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An Alternative System for Transvaginal Removal of Dermoid Cyst and a Comparative
Study with Laparoscopy

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Abstract

The objective was to introduce a new system for transvaginal removal of ovarian cyst and to evaluate its feasibility. With a new transvaginal system, ultrasound assisted culdotomy, and laparoscopy supported cystectomy if vaginal procedure failed. We conducted a retrospective review in which 35 cases using new vaginal ovarian cystectomy were compared to 40 cases of laparoscopic cystectomy for the treatment of dermoid cyst. All cystectomies were completed without conversion to laparotomy and complications. In a case from vaginal group, laparoscopy was required. No differences existed in operating time, haemoglobin decrease and C-reactive protein value between groups. Laparoscopically supported vaginal ovarian cystectomy with ultrasound-guided culdotomy was equivalent to laparoscopic cystectomy as to invasiveness and preserved the option of a completely vaginal approach. When a presumed benign dermoid cyst is located in cul-de-sac, this operation may represent a preferable alternative to an exclusively laparoscopic or exclusively vaginal ovarian cystectomy.

Introduction

Abdominal surgery has traditionally required an abdominal wall incision and this dermal incision is one of the most important determinants of invasiveness. Pain, scarring, and complications including hernia formation and adhesions are associated with the incision size¹. Although the use of laparoscopy has contributed significantly to an improvement in these shortcomings by reducing the size of the incisions, laparoscopy still possesses similar complications as laparotomy²⁻⁴.

Recently, natural orifice transluminal endoscopic surgery (NOTES) has become an area of great interest^{1,5-9}. In NOTES, natural orifices such as the mouth, anus, urethra, and vagina are used as ports of entry into the peritoneal cavity through which flexible or rigid endoscopic devices are passed. NOTES is still in the early stages of development, but is expected to prove superior to laparoscopic surgery with regard to invasiveness, as incisions in the abdominal wall are eliminated. Among natural orifices, the transvaginal route is considered to be the most promising for peritoneal cavity access

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The vagina is a unique organ, directly abutting the peritoneal cavity, but showing no visible scars after incision of the vaginal wall^{14,15}. For more than a century,

gynaecological surgeons have used the vagina as a route for the removal of intraperitoneal organs¹⁶. Vaginal hysterectomy is commonly performed by gynaecologists and has many advantages over both abdominal hysterectomy and laparoscopically assisted vaginal hysterectomy^{17,18}. Theoretically, benign ovarian cysts can also be removed vaginally^{19,20}.

Vaginal ovarian cystectomy, however, has failed to gain wide acceptance among gynaecologists. In developed countries, most benign ovarian cysts are managed laparoscopically. Vaginal ovarian cystectomy consists of culdotomy and ovarian cystectomy, and each step carries technical difficulties²¹. In the culdotomy, the peritoneal cavity cannot be opened without an accurate incision of the vaginal wall towards the cul-de-sac, and a blind incision can sometimes injure the rectum²². Even if the culdotomy is performed successfully, intrapelvic adhesions among cysts and uterus sometimes preclude completion of the cystectomy. In such cases, the surgeon must convert to laparotomy. The risk of rectal injury and the uncertainty of success have thus dissuaded most gynaecologists from adopting this procedure.

To resolve these problems, we recently proposed new techniques for culdotomy and cystectomy that do not default to laparotomy when unsuccessful. Transvaginal

ultrasound was used to identify a safe route into the cul-de-sac and this culdotomy procedure showed a high success rate^{10,23,24}. In addition, to remove the dependency on laparotomy if the vaginal approach failed, we adopted a system in which a laparoscopic system was available if needed²⁵.

The less-invasive surgery must be pursued continuously after the establishment of minimally invasive surgery by laparoscopy. Vaginal surgery has the benefit of no incisions in the abdominal wall, compared with laparoscopy. In this study, vaginal ovarian cystectomy using a new culdotomy approach and laparoscopic backup was compared to standard laparoscopic cystectomy in women with a dermoid cyst. The purpose of this study was to evaluate the feasibility of the newly presented vaginal ovarian cystectomy.

