent studies, leveraged the morcellator to enucleate the myoma down to its base by performing morcellation directly on the uterine surface without prior enucleation (i.e., simultaneous enucleation and morcellation of the myoma *in situ*).¹⁴ Although the SMI technique significantly

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* Corresponding author. Department of Obstetrics and Gynecology, Taipei Veterans General Hospital and National Yang-Ming University School of Medicine, 201, Section 2, Shih-Pai Road, Taipei 112, Taiwan.

E-mail address: chenyj@vghtpe.gov.tw (Y.-J. Chen).

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shortened surgical time, it was noted to have a higher risk for inadvertent penetration of the endometrium with the morcellator, which has been a concern, especially in large, deep intramural myomas.^{15,16} Furthermore, blood loss was slightly higher in the SMI group compared to the conventional LM group in previous studies.^{14,15}

To avoid the risk of endometrial penetration, we modified the SMI technique and called it semisimultaneous morcellation *in situ* (SSMI). We performed the morcellation toward the upper half of the myoma first and enucleated the lower half of the myoma, followed by suture of the myometrial edges, and ending with the morcellation of the remaining myoma. We hypothesized that the SSMI technique would have a shorter surgical time without an increase in blood loss and also reduce the risk of endometrial penetration as compared to the conventional LM group.

Our objective was to compare the surgical outcome of the SSMI technique and conventional LM.

Materials and methods

Patients

This study was designed as a cohort study. The participants were recruited at a tertiary medical center in northern Taiwan from January 2009 through to June 2010. Approval for the study was obtained from the Taipei Veterans General Hospital's ethics committee, and informed consent was obtained from all patients (Veterans General Hospital Institutional Review Board (VGHIRB) No.: 98-01-20A; Clinical Trial Registration: NCT00860002). Based on a previous study of surgical time and our preliminary data for the SSMI operative time, we used mean \pm standard deviation (SD) for the SSMI and conventional groups, respectively, as the primary criterion in our power analysis ($p = 0.85$, $\alpha = 0.05$, equal sizes for both groups and a two-tailed test) to calculate a minimum sample size of 50 patients for each group. Assuming a 10% dropout rate, the trial protocol specified a sample of patients.

A total of 132 patients scheduled for elective LM were screened in this study. The inclusion criteria were female, aged 30–45 years, and an American Society of Anesthesiologists physical status classification of I or II. Only intramural-type myomas >3 cm in diameter, as measured by ultrasound, were included in the study. Patients were excluded if their disease was malignant, if they needed additional adnexal surgery ($n = 8$) or if they were unwilling to participate ($n = 2$). Finally, data for 122 patients were analyzed. All the patients received routine preoperative preparation, which included the taking of a full history, a clinical examination, and laboratory testing. A review of the LM surgical records was performed, and the study population was classified into two groups: conventional LM ($n = 68$) was performed in the first 11 months of the study (January–November 2009), and the SSMI technique ($n = 54$) was applied in all cases after December 2009 (December 2009–June 2010).

All procedures were performed by a single surgeon at a single institute during the study period. The surgeon is familiar with LM surgery and since January 2007 has performed >300 cases. The postoperative assessment was performed by independent investigators.

Surgical procedures

All surgical procedures were performed under general endotracheal anesthesia with the patient in the Trendelenburg position and the bladder catheterized. The Kronner uterine manipulator (Kronner Medical Manufacturing, Roseburg, Oregon, USA) was inserted through the cervix and into the uterus.

