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Original Article

Conventional Trocar transumbilical multiport laparoscopic salpingectomy: minimal injury, better cosmetic effect

Xiaobin Huang, Kaixian Deng, Xiaochun Liu, Xingfang Huang, Rujian Zhang, Lijie Zhao, Yuhua Zheng

Department of Gynecology, Southern Medical University Affiliated Maternal & Child Health Hospital of Foshan, Foshan, Guangdong, China

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Abstract: Aim: In this study, a new LESS-transumbilical multiport laparoscopic surgery (TMLS), which had minimal injury was tested utilizing conventional laparoscopic Trocar and instrumentation. Material and Methods: A total of 90 patients with ectopic pregnancy who agreed to have their oviduct resected were randomly divided into three groups: TMLS, laparoendoscopic single-site surgery group (LESS), and conventional multi-Port laparoscopic surgery group (CMLS). The two umbilical incisions of the TMLS group were about 15 mm and 5 mm, and all pertinent medical records were collected for statistical analysis. Results: The level of umbilical incision in the TMLS group was less than that in the LESS group ($P < 0.001$). One month post operation, the CS score of wound satisfaction in the TMLS group was highest (15-23), compared with that in the LESS group 18 (15-22) or the CMLS group 16 (14-19) ($P = 0.012$, < 0.001). The suturing time of the TMLS group was similar to CMLS group ($P = 0.153$), but was less than the LESS group ($P = 0.003$). The operative time of the TMLS group was similar to the LESS group ($P = 0.763$), but was longer than the CMLS group ($P = 0.028$). The VAS score of pain in the TMLS group at 24 hours post operation was 2 (1-4), which was similar with the LESS group 3 (1-5) or the CMLS group 2 (1-4). Conclusions: It is safe, economical, effective, and feasible to use the conventional Trocar transumbilical multiport laparoscopic surgery to minimize and disperse the incision, so that the wound is smaller and the cosmetic effect is better. This kind of NOTES surgery could be generalized in the primary hospital.

Keywords: Transumbilical multiport laparoscopic surgery, laparoendoscopic single-site surgery, salpingectomy

Introduction

It has been estimated that 95% of ectopic pregnanciesare tubal. Conventional surgery has been laparotomy, while laparoscopic surgery had become the mainstream for the past 20 years. In 2002, the British Royal College of Obstetrics and Gynecology recommended the laparoscope as the preferred surgery for tubal pregnancy treatment [1]. However, conventional multiport laparoscopic surgery (CMLS) has been required to puncture at least three holes, without concerns about the cosmetic effect. In gynecology, laparoendoscopic single-site surgery (LESS) was the first one applied in fallopian tube surgery [2]. Currently, LESS is a NOTES surgery with more vitality, and it has received rapid development in recent years.

However, LESS also has its innate shortcomings. First, because the umbilical incision is about 3 cm, the umbilical region is often cut apart completely. Antoniou [3] found that, compared with CMLS, the risk of perforation hernia after LESS was slightly higher. Second, dedicated multi-channel access platform of LESS greatly increases the economic burden of patients, which hinderspromotion and development of the operation in the developing countries and primary hospitals. Third, the degree of postoperative pain of LESS is higher. According to previous reports, the VAS score at 24 hours post LESS has been higher than the multiport laparoscope. Moreover, many studies have suggested [4-6] that less incisions do not contribute to reduce postoperative pain. Compared with multiport laparoscope surgery, the umbili-

Table 1. Clinical characteristics

Variable	TMLS group	LESS group	CMLS group	F/χ^2 value	*P* value
Number	21	19	22		
Median age (year)[1]	31.10 ± 4.79	30.63 ± 4.49	31.27 ± 4.31	F = 0.107	0.899
BMI (kg/m^2)[2]	22.4 ± 3.1	21.7 ± 2.3	21.9 ± 2.2	F = 0.326	0.435
History of abdominal surgery[3]	5/21	4/19	5/22	χ^2 = 0.044	0.978
Size of ectopic pregnancy (mm)[2]	3.53 ± 0.74	4.02 ± 1.43	3.81 ± 0.77	F = 1.17	0.318
Mean Serum β-HCG before operation (U/L)[1]	2697 (345.37-32154.00)	3301 (267.00-35298.00)	3722.5 (412-33056.00)	χ^2 = 0.325	0.850

Notes: [1]The median data was analyzed using K-independent samples Test; [2]The measurement data was analyzed using One-Way ANOVA; [3]The nonparametric test was analyzed using Chi-square Test.

cal incision of LESS is much larger (10 mm), so it often needs multi-layer suture and the pain is more severe.

