

## Original Article

# Complex cases of total laparoscopic hysterectomy: a 140-case series

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**Abstract:** Objective: To investigate the feasibility of total laparoscopic hysterectomy (TLH) for complex cases such as a large uterus, cervical myoma, broad-ligament myoma, and severe pelvic adhesion, which remains controversial. Methods: In this study, 140 complex cases of TLH (study group), 150 complex cases of hysterectomy via laparotomy (control group 1), and 126 routine cases of TLH (control group 2) were included. In the study group, preoperative pelvic magnetic resonance imaging (MRI) examination was performed for full assessment. The intraoperative procedures performed included upshifting the abdominal puncture point, freeing the ureters, filling the bladder, rectal finger examination to identify and separate adhesions, and resection via the vaginal approach. The three groups were observed for surgical complications, operating time, intraoperative blood loss, and postoperative recovery. Results: TLH was successfully completed in the study group. Intraoperative blood loss was significantly lower in the study group than in control group 1 ( $P < 0.05$ ). Postoperative exhaust time and hospital stay were significantly shorter in the study group than in control group 1 ( $P < 0.05$ ). The decrease in hemoglobin level was significantly greater in the study group than in control group 1 ( $P < 0.05$ ). No significant difference in the incidence of postoperative complications was observed between the study group and control group 1 ( $P > 0.05$ ). Conclusions: TLH was feasible and safe, and can be used as the preferred surgical method. Adequate preoperative evaluation, experienced surgeons, and advanced endoscopic devices are keys to the guaranteed success of TLH.

**Keywords:** Laparoscopy, complex total hysterectomy, large uterus

## Introduction

In China, nearly one million cases of total hysterectomy are documented each year. Total laparoscopic hysterectomy (TLH) has rapidly gained popularity as one of the most commonly used hysterectomies within less than 30 years [1-4]. It has advantages such as small surgical wound, quicker recovery, no need for abdominal incision [5-7], and lower incidence of deep vein thrombosis [8]. However, for complex cases such as a large uterus (uterine weight of  $> 280$  g or at a gestational period of  $\geq 12$  weeks), cervical myoma, broad-ligament myoma, and severe pelvic adhesion, TLH is difficult to perform or associated with intraoperative complications. In these cases, TLH needs to be converted to laparotomy [9, 10]. Nowadays, minimal incision and "delicate and precise dissection" [11] have become increasingly pre-

ferred. Thus, whether TLH can be performed safely for the aforementioned complex cases is worthy of further research and investigation by clinicians. Previous studies [12-18] found that in hysterectomy for complex cases such as a large uterus, the application of laparoscopy can reduce intraoperative bleeding and postoperative pain, and shorten hospital stay.

The degree of difficulty, combined pathological factors, and surgeon experience are the determining factors of surgical success [12]. We retrospectively analyzed the clinical data of patients who underwent TLH performed by two experienced surgeons with high surgical volume in the last 3 years [19]. The patients underwent preoperative pelvic magnetic resonance imaging (MRI) examination [20] for full assessment. The intraoperative operations performed with TLH included upshifting the abdominal

puncture point [21, 22], freeing the ureters, filling the bladder, rectal finger examination to identify and separate adhesions, and resection via the vaginal approach [14, 23], with satisfactory outcomes. This study compared between TLH and hysterectomy via laparotomy for complex cases, and between complex and routine TLH cases. The objective was to investigate the safety and feasibility of TLH for complex cases and share the operative experience in these cases with other surgeons.

### Materials and methods

#### *Subjects*

From January 2012 to February 2015, 140 complex cases of TLH in the First Affiliated Hospital of Soochow University were performed. The patients were 39 to 58 years old. The study group included the following subgroups: the large uterus subgroup, 49 cases (uterine weight of 280-2000 g/uterus or at a gestational period of 12-22 weeks); the "huge broad-ligament myoma and cervical myoma" subgroup, 46 cases (myoma diameter of > 5 cm); the pelvic adhesion subgroup, 25 cases (with history of cesarean delivery or severe endometriosis); and the other subgroup, 20 cases (with other coexisting complex factors). Control group 1 included 150 complex cases of TLH, with the patients' ages ranging from 45 to 61 years and uterine sizes ranging from 12 to 25 gestational weeks, or with one or more complex factors. Control group 2 included 126 cases of routine laparoscopic hysterectomy, with the patients' ages ranging from 45 to 65 years and uterine sizes < 12 gestational weeks. The purpose of setting up the second control group was to understand and compare the differences in the surgical time, intraoperative blood loss, hospital stay, postoperative complications, and hospital costs between difficult and general laparoscopic hysterectomy. This study was conducted in accordance with the declaration of Helsinki. This study was conducted with approval from the Ethics Committee of Soochow University. Written informed consent was obtained from all participants.

