



Comparing outcomes of ovarian cystectomy by vaginal natural orifice transluminal endoscopic surgery versus laparoendoscopic single-site surgery: A retrospective cohort study

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Abstract

Background: We aimed to compare the outcomes of ovarian cystectomy (OC) performed by vaginal natural orifice transluminal endoscopic surgery (vNOTES) vs transumbilical laparoendoscopic single-site surgery (LESS).

Methods: We retrospectively analyzed the data of patients in our hospital who underwent OC either by vNOTES or LESS between January 2015 and September 2021. Demographic data were collected. The primary outcome was the conversion rate. The secondary outcomes were the duration of surgery, length of hospital stay, estimated blood loss, maximum body temperature within 48 hours after operation, and duration of maximum body temperature (hours), among others. Statistical analysis was done using the SPSS software.

Results: Exactly 284 patients were screened. The vNOTES and LESS groups consisted of 21 and 47 patients, respectively. There was no significant difference in the conversion rates between the two groups (0 vs 8.5% in vNOTES and LESS, respectively; $p = 0.303$). Compared with the vNOTES group, the LESS group had a larger cyst diameter (6.00 ± 2.32 vs 4.69 ± 1.29 cm; $p = 0.004$), more endometriotic cysts (42.6% vs 9.5%; $p < 0.001$), and more pelvic adhesions requiring adhesiolysis (57.4% vs 19.0%; $p = 0.003$). At baseline, there were no other differences between the groups. The secondary outcomes included a shorter duration of surgery (70.14 ± 27.30 vs 99.57 ± 36.26 minutes; $p = 0.001$) and lower estimated blood loss (64.29 ± 39.19 vs 163.43 ± 251.20 mL; $p = 0.011$) in the vNOTES group. Regression analysis showed the diameter of the ovarian cyst correlated with surgical time. The complication was comparable between the two groups.

Conclusion: Above all, the advantages of vNOTES include an absence of visible scars, shorter surgical duration, and less blood loss when compared with LESS. Further large-scale prospective trials should confirm the results of our study.

Keywords: Laparoendoscopic single-site surgery; Ovarian cystectomy; Vaginal natural orifice transluminal endoscopic surgery

1. INTRODUCTION

Ovarian cysts are common diseases among women.¹ For women of reproductive age, most ovarian cysts they experience are benign and can be managed conservatively.¹ However, bothersome symptoms such as lower abdominal pain or menorrhagia may cause women with ovarian cysts to seek medical intervention.^{1,2} Approximately 5% to 10% of women will need surgical intervention for symptomatic ovarian cysts throughout their lifetime.^{3,4}

The indication for laparoscopic ovarian cystectomy includes all benign lesions: a mass <5 cm with liquid or dermoid content, a thin wall (<3 mm), less than three fine partitions (<3 mm), no solid part and normal Doppler.^{5,6} The other benign cyst with a diameter range of 5 to 10 cm is also indicated for laparoscopic surgery.^{5,6} Organic ovarian cyst like endometriosis or teratoma is not remission spontaneously; surgical removal is the standard procedure. Laparoscopic ovarian cystectomy is the gold standard.⁷

Ovarian torsion is a true surgical emergency that must be considered in the differential diagnosis of any female patient presenting with acute abdominal pain.^{8,9} Recently, it has been proven that the most common cause of ovarian torsion is an ovarian cyst.¹⁰

Regarding surgical techniques in gynecology, minimal-invasive surgery (MIS) has become mainstream, with the advantages of cosmetic effects and rapid recovery.^{3,11} Among the types of MISs, laparoendoscopic single-site surgery (LESS) involves the creation of a hole in the umbilicus.^{3,12-16} In contrast, vaginal natural orifice transluminal endoscopic surgery (vNOTES) involves using the vagina as a pathway to the pelvic cavity, minimizing visible wounds in the patient's body.^{3,17-20}

Although vNOTES has been reported to have more advantages than LESS, more studies are still needed to verify that

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claim.^{3,21,22} Therefore, our study aims to assess the safety, feasibility, advantages, and disadvantages of vNOTES vs LESS in ovarian cystectomy (OC). We retrospectively analyzed the data of patients who underwent OC by either vNOTES or LESS due to benign ovarian cysts.

