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Vaginal natural orifice transvaginal endoscopic surgery (vNOTES) for benign ovarian cysts is safe and feasible in same-day discharge: a retrospective cohort study

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Abstract

Background Advances in minimally invasive surgery and the development of Enhanced Recovery After Surgery (ERAS) have favored the spread of day-surgery programs. Even though Vaginal natural orifice transvaginal endoscopic surgery (vNOTES) is accepted as an innovative treatment for benign ovarian cysts that is rapidly gaining recognition worldwide, the safety and feasibility of same-day surgery (SDS) have yet to be established.

Objective This study aimed to evaluate the safety and feasibility of day surgery compared to inpatient surgery of patients undergoing vNOTES for benign ovarian cysts by determining perioperative outcomes.

Materials and methods The study consisted of 213 patients who underwent vNOTES for ovarian cystectomy at a single institution from January 2020 to November 2022. Based on the hospital stay, patients were classified into the same-day surgery group (SDSG) and the inpatient surgery group (ISG); after data processing and screening considering the balance of the two groups, SDSG has 83 samples ($n=83$), and ISG has 113 samples ($n=113$). The patient's demographic characteristics and follow-up data were collected during the perioperative period by doctors and nurses for medical tracking and analysis purposes and 1-month postoperatively by doctors in charge of their operation. Independent sample t-tests were performed to verify if there was any major difference between these two groups for continuous data like age, BMI, and cyst diameter, and Pearson's chi-squared tests were used to test whether there was a major difference between these two groups for categorical data like cyst count, abdominal surgery history and whether their cyst is bilateral ovarian cysts or not. The association between exhaust time and postoperative characteristics and the association between levels of pain and postoperative characteristics were

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further analyzed to unveil the confounding factors contributing to the same-day discharge method's quick recovery nature.

Results Upon performing propensity score matching, 196 patients were finally enrolled in this study for the matched comparison, including 83(42.3%) patients in the SDSG and 113(57.7%) patients in the ISG. There was no statistical difference between the two groups in terms of duration of operation (85.0 ± 41.5 min vs. 80.5 ± 33.5 min), estimated blood loss (27.7 ± 28.0 ml vs. 36.3 ± 33.2 ml), preoperative hemoglobin levels (128.8 ± 13.2 g/L vs. 128.6 ± 14.0 g/L), postoperative hemoglobin difference at 24 h (16.5 ± 15.4 g/L vs. 19.3 ± 9.1 g/L), pelvic adhesions (42 (50.6%) vs. 47 (41.6%)), and postoperative complications (7(8.4%) vs. 4(3.5%)). The SDSG group showed less time of feeding/off-bed/exhaust/urination after surgery, shorter hospitalization duration, a lower postoperative 6-hour pain score, and a lower incidence of analgesic drug use. Multiple linear regression analysis showed that advancing the time of postoperative off-bed activity and feeding reduced the postoperative exhaust time by 0.34 (95% CI: 0.185–0.496, 0.34 h, $p < 0.001$) and 0.299(95% CI: 0.158–0.443, 0.229 h, $p = 0.036$) hours. In addition, Ordinal logistic regression revealed a correlation between pain scores and bilaterality of cyst, increasing about 25.98 times the risk of pain levels when ovarian cysts are bilateral (OR: 26.98, 95% CI: 1.071–679.859, $P = 0.045$).

Conclusion In this pilot study, same-day discharge after vaginal natural orifice transvaginal endoscopic ovarian cystectomy is safe and feasible. The vNOTES for ovarian cystectomy combined with the same-day discharge shorten the exhaust time and duration of hospitalization, reduce postoperative pain, and lower the use incidence of analgesic drugs.

Keywords Vaginal natural orifice transvaginal endoscopic surgery (vNOTES), Enhanced recovery after surgery (ERAS), Same-day surgery (SDS), Benign ovarian cysts

Introduction

The ovarian cyst is a common gynecologic problem [1]. Most ovarian tumors (80–85%) are benign, and ovarian cystectomy is suggested to make a precise diagnosis and prevent potential torsion or rupture in women of reproductive age [2], particularly when they cause symptoms or infertility [3]. Transumbilical laparoendoscopic single-site surgery (LESS) (TU-LESS) has been accepted as a preferred surgical approach in treating ovarian cysts in the past decades [4]. Recently, with the continuous development of minimally invasive techniques, vaginal natural orifice transluminal endoscopic surgery (vNOTES) has shown promise as a less invasive approach with better cosmetic results than conventional laparoscopic methods [5–7]. Due to favorable surgical outcomes, fewer complications, less pain, and improved cosmetic results, vNOTES has been applied to different indications in gynecologic surgery, including the removal of ovarian cysts [8–11]. However, there has been much doubt about the safety and feasibility of vNOTES for benign ovarian cysts [12–14].