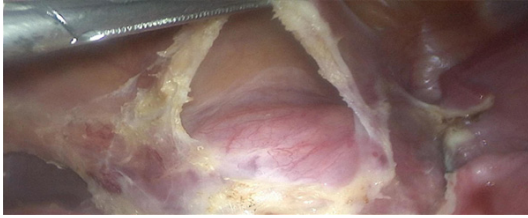
#### *Surgical procedures*

For the study group, the procedure was performed with the patient in the bladder lithotomy position. The hips were extended 10 cm from

the bed edge, and the lower limbs were fully extended outward. The appropriate uterus-lifting cup was selected. The puncture hole for laparoscope placement was made 5-6 cm above the fundus. For the patients who were at > 16 gestational weeks of their pregnancy, the midpoint of the navel and xiphoid line, also known as the Li-Huang point, was selected as the location for laparoscope placement. To obtain the best exposure of the surgical field, a 30° laparoscope was selected.

Vessels were treated as follows: If the vessels were too close to the uterine horn during the separation of the annex, which might easily result in bleeding, the vessels were slightly kept away from the uterine horn. The uterine artery and vein were freed and exposed slightly above the uterine isthmus. Then, a bipolar electrocoagulation probe (Shanghai Kangji Medical Devices Co., Ltd., Shanghai, China) was used to solidify the vessels and form a coagulation zone about 1.0 cm long. The end close to the pelvic wall was clamped with a plastic clip (Nanchang Guangshuo Medical Devices Co., Ltd., Nanchang, China). Then, an ultrasonic knife (Johnson & Johnson Medical Equipment Co., Ltd., Shanghai, China) was used to amputate the uterine artery and vein at the lateral side of the coagulation zone [24]. The ureters were pushed outward for processing the peri-uterine tissues close to the cervical side and for completing the TLH.

In huge broad-ligament myoma and cervical myoma, the myoma pushed the ureters between the lateral side of the myoma and the pelvic wall, and its blood supply still mainly came from the tumor pedicle attached to the uterine. Thus, TLH for such cases was performed as follows: The uterus-lifting cup was used to firmly push the uterus upward. Normally, the peritonea at the anterior and posterior lobes of the broad-ligament were opened after amputating the annex for the direct approach toward the myoma surface. Then, the capsules were separated and pushed away, closely attaching them to the myoma surface. At this time, the ureters were pushed open to expose their directions or to at least free the ureters. If necessary, retrograde ureteral catheterization was performed intraoperatively. In order to reduce bleeding, a diluted pituitrin solution was injected in the tumor pedicle. After that, the



**Figure 1.** There was no dense or only loose adhesion formed between the bladder and cervix.

uterine vessels were treated. TLH for cervical myomas was similar to that used in a transabdominal surgery. After coagulating and cutting the uterine artery and vein, the cervical myoma was eliminated, followed by hysterectomy. The endovascular blood vessel ends were coagulated through two-point coagulation, avoiding excessive coagulation, which can lead to rectal injury.

TLH for pelvic adhesion was performed as follows: When previous cesarean section resulted in adhesion between the bladder and lower-mid segments of the anterior uterine wall, a uterus-lifting cup was used to firmly push the uterus upward to cause tension to the adhesion. The bladder-cervix gap was gradually separated, and then the bladder was pushed downward, during which the anterior uterine wall should be attached as closely as possible to avoid damaging the bladder. Moreover, most cesarean sections result in adhesions mainly forming at the surgical scar (**Figure 1**), and no adhesion or only loose adhesion might form between the bladder and cervix. Therefore, separation of the bladder-cervix gap from the lateral vesical crypt was used as a breakthrough point so that the bladder could be separated from the cervix. Thereafter, the scar at the peritoneal reentry was cut to avoid damage and reduce bleeding. The uterus-rectum space was found at the adhesion of the posterior uterine wall, and then a sharp and blunt dissection was performed. For severe dense adhesions, an ultrasonic knife could slowly remove the uterine serosa at the adhesion site from up to bottom to avoid intestinal injury. In the presence of an ovarian chocolate cyst, the ovary would adhere to the lateral pelvic wall and rectum. Liquid would be absorbed clearly. Then, the ovary was lifted, and one suction head was used to absorb the liquid and simultaneously bluntly separate the adhesions between the ovary, pelvic wall, and

uterine. After the ovary was freed and returned to its normal condition, the dissection was performed according to the routine procedures.