In this study, the author explored a new LESS-transumbilical multiport laparoscopic surgery (TMLS), which had minimal injury and could utilize conventional laparoscopic Trocar and instrumentation. It would not increase the economic burden of patients with exact treatment effect. With minimal injury and more subtle scars, it meets the concept of NOTES.

Materials and methods

Study design

This study was approved by the Hospital Ethics Committee and was derived from the 2016 Annual Medical Science and Technology Research Project of Foshan City Science and Technology Bureau "the research of laparoendoscopic single-site surgery technology im-|provement and its application in the gynecology" (project number: 2015AB0395).

The ectopic pregnancy patients were divided into three groups randomly according to the random number table method, whose consent forms were obtained prior to cut off their fallopian tube. A total of 30 patients underwent transumbilical multiport laparoscopic surgery (TMLS group), while another 30 patients underwent laparoendoscopic single-site surgery (LESS group), and the other 30 patients underwent conventional multi-port laparoscopic surgery (CMLS group). The total number of the included cases accounted for 10.4% of the total cases of ectopic pregnancy admitted in our hospital.

The inclusive criteria were tubal pregnancy with primary clinical diagnosis and intraoperative diagnosis, according to medical history, clinical examination, blood β-HCG and transvaginal colorful ultrasonography. Preoperative exclusion criteria were obesity (BMI > 35 kg/m^2), hemorrhagic shock, and high risk of preoperative ovarian non-physiological cysts and general anesthesia. Intraoperative exclusion criteria were patients who received salpingostomy, sutured after cornual pregnancy, combined with uterine surgery and combined with severe pelvic adhesions.

Surgical procedures might be more complicated due to obesity, severe pelvic adhesions, combining with uterine surgery, salpingostomy etc. Therefore, it was likely to affect the results of the study. The pelvic adhesions adopted the American Fertility Association's improved scoring criteria [7].

Final completed cases were 21 cases in the TMLS group, 19 cases in the LESS group and 22 cases in the CMLS group, respectively. Informed consent was obtained from patients and their families before surgery. The authors performed all surgeries. All patients were enrolled in a comprehensive medical history and physical examination, auxiliary examination. Clinical data of the three groups were collected, including age, height, weight, previous abdominal surgery, the size of preoperative ultrasonography pelvic mass, the level of preoperative serum β-HCG, etc. There was no significant difference in any clinical parameters among the three groups (**Table 1**).

Equipment and instrument

Shared equipment: Three groups were all treated with conventional laparoscopic puncture outfit. Major equipment was Germany Storz HD Laparoscopic System, Germany Erbo electronic medical equipment company ERBE VIO high frequency electrosurgical workstations and BiClamp bipolar electrocoagulation tongs.

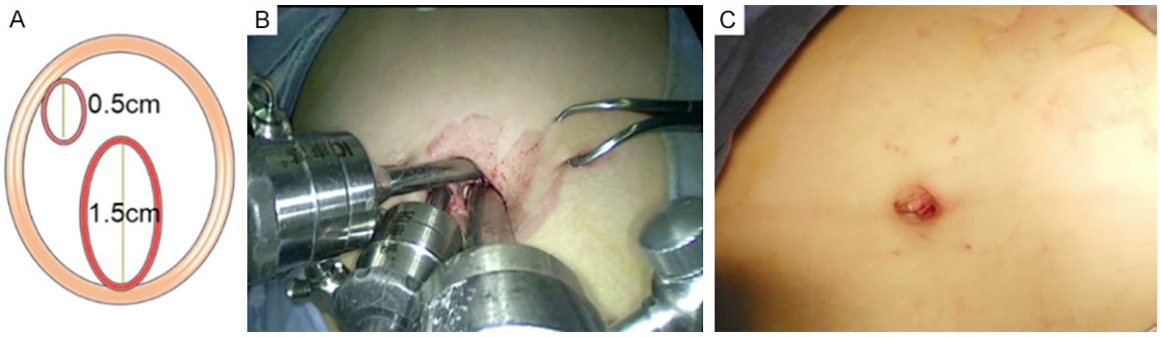

Figure 1. A: Incisiondistributions of TMLS; B: Trocar locations of TMLS; C: Postoperative incision of TMLS.

