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Original Article

Robotic myomectomy for large uterine myomas

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ABSTRACT

Objective: To evaluate surgical outcomes and feasibility of robotic myomectomy in large uterine myomas.
Materials and methods: This is a retrospective study for robotic myomectomies performed from October 2012 to August 2017 by a single surgeon in a tertiary care referral hospital. Demographics, diagnosis, perioperative variables, operative outcomes and complications were recorded. Large uterine myoma was defined as the estimated diameter of dominant myoma equal to or larger than 10 cm by sonography.
Results: Seventy-four patients were included and 32 (43.2%) patients had large uterine myoma. Patients with myoma larger than 10 cm showed significantly heavier myoma weight (446.5 ± 206.2 mg vs. 288.1 ± 147.5, $p < 0.001$), similar blood loss (309.4 ± 190.3 mL vs. 200.9 ± 285.9 mL, $p = 0.06$), and longer operative time (263.4 ± 83.7 min vs. 219.1 ± 75.7 min, $p = 0.02$) compared with patients with myoma <10 cm. The largest myoma removed was 20 cm in diameter. Perioperative complications were rare.
Conclusion: Robotic myomectomy is feasible for managing large uterine myomas. It is a safe procedure with acceptable longer operative time.

Introduction

Uterine myoma is the most common benign tumor in women. Patients with uterine myoma may suffer from abnormal bleeding, pelvic pain, bulky symptoms and obstetric complications [1]. There are various treatment options to myoma, including medical managements, surgical interventions such as hysteroscopic resection, myomectomy or hysterectomy and less invasive techniques such as magnetic resonance-guided high-intensity focused ultrasound [2]. Among these methods, myomectomy remains the gold-standard for women who need to preserve their uterus. During the advancement of minimally invasive surgical techniques, robotic-assisted technique overcomes most of the technical challenges of laparoscopy, and brings the benefits of less blood loss, length of hospital stay and conversion to open surgery [3,4].

Patients with large myoma are more likely to suffer from intraoperative complications, such as more blood loss resulting with the need of blood transfusion. On these difficult cases, minimally invasive surgeries, such as laparoscopic surgeries and robotic surgeries, have been proved as safe as traditional surgery with low complication rates [5]. Robotic technique provides many additional benefits compared to laparoscopic technique. Several studies have compared robotic myomectomy (RM) to laparoscopic myomectomy (LM) and reported that although RM requires longer operative time, it brings less intraoperative blood loss, shorter hospital stay, and less postoperative abdominal drainage [2,6–8]. However, the specific advantage of RM on large myoma has not been well studied. In addition, surgeons who begin their practice of RM may find the orientation between large myoma and other pelvic structures difficult to be handled and may require longer learning curve [9]. Surgeons may need to face extra stressful condition as patients need to afford higher cost for robotic system comparing to laparotomic surgery [10]. These factors would weaken surgeons' ambition to perform RM on difficult cases. Since robotic surgery has been widely used worldwide, we would like to explore the feasibility and safety of performing RM in large myomas. In this study, we report our initial experience and surgical outcomes in performing RM for large myomas.

Materials and methods

We retrospectively enrolled 74 patients who received RM in a single institute by a single experienced laparoscopic surgeon

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between October 2012, our first case, to August 2017. Inform consent was obtained from the ethical committees of National Taiwan University Hospital. Medical records were reviewed for demographic data, including age, body mass index (BMI), sexual experience, parity and history of prior abdominal or pelvic surgeries. The major symptom caused by myoma was recorded. Operative outcomes, including operative time, number, size and collected weight of the removed myomas, estimated blood loss (EBL), concomitant surgery, presence of pelvic adhesion and length of hospital stay were reviewed. The operative time was calculated from the first skin incision to the end of skin wound closure. The size of myoma was determined by transabdominal or transvaginal sonography prior to the surgery. Large myoma was defined as those diameter equal to or greater than 10 cm.

