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Transvaginal natural orifice transluminal endoscopic surgery (vNOTES) in gynecological emergencies

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ABSTRACT

Objective: Transvaginal natural orifice transluminal endoscopic surgery (vNOTES) is an emerging minimally invasive approach increasingly applied to perform many gynecological procedures. Despite a still limited level of evidence, compared to conventional laparoscopy, vNOTES seems to be associated with reduced blood loss, shorter operative time, less postoperative pain, shorter hospitalization time, better cosmetic results and decreased postoperative morbidity. Although growing evidence supports the effectiveness of vNOTES for elective adnexal surgeries, there is still limited knowledge regarding its feasibility and safety in emergency settings. In the present study, we report our experience performing vNOTES in gynecological emergency cases.

Study design: We prospectively collected and analyzed data from patients who underwent vNOTES for gynecological emergencies between November 2021 and June 2023. Demographic and perioperative characteristics were collected and analyzed.

Results: Seventeen patients were included. Interventions were realized for suspicion of ectopic pregnancy in 7 cases (41.2%), for suspicion of adnexal torsion in 7 cases (41.2%), for post-hysterectomy hemoperitoneum in 2 cases (11.8%), and for uncontrollable uterine bleeding in 1 case (5.9%). Emergency procedures included unilateral salpingectomy (35.3%), ovarian cystectomy (23.5%), ovarian cystotomy (17.6%), adnexal detorsion (11.8%), hemoperitoneum drainage (11.8%), hysterectomy (5.9%), and appendectomy (5.9%). The overall median operative time was 38 [18–72] minutes. The median estimated intraoperative blood loss was 30 [5–150] mL, and no intraoperative complications occurred. Conversion to conventional laparoscopy or laparotomy was never needed. Patients stayed hospitalized for a median time of 30 [4–144] hours after the intervention. The median visual analog scale value for postoperative pain evaluation was 2 [0–5] at 12, 24, and 48 postoperative hours. No complications associated with the procedure occurred.

Conclusions: This study demonstrated the feasibility of performing vNOTES procedures for managing gynecological emergencies such as tubal ectopic pregnancy, adnexal torsion, painful ovarian lesions, post-hysterectomy hemoperitoneum, and uncontrollable uterine bleeding. Associated with data reported in the available literature, our results suggest potential benefits in treating gynecological emergencies by vNOTES over conventional laparoscopy. However, stronger evidence from larger studies is needed to confirm it.

1. Introduction

Common gynecological emergencies include tubal ectopic pregnancy, adnexal torsion, ovarian cyst rupture, and tubo-ovarian abscess. These conditions often require surgical procedures that can be performed by conventional laparoscopy (CL) or open surgery. In the last decades, minimally invasive techniques have been increasingly used in emergency surgery, considerably reducing the morbidity associated with open approaches. To minimize surgical morbidity further, some authors proposed to manage gynecological emergencies by transvaginal natural orifice transluminal endoscopic surgery (vNOTES) [1–3].

vNOTES is an emerging minimally invasive approach increasingly

Abbreviations: CL, conventional laparoscopy; vNOTES, transvaginal natural orifice transluminal endoscopic surgery; VAS, visual analog scale; BMI, body mass index.

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applied to perform many gynecological procedures [4]. Despite a still limited level of evidence, compared to CL, vNOTES seems to be associated with reduced blood loss, shorter operative time, less postoperative pain, shorter hospitalization time, better cosmetic results, and decreased postoperative morbidity [1,4,5]. Although growing evidence supports the effectiveness of vNOTES for elective hysterectomy and adnexal surgeries [6–9], there is still limited knowledge regarding its feasibility and safety in emergency settings.

In the present study, we report our experience performing vNOTES in gynecological emergency cases.

2. Material and methods

2.1. Patients selection, data collection, and methods

This study aimed to determine the feasibility and safety of vNOTES in treating gynecological emergencies. We prospectively collected and analyzed data from patients who underwent vNOTES for gynecological emergencies in our non-university teaching hospital between November 2021 and June 2023. Patients were operated on by two experienced vNOTES surgeons (SS and DH) and represented approximately one-third of all gynecological emergencies treated at our institution during the study period (intrauterine aspirations and curettages excluded), with the remaining cases being managed by CL. The choice to perform these procedures by vNOTES was surgeon-driven and in accord with the patients. All patients gave written informed consent, and the project received approval from the local ethical committee (CER-VD) with registration number 2021–02346.

Demographic intraoperative and postoperative characteristics were collected and analyzed. Intraoperative data included the type of surgical procedure, operating time, intraoperative blood loss (directly measured by aspirated blood after the drainage of an eventual preoperative hematoma), intraoperative complications, and the need to convert to CL or laparotomy. Postoperative data included pain evaluation with the visual analog scale (VAS) graded from 0 to 10 at 12, 24, and 48 h after surgery, the use of opioid analgesics, and the type and grade of postoperative complications that occurred up to 6 weeks after surgery. Postoperative complications were graded using the Clavien-Dindo classification [10].

