



Intraoperative ultrasound-assisted enucleation of residual fibroids following laparoscopic myomectomy

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ARTICLE INFO

Keywords:

Fibroids
Uterine
Myomectomy
Ultrasonography
Laparoscopy

ABSTRACT

Aim: To investigate if intraoperative ultrasounds by laparoscopic and transvaginal ultrasonography (LUS and TVS) could improve enucleating the residual fibroids following laparoscopic myomectomy (LM).

Methods: From March to December 2016, 78 women with uterine fibroids underwent LM, LUS and TVS were applied to detect residual fibroids and to guide surgeons to enucleate them after the visible fibroids were removed during LM operation.

Results: The total number of residual fibroids found by LUS was 140, and the total number found by TVS was 127 following LM ($P = 0.03$). LUS is statistically superior to TVS in the detection of residual fibroids in the anterior wall ($P = 0.004$), in the detection of intramural fibroids ($P = 0.002$), and in the detection of fibroids with a diameter ranging from 0.5 to 1 cm ($P = 0.002$). According to the total number of enucleated fibroids by LM, patients were divided into three groups (Group 1: 2 to 4, Group 2: 5 to 7 and Group 3: ≥ 8 fibroid counts). The percentages of patients in each group with residual fibroids at the end of surgery were 22.2%, 51.9% and 66.7% respectively.

Conclusions: Both LUS and TVS are beneficial to surgical treatment of fibroids by assisting enucleation of residual fibroids following LM, while LUS is more effective in localizing residual fibroids than TVS.

1. Introduction

Uterine fibroids are the most common benign tumors in women at reproductive age, with a prevalence rate reaching 20–50% based on post mortem studies [1]. Moreover, the prevalence raises to 70%–80% in women over the age of 50 [2]. Symptoms of uterine fibroids include hypermenorrhea, space-occupying symptoms (frequent urination and constipation), miscarriage and infertility. It was reported that 20–50% of patients with fibroids are symptomatic, and 53.7% of symptomatic patients feel that symptoms caused by uterine fibroids negatively impact their life and work [3].

There are many treatments for uterine fibroid, such as surgery, drugs, radiofrequency ablation and uterine artery embolism. Most uterine fibroid patients with symptoms are treated with surgery. Myomectomy is a conventional approach of treating uterine fibroids. Recently, with the development of minimally invasive technique, laparoscopic myomectomy (LM) has been routinely applied in clinical practice. While the surgical approach is generally safe [4], studies have

shown that the residual rate of fibroids and recurrence rate after LM are high. Yoo et al. have reported that recurrence rates are 11.7%, 36.1%, 52.9%, and 84.4%, respectively, at 1, 3, 5, and 8 years after LM [5]. Thus, how to improve the efficacy of laparoscopy is an urgent issue for a better treatment of this disease. In this study, laparoscopic ultrasonography (LUS) and transvaginal ultrasonography (TVS) were used to assist the removal of macroscopically invisible residual fibroids following LM. We compared the two techniques to explore the effective ways to reduce the residual fibroids during LM.

2. Patients and methods

2.1. Patients

78 patients with uterine fibroids who underwent LM at Beijing Obstetrics and Gynecology Hospital from March 2016 to December 2016 were analyzed. Patients were diagnosed with multiple uterine fibroids clinically and preoperatively by TVS. All patients had LM

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<https://doi.org/10.1016/j.cca.2018.05.024>

Received 28 April 2018; Received in revised form 9 May 2018; Accepted 11 May 2018
Available online 25 May 2018

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indications. Submucosal myoma which was an indication for hysteroscopic surgery was excluded from the study. Preoperative cervical cytological examination, colposcopy examination and diagnostic uterine curettage if necessary, were performed to exclude malignant diseases. No patient included in the study had contraindications for laparoscopic surgery. The median age of patients was 39 years old (Ranges 34.5 to 45.0), the median of gravidity was 2 times (range: 1 to 3 times, and the median of parity was once (0 to 1 times). There were 28 (35.8%) patients with hypermenorrhea and 2 (2.6%) of them had irregular vagina bleeding. Twelve (15.4%) patients had space-occupying symptoms such as frequent urination and constipation, and 8 patients (10.3%) were diagnosed for infertility.