Surgical techniques

All patients received general anesthesia under lithotomy position. Valtchev uterine mobilizer (CONKIN, Canada) was placed vaginally in all cases except patients who denied having sexual debut. Veress needle (UNIMAX Taipei, Taiwan) for insufflation was placed in the umbilicus or at 2–5 cm above the umbilicus depends on the size of the uterus. A 12 mm or 8 mm incision was made over the umbilicus through which the operative camera was placed after insufflation. The patient was then shifted to Trendelenburg position. Two to three 8 mm assistant ports (depending on the location and size of the myomas) and one 12 mm assistant port were inserted on right and left upper abdomen under laparoscopic inspection respectively, then the da Vinci Si or the Xi surgical system (Intuitive Surgical Inc., USA) was docked. The location and size of myomas were carefully inspected. Diluted vasopressin was injected into the myoma bed for vasoconstriction and subsequently minimized the blood loss during surgery. After dissecting by bipolar and monopolar cutting device, the myoma was enucleated from the uterus by assistant tenaculum applied from the assistant port. The uterine wound was closed either with 1-0 V-Loc (Covidien, USA) or with 2-0 monocryl (Ethicon Endo-Surgery Inc., USA) for at least 2 layers. After closure of the hysterotomy, Seprafilm (Sanofi-aventis, USA) was applied in all cases as an adhesive barrier. The resected myomas were removed by mechanical morcellation (Gynecare, Ethicon, Inc., USA) either by in-situ method [11] or after enucleation. However, since April, 2014, we abandoned mechanical morcellation according to FDA's recommendation. We then extended the umbilical wound to 2 cm and applied Alexis wound retractor (Applied Medical, USA). The resected myomas were grasped to this umbilical wound and removed after shaving to long stripes by scalpel. The abdominal incision wounds were closed by 3-0 vicryl (Ethicon Endo-Surgery Inc., USA).

Outcome assessments

Surgical complications, including laparoconversion, excessive blood lost (defined as EBL greater than 500 mL), the requirement of blood transfusion, pelvic organ injury, acute urinary retention, abnormal wound healing, and subsequent exploratory laparotomy were recorded if presence. Patients were discharged under uneventful postoperative recovery. All patients were appointed to the outpatient department 7–10 days after surgery to evaluate postoperative recovery and the wound status.

Statistical analysis

Data were analyzed by SPSS version 22.0. Continuous variables were reported as mean and standard deviation, and discrete variables are reported as percentages of the total. Comparisons of continuous variables across study were analyzed by an independent sample t-test, and discrete variables between groups were compared by a chi-squared test or Fisher's exact test. The square of correlation coefficient, R-value, was presented. A two-tailed p-value less than 0.05 was considered statistically significant.

Results

Seventy-four patients were included and analyzed. The average age was 38.7 years old and BMI was 21.8 kg/m^2. Patients were divided into two groups according to the size of the dominant myoma removed. Forty-two (56.8%) patients had myoma smaller than 10 cm, and 32 (43.2%) patients had myoma equal to or larger than 10 cm. There were no significant differences in age, BMI, percentage of patient without sexual experience or parity, and symptoms between the two groups of patients. Patients with large myoma did not have significantly more symptoms (Table 1). Patients with small myoma had a slightly higher rate, though without statistical significance, of previous abdominal or pelvic surgery, including adnexa surgery, myomectomy, Cesarean section, appendectomy or cholecystectomy. Six patients with small myoma and 3 patients with large myoma had histories of previous myomectomy or LM.

Among all patients, 9.0 ± 2.9 myomas were removed during the surgery. The mean size of myoma was 9.2 ± 2.8 cm, and the mean weight was 327.9 ± 206.8 g. In the group of patients with large myoma, the collected weight of all resected myomas and the operative time were significantly greater and longer. Most of the resected myomas were intramural or subserosal type. There was no difference in the number of myoma removed, location of the myoma, rate of concomitant surgery, pelvic adhesion and EBL during operation between the two groups of patients (Table 2). The most common concomitant surgery performed was oopherocystectomy for endometrioma. Seven patients with small myoma and 3 patients with large myoma received either unilateral or bilateral oopherocystectomy. No significant additional blood loss or operative time was caused by concomitant surgery or adhesiolysis. There were no differences in complication rates and days of hospital stay between the two groups of patients.

The largest myoma removed was 20 cm in diameter. It was an intramural myoma located over anterior uterine wall. In this case, the intraoperative blood loss was 700 mL and the operative time was 286 min. The second largest myoma removed was 18 cm in diameter. In this case, five myoma were resected and the total myoma weight was 1250 g, which was the heaviest among all cases. The intraoperative blood loss was only 100 mL, but the operative time was 420 min.

All these cases were further divided into two periods of operation performed before and after April, 2014. The clinical characteristics and surgical outcome between these two groups of patients were compared. Patients who received operation after April, 2014 had significantly larger myoma (9.3 ± 2.9 versus 7.9 ± 2.3 cm, $p = 0.04$) and shorter operative time (225.0 ± 82.7 versus 273.9 ± 68.9 min, $p = 0.01$) compared with patients who received operation before April, 2014. But, there were no differences in number of myoma, myoma weight and EBL between these two periods of operation (Table 3).

Discussion

Our study shows the feasibility of RM in large uterine myomas. With the assistance of robotic technique, patients with myoma greater than 10 cm had similar blood loss and low complication as those whose myoma was less than 10 cm, although it took more operative time.

Table 1
Characteristics of patients with dominant myoma <10 versus ≥10 cm.

