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ORIGINAL RESEARCH

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Application of transumbilical paring and retrieving techniques in laparoscopic myomectomy

Wei Kong[1,*,†], Guangwu Xiong[2,†], Peng Guo[3], Xue Li[1], Li Shen[1], Li Yang[1], Huicheng Xu[1], Jingbo Wang[1]

[1]Guiqian International General Hospital, 550018 Guiyang, Guizhou, China
[2]Peking University International Hospital, 102206 Beijing, China
[3]Anshun City People's Hospital, 561099 Anshun, Guizhou, China

***Correspondence**
kongwei.cq@foxmail.com
(Wei Kong)

† These authors contributed equally.

Abstract

To investigate the safety and effectiveness of transumbilical paring and retrieving techniques (TPRT) in conventional laparoscopic surgery (CLS). From July 2020 to October 2021, TPRT, based on transumbilical laparoendoscopic single-site surgery (TU-LESS), was applied to 111 cases of conventional laparoscopic myomectomy. The operation procedures included routine conventional laparoscopic myomectomy and uterine suture, placement of the endoscopic bag, tumor bagging, umbilical incision, paring and retrieving the tumor, and repairing the umbilical incision. Under direct vision, the tumor in the specimen bag was removed by clamping, pulling and reducing through the umbilical incision. All operations were successfully completed. The average number of leiomyomas removed was 1.94 (range, 1–11), and the mean tumor weight was 155.45 g (range, 40–665 g). The mean total tumor removal time, from endoscopic bag placement to umbilical incision repair, was 12.60 min (range, 6–28 min). The mean visual analog scale (VAS) scores evaluated on postoperatively day 1 was 2.59 (range, 1–4). Most of the removed lesions were diagnosed as benign leiomyoma on postoperative pathology, and no malignancy was observed in any resected samples. All cases were followed up through outpatient visits or telephone, and the average follow-up time was 7.55 months (range, 1–16 months). The umbilical incisions healed without complications, and there were no complaints of umbilical discomfort.TPRT was found to be safe, time-saving, cost-efficient, and easy to perform and learn.

Keywords

Laparoscopy; Myomectomy; Umbilical incision; Leiomyoma; Transumbilical paring and retrieving techniques; Transumbilical laparoendoscopic single-site surgery

1. Introduction

Myomectomy is the first choice of surgical treatment for women of childbearing age who want to maintain fertility [1]. It can be performed *via* laparotomy, laparoscopy or transvaginally. In laparoscopic myomectomy, removal of the tumor from the abdominal cavity is a critical step. In transumbilical laparoendoscopic single-site surgery (TU-LESS) [2], the tumor can be quickly removed through an umbilical incision. In conventional laparoscopic surgery (CLS), the tumor can be removed through a small incision either in the abdominal wall or in the posterior wall of the vagina. However, the transvaginal method is risky due to complications such as retrograde infections and rectal injury.

Presently, most leiomyoma is removed through the abdomen puncture hole after segmentation with an electromechanical power morcellator [3, 4]. Nevertheless, clinical researchers [5, 6] have found two main issues with such morcellators. First, power morcellators can lead to insidious uterine sarcoma and affect the patients' survival outcomes after surgery. Second, they might cause leiomyomatosis peritonealis disseminata (LPD). To overcome these issues, the latest expert consensus [7, 8] and the U.S. Food and Drug Administration [9] recommend a standard tumor removal procedure requiring the combination of morcellators with special disposable endoscopic retriever bags to prevent tumor implantation and subsequent risks of metastasis. However, such procedures were shown to prolong the operation time by 20–30 min due to the additional time it takes to place the bag in the abdomen and the specimen in the bag [7]. In addition, the tumor bag is relatively expensive and not easy to be widely used, and the use of morcellators in the abdominal cavity might trigger some other complications [10].

As an attempt to improve operational efficiency whilst abiding by the tumor-free technique principle in CLS, we devised a methodology to improve leiomyoma removal by combining the transumbilical laparoendoscopic single-site surgery (TU-LESS) and vaginal "Pare Apple" tumor extraction techniques [11], and called it the Transumbilical Paring and Retrieving Technique (TPRT).

Thus, the aim of this present study was to determine the safety and feasibility of TPRT in CLS. Overall, TPRT allowed

the tumor to be removed through an extended transumbilical incision without any special consumables or instruments, and our assessments showed the proposed tumor removal procedure was faster and safer than the recommended standard method.