The primary outcome was the feasibility of performing the surgery as initially planned, considering the conversion rate to other approaches than vNOTES, and the rate of uncompleted procedures for any reason. Continuous variables were presented as median and range. Dichotomous variables were presented as absolute numbers and percentages. Statistical analysis was performed using IBM SPSS version 20 (IBM, Corp., Armonk, NY, USA).

2.2. Surgical technique

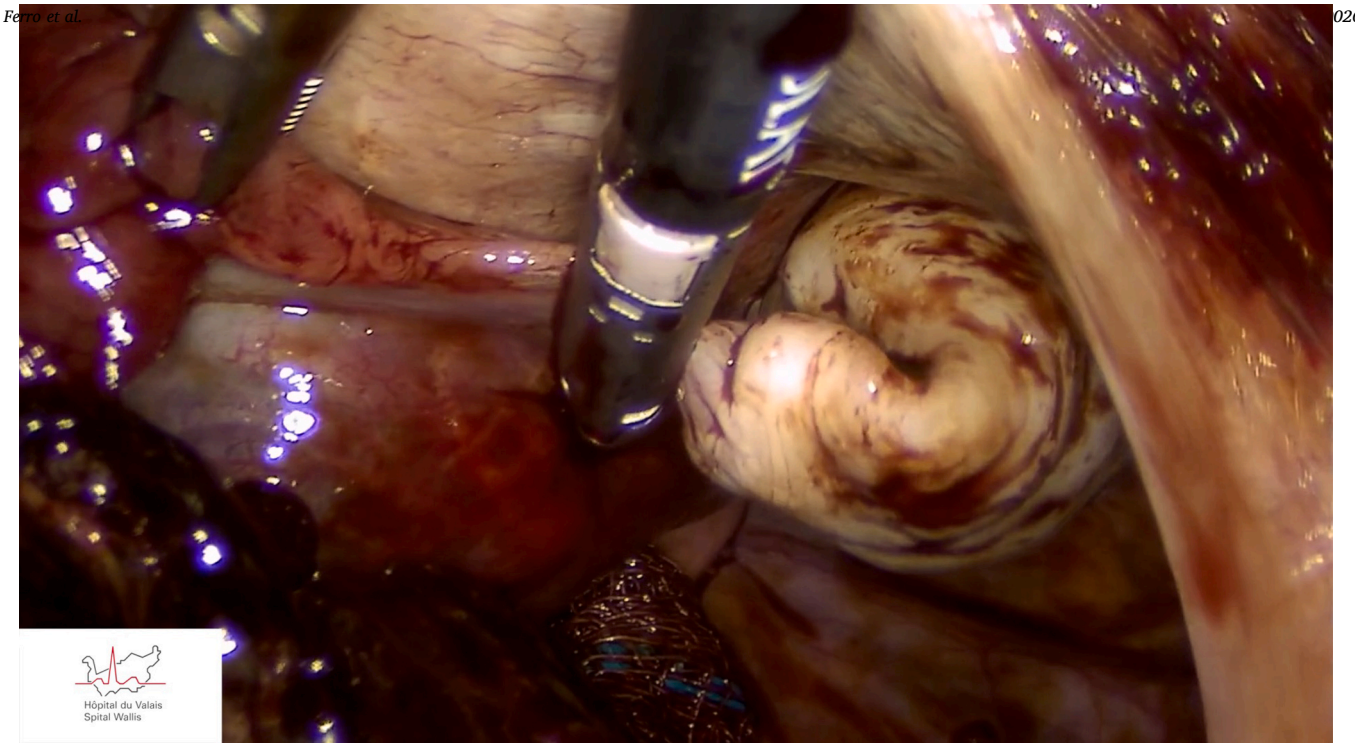
Patients were placed in a dorsal lithotomy position under general anesthesia. They received prophylactic intravenous antibiotics with cefuroxime 1.5 g and metronidazole 500 mg. A Foley catheter was placed to keep the bladder empty. Access to the peritoneal cavity was achieved through a 2.5-cm posterior colpotomy through the pouch of Douglas. A vNOTES port (GelPoint vPath, Applied Medical, Rancho Santa Margarita, CA, USA) was inserted into the abdominal cavity. In the case of a pelvic hematoma complicating a recent hysterectomy, the suture of the vaginal vault was opened, and the vNOTES port was inserted into the pelvis. Carbon dioxide was insufflated to create a pneumoperitoneum with an intraabdominal pressure of 10–12 mmHg. Three trocars were used to introduce a 10-mm rigid 30° camera, 5-mm Johan and bipolar graspers, and a bipolar sealing device. Tubal ectopic pregnancies were managed with anterograde salpingectomy or "tubal milking" procedure. Ovarian cysts were managed with cystotomy or cystectomy. Uncontrollable hemorrhagic uterine bleeding was managed with a vaginal-assisted NOTES hysterectomy. Cases of post-hysterectomy hemoperitoneum were managed with transvaginal blood drainage and vNOTES surgical hemostasis. As for all other vNOTES procedures, patients were preoperatively prepared for eventual rapid conversion to CL or laparotomy in case of intrabdominal bleeding uncontrollable by vNOTES (e.g., bleeding coming from the upper abdomen). Specimens were extracted through the vagina. A specimen retrieval bag was used to remove large or suspicious specimens. At the end of the procedure, the posterior colpotomy or the vaginal cuff was closed under direct vision with a running suture using Vicryl 0. Clindamycin vaginal cream was administered once a day for the first 7 postoperative days. Postoperative pain management included the routine administration of non-steroidal anti-inflammatory drugs and paracetamol for the first 24 postoperative hours, followed by patients' self-regulation on analgesic consumption. During the hospitalization, regular pain assessment was performed, and in the case of unsatisfactory pain relief, opioid analgesics were administered. Patients were asked to avoid sexual intercourse for the first 6 postoperative weeks. Surgical techniques for "tubal milking", salpingectomy, cystotomy, and cystectomy are demonstrated in Supplementary Video 1.