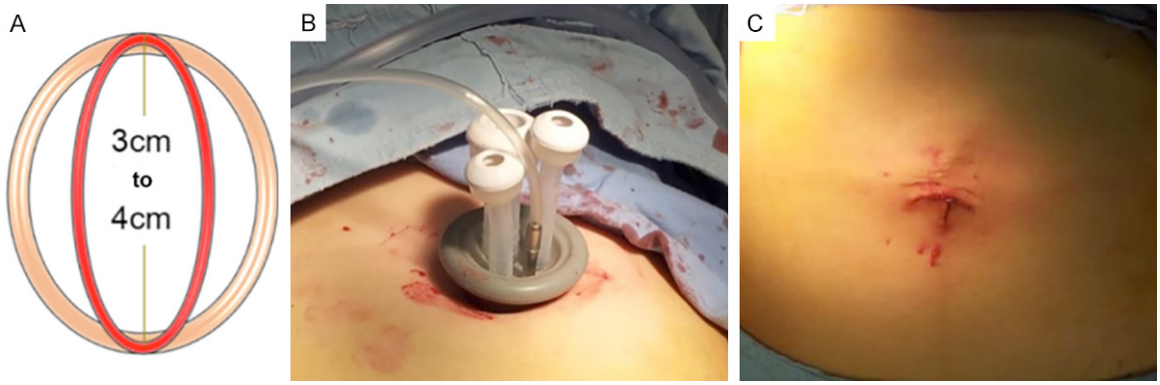

Figure 2. A: Incision distributions of LESS; B: Multiportal channel of LESS; C: Postoperative incision of LESS.

Special instrument: Transumbilical laparoscopic surgery (TMLS group/LESS group) and abdominal wall lifting were used.

A. Bendable and turnable dissecting forceps: When operating accessories, a bendable and turnable dissecting forceps was used to assist exposure.

B. Abdominal wall lifting: A 2-0 absorbable line was used to puncture into the abdominal cavity via inferior abdominal wall without vascular of diseased side. The abdominal wall knot was then sewed after the line had punctured the fallopian tube ampulla mesentery or ovarian parenchyma, and was pulled through the line knot to assist in exposing surgery field.

C. Uterus-lifting cup: For the TMLS and LESS groups, the author used a uterus-lifting cup to assist in exposing surgery field for those patients who had sexual life.

Operative procedures

The patients received the tracheal intubation plus combined intravenous inhalational anesthesia and took the bladder lithotomy position. Then the author disinfected the surgery field conventionally, spread the towel, established pneumoperitoneum by using Veress transumbilical pneumascos needle, and set the maximum pressure of pneumoperitoneum at 13 mmHg.

TMLS group: First, a 10 mm incision was placed along the umbilicus folds, a 10 mm Trocar, probe was placedto eliminate the possibility of ovarian cancer, severe pelvic adhesions, effusion of atresia tubalis, etc. Second, the incision was expanded to 15 mm and a 5 mm Trocar was added, staggering the puncture path to avoid leakage. Thena 5 mm incision was taken at the umbilicus side edge or lower edge and a 5 mm Trocar was added. Incision and Trocar distributions are shown in **Figure 1A**, **1B**. Third, a bendable and turnable dissecting forcepswas used to pull tissue and expose the field of view, and straight instruments tooperate such as bipolar coagulation forceps, scissors, straws, etc. If the pelvic was adhered, abdominal wall lifting was performed to help expose the surgery field. After freezing membrane blood ves-