Materials and Methods

The diagnosis of dermoid cyst was determined by preoperative transvaginal ultrasonography^{26,27}. The indications for cystectomy were that the dermoid cysts were presumed benign and the premenopausal women wished to preserve the ovaries. In the majority of cases, magnetic resonance imaging (MRI) was used to distinguish benign dermoid cyst from dermoid cyst with malignant transformation or other ovarian tumours including malignancies. Dermoid cysts with serum squamous cell carcinoma antigen levels outside the normal range were excluded from the indications for cystectomy, due to the possibility of malignant transformation²⁸⁻³⁰. Dermoid cysts with alpha-fetoprotein levels outside the normal range were also excluded because of the possibility of being immature³¹.

For the treatment of presumed benign dermoid cysts, 93 women had undergone ovarian cystectomy between January 2004 and September 2009 at Kanazawa University Hospital or Sagawa Clinic. Of these 93 women, we identified 75 women with a unilateral cyst located in the cul-de-sac. Residual 18 women had either bilateral cysts or unilateral cyst located in the vesico-uterine fossa. A transvaginal approach using

culdotomy was applied in 35 of these women, and a standard laparoscopic method was used in the remaining 40 women.

The vaginal approach for cystectomy was explained to the women by two gynaecological surgeons. During the study period, 42 women with unilateral dermoid cyst in the cul-de-sac were introduced to these two surgeons. After excluding three women who were still virgins, 39 women received explanations of not only the laparoscopic method, but also the transvaginal approach to removing the cyst. Thirty-five of the 39 women wished to undergo transvaginal cystectomy and four women elected for laparoscopic cystectomy. As the three virgins were treated by laparoscopic cystectomy, seven of the 42 women were treated using the laparoscopic method. During the same period, 33 women were introduced to another four surgeons who were specialists in the laparoscopic surgery, and were all treated using the laparoscopic method. In total, 35 women were treated using the transvaginal approach and 40 women were treated using the laparoscopic method.

Age, body mass index, parity, and maximum cyst diameter were determined in both vaginal and laparoscopic groups as preoperative characteristics (Tables 1).

Completion rate, rate of conversion to laparoscopy or laparotomy, intraoperative

complications, operating time, haemoglobin decrease on postoperative day 1, C-reactive protein (CRP) level on postoperative day 3 and postoperative complications were examined as intra- and postoperative outcomes and compared between groups (Tables 2,3). Estimated blood loss could not be calculated in half of the laparoscopy cases, since the blood was combined with aspirated cyst contents and irrigation.

Haemoglobin decrease was therefore used to evaluate blood loss. Haemoglobin value was examined preoperatively and on postoperative day 1, and the decrease calculated as the difference between these two values. CRP increases when infection or inflammation occurs, so we used the CRP level as an indicator of infection, inflammation and the invasiveness of surgery. Preoperative CRP levels were all below the limit of detection.

Normally distributed data were reported as the mean \pm standard deviation, whereas skewed data were reported as the median with interquartile range. To test differences, Student's *t*-test was used for normally distributed data, whereas Mann-Whitney U test was used for skewed data. Values of $P < 0.05$ were considered statistically significant.

Operative procedure for the vaginal approach:

Women were administered enemas on both the day prior to and the day of surgery. Antibiotic prophylaxis was intravenously used on the day of surgery and subsequent two days. The operation began transvaginally with the woman in the dorsal lithotomy position on the operating table under general or spinal anaesthesia. Disinfection of vagina was achieved by povidone iodine. Culdotomy was completed first, followed by ovarian cystectomy, which was performed through the defect in the vaginal wall (Figure 1).

Each culdotomy was assisted by transvaginal ultrasonography. In the first eight cases, ultrasound and a renal balloon dilator catheter were used for culdotomy²³. In the last 27 cases, ultrasound and an umbrella Hakko needle was used for culdotomy^{10,24}. With both methods, transvaginal ultrasonography visualized the safe vaginal area for entry into the cul-de-sac.

In the former group, following centesis to the vaginal wall by the needle under ultrasound guidance, a balloon catheter dilated the route toward the cul-de-sac²³.