After TLH, the intra-bag morcellation technique and “cut the apple” morcellation technique via the vagina approach were used to resect the tissue. In control groups 1 and 2, the operations were completed by using routine surgical methods.

### *Observation indexes*

The observation indexes included the general conditions of the patients (age, size of the uterus, and operation indications), estimated intraoperative blood loss, operating time (from cutting the skin to the completion of the incision suture), postoperative anal exhaust time, preoperative and postoperative decrease in hemoglobin level, mean length of hospital stay, surgical complications (intraoperative visceral injury, intraoperative bleeding, postoperative incision infection, vaginal stump polyps, organ prolapse, etc.), surgery and anesthesia costs, and total hospital cost. The observation indexes were based on the intraoperative and postoperative records in the Haitai electronic medical record system, preoperative and postoperative laboratory sheets, body temperature, and follow-up survey.

### *Statistical analyses*

All statistical analyses were performed by using the SPSS 17.0 software (SPSS Inc., Chicago, IL, USA). Data were presented as mean  $\pm$  SD. Comparisons between two groups were performed by using the *t* test, and quantitative data and rate comparisons were performed by using the  $\chi^2$  test. *P* values of  $< 0.05$  were considered statistically significant.

## **Results**

### *Overall treatment outcome*

Surgery was successfully completed in all the patients in the three groups, with a success rate of 100%. None of the patients in the study group and control group 2 was converted to laparotomy, and no serious intraoperative bleeding or serious ureter, bladder, or bowel injury occurred in the three groups.

**Table 1.** Comparison of intraoperative situations among the three groups

| Group     | Cases | Operation time (min) | Estimated blood loss (ml) |
|-----------|-------|----------------------|---------------------------|
| Study     | 140   | 129.42 ± 3.70        | 52.79 ± 4.20              |
| Control 1 | 150   | 106.54 ± 6.24        | 103.02 ± 21.83            |
| Control 2 | 126   | 110.34 ± 4.23        | 49.18 ± 13.87             |
| P1        |       | 0.0055               | 0.0173                    |
| P2        |       | 0.0042               | 0.6884                    |

Note: P1: Comparison between the study group and the control group 1; P2: Comparison between the study group and the control group 2.

**Table 2.** Comparison of postoperative anal exhaust time and hospital stay among the three groups

| Group     | Cases | Postoperative exhaust time (h) | Postoperative hospital stay (d) | Decreased hemoglobin amount (g/l) |
|-----------|-------|--------------------------------|---------------------------------|-----------------------------------|
| Study     | 140   | 20.12 ± 0.38                   | 4.12 ± 0.45                     | 11.01 ± 0.74                      |
| Control 1 | 150   | 30.21 ± 2.43                   | 6.52 ± 1.25                     | 15.87 ± 6.37                      |
| Control 2 | 126   | 19.43 ± 0.96                   | 3.97 ± 0.62                     | 10.14 ± 0.90                      |
| P1        |       | 0.0021                         | 0.0352                          | 0.0266                            |
| P2        |       | 0.3115                         | 0.8728                          | 0.2655                            |

Note: P1: Comparison between the study group and the control group 1; P2: Comparison between the study group and the control group 2.

#### Operation time and estimated intraoperative blood loss

The operation times in the study group, control group 1, and control group 2 were 129.42 ± 3.70, 106.54 ± 6.24, and 110.34 ± 4.23 min, respectively. The amounts of intraoperative blood loss in the three groups were 52.79 ± 4.20, 103.02 ± 21.83, and 49.18 ± 13.87 ml, respectively. Operation time was significantly longer in the study group than in control groups 1 and 2 ( $P_1=0.0055$ ,  $P_2=0.0042$ ). Intraoperative blood loss was significantly lower in the study group than in control group 1 ( $P_1=0.0173$ ), with no significant difference with control group 2 ( $P_2=0.6884$ ; **Table 1**).

#### Postoperative exhaust time, hospital stay, and decreased hemoglobin level

The postoperative exhaust times in the study group, control group 1, and control group 2 were 20.12 ± 0.38, 30.21 ± 2.43, and 19.43 ± 0.96 h, respectively. The lengths of hospital stay in the three groups were 4.12 ± 0.45, 6.52 ± 1.25, and 3.97 ± 0.62 days, respectively. The

decreased hemoglobin levels in the three groups were 11.01 ± 0.74, 15.87 ± 6.37, and 10.14 ± 0.90 g/l, respectively. Postoperative exhaust time and length of hospital stay were significantly shorter in the study group than in control group 1 (Postoperative exhaust time  $P_1=0.0021$ , length of hospital stay  $P_1=0.0352$ ). The decrease in hemoglobin level was significantly higher in the study group than in control group 1 ( $P_1=0.0266$ ). No significant differences in the above-mentioned indexes were found between the study group and control group 2 ( $P > 0.05$ ; **Table 2**).

