



Original article

Natural orifice transluminal endoscopic surgery in gynecology

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ABSTRACT

Objective: To present our initial experiences in transvaginal natural orifice transluminal endoscopic surgery (NOTES) for adnexal surgeries and hysterectomies.**Materials and Methods:** From September 2010 to December 2010, a total of 15 patients with benign adnexal or uterine diseases who were eligible for laparoscopic surgeries were recruited to undergo transvaginal NOTES at a tertiary referral medical center. Intraoperative and postoperative surgical outcomes were measured.**Results:** Transvaginal NOTES was successfully completed in five adnexal surgeries and 10 hysterectomies without complications, an ancillary port on the abdomen, or conversion to conventional laparoscopy or laparotomy. For the 10 hysterectomies, the surgical time was 93.4 ± 6.3 minutes (mean \pm standard deviation), intraoperative estimated blood loss 245 ± 54.0 mL, uterine weight 440.1 ± 76.5 g, and the postoperative hospital stay 2.7 ± 0.3 days. No patients required intraoperative blood transfusion. The two tubal sterilizations were completed in 18 minutes and 30 minutes, respectively, with negligible blood loss. The two salpingectomies, including one ruptured ectopic pregnancy with 2000 mL hemoperitoneum, were completed in 62 minutes and 116 minutes, respectively. The enucleation was completed in 64 minutes with 20 mL estimated blood loss.**Conclusion:** Our preliminary results indicate that transvaginal NOTES for adnexal surgeries and hysterectomies is feasible and safe. However, this procedure is still new and should only be used as an alternative for conventional laparoscopic surgery in highly selected cases.

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Introduction

Natural orifice transluminal endoscopic surgery (NOTES) is a newly developed method of minimally invasive surgery. NOTES uses the natural orifices of the body surface, such as the mouth, the anus, and the vagina, as the surgical channel of endoscopy to avoid incision scars on the abdominal wall, prevent complications of trocar wound, and achieve better cosmetic outcomes. NOTES has been applied in general surgery, including cholecystectomy, gastrojejunostomy, and splenectomy, and its safety and feasibility are also proved.¹

Among the routes of NOTES, the transvaginal approach is most frequently used and it is similar to the previous concept of culdoscopy or ventroscopy in gynecology, which was first reported in 1901 for visualization of the intraabdominal organs.² A few papers discussing the use of culdoscopy in diagnostic^{3,4} and therapeutic^{5–7} purposes are available in the literature. However, culdoscopy has been criticized for increased risk of infection and restricted surgical fields; its application diminished after the rising popularity of laparoscopy since 1970.

Because of increased experiences from single-port laparoscopy and progress in both laparoscopic instrumentation and electrocoagulation, we can establish a surgical channel at the vagina to evolve the previous concept of culdoscopy into transvaginal NOTES to broaden clinical application from diagnostic purposes or simple surgery to complex procedures. Therefore, this article presents our initial experiences in transvaginal NOTES for adnexal surgeries and hysterectomies in highly selected patients with benign gynecologic diseases.

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Materials and methods

Patients

From September 2010 to December 2010, 15 patients with benign adnexal or uterine diseases and required surgeries in Chang Gung Memorial Hospital were included. The exclusion criteria were (1) serious systemic diseases prohibiting pneumoperitoneum and Trendelenburg position; (2) virginity or restrictive vaginal space; (3) cul-de-sac obliteration or severe pelvic adhesion suspected in pelvic examination; (4) moderate to severe endometriosis; (5) stage III or IV uterine prolapse; (6) pregnancy; and (7) malignancy. Obesity (body mass index [BMI] ≥ 30 kg/m²) and absence of vaginal delivery were not considered as contraindications.

The study was reviewed and approved by the Human Investigation Review Board of Chang Gung Memorial Hospital. All patients gave written informed consent. All surgical procedures were performed by experienced gynecologic endoscopists.

Surgical techniques

After administration of general anesthesia and endotracheal intubation, patients were placed in the Trendelenburg position with legs bandaged and supported in stirrups. The detailed surgical procedures were described in previous publications^{8,9} and briefed as described in the following paragraphs.