SSMI group

Pneumoperitoneum by insufflation with carbon dioxide was established either with the use of a Veress needle, for patients without prior surgery, or by the open method with a 1.2-cm umbilical incision, for patients with history of surgery. A primary 10-mm trocar was inserted through the umbilicus to introduce the videolaparoscopic system (Karl Storz). Three other accessory 0.5-cm trocars were inserted; two were 2 cm above the anterosuperior iliac spines and lateral to the rectus abdominis muscle, and the third was placed at the suprapubic area, to facilitate insertion of laparoscopic operative instruments. A panoramic 360° evaluation of the pelvis was performed to check for adhesions and other pelvic pathology, which could complicate the procedure. Vasoconstrictive solution (vasopressin 20 μ /mL diluted in 60 mL of saline solution) was injected at various points over the dome of the uterus and at the uterine attachment to the myoma. The left lower quadrant port was then converted to a 1.2-cm incision for insertion of the morcellator (Karl Storz). The SSMI group underwent three steps: (1) the upper half of the myoma was enucleated by morcellation (Figure 1A–C); (2) the residual lower half was enucleated by sharp dissection down to the myoma base (Figure 1D); and (3) myometrial edges were reapproximated in two layers with interrupted figure-of-8 intracorporeal knots (Polysorb 0) prior to morcellation of the isolated lower half of the myoma (Figure 1E and F). Hemostasis was assured. A closed wound vacuum reservoir (CWV) drain was inserted and placed in the cul-de-sac. The 1.2-cm abdominal incisions were closed in two layers (Polysorb 2-0,

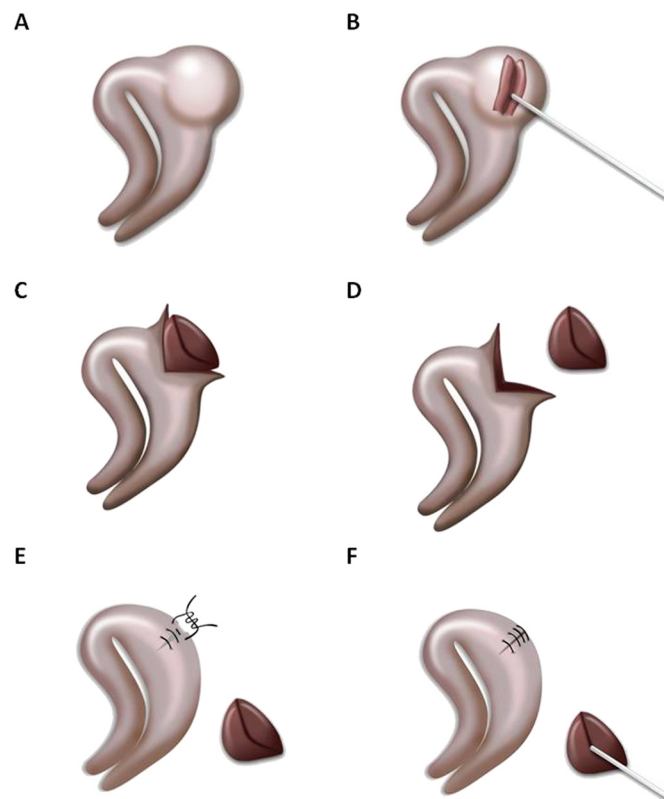


Figure 1. Illustration of laparoscopic myomectomy with semisimultaneous morcellation *in situ* in three steps. Step 1: (A) Identification of location of intramural myoma. (B) Enucleation of the upper one half of the myoma by morcellation. Step 2: (C and D) Enucleation of the lower half of the myoma from its attachment to the myometrium by sharp dissection. Step 3: (E and F) Reapproximation of myometrial edges with interrupted figure-of-8 sutures and then morcellation of the enucleated lower half of the myoma.

Dexon 3-0), and the 0.5-cm incisions were closed with Dermabond (Ethicon Inc., Johnson & Johnson Co.)

Control group (conventional morcellation)

The trocar insertion was the same as that in the SSMI group. Then, we enucleated the entire myoma. The myometrial edges were sutured in two layers, with interrupted figure-of-8 intracorporeal knots (Polysorb 0). Hemostasis was assured. The enucleated myoma was then removed by morcellation. A CWV drain was inserted and placed in the cul-de-sac. The 1.2-cm abdominal incisions were closed in two layers (Polysorb 2-0, Dexon 3-0), and the 0.5-cm incisions were closed with Dermabond (Ethicon Inc., Johnson & Johnson Co.)

Evaluation parameters

The parameters, which were considered to compare both groups, were myoma character (size, location, weight, and number), surgical parameters, and morbidity. The surgical parameters included surgical time (minutes), estimated blood loss (mL), and time of removal of CWV drain (days). Morbidity included percentage of blood transfusion, ileus, uterine hematoma, and intestinal serosal tears. Patient discomfort consisted of flatus day (time of return of gastrointestinal function), postoperative use of analgesia (accumulative dosage of meperidine hydrochloride), and length of hospital stay (days). The cost of hospitalization of the two groups was also compared.