#### Postoperative complications

In the study group, one patient had bleeding from the vaginal stump on postoperative days 9 and 13. One patient had hemorrhage from the vaginal stump on postoperative day 16. Therefore, uterine arterial embolization was performed under digital subtraction angiographic guidance, and the patient was discharged after the bleeding was stopped. One patient was found as having atypical endometrial hyperplasia in an intraoperative rapid pathological examination. The postoperative conventional pathological examination result suggested type I endometrial adenocarcinoma. Thus, the patient underwent an additional surgery after TLH.

In control group 1, two patients had wound fat liquefaction, with one having vaginal bleeding on postoperative day 9 and the other having postoperative high fever. In control group 2, one patient had vaginal fluid with fever on postoperative day 11 and another patient had vaginal bleeding 3 months after surgery. The incidence rate of postoperative complications in the study group was 2.85%. There was no significant difference between the study group and the control group ( $P_1=1$ ,  $P_2=0.9749$ , **Table 3**).

#### Hospital cost

**Table 4** shows that the study group had significantly higher hospital costs than control group 2 ( $P_2=0.0334$ ). This was mainly due to the prolonged operation time, which resulted in increased cost of anesthesia. The hospital costs in the study group and control group 2



# Total laparoscopic hysterectomy

**Table 3.** Comparison of postoperative complications among the three groups

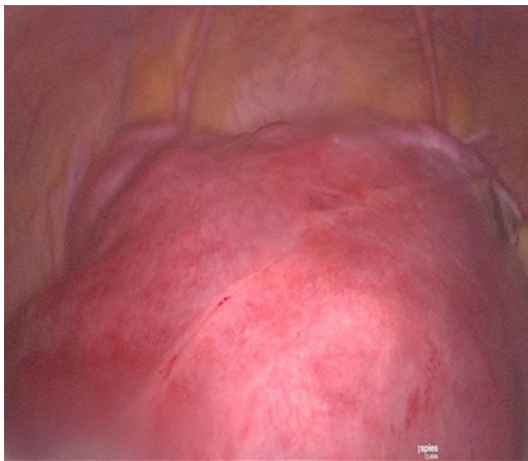
| Group     | Wound fat liquefaction | Bleeding from vaginal stump | Postoperative infection (fever) | Adjacent organ injury | Postoperative secondary surgery | Sum    |
|-----------|------------------------|-----------------------------|---------------------------------|-----------------------|---------------------------------|--------|
| Study     | 0                      | 3                           | 0                               | 0                     | 1                               | 4/140  |
| Control 1 | 2                      | 1                           | 1                               | 0                     | 0                               | 4/150  |
| Control 2 | 0                      | 1                           | 1                               | 0                     | 0                               | 2/126  |
| P1        |                        |                             |                                 |                       |                                 | 1      |
| P2        |                        |                             |                                 |                       |                                 | 0.9749 |

Note: P1: Comparison between the study group and the control group 1; P2: Comparison between the study group and the control group 2.

**Table 4.** Comparison of hospital costs (RMB)

| Group     | Hospital costs    | Cost of anesthesia | Operation cost   |
|-----------|-------------------|--------------------|------------------|
| Study     | 13504.23 ± 199.78 | 1139.53 ± 51.31    | 5816.62 ± 124.01 |
| Control 1 | 10590.32 ± 254.49 | 1003.57 ± 13.22    | 1996.48 ± 72.85  |
| Control 2 | 12743.80 ± 362.31 | 1032.66 ± 39.37    | 5393.84 ± 222.19 |
| P1        | < 0.0001          | 0.0113             | < 0.0001         |
| P2        | 0.0334            | 0.0458             | 0.0451           |

Note: P1: Comparison between the study group and the control group 1; P2: Comparison between the study group and the control group 2.