2.2. Instrument

The Color Doppler instrument Esaotemylab and laparoscopic ultrasonic probe 8666 were used in the study. Probe frequency was 4 to 10 MHz, with a center frequency of 7.5 MHz and a rotation range of 360 degree. Transvaginal ultrasonic probe was 9118 with a frequency of 4 to 8 MHz.

2.3. Methods

3 U of Pituitrin diluted in 10 ml saline was infused to uterine muscular before visible uterine fibroids were removed one by one. The surgical procedures were as follows: an incision was made on the surface of seromuscular layer and reach fibroids using a monopole and fibroids were enucleated completely. After removal of as many fibroids as you can from this incision, full-thickness suture or layered suture with absorbable thread was used to close the uterine wound. The enucleated fibroids were removed by Spin tumor device. After all visible uterine fibroids were enucleated, LUS was used (Fig. 1) to detect any residual fibroids in muscular layer, which was followed by TVS to check again. If there were residual fibroids, localized by monopole (Fig. 2), except for small deep uterine fibroids, the surgeon will enucleate fibroids as many as possible with the guidance of ultrasound. During the surgery, ultrasound was performed by the same doctor experienced in ultrasound.

The project was approved by the Ethics Committee of Beijing Obstetrics and Gynecology Hospital, Beijing Capital Medical University. Consent forms were obtained from all participating patients.

2.4. Statistics

Statistical analyses were performed using the SPSS20.0 (IBM, USA) software. All the quantitative data in this study are non-normal distribution determined by Kolmogorov-Smirnov tests, and were expressed



Fig. 1. Fibroids were shown from a uterus scan by laparoscopic ultrasound. LUS is easy to use for exploring the abdominal cavity by applying ultrasound probe through Trocar port, and clear images can be obtained.

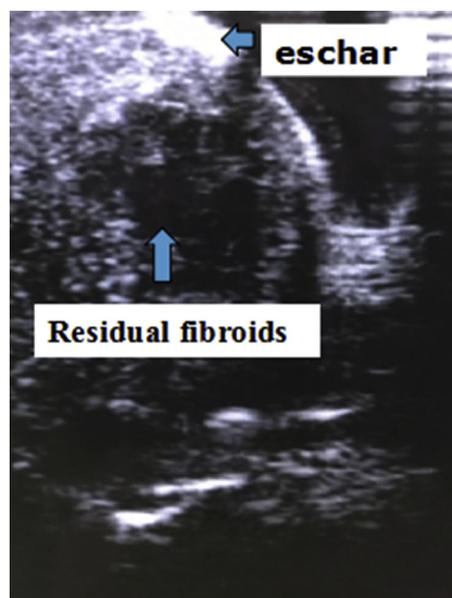


Fig. 2. LUS assisted enucleation of a fibroid. Subserosal layer of uterus proximal to the residual fibroid was electro-coagulated by a monopole to guide surgical enucleation with minimally invasive procedure. Upper arrow: an eschar after coagulation; Central arrow: a residual fibroid.

by quartiles as median and the interquartile range. Wilcoxon signed rank test was used for quantitative data and chi-square (χ^2) test was used for qualitative data: P < 0.05 was considered to be statistically significant.