In the latter group, an umbrella Hakko needle was a guide for the entry into intraperitoneal cavity^{10,24}. After a vaginal ultrasound probe with a needle guide was inserted into the vagina, the ovarian cyst was directly punctured under ultrasound

guidance with an umbrella Hakko needle via the center of the posterior vaginal fornix (Figure 2-A, 2-C). Following ultrasonographic confirmation of the placement of the top of the umbrella needle into the cyst, the umbrella portion of the needle was opened (Figure 2-B). Following the extraction of the ultrasound probe from the vagina, the needle remained, penetrating the center of the posterior vaginal fornix. While the needle was gently retracted towards the operator's side, the vaginal walls on both sides of the needle were incised with an electric scalpel (Figure 2-D). Following an adequate incision of the vaginal wall, the ovarian cyst wall was visible in the cul-de-sac through the vaginal defect. By enlarging the defect in the vaginal wall with forceps, the culdotomy was completed (Figure 2-E). The final size of incision was about 3cm. This culdotomy procedure was named Culdotomy 2U²⁴. In cases in which the ovarian cyst was a short distance from the cul-de-sac, we adopted the Culdotomy 4S2U procedure¹⁰. In this procedure, saline solution was infused into the intrapelvic cavity from a balloon catheter inserted into the uterus via the fallopian tubes and an artificially-developed, saline solution space in the cul-de-sac was punctured by the umbrella needle under the guidance of transvaginal ultrasound (Figure 2-C). After successful culdotomy, the ovarian cyst wall was visible in the cul-de-sac.

The ovarian cyst was then partially exteriorised through the vaginal wall defect towards the side of the operator. The cyst contents were then aspirated with another needle to reduce the volume and permit further exteriorisation (Figure 2-F). If the dermoid cyst had too many solid components or the cyst fluid was too viscous for drainage, cyst contents were removed by enlarging the culdotomy. Any cyst contents that spilled into the peritoneum were carefully aspirated and wiped away. After the partial descent of the cyst into the vagina, transvaginal ovarian cystectomy was performed in a manner similar to that of the procedure for laparotomy (Figure 2-G). Perfect resection of cyst wall was confirmed by no rupture and round shape of the removed cyst wall bottom. Following hemostasis and repair of the remaining ovarian tissue (Figure 2-H), the defect in the vaginal wall was closed with sutures transvaginally (Figure 2-I).

If vaginal ovarian cystectomy was impossible because of failed culdotomy or no descent of cyst into the vagina secondary to intrapelvic adhesions or in the event of uncontrolled bleeding, cystectomy was completed by laparoscopy (Figure 1)²⁵.

Laparoscopic ovarian cystectomy was performed using a standard laparoscopic

procedure. After removal of the resected surgical specimen via the vagina, the vaginal defect was closed transvaginally.

The umbrella Hakko needle is a newly developed device that has not yet been approved for medical use^{10,24}. The Kanazawa University Hospital ethics committee and institutional review board authorised experimental use of this device in vaginal ovarian cystectomy. A full explanation of the device was provided to the women, all of whom provided informed consent prior to participating in the study.

Laparoscopy operative procedure:

Gas laparoscopy was performed in all laparoscopic cases. The woman was placed in the dorsal lithotomy position on the operating table under general anaesthesia and the first trocar was inserted from below the umbilicus into the intraperitoneal cavity using the open method. Following visualisation of the intraperitoneal cavity with the scope, two additional ports were inserted. A uterine manipulating device was used to move the uterus in all women except those who were virgins. In most cases cystectomy was completed intra-abdominally. In some cases the cyst contents were aspirated intra-abdominally and the cyst was removed extra-abdominally. Following hemostasis

with bipolar forceps and irrigation of the intraperitoneal cavity, the laparoscopic procedure was finished with suturing of the port wounds.

Results

Age, body mass index, parity, and cyst diameter were compared between the vaginal and laparoscopic groups as preoperative patient characteristics (Table 1). No significant differences were noted between groups, although the vaginal group tended to show higher mean age and fewer nulliparous women compared to the laparoscopic group.

All cases were divided into nulliparous and pluriparous classes. In each class, age, body mass index, and cyst diameter were compared between vaginal and laparoscopic groups (Table 1). In the nulliparous class, mean age tended to be higher and body mass index tended to be lower in the vaginal group, but these differences were not significant. In the pluriparous class, no differences were apparent between groups.

All cystectomies in both vaginal and laparoscopic groups were completed without conversion to laparotomy. Laparoscopy was required to complete the cystectomy in a case from the vaginal group due to uncontrolled bleeding. No major intraoperative complications, including rectal injury, were encountered in either group (Table 2).