**Figure 2.** The uterus filled the pelvic cavity.

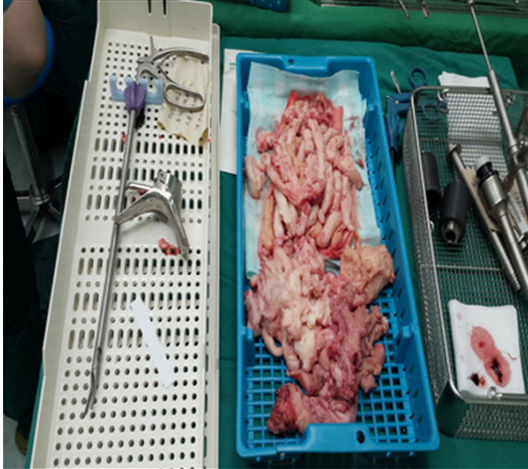
were significantly higher than those in control group 1 ( $P1 < 0.0001$ ). This was mainly due to the longer operation time required for TLH. In general, the difference in total hospital cost between the study group and control group 1 was less significant than the difference in surgery cost plus anesthesia cost between the two groups. This indicated that compared with control group 1, the study group had shorter time to hospital discharge, which could offset a portion of the surgery cost. The higher surgery cost in the study group was mainly caused by the use of many kinds of surgical instruments

and equipment, and other factors.

## Discussion

No precise unified summary has been reported about TLH in China and abroad. Combining all the literature, we generally think that situations previously observed as contraindications of hysterectomy such as a large uterus (uterus size at  $\geq 12$  gestational weeks or uterine weight of  $> 280$  g), histories of cesarean section and endometriosis caused by pelvic adhesion, huge broad-ligament myoma, and cervical myoma could be called complex cases of TLH. Since the clinical application of TLH, the proportion of hysterectomy cases in our hospital has gradually declined and experience with TLH has gradually accumulated. Even uteruses of about 20 gestational weeks in size could also be resected safely, with the largest uterus resected by TLH ever reported to date being 3000 g. In this study, two patients had large uteruses of 2000 and 1750 g, respectively (**Figures 2 and 3**). Histories of abdominal and pelvic surgeries and cesarean section, huge cervical myoma, or broad-ligament myoma are no longer the absolute contraindication of TLH, and the surgical success rate in these patients is close to 100%.

In this study, TLH was successfully completed in 140 cases in the study group, with a success rate of 100%, indicating that TLH is feasible. However, the procedure should be performed by physicians with experienced laparoscopic skills. The study groups showed less blood loss, less pain, and quicker postoperative recovery. Early postoperative exhaust time could facilitate patients' return to oral intake and postoperative recovery. The fact that in the study



**Figure 3.** One 1750 g-in-weight uterus sample.

group, the postoperative hospital stay was significantly shorter and the post-TLH complication rates were not increased confirms the feasibility and superiority of TLH, consistent with the results of the study by Amanda Grant-Orser and other studies [9, 12, 16, 25]. However, operation time was significantly longer in the study group than in control group 1, consistent with the result reported by Mebes et al [26] but contrary to that reported by Yavuzcan et al [9, 24, 27, 28]. This might be because these studies only included large uteruses, but the present study included various other difficult and complex factors that led to the prolonged operation time.

As for surgical cost, longer operation time, more-advanced surgical instruments, and greater equipment requirement would relatively result in higher surgical costs. However, it is worth noting that toward the whole society, the overall cost of medical practice includes not only calculable direct costs such as drugs, surgeries, laboratory tests, or beds but also indirect costs such as medical practice-related job losses. When evaluating the cost-effectiveness of TLH and total abdominal hysterectomy (TAH), it should be noted that although the direct medical cost of TLH was slightly higher than that of TAH, the length of hospital stay for TLH was shorter than that for TAH. In this study, the difference in total length of hospital stay between the TLH and TAH groups was less significant than the difference between the TLH and “TAH surgery plus anesthesia” groups, indicating that the time to postoperative discharge in the

TLH group was shorter, partially offsetting the cost of TLH and anesthesia. The patients in the TLH group exhibited quicker postoperative recovery and were more comfortable, and almost none of the patients complained of abdominal incision-related pain during the follow-up period. The patients could return to work more quickly and get the corresponding pay, which could also better offset the partial medical cost or all costs than the TAH group. We could consider TLH as safe, feasible, and economical when considering with many other factors such as society or work. Therefore, this surgical technique should be used as the preferred solution for hysterectomy [16, 29-32].

A previous study showed that the most important factor that leads to complications was lack of surgeon experience. In particular, when the intraoperative uterine vascular bleeding is severe, in panic, the surgeon tends to clamp massive tissue for coagulation, thus damaging the ureters. Vree et al [19] studied the impacts of surgeon surgical volume on the perioperative results of hysterectomy, dividing surgeons into three categories according to their average annual number of surgeries as follows: low surgical volume (< 11 cases/year), moderate surgical volume (11-50 cases/year), and high surgical volume (> 51 cases/year). Compared with the surgeons with moderate surgical volumes, the surgeons with high surgical volumes needed a shorter operation time and resulted in less amounts of estimated blood loss. The incidence of postoperative complications was negatively correlated with surgeon surgical volumes [33].