Historically, the classic surgical postoperative management maxim was “wait and see”.

where the surgeon reacts to the patient's postoperative events [15–17]. In recent years, there has been a paradigm shift to a more active attitude initially presented by Kehlet and Dahl in 2003 [18], which is currently referred to as enhanced recovery after surgery (ERAS). Many pieces of literature have shown that ERAS has resulted in shorter hospital stays, fewer postoperative complications, and lower costs while being proven to benefit the patient

and healthcare systems [19–23]. In recent years, there has been a notable development in day surgery practice in China based on the ERAS method [24–27]. More and more hospitals have incorporated day surgery pathways into their standard perioperative care for patients undergoing benign gynecological procedures, including hysterectomy, myomectomy, ovarian cyst, adnexal surgery, and pelvic organ prolapse surgeries [28–31]. Day surgery has been regarded as a global surgical quality improvement initiative that results in clinical and cost benefits [32, 33]. Furthermore, vNOTES and ERAS generate additive benefits, allowing for improved outcomes and faster recovery [8, 34]. However, no studies focused on the safety and feasibility of day discharge after vNOTES for benign ovarian cysts.

The purpose of this study was to retrospectively evaluate the safety and feasibility of same-day discharge for patients with vNOTES ovarian cystectomy procedures. Propensity score matching (PSM) analysis was performed to eliminate bias between patients receiving vNOTES ovarian cystectomy in the same-day surgery group (SDSG) and the inpatient surgery group (ISG).

Materials and methods

Study design and participants

The present study was embedded in the Longitudinal Vaginal Natural Orifice Transluminal Endoscopic Surgery Study (LovNOTESS), conducted in Chengdu (China Clinical Trials Registry ChiCTR2100053483, November 22, 2021), aiming to determine the feasibility and safety of same-day discharge after vNOTES for benign ovarian

cysts. This retrospective study was approved by the Ethics Committee of the Chengdu Women's and Children's Central Hospital (No. 202180). The study was conducted at the Chengdu Women's and Children's Central Hospital (inpatient department or day discharge center) from December 2021 to November 2022. Before the surgery, each patient was informed of the surgical risks (i.e., bladder, ureter, and rectum injuries) and benefits by their doctors. They then signed written informed consent according to the hospital's guidelines as part of the general routine before surgery. All the participants received vNOTES ovarian cystectomy performed by equally experienced senior consultants. All medical records were individually reviewed, including outpatient clinic notes, operative and pathology reports, recovery room records, and admission notes. Each patient who chooses vNOTES should be evaluated in detail before the operation, and the vNOTES approach should be avoided in one of the following cases: (1) history of rectal surgery, suspected of rectovaginal septum endometriosis, tumors, or severe adhesions; (2) virgin; (3) pregnant women. When meeting the criteria for the vNOTES surgery, patients chose the methods of their surgery according to their wishes; the options were same-day surgery or inpatient surgery; the patient's choice was not guided or suggested by their doctors. Patients who chose same-day surgery were included in the SDSG group, and others who decided inpatient surgery were included in the ISG group. Same-day surgery is a surgical procedure planned and conducted with the patient discharged in 24–48 h (the Chinese Ambulatory Surgery Alliance). X-ray of the chest, blood tests, biochemical blood tests, leukorrhea tests, biochemical blood, electrocardiogram, and ultrasound examination as preoperative evaluations in the outpatient department examined the patients in the SDSG. On the day of surgery, the medical experts enlightened the patients with written informed consent about the possible risks and complications associated with the procedure. The ISG differed from the day surgery center; the patient's preoperative examination and communication were accomplished during the hospitalization days before surgery.

According to the ERAS protocol, bowel preparation is not routinely recommended [35–37]. ERAS guidelines suggest that solid food should be allowed for up to 6 h before surgery and clear fluids for up to 2 h before the induction of anesthesia. The gynecological inpatient ward patients were given Sodium Phosphates Oral Solution for bowel preparation the day before the operation. In this study, both groups received Cefazolin 1 g intravenous infusion 30 min before the operation to prevent infection. After general anaesthesia with endotracheal intubation, a urinary catheter was inserted into ISG. However, for same-day surgery patients, the insertion of urinary catheters was prohibited. Patients in inpatient

groups used a patient-controlled analgesia (PCA) pump to relieve postoperative analgesia and took out the urinary catheter after the operation. Non-steroidal anti-inflammatory drugs (NSAIDs) and ibuprofen capsules were given to the day surgery patients if needed.

The discharge criteria were categorized into three categories: (1) normal vital signs; (2) no postoperative complications (fever, nausea, Urinary tract infection, Vaginal bleeding, and pain); (3) results of blood tests were normal.

Postoperatively, patients were followed up in the outpatient clinic at 1 and 4 weeks. In addition to the general screening and imaging examination, both groups were also evaluated for abnormal vaginal discharge, incisional complications, abdominopelvic hematoma, and infection. To ensure the well-being of the patients after surgery, the medical officers carried out several follow-up communications with the patients and their families by phone call or IM messages. Hospital and clinic notes were reviewed to determine any postoperative visits to the emergency room and postoperative hospital admissions within one month of surgery.