Table 2. Operation outcomes

	TMLS group	LESS group	CMLS group	*F*/LSD-t* Value	*P* Value
Number	21	19	22		
Duration of operation (min)	31.43 ± 8.40	32.11 ± 6.63	26.60 ± 8.87	Between Groups $F = 3.857$	Between Groups $P = 0.027$
				Multiple Comparisons:	Multiple Comparisons:
				TMLS: LESS 0.30	TMLS: LESS0.763
				TMLS: CMLS 2.25	TMLS: CMLS 0.028
				LESS: CMLS 2.50	LESS: CMLS 0.015
Duration of wound suture (min)	4.76 ± 1.22	5.95 ± 1.47	4.23 ± 0.92	Between Groups $F = 0.60$	Between Groups $P < 0.001$
				Multiple Comparisons:	Multiple Comparisons:
				TMLS: LESS 3.09	TMLS: LESS 0.003
				TMLS: CMLS 1.45	TMLS: CMLS 0.153
				LESS: CMLS 4.53	LESS: CMLS 0.001
The length of the incision (mm)	18.81 ± 1.17	29.16 ± 1.30	11.77 ± 0.81	Between Groups $F = 1275.028$	Between Groups $P < 0.001$
				Multiple Comparisons:	Multiple Comparisons:
				TMLS: LESS 29.66	TMLS: LESS < 0.001
				TMLS: CMLS 20.93	TMLS: CMLS < 0.001
				LESS: CMLS 50.38	LESS: CMLS < 0.001

Notes: *One-Way ANOVA; P < 0.05 means significant difference.

Table 3. Postoperative outcomes

Variable	TMLS group	LESS group	CMLS group	$t/\chi^2/Z$	*P* value
Number	21	19	22		
Pass gas in the first day post operation[1]	19/21	18/19	19/22	$\chi^2 = 0.819$	0.664
The use of analgesic[1]	6/21	7/19	5/22	$\chi^2 = 0.989$	0.610
Follow-up rate in the first month[1]	20/21	18/19	19/22	$\chi^2 = 0.819$	0.664
The median VAS score of pain in the first 24 h post operation[2]	2 (1-4)	3 (1-5)	2 (1-4)	Between Groups $\chi^2 = 8.122$	Between Groups P = 0.017
				Multiple Comparisons χ^2:	Multiple Comparisons *P* value:
				TMLS: LESS -1.216	TMLS: LESS 0.672
				TMLS: CMLS 1.643	TMLS: LESS 0.672
				LESS: CMLS 2.83	LESS: CMLS 0.014
Cosmetic scale of wound 1 month post operation (median)[2]	19 (15-23)	18 (15-22)	16 (14-19)	Between Groups	Between Groups
				$\chi^2 = 23.963$,	P < 0.001
				Multiple Comparisons	Multiple Comparisons
				Z value:	*P* value:
				TMLS: LESS 2.604	TMLS: LESS 0.012
				TMLS: CMLS 6.865	TMLS: CMLS < 0.001
				LESS: CMLS 4.054	LESS: CMLS < 0.001

Notes: [1]The nonparametric test was analyzed using Chi-square Test. [2]The median data was analyzed using K-independent samples Test.

sels by bipolar coagulation forceps, fallopian tubes were collected and the specimens were placed into the specimen bags. Fourth, the specimen was removed by pulling out and fixing the specimen bag by using the 5 mm Trocar. Then the specimen bag was removed through the 15 mm incision. Fifth, a 2/0 absorbable vicryl suture was used to seam the peritoneum and anadesma hierarchically and a 4/0 absorbable vicryl suture was used to intradermal suture. Intradermal suture was done for the 5 mm incision (**Figure 1C**).

LESS group: Three Trocar were used for the same skin incision with the length of about 25 mm-35 mm, and putting into the multi-channel port (**Figure 2A**, **2B**). The other steps were basically similar to the TMLS group. **Figure 2C** shows the postoperative incision.

CMLS group: A total of 3-4 puncture holes and intra-cavity operation methods were basically similar to the first two groups.

Postoperative management and observation

Antibiotics were used at perioperative stage within 24 hours to prevent infection. Detection of blood β-HCG was donein the first 24 hours post operation. Hospital discharge was at 48-72 hours post operation and blood β-HCG was monitored until the normal range every week.

The duration of operation (from insertion of pneumascos needle to the end of suturing skin) was recorded, as well as the duration of wound suture, intraoperative blood loss, the pelvic adhesions, the combined operation, pass gas in the first day post operation, the first postoperative day pain score, pathologic examination results, the use of postoperative analgesic, with or without fever (pathogenicity > 38.0°C), with or without blood transfusion cases, postoperative blood β-HCG, the incidence of persistent ectopic pregnancy, and recorded whether patients use analgesics after surgery.

The first day after surgery, the nurses evaluated VAS score (0-10 points) for the patients in the morning and afternoon rounds, and the highest score as a statistical data.

Wound satisfaction scores from the patients were recorded through CS Scorewhich was presented by Dunker (**Figure 1A**) [8] at 1 month after surgery. The score range was 3-24, and the higher the score, the more satisfactory the appearance of the wound.