Operating time, haemoglobin decrease on postoperative day 1 and CRP level on postoperative day 3 were compared between groups, in the nulliparous and pluriparous

classes. Haemoglobin decrease is shown as mean \pm standard deviation because of the normal distribution, while data for operating time and CRP level are shown as median with interquartile range because of the skewed distribution.

Operating time and haemoglobin decrease were compared between groups as intraoperative outcomes (Table 3). Operating time tended to be shorter in the vaginal group than in the laparoscopic group in both nulliparous and pluriparous classes, but the differences were not significant. No significant difference existed between the two groups with regard to haemoglobin decrease.

CRP level was compared between groups as postoperative outcomes (Table 3). No difference between groups was identified about CRP level. No severe postoperative complications or cases of malignancy were identified in either group.

Discussion

Vaginal ovarian cystectomy requires no incisions into the abdomen. If completed successfully, the procedure may be less invasive than laparoscopy³². The conventional transvaginal approach, however, is not always successful and is often difficult²¹. A restrictive surgical field, lack of confidence in performing the culdotomy, difficulty in observing and irrigating intraperitoneal cavity and a reluctance to convert to laparotomy in unsuccessful cases are factors that have dissuaded most gynaecologists from adopting this procedure. We have proposed two solutions to some of these shortcomings^{10,23,24,25}. The first is a new culdotomy technique and the other is support by laparoscopy. Our modifications have evolved into laparoscopically supported vaginal ovarian cystectomy with ultrasound-guided culdotomy. We therefore compared this new system of vaginal ovarian cystectomy with standard laparoscopic cystectomy.

To avoid sampling bias between the two groups, we gave thought to the following points. The histological type of ovarian cysts was limited to dermoid cysts.

Operative procedure was limited to cystectomy only. Bilateral cysts were excluded

and the object of surgery was restricted to unilateral cyst located in the cul-de-sac.

Eligible cases were selected from the same facilities within the same period.

Analysis of preoperative patient characteristics revealed fewer nulliparous women in the vaginal group, compared to the laparoscopic group (Table 1). Women were required to be non-virginal for employment of the transvaginal route. As a result, three women who were virgins were intentionally assigned to the laparoscopic group. Of the four women who desired laparoscopic operation after explanation of the transvaginal method, three were nulliparous by chance. If they had been included in the vaginal group, there would have been more nulliparous women in the vaginal group. Bias of parity may have influenced operative outcomes, as the transvaginal procedure may be easier in pluriparous women, compared to nulliparous women. We thus divided cases into nulliparous and pluriparous classes for analysis.

Analysis of preoperative patient characteristics in the nulliparous class showed a tendency toward older age and lower body mass index in the vaginal group, although these differences were not significant (Table 1). The absence of virgins seems likely to have increased the mean age in the vaginal group. We do not know why body mass index was lower in the vaginal group.

All culdotomies were achieved successfully with ultrasound-guided methods in the vaginal group. In the last 27 of the 35 cases, the latest culdotomy procedures were adopted^{10,24}. Transvaginal ultrasonography visualised the safe vaginal area for entry into the cul-de-sac and a newly developed umbrella Hakko needle guided for the correct incision of the vaginal wall. This method was simple and the operating time for culdotomy was short. We think that each successful culdotomy was due to this technique.

No cases showed poor descent of the cyst to the vagina and resultant conversion to laparoscopy. This finding suggests that adhesions are rare and removal of a cyst wall through the vaginal wound is possible in the majority of cases of dermoid cyst. In one case, laparoscopy was required because of uncontrolled bleeding from remaining ovarian tissue. In our system, laparoscopy guarantees completion of the operation whenever the transvaginal procedure fails, thus sparing the woman a highly invasive procedure. In this sense, our system worked well²⁵.

Some gynaecologists may claim that laparoscopically supported vaginal ovarian cystectomy is not an operative method, as the laparoscopy is not always used and the procedure differs among cases. Allowing for this point, we consider our method as a

system. There is merit to recognising transvaginal cystectomy with backup laparoscopy as a definite operation system. Traditional vaginal cystectomy without laparoscopic support must sometimes be converted to laparotomy, and has thus failed to gain wide support from both surgeons and patients. Recognition of our method as an operative system could lead to a dramatic effect on vaginal ovarian cystectomy. Gynaecologists would be able to confidently recommend a vaginal approach to women. Women would be more likely to accept a vaginal approach if a minimally invasive procedure is more certain. Vaginal ovarian cystectomy combined with laparoscopic support should be recognised as a new operative system.