Statistical analysis

Statistical software (SPSS, version 17.0; SPSS Inc., Chicago, IL, USA) was used to analyze all the data. Data are presented as the mean \pm standard deviation (SD) and n (%). The parametric-independent sample t test was used to compare the differences between the two groups. Fisher's exact test and χ^2 analysis were used for categorical variables. For all statistical evaluations, $p < 0.05$ was used to reject the null hypothesis. Multivariate analysis was performed using linear regression. The outcome variable for these analyses was surgical time. The study group, Body Mass Index (BMI), and myoma characteristics (location, weight, and number) were used as covariates.

Results

Demographic parameters, including age, BMI, previous surgical history, and myoma largest diameter, number, and location, were comparable between the two groups (Table 1). There were no significant differences among these variables (Table 1). None of the patients was converted to laparotomy in either group.

Surgical outcomes are shown in Table 2. The myoma weight, surgical blood loss, drain removal time, total meperidine HCl dose, time to first flatus, and length of postoperative hospital stay showed no significant difference between the two groups. Furthermore, SSMI did not increase the incidence of inadvertent penetration of the endometrium (SSMI group vs. control group: 1.9% vs. 2.9%, $p = 1.000$). Blood loss in the two group was also no difference (SSMI group vs. control group: 178 ± 147 mL vs. 203 ± 185 mL, $p = 0.417$). The only statistically significant difference in the clinical characteristics between the two groups was surgical time. Surgical time in the SSMI group was shorter than that in the control group (163.2 ± 46.8 minutes vs. 189.4 ± 56.7 minutes; $p = 0.007$; Table 2).

Upon analysis of multiple predictive factors affecting surgical time, it was noted that the SSMI technique and myoma weight were major predictive factors affecting surgical time (Table 3).

Neither group had intraoperative complications, nor was there a difference in the rate of perioperative complications between the two groups (7.4% vs. 13.2%, $p = 0.300$; Table 4). There were three cases (5.5%) of postoperative anemia in the SSMI group and eight cases (11.8%) in the control group with $p = 0.343$. Other postoperative complications in the SSMI group were one case of ileus (1.8%) and one case of intestinal serosal tear (1.8%). There was one case of postoperative uterine hematoma (1.8%) in the conventional group.

The case of ileus in the SSMI group was managed with nasogastric decompression. She had a return of normal gastrointestinal function at the 4th postoperative day. The case of intestinal serosal tearing in the SSMI group was not caused by morcellation; rather it was secondary to adhesiolysis of severe pelvic endometrial adhesions between the colon and the posterior uterine wall and bilateral adnexae. The intestinal serosal tear was sutured laparoscopically. The presence of flatus was achieved on the 1st postoperative day, and the patient was asymptomatic when she went home on the 3rd postoperative day. The case of postoperative uterine hematoma in the conventional group, measuring 1.5 cm, had a preoperative solitary 10.8-cm anterofundal, intramural myoma with a subserous component. It was observed and managed conservatively with tranexamic acid. The uterine hematoma was resolved on repeat transvaginal ultrasound 1 month from the surgical procedure.

Discussion

Our study showed the advantage of the SSMI technique with a shorter surgical time and the better adroit manipulation. The conventional technique separates the myoma completely from the uterus before morcellation,¹² so there is limited space available for the push–pull maneuvers.¹⁷ Additionally, traction by a myoma screw or grasper may not be adequate or efficient and repeat repositioning of the screw is required in the conventional technique, which may be very cumbersome.¹⁸ Our technique offers certain advantages that help to overcome these problems. First, the combination of enucleation and morcellation for the upper half of the myoma is less demanding for the operator (Figure 1B). Second, morcellation created more space for a better view and optimum movement of instruments (Figure 1C). Third, enucleation of the lower half of the myoma became easier and faster because the initial morcellation of the upper half of the myoma provides more space for maneuverability of instruments, similar to *in situ* morcellation¹⁴ (Figure 1D). Therefore, the SSMI technique could reduce surgical time and is an efficient alternative LM technique.