2. METHODS

2.1. Ethical approval

The study was approved by the Research Ethical Committee of our Hospital (IRB 111-193-B, approval date: September 20, 2022). Written informed consent was waived due to the low risk of this study, and the research methodology was performed following all relevant guidelines and regulations. This study has been conducted according to the Helsinki Declaration of human rights. We retrospectively analyzed the data of all patients in our hospital who underwent OC by either vNOTES or LESS due to benign ovarian cystic lesions between July 2016 and September 2021 (International Classification of Diseases, 10th revision: N83.2).

The inclusion criteria were as follows: (1) patients who underwent laparoscopic surgery for ovarian cysts, (2) patients whose vital signs were stable and laparoscopic surgery could be tolerated, and (3) patients whose pathology report showed benign ovarian cysts. The exclusion criteria were as follows: (1) patients that had pelvic inflammatory disease and (2) menopausal patients. The case collection flowchart is illustrated in Figure 2.

2.2. Demographic data

Demographic data were collected. This included age (years), body mass index (BMI, kg/m²), number of vaginal births, prior abdominal surgery, prior cesarean section, the diameter of the cysts (cm), type of cyst (endometriotic cyst, teratoma, and other ovarian cysts), and pelvic adhesions requiring adhesiolysis.

The primary outcome was the conversion rate. The secondary outcomes were the duration of surgery (minutes), duration of hospitalization (days), estimated blood loss (mL), maximum body temperature within 48 hours after operation, the duration for which the maximum body temperature lasted (hours), maximum visual analog scale (VAS) score within 48 hours after operation, and the duration for which the maximum VAS score lasted (hours).

2.3. Procedure

The surgical procedure was described below:

2.3.1. LESS OC

A vertical incision (2 cm) along the umbilicus was made. Then we inserted a glove port (Nelis, Seoul, Korea) through the umbilical wound. Then a pneumoperitoneum was made by instillation

with CO₂ and maintained the pressure of 12 mmHg. The OC procedure began with an incision over the ovarian cyst surface without puncturing the cyst. A blunt dissection and counter traction with Dolphin forceps and LigaSure (Medtronic, Minneapolis, MN, USA) was performed (Fig. 1A). The cyst wall was separated from the ovarian surface and removed through the glove port. Then we sutured the incision with an interrupted suture.

2.3.2. vNOTES OC

For vNOTES OC, a transverse incision wound along the posterior fornix was performed. Then we used scissors to dissect the posterior rectovaginal space and entered the cul-de-sac. A glove port was inserted into a posterior cul-de-sac and made pneumoperitoneum. A hook scissor was used to cut the ovarian surface, and two dolphin graspers dissected the ovarian cyst (Fig. 1B). After isolating the cyst from the ovarian surface, the ovarian cyst was removed through a glove port. Then we removed the glove port and approximated the vaginal wall with suture materials.

2.3.3. Indications of OC

The indication of ovarian cystectomy in our series: endometrioma, teratoma, serous cystadenoma, ovarian cyst rupture, and torsion. The decision of the technique used depended on the surgeon's surgical experience and favor. Teratoma and serous cystadenoma were favored for vNOTES. Endometrioma, cyst rupture, and torsion were favored for LESS. Only one surgeon performed vNOTES in our hospital (D.-C.D.).

2.3.4. Postoperative care

All patients in both groups received fluid supplementation with 1500 mL of normal saline and 1000 mL of Dextrose 5% in water (D5W). Foley catheterization was carried out 1 day after the operation. The patients were discharged based on these criteria: (1) staying afebrile for at least 24 hours and (2) having no evidence of surgical complications. All the surgeries were performed by one of the authors (D.-C.D.).