In terms of operating time, haemoglobin decrease and CRP level, no differences existed between groups. These findings suggest that cystectomy via a vaginal route is comparable to laparoscopic cystectomy in terms of invasiveness.

Although no intra- or postoperative complications were apparent in the vaginal group, infertility and dyspareunia over the long term must be evaluated. According to a questionnaire about transvaginal NOTES to gynaecologists, infertility and dyspareunia after the operation remain matters of concern³³. We are now addressing these questions with a questionnaire to women undergoing vaginal ovarian cystectomy.

We must take into consideration the influences of intraperitoneal spillage of cyst contents. When performing ovarian cystectomy, either laparoscopically or transvaginally, avoiding intraperitoneal spillage in all cases is not feasible^{34,35}. Preoperative minimisation of the possibility of ovarian malignancy is thus imperative^{26,27,36}. Meticulous preoperative studies, including ultrasound, MRI, and tumour marker levels are essential to exclude all cases of possible malignancy²⁶⁻³¹. In some cases in which preoperative examinations don't perfectly deny the possibility of malignancy, laparoscopy should be selected because laparoscopic inspection may be useful to find occult ovarian malignancy.

Chemical inflammation after intraperitoneal spillage must also be avoided. CRP level of the vaginal group was statistically equal to that of the laparoscopic group. This result suggests that intraperitoneal spillage in the vaginal group was minimal and chemical inflammation did not occur. However, the degree of intraperitoneal spillage should be estimated using a different method. Currently, we perform intraperitoneal observation with a flexible endoscope via a vaginal wound during vaginal ovarian cystectomy. Using this scope, the pelvic cavity can not only be observed, but also

irrigated. This method may thus become useful as a routine procedure for vaginal ovarian cystectomy.

We named the new vaginal ovarian cystectomy using ultrasound and an umbrella needle, as applied in the last 27 cases, “laparoscopically supported vaginal ovarian cystectomy with the assistance of ultrasound and an umbrella needle” (LSVOC2U).

Our system showed a reliable profile comparable to conventional laparoscopy for the treatment of dermoid cyst located in the cul-de-sac. If the woman desires a minimally invasive, scarless surgery, this method may be the preferred alternative to an exclusively laparoscopic or exclusively vaginal ovarian cystectomy.

Figure Legends

Figure 2 The procedure of vaginal ovarian cystectomy

- A. The top of the umbrella Hakko needle. The umbrella portion is closed.
- B. The top of the umbrella Hakko needle. The umbrella portion is opened.
- C. With the patient in the dorsal lithotomy position, the ovarian cyst or saline solution space in the cul-de-sac is punctured under ultrasound guidance through a needle guide; an umbrella Hakko needle is inserted at the center of the posterior vaginal fornix.
- D. Vaginal walls on both sides of the needle are incised with an electric scalpel.
- E. Following an adequate incision of vaginal wall, the ovarian cyst wall in the peritoneal cavity is visible. In Culdotomy 2U, the cyst punctured by an umbrella needle is found.
- F. The aspiration of cyst contents with the needle promotes the reduction and exteriorisation of cyst.
- G. After descent of the cyst into the vagina, ovarian cystectomy is performed.
- H. After hemostasis, the remaining ovarian tissue is repaired.
- I. The defect in the vaginal wall is closed with sutures transvaginally.

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Table 1. Preoperative patient characteristics

All patients	Vaginal group n=35	Laparoscopic group n=40	p
Age (yrs)	31.5 ± 6.0	28.9± 7.3	0.09
Body Mass Index	20.8 ± 3.0	21.7± 3.2	0.21
Diameter (cm)	6.1 ± 2.0	6.1 ± 2.4	0.98
Nullipara	20(56)	29(73)	0.17
Nullipara	n=20	n=29	
Age (yrs)	29.0± 5.7	26.6± 6.7	0.20
Body Mass Index	20.3 ± 3.5	21.9± 2.8	0.08
Diameter (cm)	6.1 ± 1.7	6.2 ± 2.6	0.95
Pluripara	n=15	n=11	
Age (yrs)	34.9 ± 4.7	34.8± 5.2	0.95
Body Mass Index	21.2 ± 2.1	21.1± 4.3	0.93
Diameter (cm)	6.1 ± 2.4	6.0 ± 2.1	0.92

Data are presented as mean ± standard deviation or n (%).