Adnexal surgery

A 3-cm posterior colpotomy was created by conventional vaginal surgery. A small wound retractor (Alexis; Applied Medical Resources Corp., Rancho Santa Margarita, CA, USA) was inserted and fixed from behind the colpotomy to the vaginal introitus to maximize and protect the wound. A disposable surgical glove was draped around the rim of the wound retractor, and three 5-mm cannulas were introduced. Instruments used included a 5-mm, 30-degree endoscope (Karl Storz GmbH & Co. KG, Tuttlingen, Germany), conventional rigid laparoscopic instruments, and a LigaSure device (Covidien, Mansfield, MA, USA) or Plasma-Kinetic knife (Gyrus Medical, Inc., Maple Grove, MN, USA). Tubal sterilization, salpingectomy, or enucleation followed by suture was performed as in single-port laparoscopic surgery. The specimens were removed either directly from the cannulas or through the colpotomy wound, which was protected by the wound retractor. After final checkup for hemostasis and removal of the surgical glove with the cannulas and the wound retractor, the procedure was ended with closure of the colpotomy wound.

Hysterectomy

After a 12-French Foley catheter was inserted, hysterectomy was begun with circumcision of the vaginal mucosa around the cervix followed by a 3-cm posterior colpotomy. The anterior portion was carried out by pushing up the vaginal mucosa along with the uterocervical fascia at the anterior fornix. Unless the peritoneum between the bladder and the uterus could be identified and cut confidently, anterior colpotomy was not completed until during the later laparoscopic phase. By exposing the extraperitoneal space along with the bilateral board ligaments, the transverse cervical and the uterosacral ligament complexes were well exposed and then clamped and divided using a LigaSure device. Then, the surgical channel was established as that in adnexal surgery with the same instruments used. After adequate pneumoperitoneum, the bilateral broad ligaments of the uterine vessels were identified by grasping the cervix and pushing contralaterally with the

endoscopic single-tooth tenaculum. The uterine vessels were secured and divided using a LigaSure device. Following the stump of the uterine arteries and the anterior margin of the uterus, we were able to trace and identify the uterovesical junction from both the caudal and cephalic point of view. After dissecting the junction with a laparoscopic scissor, the anterior colpotomy was completed under laparoscopic guidance. The remaining board and round ligaments were secured and divided stepwise. The tuboovarian pedicles or bilateral infundibulopelvic ligaments were divided depending on whether or not the adnexa were preserved. The uterus was then removed through the vagina, and the vaginal cuff was closed using 2-0 Vicryl sutures. The surgical procedure was concluded after a routine diagnostic cystoscopy.

Treatment protocol

Parenteral cefazolin was administered preoperatively and cefazolin and gentamicin postoperatively for 1 day as prophylactic antibiotic therapy. No other oral antibiotics were prescribed thereafter if patients were afebrile or without evidence of pelvic infection. Nonsteroidal antiinflammatory drugs were routinely prescribed after surgery and 30 mg nalbuphine was given intramuscularly if necessary. For patients who had hysterectomies, the Foley catheter was removed in the morning on the day after the surgery. Patients were discharged, according to our national regulations, with an afebrile status for at least 24 hours, no evidence of surgical complications, good wound healing, and full recovery of gastrointestinal function with satisfactory oral intake and stool passage. Patients were asked to abstain from sexual relations for 2 months after the operation and to return to the clinic 1 week and 2 months after the surgery for follow-up. Three months later, patients were evaluated regarding sexual function, including dyspareunia, postcoital bleeding, and satisfaction.

Data analysis

Patient demographics, intraoperative findings, postoperative outcomes, and pathologic reports were recorded. Surgical outcomes, including surgical time, estimated blood loss, decrease in hemoglobin, uterine weight, length of hospital stay, and complications, were all recorded. Age, BMI, and uterine weight were considered as continuous variables, and presented as mean \pm standard deviation (SD). Parity was considered a discrete variable, and presented as median (range). Descriptive statistics were performed using SPSS for Windows (release 17.0.0/2008; IBM-SPSS, Inc., Chicago, IL, USA).

Results

From September 2010 to December 2010, a total of 15 patients with mean age 43.4 ± 2.5 years and BMI 23.2 ± 0.9 underwent transvaginal NOTES, including 10 hysterectomies, two tubal sterilizations, two salpingectomies for ectopic pregnancy, and one ovarian enucleation. Two patients were nulliparous and 13 were multiparous (median 2, range 0–4), with histories of vaginal deliveries. The demographic data, surgical methods, surgical outcomes, and pathologic reports are provided in Table 1.

For the 10 hysterectomies, the surgical time was 93.4 ± 6.3 minutes, intraoperative estimated blood loss 245 ± 54.0 mL, the change of hemoglobin measured on the first postoperative day in comparison with presurgery was -1.4 ± 0.3 g/dL, uterine weight was 440.1 ± 76.5 g, and the length of postoperative hospital stay 2.7 ± 0.3 days. No patients required intraoperative blood transfusion.

Table 1
Demographic data and surgical outcomes.