Data analysis was performed to compare the differences between the SDSG and ISG groups and determine the contributing factors to patients' recovery. Propensity-score matching (PSM) was employed to control for confounding variables such as age, BMI, surgical history, and cyst parameters, ensuring that the two groups were comparable; an independent Sample T-Test was used to compare continuous variables between the two groups, and Pearson's Chi-Squared Test was applied to test for differences in categorical data between the groups. Multivariable Linear Regression Analysis was utilized to evaluate the influence of various factors on exhaust time, including feeding time, time to get out of bed, bleeding volume, hemoglobin difference, surgery duration, pelvic adhesion, age, BMI, history of abdominal surgery, presence of bilateral ovarian cysts, and cyst count. Finally, Ordinal Logistic Regression was used to analyze how the covariates affect the patients' postoperative 6-hour pain score, including exhaust time, feeding time, time to get out of bed, bleeding volume, hemoglobin difference, surgery duration, pelvic adhesion, age, BMI, history of abdominal surgery, presence of bilateral ovarian cysts, cyst count, and cyst diameter.

vNOTES procedure

Both patient groups underwent the same surgical process, as outlined here. Initially, patients were positioned in the lithotomy posture. Following the disinfection of the perineum, vagina, and cervix, a vaginal retractor was introduced to expose the cervix. The posterior lip of the cervix was secured with Allis forceps, which were then used to pull the tissue upwards to reveal the posterior

vaginal vault. The intended incision area on the posterior fornix was pinpointed, and two Allis clamps marked the spot. A 2–3 cm incision was meticulously made using tissue scissors to access the pelvic cavity. Subsequently, a disposable multi-instrument access port (Beijing Aerospace Kadi Technology Development Institute, HK-TH-60.4TY) was inserted through this incision. A pneumoperitoneum was established with CO₂ insufflation up to a pressure of 14 mm Hg. Patients were then tilted into the Trendelenburg position to facilitate bowel retraction. A 10 mm 30° endoscope from Karl Storz GmbH & Co. KG, Tuttlingen, Germany, was used to inspect the pelvic and abdominal cavities. Once the ovarian cyst's location was confirmed, its capsule was incised approximately 5 mm using an electric hook, ensuring it was not ruptured. The cyst wall was torn along the ovary's longitudinal axis. Through gentle dissection, the cyst was entirely detached from the ovary. The ovarian incision was closed with a 3–0 Vicryl suture. The ovarian cyst was then extracted through the vaginal incision in a containment bag. Lastly, the vaginal incision was closed with a 2–0 Vicryl suture [38]. The procedure was conducted following our hospital's standard operation procedure.

Data acquisition

Information on all patients was collected from hospital databases. Patients' sociodemographic data (age and body mass index (BMI)), preoperative data (cyst count, cyst max diameter, bilateral ovarian Cysts, and history of previous abdominal surgery), perioperative data (operation time, estimated blood loss, diagnosis with pelvic adhesions, and surgical conversion), and postoperative data (postoperative hemoglobin difference at 24 h, time of feeding/off-bed/exhaust/urination after surgery, postoperative 6-hour pain VAS score, use of analgesic medication, hospital stay, postoperative complications, and pathological classification) were collected from electronic medical records. Operative time was defined as the period from incision to complete closure, excluding room and anesthesia time. Blood loss was estimated by suction container contents with irrigation fluid subtracted. VAS score was used to evaluate postoperative pain, with a score of 1–10. The higher the score, the higher the level of pain. 0 was painless, and 10 was extremely painful. All patients underwent an outpatient review at our hospital or a local hospital one month later to assess postoperative recovery, as clinical data was collected by outpatient visit records or follow-up phone calls by the doctor.