2.4. Statistical analyses

Statistical analysis was done using SPSS software (version 22; IBM, New York, NY, USA). Statistical values are presented as mean \pm SD, median, and interquartile range (IQR) for continuous or ordinal variables, and for categorical variables, as frequencies and percentages. When comparing the mean differences of continuous or ordinal variables between two treatment groups, the Student *t* test or Wilcoxon rank-sum test was adopted depending on whether it followed a normal distribution. Shapiro-Wilk test was used to test whether the data followed a normal distribution. The chi-square test or Fisher exact test was used to evaluate the association between two categorical variables. Multiple linear regression was used to evaluate the

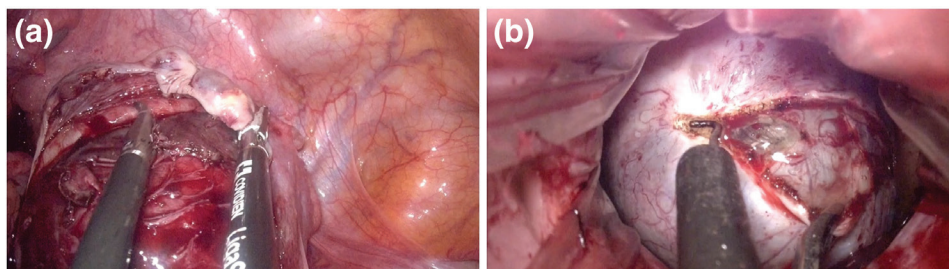


Fig. 1 Intraoperative view of ovarian cystectomy. A, LESS for ovarian endometrioma. B, vNOTES for ovarian teratoma. LESS = laparoendoscopic single-site surgery; vNOTES = vaginal natural orifice transluminal endoscopic surgery.

association between risk factors and major outcomes, including the duration of surgery and estimated blood loss. The model assumptions, including linear relationship/independence/normality/homoscedasticity, were validated via a scatter plot, normality test, and residual plot.

We used G*Power 3.1.9.2 to calculate the sample size needed. For the comparison of the mean difference of outcome between vNOTES and LESS group, we set effect size of 0.80, α of 0.05, power(1- β) of 0.80, vNOTES to LESS sample size ratio of 0.5, and two-sided test then got the estimated sample size 58 (number of vNOTES was 19 and number of LESS was 39). In this study, $p < 0.05$ was considered statistically significant.

3. RESULTS

A total of 284 patients were screened. The vNOTES and the LESS groups finally consisted of 21 and 47 patients, respectively (Fig. 2). Compared with the vNOTES group, the LESS group had larger diameter of cysts (6.00 ± 2.32 vs 4.69 ± 1.29 cm; $p = 0.004$), more endometriotic cysts (20 [42.6%] vs 2 [9.5%]; $p < 0.001$), and more pelvic adhesions requiring adhesiolysis (27 [57.4%] vs 4 [19.0%]; $p = 0.003$). At baseline, there were no other differences between the two groups (Table 1).

There was no statistical difference in the conversion rates between the two groups. However, the LESS group had four patients (8.5%) that converted to conventional laparoscopy, and

there was no conversion in the vNOTES group. The secondary outcomes included a shorter duration of surgery (70.14 ± 27.30 vs 99.57 ± 36.26 minutes; $p = 0.001$) and lower estimated blood loss (64.29 ± 39.19 vs 163.43 ± 251.20 mL; $p = 0.011$) in the vNOTES group than in the LESS group. There were no other statistically significant differences between the two groups regarding secondary outcomes, including length of hospitalization, maximum body temperature within 48 hours after operation, the duration for which the maximum body temperature lasted, maximum VAS score within 48 hours after operation, and the duration for which the maximum VAS score lasted (Table 2).