Case no.	Age (y)	Parity	C/S	BMI	Surgical indication	Surgical method	Surgical time (min)	Blood loss (mL)	Hb change (g/dL)	BT	Uterine weight (g)	Length of stay (d)
1	29	2	0	20.5	Contraception	Tubal sterilization	30	3	NA	0	NA	0
2	44	2	0	29.6	Myoma	Hysterectomy	111	250	-1.3	0	454	1
3	53	3	0	23.8	Myoma, adenomyosis	Hysterectomy	73	400	-1.3	0	284	3
4	43	2	0	28.2	Myoma, adenomyosis	Hysterectomy	60	150	-1.4	0	263	3
5	43	2	0	19.0	Contraception	Tubal sterilization	18	5	NA	0	NA	0
6	43	3	0	22.3	Myoma	Hysterectomy	67	400	-0.7	0	500	3
7	32	2	0	23.4	Tubal pregnancy	Salpingectomy	62	30	-0.9	0	NA	2
8	27	0	0	21.5	Ruptured tubal pregnancy	Salpingectomy	116	2000 ^a	+0.3	pRBC 8U	NA	2
9	54	2	0	22.1	Myoma	Hysterectomy	62	300	-0.5	0	960	3
10	48	2	0	20.4	Myoma	Hysterectomy	53	50	-0.2	0	300	2
11	50	2	0	19.1	Myoma	Hysterectomy	69	100	-2.7	0	115	3
12	48	2	0	20.3	Myoma	Hysterectomy	58	150	-1.9	0	601	2
13	49	2	0	25.0	Myoma	Hysterectomy	58	150	-2.2	0	611	4
14	42	4	1	25.9	Myoma, adenomyosis	Hysterectomy	63	200	-2.0	0	313	3
15	26	0	0	20.2	Teratoma, 4 cm	Enucleation	64	20	-1.3	0	NA	3

BMI = body mass index; BT = blood transfusion; C/S = cesarean section; Hb = hemoglobin; NA = not available; pRBC = packed red blood cell.

^a Includes hemoperitoneum.

Two patients underwent voluntary tubal sterilization with electrocautery and segmental excision. Surgical time for these two patients was 18 minutes and 30 minutes, respectively, with negligible blood loss.

Two patients had tubal ectopic pregnancies for unilateral salpingectomies. One procedure was completed without complications but ruptured ectopic pregnancy occurred preoperatively in the other patient, with an estimated 2000 mL hemoperitoneum, and eight units of packed red blood cells were transfused. Although salpingectomy was quickly performed, the surgical time was prolonged to nearly 2 hours because of a frequently blurred surgical field by massive hemoperitoneum and an abundance of blood clots requiring vigorous irrigation and suction to clear the abdominal cavity. The two patients were discharged on the second postoperative day.

One patient with a 4-cm teratoma underwent enucleation with ovarian repair without complications. Surgical time was 62 minutes, intraoperative blood loss was 20 mL, and postoperative hospital stay was 3 days.

Overall, transvaginal NOTES was successfully completed in each procedure without an ancillary port on the abdomen or conversion to conventional laparoscopy or even laparotomy. No intraoperative or postoperative complication occurred. On follow-up examinations 1 week after discharge and 3 months after the surgical procedure, all patients demonstrated good healing of the vaginal wound, and none complained of dyspareunia or postcoital bleeding.

Discussion

Minimally invasive surgery is well known by its advantages of less postoperative pain, shorter hospital stay, and faster recovery. However, trocar wound is still associated with some minor complications, such as hematoma, infection, hernia, trocar site metastases,¹⁰ and hypertrophic scar or keloid formation. Therefore, the new technique of minimally invasive surgery, single-port laparoscopy was developed recently with the aim to decrease the number of trocar insertions so wound complications can be diminished and cosmetic outcomes improved. However, loss of triangulation and instrument clashing increase complexity of procedures and limit its application to all gynecologic surgeries. NOTES is another newly developed technique in minimal invasive surgery that uses natural orifices of the human body as a surgical channel to avoid incision scar on the abdominal wall. Although the

transrectal and transesophageal approaches have been developed, transvaginal access is most frequently used and most familiar to gynecologists.