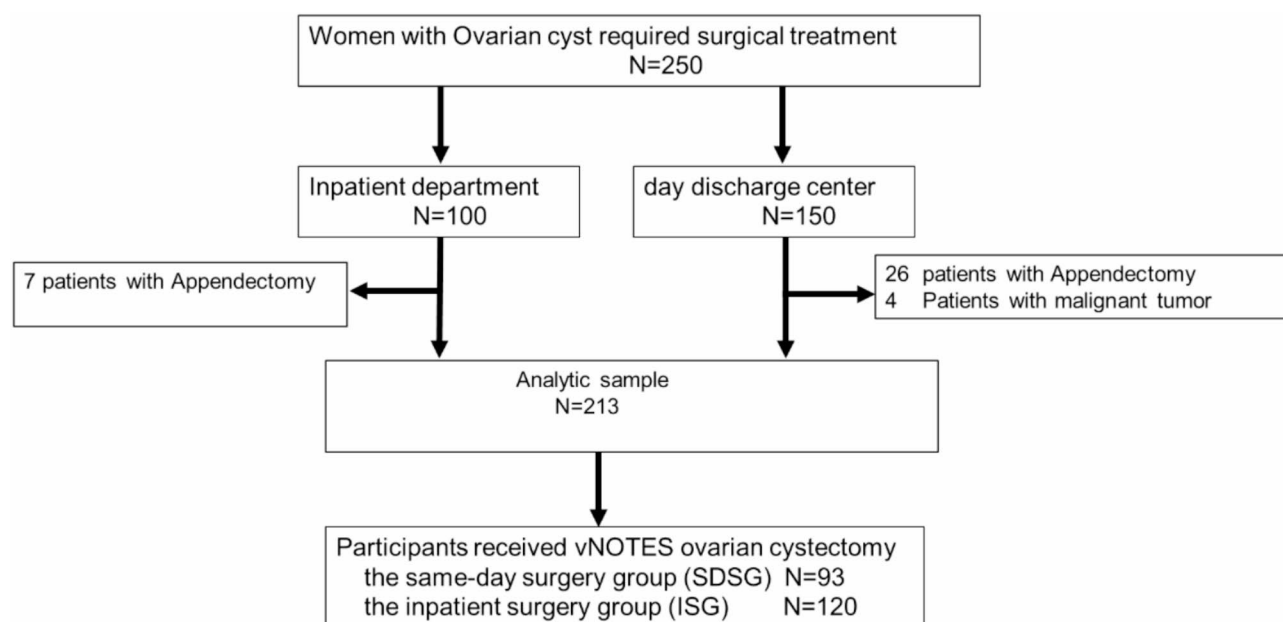
Statistical analysis

All statistical analyses were performed using SPSS version 25.0 (IBM, Armonk, NY, USA). Propensity-score matching (PMS) was performed to limit confounding

variables, including age, BMI, surgical history and cyst parameters. Continuous variables were tested with the independent sample t method, and all categorical data were tested with Pearson's chi-squared test. After PMS, the two groups of data are more balanced. Multivariable linear regression analysis was used to assess the influencing factor of exhaust time; these variables are feeding time, time to get out of bed, bleeding volume, hemoglobin difference, surgery duration, pelvic adhesion, age, BMI, whether the patient underwent abdominal surgery, whether the patient has bilateral ovarian cysts and cyst count. The postoperative 6-hour pain score was analyzed by ordinal logistic regression. The pain scores are evaluated by the patients themselves, with a 0–10 VAS score. Covariates include exhaust time, feeding time, time to get out of bed, bleeding volume, hemoglobin difference, surgery duration, pelvic adhesion, age, BMI, whether the patient underwent abdominal surgery, whether the patient has bilateral ovarian cysts, cyst count and cyst diameter were selected according to the variables in the analysis and factors reported in previous studies that would affect the dependent variable. All tests were double-tailed; a p-value of <0.05 was considered statistically significant. With balanced data, we analyzed the association between exhaust time and postoperative characteristics and the association between levels of pain and postoperative characteristics to unveil the confounding factors contributing to the same-day discharge method's quick recovery nature.

Results

The selection process for this study population is presented in Fig. 1. A total of 250 patients presented with the preoperative presumptive diagnosis of benign ovarian cyst and underwent vNOTES ovarian cystectomy were initially recruited into this study. After excluding patients with appendectomy and malignant tumors, 213 patients were available for the final analysis, of which 93(43.7%) were in SDSG and 120 (56.3%) were in ISG. The clinical characteristics of participants in SDSG and ISG before and after PSM are described in Tables 1 and 2. Upon performing propensity score matching [39, 40], 196 patients were enrolled in this study for the matched comparison, including 83(42.3%) patients in the SDSG and 113(57.7%) patients in the ISG. The average age of patients in cohorts, BMI, and maximum diameter of cysts were 32.8 ± 7.2 years, 21.8 ± 3.1 kg/m², and 4.8 ± 2.0 cm, respectively. Among these patients, 72(36.7%) had undergone abdominal surgery, 20 (10.2%) had undergone bilateral ovarian cysts. There was no statistical difference between the two groups regarding age, BMI (body mass index), previous abdominal surgery history, cyst max diameter, cyst count, and bilateral ovarian cysts (Table 2). The propensity score matching process

**Fig. 1** Selection process for this study**Table 1** Description of the patient's demographic characteristics before propensity score matching

Clinical Characteristics	SDSG	ISG	Total	p-value
N	93	120	213	
Age(year), mean \pm SD	32.2 \pm 7.3	33.3 \pm 7.2	32.8 \pm 7.2	0.26
BMI (kg/m ²), mean \pm SD	21.8 \pm 2.7	21.9 \pm 3.5	21.9 \pm 3.2	0.79
Underwent Abdominal Surgery, N (%)				
Yes	28 (30.1%)	49 (40.8%)	77 (36.2%)	0.11
No	65 (59.9%)	71 (59.2%)	136 (63.8%)	
cyst max diameter(cm), mean \pm SD	4.7 \pm 1.9	4.8 \pm 2.1	4.7 \pm 2.0	0.81
cyst count, N (%)				0.70
1	82 (88.2%)	106 (88.3%)	188 (88.3%)	
2	10 (10.8%)	11 (9.2%)	21 (9.9%)	
3	1 (1.1%)	3 (2.5%)	4 (1.9%)	
Bilateral Ovarian Cysts, N (%)	10 (10.8%)	14 (11.7%)	24 (11.3%)	0.83

Table 2 Description of the patient's demographic characteristics after propensity score matching