2. Materials and methods

2.1 Baseline characteristics

A total of 111 patients with uterine leiomyoma were recruited to undergo TPRT *via* CLS from July 2020 to October 2021. Of them, 83 were from the Guiqian International General Hospital and 28 from the Anshun People's Hospital. The mean age of the patients was 40.48 years (range, 24–49 years). Seventy-eight patients were admitted due to detection of a uterine mass during physical examination, 29 due to menstrual changes (7 with prolonged menstrual period, 19 with increased menstrual flow, and 3 with irregular vaginal bleeding), 3 due to frequent urination, 1 due to difficulty in urinating, and 1 due to lower abdominal pain. All patients underwent preoperative ultrasound examination to confirm their preoperative diagnosis, of whom 59 cases had single leiomyoma and 52 had multiple leiomyomas. The mean diameter of the leiomyomas was 68.86 mm (standard deviation (SD), ±17.70; range, 34–134 mm). The leiomyoma types were classified according to the International Federation of Gynecology and Obstetrics (FIGO) [12] (Table 1).

The study inclusion criteria were: (1) presence of uterine leiomyoma *via* gynecological and ultrasound examination, with an indication that the tumor could be removed laparoscopically, and; (2) patients willing to undergo laparoscopic myomectomy. Patients were excluded if they were unfit for surgery due to severe cardiopulmonary diseases or other comorbidities.

2.2 Surgical methods

The patients received intravenous anesthesia with endotracheal intubation and were placed in the lithotomy position. After routine disinfection and placement of surgical drapes cloth, a longitudinal skin incision of approximately 15 mm was made downward form the deepest point of the umbilicus, through which a Veress needle was inserted to establish pneumoperitoneum, and the pressure was set to 13–14 mmHg (1 mmHg = 0.133 kPa). Next, a 10-mm trocar and laparoscope were inserted, followed by two 5-mm trocars inserted at the left lower quadrant of the abdomen, similar as in CLS. Then, a routine myomectomy and uterine suture were performed.

2.3 TPRT procedure

(1) Abiding to the tumor-free technique principle, the surgical specimen was bagged and isolated from the abdominal cavity before removal. An ordinary endoscopic specimen bag that could accommodate the tumor was inserted into the abdominal cavity through the 10-mm trocar, the tumor was bagged, and the tether of the bag was clamped. The subsequent steps were performed through the lower 5-mm trocar.

(2) An umbilical incision similar to TU-LESS was made. First, it was made to stop pneumoperitoneum and pull off the 10-mm trocar. Second, a longitudinal incision of about 15 mm was made upward to form the deepest point of the umbilicus. The total length of the skin incision was 30 mm (15 mm above and below the lowest point of the umbilicus). Then, the fascia layer below the skin incision and peritoneum was expanded to 40 mm.

(3) The tumor was pared and placed in the bag through the incision. Then, the tether of the specimen bag was clamped and taken out of the abdominal cavity through the umbilical incision. The tumor was clamped and pulled by towel clips with the help of an assistant who opened and pulled the specimen bag [11]. We pared the tumor and removed it with a sharp knife in the bag during the whole procedure. After the specimen bag was pulled out, its integrity was checked.

(4) The umbilical incision was sutured using 2-0 ETHICON Coated VICRYL (VCP 345) and restored.

2.4 Statistical indicators

The time taken for tumor bagging, umbilical incision, tumor paring and retrieval and umbilical incision repair, the number, texture and weight of leiomyoma, the visual analog scale (VAS) scores at postoperative day 1, and healing of the umbilical incision one week postoperatively were prospectively evaluated and recorded for statistical analysis. Since this was an empirical exploration study, descriptive statistics of categorical data are shown as n and %, while continuous data are shown as mean ± standard deviation and range. The chi-square test was used to compare categorical variables, and the *t*-test and rank sum test to compare continuous variables. All statistical analyses were performed using the SPSS software (version 22.0, IBM statistics, Chicago, Illinois, USA) or Windows.

3. Results

All operations were successfully completed. The average number of removed leiomyomas was 1.94 ± 1.67 (range, 1–11). The mean tumor weight was 155.45 ± 95.76 g (range, 40–665). The mean total time of the entire TPRT process was 12.60 ± 3.78 min (range, 6–28 min). The mean VAS scores evaluated on postoperatively day 1 was 2.59 ± 0.65 (range, 1–4). Pathology examination showed that all tumors were benign leiomyomas, and no malignancy was detected in the surgical specimen. All the abdominal incisions healed remarkably one week after the surgery. The details of complications, timing of the procedure and the texture of the leiomyomas are shown in Table 2.

4. Discussion

4.1 Deficiencies of current laparoscopic myomectomy

In TU-LESS, the scar at the umbilicus is hidden, and the removal of the tumor through the umbilical incision is fast, safe and convenient. However, myomectomy and uterine sutures are more difficult procedures [13] because the operation time is longer, and bleeding is usually greater than in CLS. The

TABLE 1. Demographic information of 111 patients.