The Clavien–Dindo classification was used for perioperative complication classification in the two groups (Table 3).²³ There was no significant difference in adverse events between the two groups. Table 4 details illustrate the adverse events (need for blood transfusion, postoperative fever, thermal injury, and hypovolemic shock) experienced in the two groups. There was no significant difference in adverse events between the two groups.

Regarding the duration of surgery, the crude ratio showed that the surgical duration increased by 7.07 minutes as the diameter of the cyst increased by 1 cm (Table 5). Using endometrioma as a reference, teratoma and other ovarian cysts decreased the surgical duration to 33 and 22.61 minutes, respectively. For patients with pelvic adhesions requiring adhesiolysis, the duration of the surgery increased by 26.97 minutes compared to those who did not have pelvic adhesions or did not need adhesiolysis. However,

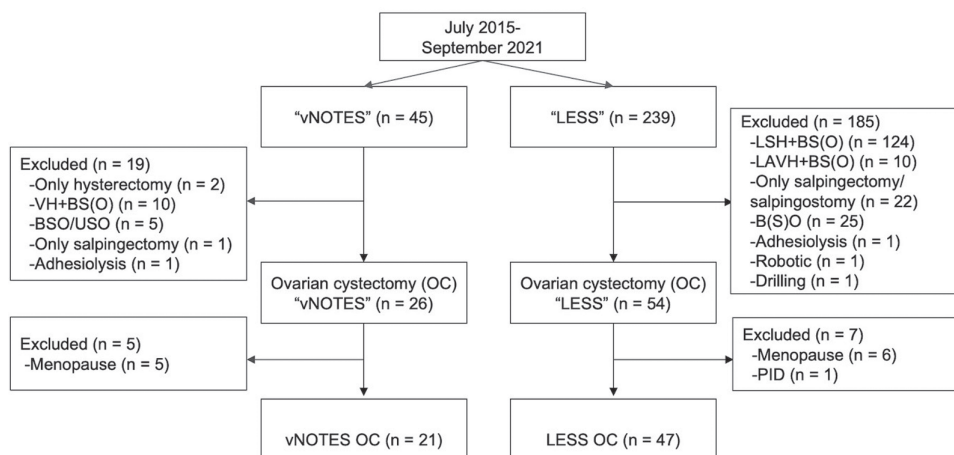


Fig. 2 Flowchart of the study. BSO = bilateral salpingo-oophorectomy; LAVH = laparoscopic-assisted vaginal hysterectomy; LESS = laparoendoscopic single-site surgery; LSH = laparoscopic supracervical hysterectomy; OC = ovarian cystectomy; PID = pelvic inflammatory disease; USO = unilateral salpingo-oophorectomy; VH = vaginal hysterectomy; vNOTES = vaginal natural orifice transluminal endoscopic surgery.

Table 1
Baseline characteristics of the vNOTES and LESS groups

Baseline characteristics	vNOTES (N = 21)	LESS (N = 47)	p
Age (y), mean ± SD	33.95 ± 9.86	32.08 ± 8.56	0.431
BMI (kg/m ²), mean ± SD	23.12 ± 4.68	22.80 ± 4.05	0.77
No. of vaginal births, median (Q1, Q3)	0 (0,1)	0 (0,0)	0.319
Prior abdominal surgery, n (%)	4 (19.0)	15 (29.4)	0.341
Prior cesarean section, n (%)	3 (14.3)	7 (13.72)	1.000
Diameter of the cyst (cm), mean ± SD	4.69 ± 1.29	6.00 ± 2.32	0.004 ^a
Type of cysts, n (%)			
Endometriotic cyst	2 (9.5)	20 (42.6)	<0.001 ^a
Teratoma	14 (66.7)	22 (46.8)	
Other ovarian cysts	5 (23.8)	5 (10.6)	
Pelvic adhesions requiring adhesiolysis, n (%)	4 (19.0)	27 (57.4)	0.003 ^a

BMI = body mass index; Q1 = first quartile; Q3 = third quartile; LESS = laparoendoscopic single-site surgery; vNOTES = vaginal natural orifice transluminal endoscopic surgery. $p < 0.05$ and considered statistical significant.