	<10 cm (n = 42)	≥10 cm (n = 32)	*p*
Age, y, range	39.9 ± 7.3, 16–51	37.1 ± 5.2, 28–48	0.06
BMI, kg/m^2, range	21.9 ± 2.9, 16.3–28.6	21.7 ± 2.4, 18.3–27.3	0.82
No sexual debut, n (%)	13 (30.9)	11 (34.4)	0.47
Without parity, n (%)	32 (80)	29 (90.6)	0.33
Previous abdominal or pelvic surgery (%)	13 (30.9)	5 (15.6)	0.11
Symptoms, n (%)			0.07
Abnormal uterine bleeding	19 (45.2)	13 (40.6)	0.29
Palpated mass	6 (14.3)	1 (3.1)	0.10
Urinary frequency	3 (7.1)	6 (18.8)	0.13
Dysmenorrhea	3 (7.1)	3 (9.4)	0.53
Abdominal fullness or pain	1 (2.4)	4 (12.5)	0.11
No symptoms	8 (19)	5 (15.6)	0.47

Data were shown as mean ± SD, range or n (%).

Gobern et al. compared three different surgical methods of myomectomy and reported that most myomas larger than 10 cm were removed transabdominally rather than laparoscopic or robotic surgery in their hospital [8]. Besides, the average size of the removed myomas was smaller in RM compared with LM [8]. This suggests that surgeons were not confident enough during their performance of RM for large myomas. Vanni et al. published the first study reporting using RM in large myoma, which was defined as myoma size greater than 6 cm. They reported 10 cases with low blood loss and short hospital stay [12]. In addition to myoma size, the location and number of myoma are also important parameters determining the complexity of surgery and the selection of suitable surgical tools for the best preservation of fertility. Cheng et al. analyzed 21 cases of RM with either multiple myomas (>2), large myoma (≥8 cm) or pelvic adhesions. They showed no laparoconversion but one case (4.8%) was complicated with focal wound erythema [13]. The reported average size of myoma was 7.3 cm, and the average EBW as 235.7 mL [13]. In a more recent study, Gunnala et al. analyzed 207 patients with RM and divided them into 2 groups according to size of the predominant myoma (≥9 cm or < 9 cm). Disappointedly, they found patients with large myoma suffered from significantly more blood loss compared with small myoma (100 versus 25 mL) [14]. In our study, we defined myoma equal to or larger than 10 cm as large myoma, which was larger than the studies mentioned above. We found RM in large myoma has similar blood loss and low complication rates as in small myoma, although it took extra 44.3 min of operative time in average. To our knowledge, this is the first study recognizing the ability in limiting blood loss of RM in large myoma.

In our study, three patients with large myoma and one patient with small myoma had excessive blood lost (more than 500 mL). Various techniques reported to reduce blood loss during myomectomy, such as identification and preservation of pseudocapsule of myoma [15], subserosal injection with diluted vasopressin [16], and intravascular oxytocin injection [17] were routinely used in our RM procedures. Among the 3 patients with large myoma, one patient had a submucosal myoma and two patients had intramural myoma that were located closely to endometrial cavity and required deep enucleation. The other patient with small myomas had uterus that was almost totally occupied by 10 intramural myomas. The smallest one removed was 4 cm in diameter. She was complicated with 1800 mL of blood loss, which was the greatest amount of bleeding among all cases. Multiple and deep myometrium incisions resulted to this massive blood loss. Temporal uterine arterial occlusion [18] was performed in 2 of our cases with small myoma but not in this case. Uterine arterial identification and occlusion is relatively difficult for large myoma. We found no much difference in decreasing blood loss and influencing of operative time in our study probably due to limited number of cases used.

After April, 2014, mechanical morcellation was officially forbidden in our hospital due to FDA's recommendation. We shaved the large myomas to long stripes by scalpel after grasping it

Table 2
Operative outcome by myoma <10 cm versus ≥ 10 cm.

	<10 cm (n = 42)	≥10 cm (n = 32)	*P*
Diameter of dominant myoma, cm, range	7.2 ± 1.7, 4.3–9	11.3 ± 2.3, 10–20	<0.001
Number of myoma, range	3.6 ± 3.3, 1–12	3.6 ± 3.1, 1–12	1.0
Myoma weight, g, range	288.1 ± 147.5, 50–540	446.5 ± 206.2, 175–1250	<0.001
Types, n (%):			0.74
Subserosal	8 (19)	6 (18.8)	0.61
Intramural	27 (64.3)	22 (68.8)	0.44
Submucosal	4 (9.5)	1 (3.1)	0.28
Intraligamentous	2 (4.8)	2 (6.3)	0.58
Operative time, minute, range	219.1 ± 75.7, 82–420	263.4 ± 83.7, 155–521	0.02
Locations, n (%):			0.77
Anterior wall	11 (26.2)	8 (25)	0.56
Posterior wall	18 (42.9)	11 (34.4)	0.31
Fundal wall	10 (23.8)	8 (25)	0.56
Lateral wall	1 (2.4)	2 (6.4)	0.40
Intraligamentous	2 (4.8)	3 (9.4)	0.37
Concomitant surgery, n (%)	6 (14.3)	3 (9.4)	0.40
Pelvic adhesion, n (%)	11 (26.2)	3 (9.4)	0.06
Estimated blood loss, mL, range	200.9 ± 285.9, 20–1800	309.4 ± 190.3, 50–800	0.06
Complications, n (%)			0.20
Laparoconversion	0	0	
Pelvic organ injury	0	0	
Excessive blood lost (>500 mL)	1 (2.4)	3 (9.4)	0.21
Blood transfusion	2 (4.8)	2 (6.4)	0.58
Acute urinary retention	1 (2.4)	2 (6.4)	0.40
Wound dehiscence	0	0	
Subsequent laparotomy	0	0	
Delay of discharge	0	0	