Clinical Characteristics	SDSG	ISG	Total	p-value
N	83	113	196	
Age (year), mean \pm SD	32.0 \pm 7.1	33.4 \pm 7.2	32.8 \pm 7.2	0.19
BMI (kg/m ²), mean \pm SD	21.7 \pm 2.7	21.9 \pm 3.4	21.8 \pm 3.1	0.75
Underwent Abdominal Surgery, N (%)				
Yes	26 (31.3%)	46 (40.7%)	72 (36.7%)	0.18
No	57 (68.7%)	67 (59.3%)	124 (63.3%)	
cyst max diameter(cm), mean \pm SD	4.8 \pm 1.9	4.8 \pm 2.1	4.8 \pm 2.0	0.87
cyst count, N (%)				0.72
1	74 (89.2%)	101 (89.4%)	175 (89.3%)	
2	8 (9.6%)	9 (8.0%)	17 (8.7%)	
3	1 (1.2%)	3 (2.7%)	4 (2.0%)	
Bilateral Ovarian Cysts, N(%)	8 (9.6%)	12 (10.6%)	20 (10.2%)	0.82

has successfully balanced the demographic characteristics of the two groups, as indicated by the non-significant *p*-values in Table 2. This suggests that the matching has effectively controlled for potential confounding factors, allowing for a more accurate comparison of outcomes between the SDSG and ISG. The perioperative characteristics of the two groups are elaborated and shown in Table 3. No significant difference ($P>0.05$) was detected between the two groups in terms of duration of operation (85.0 ± 41.5 min vs. 80.5 ± 33.5 min), estimated blood loss (27.7 ± 28.0 ml vs. 36.3 ± 33.2 ml), preoperative hemoglobin levels (128.8 ± 13.2 g/L vs. 128.6 ± 14.0 g/L), postoperative hemoglobin difference at 24 h (16.5 ± 15.4 g/L vs. 19.3 ± 9.1 g/L), pelvic adhesions (42 (50.6%) vs. 47 (41.6%)), and postoperative complications (7 (8.4%) vs. 4 (3.5%)). However, there were significant differences in the time of feeding (1.8 ± 0.9 h vs. 9.8 ± 5.7 h, $p<0.001$), off-bed activity (2.4 ± 1.1 h vs. 17.5 ± 4.9 h, $p<0.001$), and

anal exhaust time (8.5 ± 5.8 h vs. 16.9 ± 6.0 h, $p<0.001$) after operation between SDSG and ISG. Furthermore, the postoperative 6-hour pain score was significantly lower in the SDSG than in the ISG ($p<0.001$). Correspondingly, In the ISG, the use of analgesic drugs after surgery was higher than that of the SDSG, with statistical significance (12 (14.5%) vs. 70 (61.9%), $p<0.001$). The hospitalization time was significantly higher in the ISG than in the SDSG (1.0 day (1.0, 1.0) vs. 4.0 day (4.0, 5.0), $p<0.001$). This research has seven categories of pathological findings: mature cystic teratoma, ovarian endometriotic cysts, serous cystadenoma, mucinous cystadenoma, ovarian abscess, luteum hematoma, and simple ovarian cysts. In the SDSG group, the top 2 categories of pathological findings are mature cystic teratoma (69.9%) and ovarian endometriotic cysts (9.6%), while in the ISG group are mature cystic teratoma (43.4%), ovarian endometriotic cysts (32.7%).

Table 3 Description of the patient's perioperative characteristics

Variables	SDSG	ISG	Total	<i>p</i> -value
Patients	<i>N</i> =83	<i>N</i> =113	<i>N</i> =196	
Surgery Duration(min), mean \pm SD	85.0 \pm 41.5	80.5 \pm 33.5	82.4 \pm 37.0	0.39 ^a
Bleeding Volume(ml), mean \pm SD	27.7 \pm 28.0	36.3 \pm 33.2	32.6 \pm 31.3	0.056 ^a
preoperative hemoglobin(g/L), mean \pm SD	128.8 \pm 13.2	128.6 \pm 14.0	128.7 \pm 13.6	0.93 ^a
Hemoglobin difference (g/L), mean \pm SD	16.5 \pm 15.4	19.3 \pm 9.1	18.1 \pm 12.1	0.12 ^a
Pelvic Adhesions, <i>N</i> (%)				0.21 ^c
No, percentage	41 (49.4%)	66 (58.4%)	107 (54.6%)	
Yes, percentage	42 (50.6%)	47 (41.6%)	89 (45.4%)	
Exhaust time (hour), mean \pm SD	8.5 \pm 5.8	16.9 \pm 6.0	13.4 \pm 7.2	< 0.001 ^a
Time of Urination(hour), median, mean \pm SD	2.8 \pm 1.2	18.2 \pm 6.1	12.2 \pm 8.9	< 0.001 ^a
Feeding Time(hour), mean \pm SD	1.8 \pm 0.9	9.8 \pm 5.7	6.7 \pm 6.0	< 0.001 ^a
Time to get out of bed (hour), mean \pm SD	2.4 \pm 1.1	17.5 \pm 4.9	11.5 \pm 8.4	< 0.001 ^a
Pain scores (6 h after surgery), <i>N</i> (%)				< 0.001 ^c
0	51 (61.4%)	10 (8.8%)	61 (31.1%)	
1	12 (14.5%)	26 (23.0%)	38 (19.4%)	
2	12 (14.5%)	30 (26.5%)	42 (21.4%)	
3	7 (8.4%)	47 (41.6%)	54 (27.6%)	
6	1 (1.2%)	0 (0.0%)	1 (0.5%)	
Use Analgesic medication	12 (14.5%)	70 (61.9%)	82 (41.8%)	< 0.001 ^b
Hospital Stay(days), median(IQR)	1.0 (1.0, 1.0)	4.0 (4.0, 5.0)	3.0 (1.0, 4.0)	< 0.001 ^a
Postoperative complications, <i>N</i> (%)				0.14 ^c
No	76 (91.6%)	109 (96.5%)	185 (94.4%)	
Yes	7 (8.4%)	4 (3.5%)	11 (5.6%)	
Pathological classification, <i>N</i> (%)				0.003 ^b
Mature Cystic Teratoma	58 (69.9%)	49 (43.4%)	107 (54.6%)	
ovarian Endometriosis Cysts	8 (9.6%)	37 (32.7%)	45 (23.0%)	
Serous Cystadenoma	7 (8.4%)	8 (7.1%)	15 (7.7%)	
Mucinous Cystadenoma	2 (2.4%)	4 (3.5%)	6 (3.1%)	
Ovarian Abscess	0 (0.0%)	1 (0.9%)	1 (0.5%)	
Luteal Hematoma	3 (3.6%)	2 (1.8%)	5 (2.6%)	
Simple Ovarian Cysts	5 (6.0%)	12 (10.6%)	17 (8.7%)	
Surgical conversion, <i>N</i>	0	0	0	