Characteristics	N
Age (yr)	40.48 ± 6.04
Gravidity	2.32 ± 1.65
Parity	1.20 ± 0.90
BMI	22.79 ± 3.06
Chief complaint (n, %)	
Uterine mass found on physical examination	78 (72.3%)
Menstrual changes	29 (26.1%)
Urinary system symptoms	3 (2.7%)
Lower abdominal pain	1 (0.9%)
Classification of leiomyoma diagnosed by ultrasound (n, %)	
Single	59 (53.2%)
Multiple	52 (46.8%)
Types according to FIGO diagnosed by ultrasound (n, %)	
Type 2	2 (1.8%)
Type 3	1 (0.9%)
Type 4	15 (13.5%)
Type 5	39 (35.1%)
Type 6	41 (36.9%)
Type 7	2 (1.8%)
Type 8	2 (1.8%)
Mean diameter of the largest leiomyoma diagnosed by ultrasound (mm)	68.86 ± 17.70

FIGO: International Federation of Gynecology and Obstetrics. BMI: Body Mass Index.

TABLE 2. Operation conditions and postoperative complications.

Variable	N
Average number of leiomyomas removed	1.94 ± 1.67
Texture of tumor (n, %)	
Hard	37 (33.3%)
Medium hardness	53 (47.7%)
Soft	21 (18.9%)
Time of tumor removal process (min)	
Time for placing the endoscopic bag plus bagging tumor	2.03 ± 1.24
Time for producing the umbilical incision	1.68 ± 0.63
Time for paring and retrieving tumor	5.70 ± 2.22
Time for repairing the umbilical incision	3.18 ± 1.47
Total time of tumor removal process	12.60 ± 3.78
Average tumor weight (g)	155.45 ± 95.76
Incidence of operative complications (n (%))	
Accidental skin injury around umbilicus (n (%))	6 (5.4%)
Bag breaks (n (%))	11 (9.9%)
VAS scores, 1 day postoperatively	2.59 ± 0.65
Cases with poor wound healing, 1 week postoperatively (n (%))	0

VAS: visual analog scale.

above factors directly affect the surgeon's choice of operation [14]. At present, conventional laparoscopy is the most popular method for myomectomy, and there are even many surgical reports of giant leiomyoma and difficult myomectomy in literature [1, 14, 15].

Tumor removal is an important procedure in CLS. Currently, it is mainly performed with leiomyoma morcellators, invented in 1973 [4]. According to the correlative references [3, 5, 10, 16–18], this procedure is challenging and complicated. First, considering the incisive procedure is located in the abdominal cavity, a lack of experience and skills of the operating surgeon might increase the risks of damage to intra-abdominal organs. Second, this method might lead to extensive implantation and growth of uterine leiomyoma fragments. In addition, if the tumor turns out to be an unsuspected sarcoma, this procedure may result in upstaging of the sarcoma, resulting in poor patient survival [19].

To avoid these problems, a consensus from a panel of experts [7, 8] and the U.S. Food and Drug Administration [9] recommend that the tumor-free principle be followed during tumor removal. On the basis of existing methods of tumor removal, special disposable endoscopic retriever bags are used to isolate the tumor. The procedures include placing the specimen bag into the abdominal cavity, bagging the tumor, inflating the bag to establish the operation space, crushing the tumor with a morcellator in the bag, and retrieving the tumor and the bag [7].

However, since the whole operation process is performed in the abdominal cavity, there are substantial risks of intra-abdominal tumor spillage and organ damage. Meanwhile, the techniques for placing the specimen bag into the abdomen and tumor bagging are complicated, often prolonging the operation time by 20 or more min, without including the time needed for crushing and tumor retrieval [7]. Further, although the specimen bag is disposable, it is relatively expensive and difficult to be popularized in clinics.

4.2 Advantages and practical value of TPRT

In this study, TPRT was performed in 111 patients during conventional laparoscopic myomectomy. Each TPRT was performed in line with the tumor-free technique principle. The tumor was pared in the ordinary endoscopic specimen bag, completely isolated from the abdominal wall and abdominal visceral organs. Other advantages of TPRT compared to standard methods are listed below.

First, TPRT can shorten the operation time. In our study, the mean total time of the TPRT process was 12.60 min (SD, ±3.78; range, 6–28 min). The mean time for paring and retrieving the tumor was only 5.70 min (SD, ±2.22; range, 1–14 min). Compared with the recommended method reported by Shi Yu *et al.* [20], the time taken to complete the proposed TPRT in this study was shorter. The time of recommended method, which includes placing the specimen bag into the abdominal cavity, the puncture catheter plus the tumor in a morcellation, was 22.1 min (SD, ±8.9; range, 18–45 min), the time for tumor crushing was 33.5 min (SD, ±6.5; range, 20–55 min), the time for tumor retrieval was 9.3 min (SD, ±3.7; range, 5–15 min), and the time for handling the bag was 15.4 min (SD, ±8.2; range, 8–25 min). During the TPRT procedure, the tumor was clamped directly with towel clips and was removed using the "Pare Apple" tumor extraction technique [11], which is mastered by most gynecologists and is usually performed in laparoscopic hysterectomy. When the blade was abraded by hard textures or large leiomyomas, the speed of paring and retrieving the tumor could be maintained by properly replacing a new surgical blade. These indicated that the time of tumor removal was not affected by the texture of the tumor.