Table 2
Primary and secondary outcomes of the vNOTES and LESS groups

Outcomes	vNOTES (N = 21)	LESS (N = 47)	p
Primary outcome			
Conversions, n (%)	0 (0.0)	4 (8.5)	0.303
Secondary outcomes			
Duration of surgery (min), mean ± SD	70.14 ± 27.30	99.57 ± 36.26	0.001 ^a
Length of hospital stay (d), mean ± SD	4.33 ± 1.35	5.05 ± 1.40	0.055
Estimated blood loss (mL), mean ± SD	64.29 ± 39.19	163.43 ± 251.20	0.011 ^a
Maximum body temperature (°C) within 48 h after operation, mean ± SD	37.31 ± 0.35	37.39 ± 0.47	0.434
Duration for which the maximum body temperature lasted (h), mean ± SD	14.43 ± 9.46	16.51 ± 10.59	0.474
Maximum VAS score within 48 h after operation, median (Q1, Q3)	3 (2, 5)	3 (3, 5)	0.391
Duration for which the maximum VAS score lasted (h), mean ± SD	3.6 ± 5.11	6.81 ± 8.59	0.06

Q1 = first quartile; Q3 = third quartile; LESS = laparoendoscopic single-site surgery; VAS = Visual Analog Scale; vNOTES = vaginal natural orifice transluminal endoscopic surgery. $p < 0.05$ and considered statistical significant.

Table 3
Perioperative complications distribution by CD grade

Grade	vNOTES	LESS	p
CD grade	n (%)	n (%)	
All	4 (19)	9 (19)	NS
1	0	0	
2	3 (14.2)	8 (17)	NS
3a	0	0	
3b	1 (4.7)	1 (2.1)	NS
4a	0	0	
4b	0	0	
5	0	0	

CD = Clavien–Dindo; LESS = laparoendoscopic single-site surgery; NS = not significant; vNOTES = vaginal natural orifice transluminal endoscopic surgery.

Table 4
Data on adverse events in each group

Adverse events	vNOTES (N = 21)	LESS (N = 47)	p
Need for blood transfusion, n (%)	2 (9.5)	3 (6.4)	0.640
Postoperative fever, n (%)	1 (4.8)	5 (10.6)	0.657
Thermal injury of the bowel, n (%)	0	1 (2.1)	1
Hypovolemic shock, n (%)	1 (4.8)	0	0.308

LESS = laparoendoscopic single-site surgery; vNOTES = vaginal natural orifice transluminal endoscopic surgery.

Table 5
Linear regression analysis of the risk factors related to the duration of surgery

Baseline variables	Crude				Adjusted			
	Beta	SE	95% CI	p	Beta	SE	95% CI	p
Age (y)	-0.54	0.49	(-1.52 to 0.45)	0.280	-0.41	0.56	(-1.52 to 0.70)	0.462
BMI (kg/m ²)	-0.56	1.05	(-2.66 to 1.54)	0.597	0.44	0.96	(-1.49 to 2.38)	0.647
No. of vaginal births	-2.72	4.92	(-12.53 to 7.10)	0.583	0.67	5.17	(-9.68 to 11.01)	0.898
Prior abdominal surgery	-11.16	9.94	(-31.01 to 8.68)	0.266	-17.40	10.04	(-37.5 to 2.71)	0.089
Prior cesarean section	-1.62	12.50	(-26.58 to 23.33)	0.897	1.59	12.44	(-23.32 to 26.49)	0.899
Diameter of the cyst (cm)	7.07	1.89	(3.29–10.84)	<0.001 ^a	5.65	1.89	(1.87–9.44)	0.004 ^a
Type of cysts								
Endometriotic cyst	REF				REF			
Teratoma	-33.00	10.71	(-54.38 to -11.61)	0.003 ^a	-20.96	11.64	(-44.26 to 2.33)	0.077
Other ovarian cysts	-22.61	9.82	(-42.22 to -3.00)	0.025 ^a	-13.06	9.91	(-32.91 to 6.78)	0.193
Pelvic adhesions requiring adhesiolysis	26.97	8.25	(10.51–43.44)	0.002 ^a	17.91	9.46	(-1.03 to 36.85)	0.063

BMI = body mass index; REF = reference.