One main reason for the success of TLH in the study group was that the surgeries were completed by two chief physicians with experienced clinical skills (> 100 cases/year). To overcome the difficulties in TLH, a from-simple-to-difficult process is required. With gradual improvement in surgical skills, the amount of intraoperative blood loss could be reduced, even achieving a bloodless surgery [32].

Bipolar electrocoagulation has good hemostatic effects on vessels larger than 3 mm in diameter but easily results in the formation of carbonized eschar. Once eschar is formed, coagulation inside tissues would be incomplete and the effects of hemostasis would be imprecise. Furthermore, the head of the bipolar electroco-

agulation probe might easily adhere to the tissues, and the resulting tearing might easily lead to the falling off of the scab surface and rebleeding. The ultrasonic knife is a new medical device that combines functions such as separation, hemostasis, and internal cutting. It could reduce the frequent use of single and bipolar electrocoagulation probes, scissors, or other instruments toward the abdominal cavity, thus simplifying the surgical procedures and shortening the operation time. The effective temperature of the ultrasonic knife is 65-100°C; thus, its thermal damage to the surrounding tissues would be much less than that of the above-mentioned equipment. Furthermore, it does not cause eschar formation on the wound and does not produce smoke, thereby ensuring a clear operation field. However, the energy generated by an ultrasonic knife is small, so its hemostatic effects on coarse vessels are poor. Therefore, when treating thick blood vessels such as the uterine vessels, a bipolar electrocoagulation probe should be used, followed by cutting using an ultrasonic knife, which could reliably and completely establish hemostasis, shortening the operation time, reduce the incidence of complications, and attain good postoperative recovery.

Postoperative hemorrhage from the wound caused by laparotomy or secondary surgery is the main cause of failure of TLH. Paul et al [34] studied 1613 cases of TLH and found 21 cases with postoperative secondary bleeding. The overall cumulative incidence of secondary hemorrhage in TLH is 1.3%, and the mean interval time between hysterectomy and secondary hemorrhage is 13 days. Data showed that secondary hemorrhage was rare, but its incidence in TLH was slightly higher than its incidence in other hysterectomic approaches. This might be related to the application of heat because the excessive use of these thermal instruments could lead to the necrosis of more tissues, falling off of the scab, and acute bleeding. Considering the success rate in the study group, we have reason to believe that the application of plastic clips, in terms of coagulation, could effectively reduce secondary intra-abdominal bleeding after TLH and might prevent secondary damage to the ureters caused by excessive coagulation.

A previous report described a gynecological tumor that developed after laparoscopic hyster-

ectomy with morcellation (LHM) [35]. In the present study, one case of atypical endometrial hyperplasia was confirmed in the intraoperative rapid pathological examination. The postoperative conventional pathological examination result indicated type I endometrial adenocarcinoma. Ehdavand et al [36] retrieved LHM cases completed within 5 years. Among the 352 LHM cases studied, three had unexpected malignant tumors (incidence rate, 0.9%). Four cases of variant leiomyoma (1.1%) and five cases of benign non-smooth muscle tumor (1.4%) were diagnosed before LHM. Two cases of iatrogenic abdominal parasitic myoma was diagnosed postoperatively (0.6%). During the study period, 8.6% of malignant or atypical stromal tumors were diagnosed based on examination results of morcelled specimens. Furthermore, the presence of malignant or atypical tumors concealed inside the morcelled uterine specimens was clinically possible. The use of morcelled uterine specimens has a restricted role in obtaining a correct evaluation of the pathologies of malignant or atypical uterine tumors. Moreover, the morcellation process also confers the potential risks of tumor spread and peritoneal metastasis, even rare cases of iatrogenic parasitic myoma. However, applying the intra-bag morcellation technique and “cut the apple” morcellation technique via the vaginal approach to remove tissue can effectively reduce these risks [37, 38].

In conclusion, with continuous improvements of laparoscopic equipment and surgical instruments, TLH is feasible given that it is performed by surgeons with experienced laparoscopic skills. Furthermore, the success of the operation relies on innovative surgical techniques. However, the operation time in the study group was significantly prolonged, warranting the need for continuous research and investigation on strategies to shorten the operation time, reduce the bleeding amount, and lower the incidence of complications.

### Disclosure of conflict of interest

None.