Data statistics

One-way ANOVA was used to analyze measurement data, and LSD was used to compare the multi-sample mean. Chi-square test was used to compare multiple sample rates. K-independent samples Test was used to compare median. Statistical software was IBM SPSS19.0. *P* values less than 0.05 were considered significant.

Results

Comparable clinical data of the two groups did not show significant differences. Operations of the 3 groups were conducted successfully, with no transferring to other surgical procedures and no extra operation hole beyond umbilicus. There were no intraoperative complications or no blood transfusion. Hemorrhage was less than 10 ml during all operations, and pre-operative and post-operative Hb changes were affected by pre-operative bleeding, so that Hb changes could not reflect the operation bleeding. Therefore, operation bleeding and Hb changes were not analyzed. Intraoperative statistics are shown in **Table 2**.

Duration of the operation: TMLS group was 31.43 min ± 8.40 min, LESS group was 32.11 min ± 6.63 min, and CMLS group was 26.60 min ± 8.87 min. There was no significant difference between the TMLS group and the LESS group. CMLS group compared with the TMLS group or the LESS group, showed significant differences (P = 0.028, 0.015). Two groups of transumbilical laparoscopic surgery were more time-consuming than conventional laparoscopic surgery.

Duration of wound suture: the TMLS group was 4.76 min ± 1.22 min, LESS group was 5.95 min ± 1.47 min and the CMLS group was 4.23 min ± 0.92 min. Comparing multi-group variables, the differences between any two groups were significant (F = 10.60, P < 0.001). The LESS group compared with the TMLS and CMLS groups, there were significant difference (P = 0.003, < 0.001). While there was no significant difference between the TMLS group and the

CMLS group (P = 0.153). Time of the LESS group was the longest, and other two groups were similar.

The length of the incision: The length of the incision was 18.81 mm ± 1.17 mm in the TMLS group, 29.16 mm ± 1.30 mm in the LESS group and 11.77 mm ± 0.81 mm in the CMLS group after surgery. Compared among groups, there were significant difference (F = 1275.028, P < 0.001), and so were pairwise comparisons (P < 0.0001). The incision of the LESS group was the largest and the CMLS group was the smallest.Postoperative statistics are shown in **Table 3**.

The median VAS score of pain in the first 24 hours post operation: the TMLS group was 2 (1-4), the LESS group was 3 (1-5) and the CMLS group was 2 (1-4). Significant difference was noted between the LESS group and the CMLS group (P = 0.014). However, the TMLS group compared with the CMLS group or the LESS group, there was no significant difference. The VAS score of pain in the LESS group at 24 hours post operation was more obvious than the conventional laparoscopic surgery, while the TMLS group and the CMLS group were similar.

The score of wound satisfaction: Follow-up rates in the first month of the 3 groups respectively were 20/21, 18/19 and 19/22, with no significant difference. 1 month after surgery, it was difficult to find the scars hidden in umbilical hole. One month post operation, the CS score (median) of wound satisfaction in the TMLS group was 19 (15-23), the LESS group was 18 (15-22) and the CMLS group was 16 (14-19). Among them, the TMLS group compared with the LESS group and the CMLS group, there were significant differences (P = 0.012, < 0.001). Significant difference was noted between the LESS group and the CMLS group (P < 0.001). The wound satisfaction degree of transumbilical multiport laparoscopic surgery was the highest.

The use rates of analgesic in the three groups respectively were 6/21, 7/19, 5/22 (χ^2 = 0.989, P = 0.610). Pass gas rates in the first day post operation in the three groups respectively were 19/21, 18/19, 19/22 (χ^2 = 0.819, P = 0.664). Operation fee and supplies in three groups were the same as those in conventional laparoscopy, so the hospitalization costs were not compared. All wounds were grade A healing and persistent ectopic pregnancy did not occurred. Postoperative pathological examination confirmed placental villi and trophoblast cells.

Discussions

LESS was applied to gynecological sterilization firstly [2], and it developed quickly in recent years. Compared with the transgastric, transvaginal, transeaical, transrectal and other NOTES surgery, LESS can use conventional laparoscopic instrumentation through the navel of the most superficial natural scar, becoming the most viable NOTES surgery. Achieving minimally invasive treatment and the needs of beauty, LESS surgery meets the majority of female patients' requirements, reflects the humanistic care and meets the biological-psychological-social medical model requirements.