Data were shown as mean ± SD, range or n (%).

Table 3
Myoma characteristics and operative outcome by surgical period.

	Before April, 2014 (n = 20)	After April, 2014 (n = 54)	*P*
Diameter of dominant myoma, cm, range	7.9 ± 2.3, 4.8–12	9.3 ± 2.9, 4.3–20	0.04
Number of myoma, range	3.5 ± 3.1, 1–12	3.5 ± 3.3, 1–15	0.46
Myoma weight, g, range	275.2 ± 172.8, 21–620	346.2 ± 215.8, 50–1250	0.17
Operative time, minute, range	273.9 ± 68.9, 174–380	225.0 ± 82.7, 82–521	0.01
Estimated blood loss, mL, range	183.0 ± 161.1, 20–500	271.9 ± 277.3, 20–1800	0.09

Data were shown as mean ± SD, range.

to the extended umbilical wound and then removed it. During the whole procedure, the myoma was grabbed by towel clips and leaved no fragments or pieces into the abdominal cavity until being removed completely. We found this method safe and equally effective as mechanical morcellation. When we compared patients according to period of operation cutting at April, 2014 when morecellation was no longer used, we found larger dominant myoma removed and shorter operative time than before (Table 3). In our previous study, we found a significant reducing of operative time by using simultaneous morcellation *in situ* during laparoscopic myomectomy [11]. Without morcellation *in situ*, enucleation of large myomas could be difficult due to space limitation as compare to small myomas. Yet, we have less operative time despite of larger myoma removed after 2014 when morceallation was no longer used. Learning curve could be a more likely reason to explain such improvement.

Nearly half of our patients (48.6%, 36/74) denied sexual debut and uterine manipulators were not used in these cases. The myoma size of these patients was similar to those who had sexual experience. There is no differences on the average operative time (249.9 ± 96.6 versus 232.6 ± 74.0 min) and blood loss (226.7 ± 187.9 versus 258.0 ± 280.6 mLs) between these patients. Therefore, we did not find uterine manipulator necessary in the RM procedures. In LM, surgical steps such as myometrium suture and application of adhesion barrier after myoma enucleation are very much uterine manipulators dependent. However, the EndoWrist instrument (Intuitive Surgical Inc., USA) enables surgeons to perform such works even when there is no uterine manipulator to move the uterus slightly or to offer a countertraction. On the other hand, more than half of our patients (39/74, 52.7%) had myoma located within posterior uterine wall and some even located near cervix, which was challenging for surgeons to perform suture, yet was overcome by using EndoWrist instrument. This fact again highlights the technical advantage of EndoWrist instrument in robotic surgery.

Pitter et al. presented the largest series on pregnancy rate and pregnancy outcome after RM [19]. Totally, 872 women with mean age of 34.8 years received RM in this study. The mean number of myomas removed was 3.9 and the mean size of myoma was 7.5 cm. One hundred and seven (12.3%) women were subsequently pregnant within 12.9 months after surgery and 92 deliveries was reported. For our patients, follow-ups is ongoing and the pregnancy outcome is now under calculating. However, our patients were elder and most of them expressed no will to conceive.

There are several limitations in our study. First is its retrospective nature. Some variables could not be analyzed due to lack of information. Some clinical information were not recorded in some patients. Second, this study was performed during a time span of 5 years, which included the surgeon's learning curve and modification of surgical techniques. Third, since clinical follow up is ongoing, recurrence of myoma and fertility rate after operation were not yet been studied. The elder age and higher percentage of unmarriage of our patients may lower the pregnancy rate in further study.

Conclusion

Robotic myomectomy is feasible for managing large uterine myoma, such as those larger than 10 cm in diameter. It is a safe procedure with low complication rate, acceptable blood loss and takes a reasonable longer operative time. Uterine manipulator is not necessary in this procedure, especially in patients who had no sexual debut.

Conflict of interest

The authors have no conflicts of interest relevant to this article.

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