Another major concern regarding the efficacy of this technique concerns hemostasis. Myomas have a relatively hypovascular center but are surrounded by a rich perifibroid arterial plexus.¹⁹ Sinha et al.²⁰ reported that in their study of enucleation by morcellation of myomata while still attached to the uterus, the SMI group had a mean blood loss of 284 ± 229 mL vs. 219 ± 111 mL in the conventional LM group. In another SMI study by Torng et al.,¹⁵ the mean blood loss of the SMI group was 138 ± 172 mL vs. 93 ± 82 mL in the conventional LM group ($p < 0.001$). Both studies documented higher blood loss in the SMI group when compared to the conventional group. Less blood loss with the SSMI technique in our study may be attributed to four factors: (1) the lower half of myoma is smaller in size after the SSMI procedure, providing more space for maneuverability of instruments similar to *in situ* morcellation,¹⁴ which may help to coagulate the feeding vessels of myomata attachments to the myometrium during enucleation (Figure 1B and C); (2) repeated repositioning of the screw is not required during

Table 1
Demographic data and surgical variables in semisimultaneous morcellation *in situ* and conventional laparoscopic myomectomy.

Basic data	SSMI group n = 54	Control group n = 68	p	95% confidence interval
Age (y)	39.20 ± 6.02	40.12 ± 7.36	0.463 ^a	−0.914 (−3.370–1.542)
BMI (kg/m ²)	23.97 ± 2.26	24.07 ± 1.94	0.808 ^a	0.381 (−0.847–0.662)
Myoma number	1.83 ± 1.06	2.09 ± 1.52	0.298 ^a	−0.255 (−0.738–0.228)
Maximum diameter (cm)	6.53 ± 2.43	6.22 ± 1.96	0.439 ^b	0.309 (−0.479–1.097)
History of abdominal surgery	11 (20.4)	17 (25)	0.546 ^b	0.859 (0.516–1.431)
Location of myoma				
Anterofundal	33 (61.1)	38 (55.9)	0.561 ^b	1.129 (0.747–1.705)
Posterior	21 (38.8)	30 (44.1)	0.561 ^b	0.886 (0.587–1.338)

Data are presented as n (%) or mean ± standard deviation.

*p < 0.05 is statistically significant.

CI = confidence interval; SSMI = semisimultaneous morcellation *in situ*.

^a t-test: mean difference; mean difference (95% CI).

^b Chi-square test or Fisher's exact test: relative risk (95% CI).

Table 2
Comparison of surgical results between semisimultaneous morcellation *in situ* and conventional laparoscopic myomectomy.

Basic data	SSMI group n = 54	Control group n = 68	p	95% confidence interval
Myoma weight (g)	160.83 ± 156.23	159.87 ± 148.33	0.972 ^a	0.966 (−53.844–55.776)
Surgical time (min)	163.15 ± 46.82	189.41 ± 56.69	0.007 ^{a,*}	−26.264 (−45.235–7.293)
Blood loss (mL)	177.78 ± 147.40	202.94 ± 185.07	0.417 ^a	−25.163 (−86.325–35.998)
CWV drain removed (d)	2.30 ± 0.57	2.28 ± 0.75	0.891 ^a	0.017 (−0.227–0.261)
Total meperidine HCl dose (mg)	69.63 ± 31.26	70.00 ± 22.26	0.939 ^a	−0.370 (−9.975–9.234)
Flatus (d)	1.26 ± 0.55	1.19 ± 0.39	0.432 ^a	0.068 (−0.103–0.239)
Hospital stay (d)	4.35 ± 0.61	4.32 ± 0.96	0.852 ^a	0.028 (−0.272–0.329)
Blood transfusion	3 (5.6)	8 (11.8)	0.343 ^b	0.594 (0.221–1.591)
Penetration of the endometrium	1 (1.9)	2(2.9%)	1.000	0.623 (0.055–7.055)

Data are presented as n (%) or mean ± standard deviation.

*p < 0.05 is statistically significant.