BMI: body mass index, SDSG: same-day surgery group, ISG: inpatient surgery group

a: Average and standard deviation. Student's t-Test. b: Number (percentage). Chi-squared Test. c: Number (percentage) Fisher Exact Test

Table 4 Association between exhaust time and postoperative characteristics

Exhaust Time	Beta	standard error	t	P-Value	95% CI
$R^2 = 0.2983$					
Feeding Time(hour)	0.229	0.108	2.120	0.036	(0.0158,0.443)
Time to Get Out of Bed(hour)	0.340	0.079	4.320	0.001	(0.185,0.496)
Bleeding Volume(ml)	-0.008	0.021	-0.390	0.694	(-0.0500,0.0334)
Hemoglobin Difference(g/L)	-0.042	0.041	-1.030	0.303	(-0.124,0.0388)
Surgery Duration(min)	0.006	0.021	0.270	0.789	(-0.0351,0.0461)
Pelvic Adhesions	0.176	1.433	0.120	0.903	(-2.657,3.009)
Age(year)	-0.036	0.076	-0.470	0.641	(-0.186,0.115)
BMI(kg/m ²)	0.013	0.170	0.080	0.938	(-0.323,0.350)
Underwent Abdominal Surgery	-0.665	1.423	-0.470	0.641	(-3.478,2.148)
Bilateral Ovarian Cysts	-4.617	4.915	-0.940	0.349	(-14.333,5.098)
Cyst Count	3.206	4.142	0.770	0.440	(-4.981,11.393)

Table 5 Association between levels of Pain and postoperative characteristics

Level of Pain	OR	standard error	z	P-Value	95% CI
Exhaust Time(hour)	0.990	0.025	-0.410	0.678	(0.942, 1.039)
Feeding Time(hour)	1.068	0.036	1.960	0.051	(1.000, 1.141)
Time to Get Out of Bed(hour)	1.091	0.028	3.450	0.001	(1.038, 1.147)
Bleeding Volume(ml)	0.996	0.006	-0.660	0.508	(0.984, 1.008)
Hemoglobin Level Difference(g/L)	1.002	0.013	0.190	0.853	(0.978, 1.0277)
Surgery Duration(min)	1.003	0.006	0.440	0.663	(0.991, 1.0143)
Pelvic Adhesions	1.845	0.788	1.430	0.152	(0.799, 4.261)
Age(year)	1.008	0.022	0.370	0.709	(0.966, 1.0525)
BMI (kg/m ²)	0.969	0.049	-0.620	0.538	(0.877, 1.0707)
Underwent Abdominal Surgery	0.487	0.210	-1.670	0.096	(0.209, 1.135)
Bilateral Ovarian Cysts	26.984	44.423	2.000	0.045	(1.071,679.859)
Cyst Count	0.085	0.118	-1.770	0.077	(0.0056, 1.302)
Cyst Diameter	0.999	0.081	-0.010	0.994	(0.852, 1.172)

Early postoperative anal exhaust indicates faster recovery of gastrointestinal function [16]. Multiple linear regression analysis was conducted to investigate the factors influencing postoperative anal exhaust time in Table 4, and the results showed that anal exhaust time was correlated with the time of postoperative off-bed activity and feeding. Interestingly, the exhaust time was delayed by approximately 0.34 h when the postoperative off-bed activity was delayed by 1 h (95% CI: 0.185–0.496, 0.34 h, $p < 0.001$). Moreover, anal exhaust time was delayed by approximately 0.229 h when postoperative feeding time was delayed by 1 h (95% CI: 0.158–0.443, 0.229 h, $p = 0.036$) (Table 4). This regression correlated with the situation in which patients in the SDSG group were encouraged to get out of bed earlier and eat earlier.