^a $p < 0.05$ was considered statistical significantly.

after adjustment for age, BMI, number of vaginal births, prior abdominal surgery, prior cesarean section, the diameter of the cyst, type of cyst (endometriotic cyst), and adhesiolysis, only the diameter of the cyst influenced the surgical duration (Table 5).

Furthermore, no baseline variables influenced estimated blood loss, either before or after the adjustment for covariates (Table 6).

4. DISCUSSION

There was no conversion in the vNOTES group. At the same time, LESS had an 8.5% conversion rate. The vNOTES OC group had a smaller diameter of ovarian cysts, more percentage of teratoma and other ovarian cysts, and fewer pelvic adhesions. The vNOTES OC had a shorter surgical time and lower blood loss than LESS OC. The diameter of the ovarian cyst affected the surgical time.

The primary outcome was the conversion rate. Previous studies reported no conversion in the vNOTES or LESS groups.^{3,18,21,22} In our study, no conversion was observed in the vNOTES group, but four were observed in the LESS group and were switched to multiport laparoscopic surgery. The cause of the conversion in our study was mainly due to severe pelvic adhesions.

Both vNOTES and LESS have the advantage of short surgical time than open surgery.²⁴ A previous study noted a shorter surgical time in the vNOTES than in the LESS group.²⁵ Another previous study reported that 14 patients underwent vNOTES OC

Table 6
Linear regression of risk factors related to blood loss

Baseline variables	Crude				Adjusted			
	Beta	SE	95% CI	p	Beta	SE	95% CI	p
Age (y)	-2.52	2.93	(-8.37 to 3.34)	0.394	-3.35	3.77	(-10.89 to 4.2)	0.379
BMI (kg/m ²)	-1.20	6.24	(-13.67 to 11.26)	0.848	2.43	6.70	(-10.97 to 15.84)	0.718
No. of vaginal births	5.92	29.15	(-52.27 to 64.11)	0.840	18.34	35.76	(-53.24 to 89.92)	0.610
Prior abdominal surgery	-53.60	42.79	(-139.03 to 31.84)	0.215	-54.76	55.04	(-164.93 to 55.42)	0.324
Prior cesarean section	-35.31	34.91	(-105.00 to 34.39)	0.316	-8.41	46.31	(-101.11 to 84.29)	0.857
Diameter of cyst	-7.41	12.28	(-31.93 to 17.11)	0.548	-12.06	13.16	(-38.40 to 14.27)	0.363
Endometriotic cyst	REF				REF			
Teratoma	-116.43	66.58	(-249.4 to 16.54)	0.085	-139.62	82.32	(-304.40 to 25.16)	0.095
Other ovarian cysts	-41.41	61.06	(-163.35 to 80.54)	0.500	-36.15	71.25	(-178.77 to 106.47)	0.614
Pelvic adhesions requiring adhesiolysis	25.31	52.49	(-79.5 to 130.11)	0.631	13.71	67.01	(-120.43 to 147.85)	0.839

BMI = body mass index; REF = reference.

also showed a short surgical time (37 minutes).¹⁸ Another two studies also showed vNOTES had a shorter surgical time than LESS.^{3,21} However, a previous study did not find a difference in surgical time between vNOTES and LESS.²² In agreement with previous studies, our study also found that the vNOTES OC had a shorter surgical time than LESS.