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## References

- [1] Pitter MC, Simmonds C, Seshadri-Kreaden U and Hubert HB. The impact of different surgical modalities for hysterectomy on satisfaction and patient reported outcomes. *Interact J Med Res* 2014; 3: e11.
- [2] Washburn EE, Cohen SL, Manoucheri E, Zurawin RK and Einarsson JL. Trends in reported resident surgical experience in hysterectomy. *J Minim Invasive Gynecol* 2014; 21: 1067-1070.
- [3] Atallah D, El Kassis N, Moukarzel M, Ghaname W, Suidan J, Chalouhy C, Gadonneix P and Villet R. From the open approach to laparoscopy. Background, rationale, technique. *J Med Liban* 2013; 61: 55-60.
- [4] Turner LC, Shepherd JP, Wang L, Bunker CH and Lowder JL. Hysterectomy surgical trends: a more accurate depiction of the last decade? *Am J Obstet Gynecol* 2013; 208: 277, e1-e7.
- [5] Laberge PY and Singh SS. Surgical approach to hysterectomy: introducing the concept of technicity. *J Obstet Gynaecol Can* 2009; 31: 1050-1053.
- [6] Cheung V, Rosenthal DM, Morton M and Kadanka H. Total laparoscopic hysterectomy: a five year experience. *J Obstet Gynaecol Can* 2007; 29: 337-343.
- [7] Pather S, Loadsman JA, Mansfield C, Rao A, Arora V, Philp S and Carter J. Perioperative outcomes after total laparoscopic hysterectomy compared with fast-track open hysterectomy-a retrospective case-control study. *Aust N Z J Obstet Gynaecol* 2011; 51: 393-396.
- [8] Barber EL, Neubauer NL and Gossett DR. Risk of venous thromboembolism in abdominal versus minimally invasive hysterectomy for benign conditions. *Am J Obstet Gynecol* 2015; 212: 609, e1-7.
- [9] Yavuzcan A, Çağlar M, Ustün Y, Dilbaz S and Kumru S. Evaluation of the outcomes of laparoscopic hysterectomy for normal and enlarged uterus (> 280 g). *Arch Gynecol Obstet* 2014; 289: 831-837.
- [10] Smorgick N, Dalton VK, Patzkowsky KE, Hoffman MR, Advincula AP and As-Sanie S. Comparison of 2 minimally invasive routes for hysterectomy of large uteri. *Int J Gynecol Obstet* 2013; 122: 128-131.
- [11] Jiménez AM and Colomer AT. An update of anatomical references in total laparoscopic radical hysterectomy: from surgical anatomy to anatomical surgery. *J Minim Invasive Gynecol* 2008; 15: 4-10.
- [12] Grant-Orser A, El Sugy R and Singh SS. Does laparoscopy safely improve technicity for complex hysterectomy cases? *J Obstet Gynaecol Can* 2014; 36: 248-252.
- [13] Chiu LH, Chen CH, Tu PC, Chang CW, Yen YK and Liu WM. Comparison of robotic surgery and laparoscopy to perform total hysterectomy with pelvic adhesions or large uterus. *J Minim Access Surg* 2015; 11: 87-93.
- [14] Günthert AR, Christmann C, Kostov P and Mueller MD. Safe vaginal uterine morcellation following total laparoscopic hysterectomy. *Am J Obstet Gynecol* 2015; 212: 546, e1-e4.
- [15] Uccella S, Cromi A, Serati M, Casarin J, Sturla D and Ghezzi F. Laparoscopic hysterectomy in case of uteri weighing  $\geq 1$  kilogram: a series of 71 cases and review of the literature. *J Minim Invasive Gynecol* 2014; 21: 460-465.
- [16] Uccella S, Cromi A, Bogani G, Casarin J, Formenti G and Ghezzi F. Systematic implementation of laparoscopic hysterectomy independent of uterus size: clinical effect. *J Minim Invasive Gynecol* 2013; 20: 505-516.
- [17] Lete I. Hysterectomy for fibroids. *Med Clin (Barc)* 2013; 141: 13-16.
- [18] Alperin M, Kivnick S and Poon KY. Outpatient laparoscopic hysterectomy for large uteri. *J Minim Invasive Gynecol* 2012; 19: 689-694.
- [19] Vree FE, Cohen SL, Chavan N and Einarsson JL. The impact of surgeon volume on perioperative outcomes in hysterectomy. *JSLs* 2014; 18: 174-181.
- [20] Hatta K, Terai Y, Okuda K, Nakamura Y, Yoo S, Tanaka Y, Tsunetoh S, Hayashi A, Yamashita Y and Ohmichi M. Preoperative assessment by magnetic resonance imaging is useful for planning the treatment of an enlarged uterus by total laparoscopic hysterectomy. *J Obstet Gynaecol Res* 2013; 39: 814-819.
- [21] Lee YS. Benefits of high epigastric port placement for removing the very large uterus. *J Am Assoc Gynecol Laparosc* 2001; 8: 425-428.
- [22] Huang CY, Wu KY, Su H, Han CM, Wu PJ, Wang CJ, Lee CL and Yen CF. Accessibility and surgical outcomes of transumbilical single-port laparoscopy using straight instruments for hysterectomy in difficult conditions. *Taiwan J Obstet Gynecol* 2014; 53: 471-475.
- [23] Nevarez Bernal RA, Chaya Hajj M, Velázquez Magaña M, Vilchis Nava P and Buen-Abad EI. A technique for total laparoscopic hysterectomy with vaginal morcellation on large uteri in order to maintain minimal invasion. *Ginecol Obstet Mex* 2012; 80: 769-771.
- [24] Roman H, Zanati J, Friederich L, Resch B, Lena E and Marpeau L. Laparoscopic hysterectomy of large uteri with uterine Artery coagulation at its origin. *JSLs* 2008; 12: 25-29.
- [25] Twijnstra AR, Blikkendaal MD, van Zwet EW, van Kesteren PJ, de Kroon CD and Jansen FW. Predictors of successful surgical outcome in laparoscopic hysterectomy. *Obstet Gynaecol* 2012; 119: 700-708.