Analgesics are not routinely used after surgery, and patients actively requesting the use of analgesics may be experiencing greater pain. Further ordinal logistic regression revealed that the 6-h postoperative pain score was correlated with the bilateral ovarian cysts and time of postoperative off-bed activity in Table 5. The analysis shows that time to get out of bed strongly correlates with pain score; the risk of pain level increased by 9.1% when

the time of postoperative off-bed activity increased by 1 h (OR:1.091, 95% CI: 1.038–1.147, $p < 0.001$). In addition, there is a correlation between pain scores and bilaterality of cysts [41], increasing about 25.98 times the risk of pain levels when ovarian cysts are bilateral (OR: 26.98, 95% CI: 1.071–679.859, $P = 0.045$).

Discussion

The benefits of vNOTES are manifold, encompassing diminished postoperative discomfort, expedited recovery times, a lower incidence of postoperative wound infections, and superior aesthetic outcomes [41]. Extensive research has demonstrated the successful application of vNOTES in a variety of gynecological operations, such as the removal of fallopian tubes (salpingectomy), cysts from the ovaries (ovarian cystectomy), uterine fibroids (myomectomy), the uterus itself (hysterectomy), lymph node removal (lymphadenectomy), and the surgical repair of pelvic organ prolapse (sacrocolpopexy) [40–44]. Since same-day surgery has substantially lower cost and better efficiency, it has been recognized worldwide with great popularity [45–53]. In Western countries, 60%–70% of surgery is day surgery [32]. With the rise of minimally

invasive gynecologic surgery, the number of day gynecological surgeries has increased considerably [49]. Recently, day surgery has been extensively promoted in China, with the application of Enhanced recovery after surgery (ERAS) in clinical practice as a perioperative optimization strategy [24, 25, 50]. Accumulating evidence highlighted that adopting ERAS in day surgery resulted in a lower complication rate and shorter hospital stays compared to inpatient surgery [46, 51, 52].

As previously discussed, the prospect of same-day vNOTES surgery is compelling due to its integration of the practicality inherent in vNOTES with the added benefits of the Enhanced Recovery After Surgery (ERAS) approach. Several studies have confirmed that vNOTES is not only feasible and safe for the treatment of benign ovarian tumors but also appears to yield better surgical outcomes. These improved outcomes include reduced blood loss, shorter operating times, and decreased hospital stay compared to traditional laparoscopic methods [34, 53]. However, there is a scarcity of studies that concentrate on the benefits and safety of vNOTES when performed as day surgery in accordance with Enhanced Recovery After Surgery (ERAS) protocols. This research seeks to address this knowledge gap by conducting a retrospective analysis of the clinical profiles and perioperative information of patients who underwent vNOTES ovarian cystectomy. The comparison will be made between those treated in a hospital inpatient department and those in a day surgery setting. The study's goal is to assess the safety and practicality of performing vNOTES for benign ovarian cysts as a day surgery procedure. The findings could establish a theoretical foundation for the broader application of vNOTES in same-day discharge scenarios in the future.

Intraoperative blood loss is an important measure of the safety of surgery [54, 55]. The operation duration reflects the effectiveness of the surgery. This research found that there was no significant difference between the Same-Day Surgery Group (SDSG) and the Inpatient Surgery Group (ISG) in terms of demographics, blood loss during the operation, the duration of the surgical procedure, and the incidence of postoperative complications. This indicates that day surgery can match the safety and efficacy of inpatient surgery when performing oophorocystectomy using vNOTES. Although the surgery operation time shows no difference between SDSG and ISG, same-day surgery cost is considerably lower than inpatient surgery, and lesser hospital length of stay promotes the utilization of hospital beds and medical resources. The ovarian cysts of SDSG and ISG are mainly endometrial implantation cysts and mature teratoma. Literature has reported that an endometrial implantation cyst is more likely to cause Pelvic adhesions. Hence, a mature teratoma is more suitable for same-day surgery

than an endometrial implantation cyst. A potential limitation of vNOTES is adhesion between the mass and the uterus or pelvic fascia, which may make it difficult to proceed with the resection. Patients choosing vNOTES require thorough preoperative assessment, including history of dysmenorrhea, previous pelvic surgery, difficult uterine activity, tenderness of sacral ligament nodules, and vaginal ultrasound. Patients with severe pelvic adhesions are also advised against surgery with a Vaginal natural orifice approach.