Table 2. Intraoperative outcomes

	Vaginal group	Laparoscopic group
Completion cases	35 (100)	40 (100)
Conversion to laparotomy	0 (0)	0 (0)
Conversion to laparoscopy	1 (3)	
Complications	0 (0)	0 (0)

Data are presented as n (%).

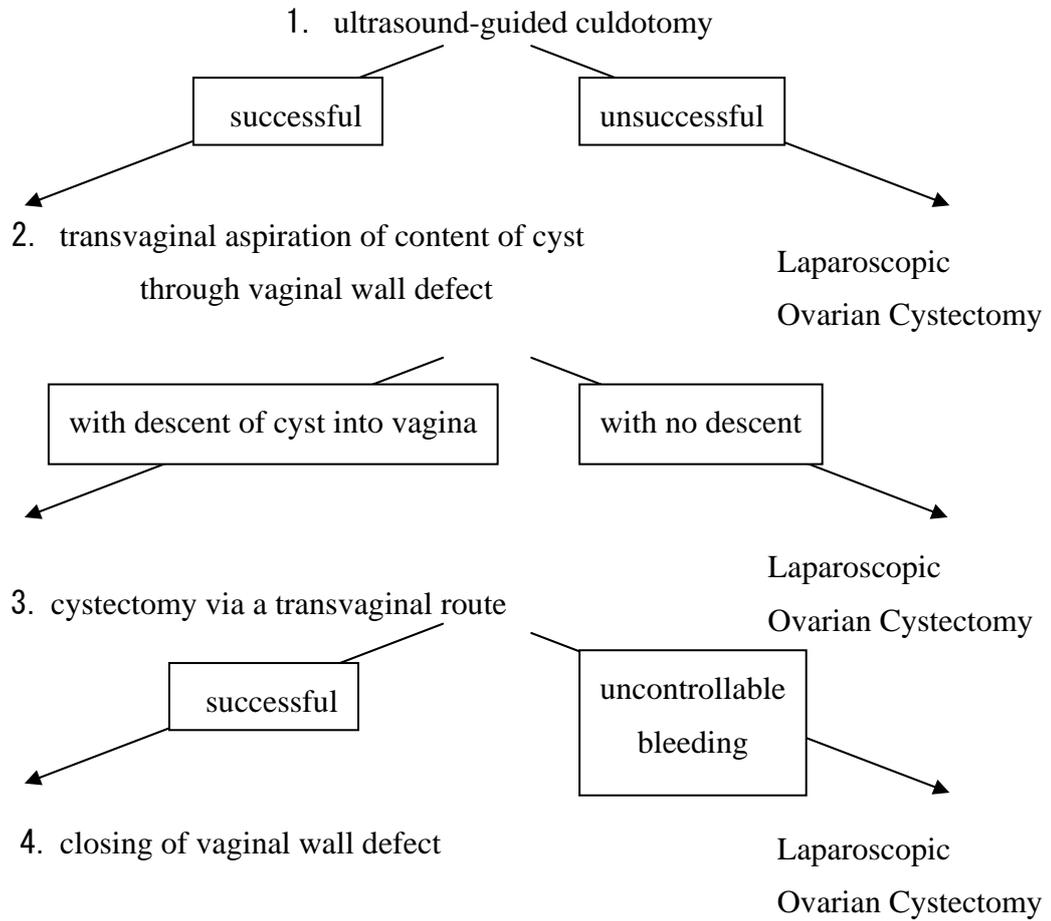
Table 3. Intra- or postoperative outcomes
in the nulliparous and pluriparous classes

Nullipara	Vaginal group	Laparoscopic group	p
Operating time (min)	95.5 [74-129]	120 [96-140]	0.15
Hb decrease (g/dl)	1.65 ± 0.55	1.61 ± 0.90	0.87
CRP Day3 (mg/dl)	1.5 [0.6-2.6]	1.9 [0.4-3.2]	0.22
Pluripara	Vaginal group	Laparoscopic group	p
Operating time (min)	80 [63-126]	105 [90-131]	0.19
Hb decrease (g/dl)	1.43 ± 0.82	1.63 ± 0.81	0.54
CRP Day3 (mg/dl)	1.8 [1.1-2.6]	1.9 [1.3-2.6]	0.26

Data are presented as median [interquartile range] or mean ± standard deviation.