## Total laparoscopic hysterectomy

- [26] Mebes I, Diedrich K and Banz-Jansen C. Total laparoscopic hysterectomy without uterine manipulator at big uterus weight (> 280 g). *Arch Gynecol Obstet* 2012; 286: 131-134.
- [27] Seracchioli R, Venturoli S, Vianello F, Govoni F, Cantarelli M, Gualerzi B and Colombo FM. Total laparoscopic hysterectomy compared with abdominal hysterectomy in the presence of a large uterus. *J Am Assoc Gynecol Laparosc* 2002; 9: 333-338.
- [28] Hillis SD, Marchbanks PA and Peterson HB. Uterine size and risk of complications among women undergoing abdominal hysterectomy for leiomyomas. *Obstet Gynecol* 1996; 87: 539-543.
- [29] Fidias Noguera-Sánchez M, Briones-Garduño JC, Rabadán-Martínez CE, Antonio-Sánchez P, Bautista-Gómez EJ and Ceja-Sánchez JM. Laparoscopic hysterectomy as first-line procedure in the treatment of women with benign uterine pathology. *Ginecol Obstet Mex* 2013; 81: 448-453.
- [30] Bonilla DJ, Mains L, Whitaker R, Crawford B, Finan M and Magnus M. Uterine weight as a predictor of morbidity after a benign abdominal and total laparoscopic hysterectomy. *J Reprod Med* 2007; 52: 490-498.
- [31] O'Hanlan KA, McCutcheon SP and McCutcheon JG. Laparoscopic hysterectomy: impact of uterine size. *J Minim Invasive Gynecol* 2011; 18: 85-91.
- [32] Shahid A, Sankaran S and Odejinmi F. Laparoscopic subtotal hysterectomy for large uteri using modified five port technique. *Arch Gynecol Obstet* 2011; 283: 79-81.
- [33] Wallenstein MR, Ananth CV, Kim JH, Burke WM, Hershman DL, Lewin SN, Neugut AI, Lu YS, Herzog TJ and Wright JD. Effect of surgical volume on outcomes for laparoscopic hysterectomy for benign indications. *Obstet Gynecol* 2012; 119: 709-716.
- [34] Paul PG, Prathap T, Kaur H, Shabnam K, Kandhari D, Chopade G. Secondary hemorrhage after total laparoscopic hysterectomy. *JSLS* 2014; 18: e2014.00139.
- [35] Theben JU, Schellong AR, Altgassen C, Kelling K, Schneider S and Große-Drieling D. Unexpected malignancies after laparoscopic-assisted supracervical hysterectomies (LASH): an analysis of 1,584 LASH cases. *Arch Gynecol Obstet* 2013; 287: 455-462.
- [36] Ehdaivand S, Simon RA, Sung CJ, Steinhoff MM, Lawrence WD and Quddus MR. Incidental gynecologic neoplasms in morcellated uterine specimens: a case series with follow-up. *Hum Pathol* 2014; 45: 2311-2317.
- [37] Cohen SL, Einarsson JI, Wang KC, Brown D, Boruta D, Scheib SA, Fader AN and Shibley T. Contained power morcellation within an insufflated isolation bag. *Obstet Gynecol* 2014; 124: 491-497.
- [38] McKenna JB, Kanade T, Choi S, Tsai BP, Rosen DM, Cario GM and Chou D. The Sydney Contained in Bag Morcellation technique. *J Minim Invasive Gynecol* 2014; 21: 984-985.