Second, TPRT has a lower risk of injury to abdominal organs. Different from the recommended method procedure performed in the abdominal cavity, the possible traumatic excision of TPRT was close to the abdominal wall, around the umbilicus. In our study, due to lack of experience and carelessness in the early stage, there were 11 accidental specimen bag breaks, 6 of which affected the local umbilicus skin, which was then repaired by washing and suturing. There were no other major complications or accidents. Local umbilicus skin damage is easy to repair, and this can be avoided in the future by using a thyroid retractor, small S-hook and other general surgical instruments when the specimen bag is pulled open.

Third, TPRT can be easily popularized because it is easy to learn and perform and is not expensive. Paring the tumor through the umbilicus incision is equivalent to a simple laparotomy around the umbilicus, making it easy for most surgeons to master. In this study, the largest leiomyoma removed had a diameter of 134 mm and was removed within 10 mins through a 30-mm umbilical incision. TRPT can also be used for the complete and safe removal of other tumors, such as pelvic endometriosis nodules, exfoliated ovarian tumors, subtotal hysterectomy specimens, *etc*. Meanwhile, TPRT does not need special disposable endoscopic retriever bags or morcellators; commonly used instruments, blades and specimen bags are enough. It should be noted that the length of the incision can be determined based on the size, texture of the leiomyoma and the thickness of the patient's abdominal wall. For obese patients, the umbilical incision can be slightly extended, and reduced for smaller tumors.

In addition, since the scars on the abdominal skin are small, this technique is expected to be widely accepted by the patients. In contrast, the incision with the recommended method extends the 5-mm puncture hole to >15 mm to facilitate the insertion of the leiomyoma morcellator. In the proposed TPRT method, we extended the umbilicus incision as in TU-LESS. Owing to the good ductility of the umbilicus, we could restore the normal appearance of the umbilicus after the tumor was removed. There were only two additional 5-mm scars compared with TU-LESS. It is well known that the difficulty of CLS is much lower than TU-LESS, and the indications of CLS are greater.

4.3 Query of TPRT

The key point of TPRT is replacing the incision that originally needed to be extended in the lower abdomen to the umbilicus during CLS. While optimizing the surgical procedure, attention should be paid to the related complications. The main query is that the extended umbilical incision might cause postoperative wound infection, scars and umbilical hernia because

the umbilical region is the weakest part of the abdomen. In a retrospective study by Park JY, focusing on the complications of transumbilical single port laparoscopic surgery [21], they reported that the incidence of postoperative umbilical hernia was 0.4% (2/515) at 6 months and 8 months after surgery. The median follow-up time was 23.6 months (range, 6.2–145.4 months), equivalent to the incidence of multi-port laparoscopic umbilical hernia. The umbilical incision length of the umbilical single port laparoscopic is usually 20 mm. In this study, when the tumor was taken through the umbilical port to quickly finish this step, we often extended the incision to 25–30 mm. It was equivalent to the length of umbilical incision in robotic single hole laparoscopic surgery, which is 25–40 mm [22, 23]. In existing literature [23–25] (the average follow-up time and the number of cases were 13.6 months, 1 month, 12 months and 12 cases, 7 cases, respectively, 129 cases), no increase in complications, such as infection of the umbilical incision and umbilical hernia, was observed after robot-assisted single port laparoscopic surgery. In this study, the umbilical repair suture technique was based on the umbilical operation of TU-LESS. It is necessary to effectively close the peritoneum and fascia layer by layer, and finish the subcutaneous and skin repair suture. Further, it is also necessary to completely stop bleeding during suturing to avoid hematoma formation and reduce the risks of complications such as infections.

5. Conclusions

In conclusion, the proposed TPRT procedure could optimize the operation time and effectiveness of CLS. It is shown to be safe, quick, cheap and easy to learn, worthy of further confirmatory investigations and popularization.

AVAILABILITY OF DATA AND MATERIALS

The data are contained within this article.

AUTHOR CONTRIBUTIONS

WK, GWX —designed the research study. WK, GWX, PG, XL, LS, LY, HCX, JBW —performed the research. LY and LS —analyzed the data. WK and XL —wrote the manuscript. All authors read and approved the final manuscript.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

The study protocol was reviewed and approved by the Ethics Committee of the Medical Association of Guiqian International General Hospital (Approval Number: 2021 No.01). Written informed consents were also obtained from the patients.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

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