CRP=C-reactive protein.

Figure 1 . Procedure of Laparoscopically Supported Vaginal Ovarian Cystectomy with Ultrasound-Guided Culdotomy



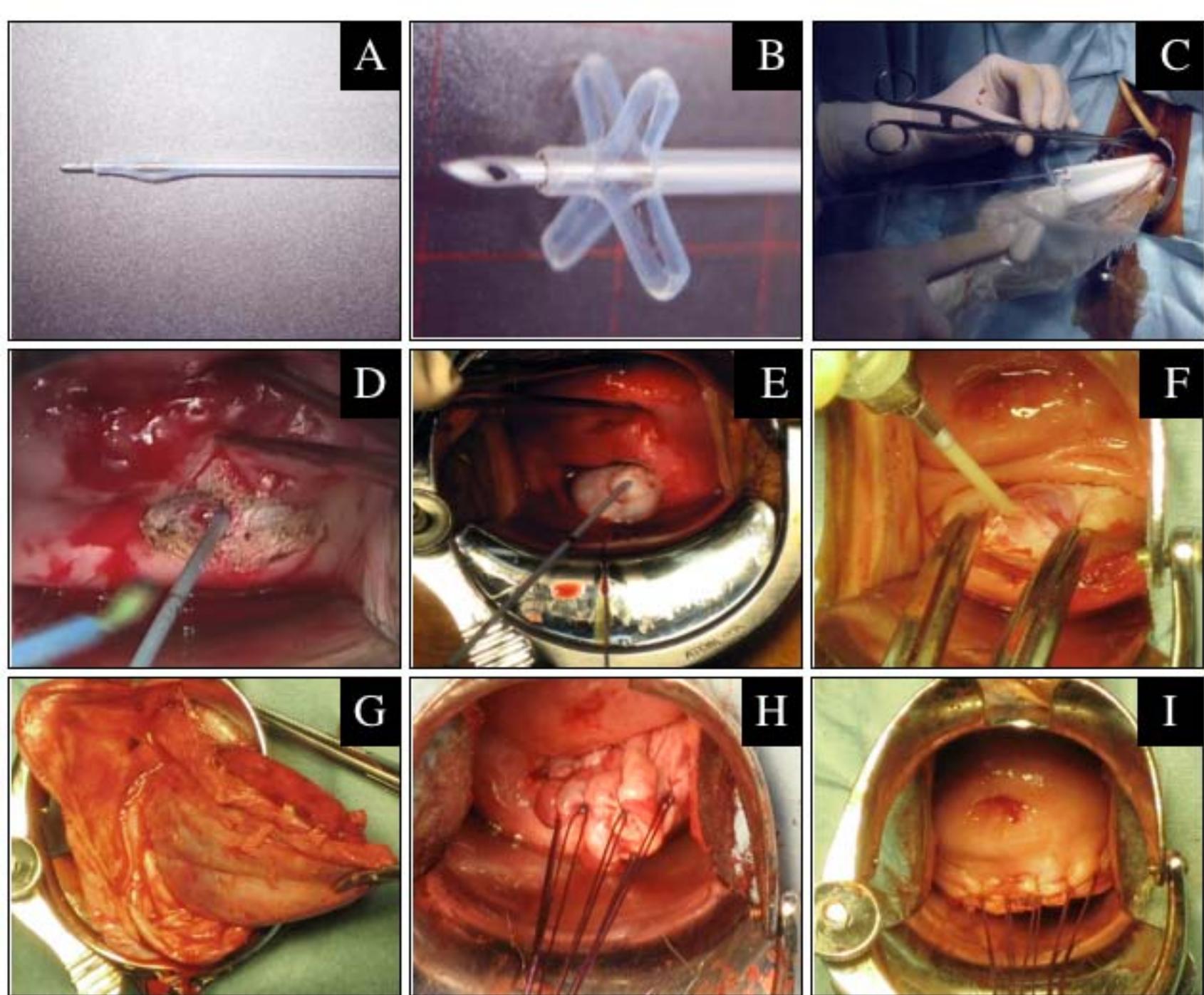


Figure.2