Transvaginal NOTES appears to be another form of single-port laparoscopy but provides invisible scar and a lesser degree of loss of triangulation and instrument crowding due to vaginal elasticity. Moreover, specimen removal is easier and safer from the vagina with protection of the wound retractor to avoid contamination and further port-site metastases if malignancy is incidentally proved. In comparison with conventional vaginal surgery, the surgical field of transvaginal NOTES can be clearly demonstrated with endoscopic guidance, and any pathology beyond the reach of the operator's fingers can be easily managed with the assistance of laparoscopic instruments. Transvaginal NOTES is especially beneficial in patients with nulliparity, obesity, a narrow vagina, or a large pathologic uterus, which are all considered as relative contraindications in vaginal surgery because of restricted downward traction of pelvic organs for surgical manipulation and hemostasis. Although transvaginal NOTES has many advantages, some complications have been reported, including rectal perforation, bleeding from the vaginal puncture site, omental prolapse,¹¹ pelvic abscess,¹² and broad ligament hematoma with emphysema.¹³ In our series, no complications were encountered and similar results were shown in a series of 68 patients at midterm follow-up.¹⁴

Although vaginal hysterectomy is preferred if hysterectomy is indicated, the abdominal approach is still the treatment of choice for most surgeons because of better surgical view and ease of hemostasis, especially after the popularity of laparoscopy since 1990. However, transvaginal NOTES for hysterectomy not only eliminates the disadvantages of the vaginal approach but provides the advantages of laparoscopic surgery. For a large uterus (>500 g), to seal the feeding vessels of the uterus at the beginning of the surgical procedure can significantly reduce intraoperative blood loss¹⁵ but it is challenging via the laparoscopic approach because of limited pelvic space. Compared with the laparoscopic approach, the most superior portion of transvaginal NOTES for hysterectomy is the easier approach to the uterine vessels at the level of the isthmus; the vessels can be quickly and safely secured before manipulation, resulting in reduced intraoperative blood loss. Nevertheless, a fixed and large uterus can enhance technical difficulty in the vaginal phase, prolong surgical time, and increase complications, especially thermal injuries. Therefore, transvaginal NOTES for hysterectomy in a nonmovable and large uterus should be cause for concern.

Vaginal tubal sterilization has been performed for years but fimbriectomy is the most popular method because of restriction of the surgical field and difficult mobilization of a nonprolapsed uterus in a young woman. In transvaginal NOTES, with endoscopy assistance, tubal sterilization can be precisely performed at the isthmic portion, which improves the outcomes of reanastomosis if patients want to conceive again. In addition, the pelvic organs can be inspected and treated simultaneously if any pathologic lesion exists. In our two patients, tubal sterilizations were completed by using a Plasma-Kinetic knife applied to the isthmic portion. Thanks to the powerful electrocauterizer, the procedures were performed efficiently and safely.

For a patient with an unruptured ectopic pregnancy who agrees to have salpingectomy instead of salpingostomy, transvaginal NOTES is an alternative method. In a patient with a ruptured ectopic pregnancy, massive hemoperitoneum and blood clots may blur the vision of endoscopy from the vaginal approach, prolong surgical time, and increase uncertainty when applying the electrocauterizer, which probably causes unexpected thermal injury. In our series, salpingectomy was completed without complications within 1 hour in the simple ectopic pregnancy, in comparison with 2 hours in the ruptured one. Therefore, transvaginal NOTES in cases with active bleeding or massive hemoperitoneum should be used with caution.

For patients with benign adnexal tumors, transvaginal NOTES is challenging in enucleation and suture because of the same problems encountered in single-port laparoscopy, such as loss of triangulation and instrument clashing. We chose the patient with one ovarian teratoma for our first case in NOTES enucleation because fewer or no pelvic adhesions were expected. To our knowledge, patients with endometriomas are relatively contraindicated for NOTES enucleation due to the high probability of pelvic adhesions, especially at the cul-de-sac, resulting in prolonged surgical time and higher risks of complications. Furthermore, most of the patients with endometriomas have other endometriotic foci at the pelvis and required complete excision to restore the normal anatomy and relieve symptoms. We used a 30-degree rigid endoscope that could not provide the panoramic view of the pelvis, so any lesions at the anterior cul-de-sac would be missed. Therefore, before the development of a new and suitable endoscope, transvaginal NOTES for enucleation should be used only in patients without or with mild pelvic adhesions. Conversion to conventional laparoscopy is definitely necessary if discrepancies between the surgical findings and preoperative imaging studies or

impressions, or unexpected severely pelvic adhesions are encountered during the surgical procedure.

In conclusion, NOTES has the advantages of minimally invasive surgery. In addition, NOTES has invisible scar preventing complications of trocar wound and promoting cosmetic outcomes. Our preliminary results showed transvaginal NOTES for adnexal surgeries and hysterectomies is feasible and safe. However, it is still in its early stages and should only be used as an alternative for conventional laparoscopic surgery in highly selected cases.

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