3. Results

252 fibroids with diameters ranging from 0.6 to 10.5 cm were enucleated before applying ultrasound examination during the laparoscopic surgery. 141 fibroids were detected by LUS and TVS following myomectomy. After ultrasound localization 107 fibroids with diameters ranging from 0.5 to 3 cm were enucleated. There were 34 residual fibroids with median diameters of 0.9 (0.6, 1.0) cm. The median value of intraoperative hemorrhage was 150 (95, 200) ml. The median operative time was 120 (90, 150) minutes. LUS and TVS data were analyzed as following:

1. Comparison of total number of fibroids: The total number of residual fibroids found by LUS was 140, and by TVS was 127. The difference is statistically significant (P = 0.03).
2. Comparison of the effect on searching for residual fibroids in different portions of the uterus: The number of fibroids detected by LUS and TVS at different locations are shown in Table 1. The result showed that the number of anterior fibroids is statistically significant, with LUS being superior to TVS. There is no significant difference in the number of fibroids in the posterior wall, uterine fundus and cervix.
3. The numbers of residual fibroids in different locations of myometrium detected by LUS and TVS are shown in Table 2. The difference

Table 1
The number of residual fibroids in different locations of uterus by 2 types of ultrasound (LUS vs. TVS).

	Anterior wall	Posterior wall	Fundus	Cervix	Total
LUS	94	37	7	2	140
TVS	84	33	7	3	127
Z value	-2.887	-1.633	0.000	-1.000	-2.968
P value	0.004	0.102	1.000	0.317	0.003

Table 2

The number of residual fibroids in different layers of myometrium by Different methods of ultrasound.

	Intramural(n)	Submucosal (n)	Subserosal (n)	Total (n)
LUS	120	14	6	140
TVS	107	13	7	127
Z value	-3.127	-1.000	-1.000	-2.968
P value	0.002	0.317	0.317	0.003

Table 3

Number of residual fibroids in different size by different methods of ultrasound.

	Diameter of 0.5–1 cm (n)	Diameter of 1–1.5 cm (n)	Diameter of 1.5–2 cm (n)	Diameter of > 2 cm (n)
LUS	43	51	28	18
TVS	33	47	29	18
Z value	-3.162	-1.190	-1.000	0.000
P value	0.002	0.234	0.317	1.0

between the numbers of intramural fibroids is of statistical significance. There is no significant difference in numbers of fibroids found in submucosa and subserosa.

- Comparison of the effect on searching for residual fibroids with different sizes: The number of fibroids in different size detected by LUS and TVS is shown in Table 3. Comparison indicated that the numbers of fibroids with diameters ranging from 0.5 to 1 cm detected by the two methods are significantly different, while there is no significant difference between numbers of fibroids with diameters > 1 cm.
- The relationship between the total number of fibroids enucleated in laparoscopic surgery and the residual rate: According to the total number of fibroids enucleated, we divided the patients into three groups (2 to 4, 5 to 7, and ≥ 8 fibroids). LUS scan of the uterus was performed at the end of the surgery, the number of final residual fibroids was recorded, and the percentage of patients in each group with residual fibroids at the end of surgery was calculated. The outcome was 22.2%, 51.9% and 66.7% respectively (Table 4.). Residual rate of fibroids among the three groups is statistically significant ($p = 0.008$) and there was a significant difference between group 1 versus group 2 ($p = 0.019$), and group 1 versus group 3 ($p = 0.041$). There was no significant difference between group 2 and group 3 ($p = 0.423$).

4. Discussion

Since it is not easy to find intramural fibroids with small size in LM, patients receiving LM may have small residual intramural fibroids. It has been recognized that post-surgery small residual fibroids represent a crucial risk factor for recurrence [6]. Studies showed that the recurrent rate after LM may be as high as 15%, leading to hysterectomy in the next 5–10 years in 10% of patients [2]. If we can enucleate more fibroids during LM, the residual rate, recurrent rate of fibroids as well as

Table 4

The relationship between the total number of fibroids enucleated and the residual rate.

Group	Total number of enucleated fibroids (n)	Patients with residual fibroids (n)	Percentage (%)
Group 1 (n = 45)	2–4	10	22.2%
Group 2 (n = 27)	5–7	14	51.9%
Group 3 (n = 6)	≥ 8	4	66.7%

re-operation rate will be reduced. While intraoperative usage of LUS and TVS in LM have been reported, no quantitative comparison on the two methods has been reported previously.