CWV = closed wound vacuum reservoir; SSMI = semisimultaneous morcellation *in situ*.

^a t-test: mean difference; mean difference (95% confidence interval).

^b Chi-square test or Fisher's exact test: relative risk (95% confidence interval).

Table 3
Correlation of laparoscopic myomectomy surgical procedure, body mass index, history of previous surgery, and myoma character with surgical time (minutes) after multiple regression.

Factors	Regression coefficient	Standard error	p
SSMI	−25.102	8.358	0.003*
BMI	2.252	1.522	0.142
Posterior location	5.057	4.345	0.247
Myoma number	2.621	3.168	0.410
Myoma weight	0.172	0.028	<0.001*

*p < 0.05 is statistically significant.

BMI = body mass index; SSMI = semisimultaneous morcellation *in situ*.

SSMI, reducing unnecessary bleeding and extra time spent controlling bleeding caused by the screws; (3) rapid homeostasis with immediate suture reapproximation of the myometrium before performing morcellation evacuation of the enucleated lower half of the myoma (Figure 1E); and (4) the SSMI technique further shortened the surgical time; this alone could decrease bleeding time.

Table 4
Complications.

Complications	SSMI group n = 54	Control group n = 68	p	RR (95% CI)
Total cases	4 (7.4)	9 (13.2)	0.300 ^a	0.671 (0.289–1.555)
Postop anemia	3 (5.5)	8 (11.8)		
Uterine hematoma	0	1 (1.5)		
Ileus	1 (1.8)	0		
Intestinal serosal tear	1 (1.8)	0		

Data are presented as n (%).

*p < 0.05 is statistically significant.

CI = confidence interval; RR = relative risk; SSMI = semisimultaneous morcellation *in situ*.

^a Chi-square test or Fisher's exact test: relative risk (95% CI).

Our experience has been encouraging. The mean blood loss was lower in the SSMI group compared to the conventional group.

This SSMI technique compares very favorably with the conventional technique with regard to endometrial penetration. In SMI, one other problem that could arise is in the case of large or deep intramural myomas extending down to the endometrium.²¹ The traction force exerted by the morcellator could cause the endometrium to be pulled up along with the myoma, and this could result in the inadvertent morcellation of the endometrium along with the myoma.^{14,15} However, in our modified procedure (SSMI), the endometrium can easily be distinguished from the residual myoma. When the endometrium is pulled, it can be separated from the myoma. The meticulous dissection of the myoma base using the SSMI technique provides safe anatomic exposure, which will help to easily distinguish endometrium from the residual myoma and avoid inadvertent morcellation of the endometrium.

There were four cases (7.4%) of complication in the SSMI group and nine cases (13.2%) in the conventional group with p = 0.300. The complication rate of SSMI in this study, including one postoperative ileus that required additional hospitalization days without surgical

intervention and three episodes of intraoperative bleeding (ranging from 500 mL to 900 mL) that required blood transfusion, was similar to other LM studies.^{15,22} However, because SSMI appeared to be much easier, especially when larger or multiple myomas were encountered, further LM without using SSMI seems impractical. Our result reported a 26-minute surgical time difference in favor of SSMI compared with conventional LM. Although the rate of conversion to laparotomy in LM has been reportedly as high as 28% in other studies,²³ all patients were successfully treated with LM in our current study. Possible explanations for this difference include the selection of the patients and experiences of the physicians. This confounding factor of patient selection for laparoscopic myomectomy could be accommodated by regression analysis to incorporate all factors, such as total myoma weight, number of myomas surgically treated, and BMI. Therefore, our results agree with most other reports that SSMI is a safe procedure for LM and the advantage of SSMI is more apparent for the larger myoma.

This study methodology has limitations. The SSMI technique was introduced in the last year of the surgery, and the analysis of its superiority was performed at the end of the surgeon's learning curve. Still, the experienced surgeon had completed >300 cases of LM before the study. Because this study is a cohort study, random classification of cases was not performed.

In conclusion, this study suggests that the SSMI surgical technique could shorten surgical time. The estimated blood loss is similar as compared with the conventional LM. Therefore, SSMI is a safe and efficient alternative LM technique for symptomatic myomas.

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