The diameter of ovarian cysts may affect surgical time. A previous study compared the surgical time between cyst diameters <6 cm and ≥6 cm; the surgical time was longer in larger cyst diameters.²⁶ Our study found larger ovarian cyst diameters had longer surgical duration.

Less blood loss was noted in both vNOTES and LESS than open surgery.²⁴ Lower blood loss was observed in the vNOTES than in the LESS group.¹⁹ Another study did not find a difference in blood loss between NOTES and LESS.^{3,22} However, our study showed less blood loss in vNOTES than in LESS.

Reduced pain was noted in both vNOTES and LESS than open surgery.²⁴ Regarding the VAS score, a lower VAS score in the NOTES group than in the LESS group.^{3,27-29} However, in the randomized controlled trial, there was no difference in the VAS (vagina or pelvis) score between the two groups.²¹ Our study also did not find a difference in pain scores between vNOTES and LESS.

A higher risk of complication (bleeding or another organ injury) was noted in both vNOTES and LESS than open surgery.³⁰ The vNOTES had a trend of increasing complication rates in the vNOTES group.²¹ In another prospective cohort study, no complications occurred preoperatively and postoperatively at 6 months.²² Another study reported only six of 296 cases had grade 1 complications in vNOTES and LESS surgeries.³ Our study also showed no statistically significant difference in complications between the two groups.

Regarding hospital stay, hospital stay was shorter in vNOTES than in LESS.^{3,22} Another randomized trial did not find a difference in hospital stay between the two groups.²¹ Our study reported no significant difference regarding hospital stay between vNOTES and LESS groups. This may have been due to Taiwan's health insurance, which bore the cost of 4 days of hospitalization.

One of the advantages of vNOTES and LESS is cosmetic outcomes compared to open surgery. LESS has improved cosmetic outcomes than standard laparoscopy.³¹ The vNOTES has outstanding cosmetic results because no skin scar is noted after surgery.³² The previous study showed vNOTES increase patient satisfaction and cosmetic results.^{18,19,27} Regarding postoperative wounds, the cosmetic outcome of vNOTES is better than LESS.

One of the disadvantages of vNOTES and LESS is limited access and visualization.³³ The previous study showed vNOTES had a blind angle when applying a 5-mm 30-degree endoscopy.³³

LESS also has limited visualization. However, if the surgery is difficult, more trocars can be inserted to help proceed.³⁴ However, vNOTES do not have more access to the inserted trocar, making it more difficult than LESS.¹⁹ Our study used 3D endoscopy to perform vNOTES and LESS, which may conquer the limited visual field.

There are several limitations to our study. First, this is a small single-center study in which only one surgeon performed all operations. Second, based on the inclusion and exclusion criteria, the conclusions of our study can be applied only to a selected population of women of reproductive age with benign ovarian cysts and without pelvic inflammatory disease. There was a trend of fewer adverse events in the LESS group, but the differences were not statistically significant, given the small sample size. Longer-term adverse events were also not measured. Finally, our approach to measuring VAS scores was simplistic. It did not assess the dosage of analgesic used as the data could not be found retrospectively. Another limitation was the indication for both kinds of surgeries. Usually, teratoma and simple cyst would be excised by vNOTES, and LESS would be utilized for endometriosis and a history of pelvic surgery or adhesion. This condition may influence the results. Nevertheless, our study found LESS OC would increase the duration of surgery and blood loss more than vNOTES. The vNOTES were surgeon-dependent because only one surgeon performed vNOTES in our hospital.

In conclusion, the vNOTES and LESS OC were safe and effective. The vNOTES OC was suggested to have a shorter surgical duration and less blood loss than LESS OC. The hospital stay, VAS score, and complication rate were comparable between the two groups. Above all, the advantages of vNOTES include an absence of visible scars, shorter surgical duration, and less blood loss when compared with LESS. The results of vNOTES OC are limited to a specific population, nonpregnant and nonvirgin women, without obliteration of cul-de-sac and inflammation conditions. Further large-scale prospective trials should confirm the results of our study.

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