TVS is widely used in clinical practice. Transvaginal ultrasound has high resolution and accuracy, does not require bladder filling, and is not affected by intestinal gas and obesity. Compared with abdominal sonography, it is much closer to pelvic organs, which enhances the quality of images. One studies by LY Pan et al. indicated that application of intraoperative TVS during LM resulted in decreased residual fibroids and recurrence [7]. The study included the TVS-guided LM group (n = 42), and LM group (n = 43). In the TVS-guided LM group, there were 11 residual fibroids discovered by TVS, with diameters ranging from 1.5 to 2.5 cm. The postoperative recurrence rate was 2.4%, which was lower than the recurrence rate of LM group (16.3%). In this study, we did not find a significant effect of reducing the postoperative residual fibroids and recurrence rate. Since gas in the abdominal cavity can interfere the quality of detection, and the clarity of images is related to the location of fibroids, the benefits by TVS detection of residual fibroids could be limited.

LUS is a new technique developed based on modern laparoscopic surgery [8]. It combines the laparoscopic instruments with intraoperative ultrasound. LUS is easy to use, and the intraoperative ultrasound probe can get access through 10 mm Trocar channel to the abdominal cavity to scan. Also, its probe could be placed on the surface of the organ. LUS has a higher frequency than TVS, and it can avoid the interference of the abdominal wall and the intestinal gas. As a result, more accurate and clearer images can be obtained. In this study, the total number of residual fibroids found by LUS was more than TVS and the difference was statistically significant. LUS is superior to TVS in the detection of fibroids in anterior wall and intramural fibroids. In addition, LUS is better than TVS in searching for fibroids with diameters ranging from 0.5 to 1 cm. These observations are consistent with previous reports showing that LUS in LM could effectively reduce the residual fibroids and recurrence [9,10].

LUS has its own limitations. The LUS device, by its nature of remote control to change the angle and position, is limited for searching fibroids in certain locations such as the low segment of the uterus or posterior wall. In this study, while LUS was better than TVS in searching for fibroids in anterior wall, there was no significant difference in searching fibroids in the posterior wall. In addition, when we scanned uterus using LUS, the vision appeared so limited that it is difficult to determine the location. Lastly, LUS requires high levels of technical training and clinical skills to apply.

Residual fibroids and recurrence rate after LM may be affected by many factors and the number of enucleated fibroids is one of the most important factors. Some studies reported that the residual rate after LM is higher in patients with enucleated fibroids ≥ 4 than in patients with enucleated fibroids < 4, the same conclusion as that from this study [11]. According to the total number of enucleated fibroids, we divided patients into three groups (2 to 4, 5 to 7 and ≥ 8), and then calculated the percentage of patients in each group with residual fibroids at the end of surgery. The outcome was 22.2%, 51.9% and 66.7% respectively, which increases with the total number of fibroids enucleated.

While both LUS and TVS can help to reduce the post-operative residual fibroids rate, LUS appears to be more effective than TVS in searching for and localizing the residual fibroids. In advanced hospitals equipped with LUS, laparoscopic myomectomy can be monitored with LUS which provides more clear images and higher detection rate of residual fibroids. In rural hospitals surgeries can be performed with the guidance of TVS in some. The application of laparoscopic sonography device and minimally invasive technique can significantly increase the surgical accuracy during enucleation of residual fibroids following visible fibroid myomectomy. These technologies can improve the quality of gynecologic surgery and benefit women's health in many hospitals.

Acknowledgement

This project was supported by funding from The National Key Research and Development Program of China (Grant number: 2016YFC1000104), the Beijing Obstetrics and Gynecology Hospital, Capital Medical University (Code: FCYY201519), Beijing Municipal Administration of Hospitals' Ascent Plan (Code: DFL20151302).

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