The data in this research also shows that with ERAS, patients of SDSG get out of bed and eat much earlier than those of ISG. Our study demonstrates that initiating early feeding following vNOTES surgery for benign ovarian cysts leads to enhanced recovery of intestinal motility, alleviation of abdominal bloating, stimulation of appetite, bolstering of the body's resistance, and prevention of postoperative complications. The study revealed that patients with bilateral ovarian cysts tend to experience higher levels of pain compared to those with unilateral cysts, and engaging in postoperative ambulation can help alleviate this discomfort. Additionally, the data indicates that quicker ambulation and resumption of eating are associated with a faster recovery from postoperative fatigue. Generally, the pain scores for both groups were recorded as low, at or below 3 points on the pain scale. The vNOTES technique was observed to cause milder postoperative discomfort, potentially due to the fact that the vaginal fornix is supplied by nerves that are less responsive to pain sensations. Additionally, conducting vNOTES for the removal of ovarian cysts in a same-day surgery context has been correlated with a shorter period of postoperative exhaustion, possibly because there is less irritation of the diaphragm from gas in the abdomen. Lower pain levels after vNOTES surgery motivate patients to resume walking activities more promptly, which aids in the quicker restoration of gastrointestinal function and expedites the alleviation of postoperative weariness.

Based on the ERAS concept, bowel preparation is not routinely recommended [35], which reduces preoperative discomfort and allows for the rapid intestinal recovery of patients. The gynecological inpatient ward patients were given Sodium Phosphates Oral Solution for bowel preparation the day before the operation. The main objective of the ERAS approach is to shorten the length of hospital stay after surgery and to promote quick recovery of the patient to normal activities, thus reducing complication rate and surgery-related costs. To achieve this goal, the ERAS program concentrates on reducing perioperative surgical stress, early patient mobilization, resumption of gastrointestinal system function, and satisfying pain control [56].

The merits of our study are the specialized study population and the standard operating procedures of vNOTES. The participants were screened using strict inclusion and exclusion criteria for this retrospective study. Simultaneously conducting other surgeries were excluded. According to the postoperative pathological report, patients with malignant tumors were also excluded. Additionally, all patients underwent outpatient review one month after surgery to check postoperative recovery and complete clinical data, resulting in a comprehensive study design. In addition, our day surgery center and inpatient department have carried out vNOTES since 2018; the number of vNOTES is nearly 2000 cases per year in the last two years. Now there is quite mature experience and standard operating procedures of vNOTES.

Upon meticulous analysis of the collected data, our findings suggest that the principal benefits of the same-day discharge approach are attributed to the patients' earlier resumption of ambulation and oral intake. These results, when juxtaposed with the standard practice of tailoring treatment to align with the specific diagnostic profiles of patients, underscore the merit of further investigation into the potential of encouraging earlier mobilization and feeding in instances of benign cysts. This strategy may enhance the therapeutic efficacy and contribute to the overall efficiency of the same-day discharge protocol for such conditions.

The pilot study has broadened our comprehension regarding the application of vNOTES in the context of same-day discharge for ovarian cystectomy. Nonetheless, our research encountered several constraints. Initially, the study's sample size was modest compared to other studies in the same domain. Additionally, a prospective follow-up of patients' post-ovarian cystectomy could yield more profound insights into the spectrum of short-term and long-term complications, as well as the possible effects of vNOTES on sexual function, fertility and the capacity for vaginal childbirth. Consequently, there is an imperative need for extensive, multicenter studies encompassing a larger patient population and a variety of gynecological conditions. Such research endeavors would be pivotal in substantiating the efficacy and safety of vNOTES, facilitating its broader adoption in day surgery settings.

Conclusion

Our study demonstrated that same-day discharge after vNOTES for benign ovarian cysts was equally safe and effective with a shorter exhaust time and duration of hospitalization, less postoperative pain, and lower use of incidence of analgesic drugs when compared to admission. Same-day discharge after vaginal natural orifice transluminal endoscopic surgery for benign ovarian cysts has been associated with high levels of patient

satisfaction and significantly decreased healthcare costs. With further popularising the minimally invasive concept of ERAS and scar-free surgery, the vNOTES in same-day procedures will inevitably achieve longer-term development. Therefore, a more extensive prospective study is required to establish the safety of this approach and promote its rapid growth.

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Y.H.L. and X.Q.G. conceived the study. L.L.W., H.S.G., and L.L.X. analyzed the data and drafted the manuscript. X.W., A.J.X., and J.H. collect data. T.J.L., X.L., J.M.L., Y.J.J., and H.W. critically revised the manuscript. All authors have accepted responsibility for the entire content of this submitted manuscript and approved submission.

Author contributions

Y.H.L. and X.Q.G. conceived the study. L.L.W., X.W., and L.L.X. analyzed the data and drafted the manuscript. H.S.G., A.J.X. and J.H. collect data. T.J.L., X.L., J.M.L., Y.J.J., and H.W. critically revised the manuscript. All authors have accepted responsibility for the entire content of this submitted manuscript and approved submission.

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Data availability

The data supporting this study's findings are available on request from the corresponding author. The data are not publicly available due to privacy restrictions.

Declarations

Ethics approval and consent to participate

This retrospective study was approved by the Ethics Committee of the Chengdu Women's and Children's Central Hospital (No. 202180). The study was conducted at the Chengdu Women's and Children's Central Hospital (inpatient department or day discharge center) from December 2021 to November 2022. Before the surgery, each patient was informed of the surgical risks (i.e., bladder, ureter, and rectum injuries) and benefits by their doctors. They then signed written informed consent according to the hospital's guidelines as part of the general routine before surgery.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

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