However, umbilical incision of LESS surgery are often 30 mm, and the umbilical hole is completely cut. The risk of Antoniou [3] postoperative incisional hernia at the umbilicus is slightly higher than conventional multi-port laparoscopic surgery. Weiss [9] found that incision length was associated with incisional hernia. Lappen [10] considered that pregnancy would increase the recurrence rate of incisional hernia, and its risk was still undervalued. Nevertheless, now we still lack of the research of gestational incisional hernia occurrence after LESS surgery and lack of long-term follow-up results. In the gestation period, increased intraperitoneal pressure and hormone changes are possible factors that could initiate abdominal hernia, so the risk of LESS postoperative umbilical hernia cannot be ignored.

In recent years, scholars had begun to research transumbilical two-port laparoscopic surgery and transumbilical three-port laparoscopic surgery [11, 12], which were considered to be safe, feasible, effective, and better cosmetic effect. Accumulating of 3 years' experience for LESS surgery [13, 14], our hospital carried out transumbilical laparoscopic surgery, including accessory surgery, uterine myomectomy and hysterectomy under LESS. We began to explore transumbilical multiport laparoscopic surgery, which could reduce the incision from 29.16 mm ± 1.30 mm to 18.81 mm ± 1.17 mm. Minimal incision could reduce the wound of the umbili-

cal region. The incisions were narrowed and dispersed, and the suturing wound was similar to conventional multi-port laparoscopic surgery, so it was faster and simpler than the LESS surgery group, shortening the wound suturing time.

LESS surgery reflects humanistic care for patients, and especially draws the attention of young women on their own body and postoperative scars. We used a scoring method proposed by Dunker [8] in 1998 to conduct a survey of patients after surgery. The method was accepted widely in the world and it was composed by the body image scale and the cosmetic scale (CS). In order to facilitate the out-patient service and simplify the investigation procedure, the CS was used for postoperative wound satisfaction survey. Nomura [15] found that CS score of single-port laparoscopic group was higher than conventional multi-port laparoscopic group, and gradually declined over time. He also thought LESS patients were more satisfied when compared their own scar with conventional multi-port laparoscopic surgery scars. In this study, the TMLS group owned the highest wound satisfaction. Wound satisfaction was closely related to wound size and weather wound could be hided. When choosing the umbilical incision, we adhered to the principle of conforming to the direction of the umbilical folds, and as far as possible to hide the incision in the wrinkle. Besides this, we narrowed and dispersed it, so it was more difficult to find scar after surgery. In these ways, we could meet the purpose of hiding scars and beauty.

It is generally only adopted the VAS score of pain in the first 24 hours post operation for comparison since LESS postoperative pain was gradually decreased [5, 15]. LESS surgery was more painful than the conventional laparoscopic group. The pain score in TMLS group decreased slightly, but the difference was not statistically significant compared with the LESS group or CMLS group.

Bendable and turnable dissecting forceps respectively adjusted curvature and direction by two knob, which form an operation triangle like multiport laparoscopic surgery, to reduce or avoid the chopstick effect. Combining uterus-lifting cup and abdominal wall lifting, it could reduce the operation difficulty and improve the operation efficiency. When operating accurately for transumbilical laparoscopic surgery, the disadvantages will be enlarged. For young patients with severe pelvic adhesions and pregnancy desire, the proposal still was adopting the conventional multi-port laparoscopic surgery to protect and promote reproductive function as the ultimate goal.

The use of conventional Trocar for transumbilical multiport laparoscopic surgery won't increase the economic burden of patients, and it is safe, effective, and feasible. It can minimize and disperse incisions, so that trauma could be smaller and the cosmetic scale could be better. It is a NOTES surgery to be generalized in the primary hospital.

This study has some shortcomings. Limited by economic factors, the study failed to use a special long-handled instruments, smaller Trocar, turnable mirror tube, etc. More inventions and applications of special instruments will be able to more effectively reduce the difficulty of operation and promote the progress of the natural cavity surgery.

Disclosure of conflict of interest

None.

Address correspondence to: Yuhua Zheng, Department of Gynecology, Southern Medical University Affiliated Maternal & Child Health Hospital of Foshan, Foshan, Guangdong, China. Tel: +86 757 82969782; E-mail: zyh2013916@163.com

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