3. Results

Between November 2021 and June 2023, 17 patients underwent vNOTES for gynecological emergencies. The median age was 39.0 [28–54] years, and the median body mass index (BMI) was 23.0 [16.9–26.0] Kg/m^2. Patients' characteristics, indications for surgery, surgical procedures, and histopathological diagnoses are summarized in Tables 1 and 2, respectively.

vNOTES procedures for gynecological emergencies were realized for suspicion of ectopic pregnancy in 7 cases (41.2%), for suspicion of adnexal torsion in 7 cases (41.2%), for post-hysterectomy hemoperitoneum in 2 cases (11.8%), and uncontrollable uterine bleeding with hemodynamic instability in 1 case (5.9%). Hemoperitoneum was observed in 3 patients (17.6%) with tubal ectopic pregnancy with a median volume of 200 [100−300] mL. Both patients presenting post-hysterectomy pelvic hematoma underwent a vaginal assisted NOTES hysterectomy the day before the surgery and presented a hemoperitoneum from diffuse light bleeding coming from the parameters with 800 mL and 1000 mL of blood, respectively. Emergency procedures included unilateral salpingectomy for tubal ectopic pregnancy (n = 6; 35.3%), ovarian cystectomy (n = 4; 23.5%), ovarian cystotomy (n = 3; 17.6%), adnexal detorsion (n = 2; 11.8%), hemoperitoneum drainage and surgical hemostasis (n = 2; 11.8%), vaginal assisted NOTES hysterectomy (n = 1; 5.9%), and appendectomy (n = 1; 5.9%). The hysterectomy was performed on a patient who already had this intervention planned. The patient presented with active uterine bleeding, which did not respond to medical treatment and curettage. She refused to undergo uterine embolization and asked to anticipate the surgery. In one patient (5.9%) presenting ectopic pregnancy, "tubal milking" was successfully realized, but we decided to subsequently perform a salpingectomy due to excessive tubal damage. In one case (5.9%), the procedure was limited to vNOTES pelvic exploration with no adnexal procedures because of an unconfirmed diagnosis of ectopic pregnancy. The overall median operative time was 38 [18–72] minutes, with a median time to install the vNOTES port of 6 [4–10] minutes. Median operative times were 28.5 [32–48] minutes for salpingectomy, 22.0 [23–38] minutes for ovarian cystotomy, 32.0 [31–43] minutes for ovarian cystectomy, and 51 [45–57] minutes for hemoperitoneum drainage. All procedures were successfully performed by vNOTES as planned, and conversion to CL or laparotomy was never needed. Intraoperative characteristics are summarized in Table 3.

Patients stayed hospitalized for a median time of 30 [4−144] hours after the intervention. Median VAS values for postoperative pain evaluation were 2 [0−5], 2 [0−5], and 2 [0−5] at 12, 24, and 48 postoperative hours, respectively. Four patients (23.5%) needed opioids during the postoperative period following adnexal torsion in two cases (11.8%), ectopic pregnancy in one case (5.9%), and appendicitis in



Supplementary Video 1. vNOTES procedures for gynecological emergencies. In this video, we demonstrate how to perform vNOTES procedures for gynecological emergencies such as ectopic pregnancy, ovarian cyst rupture, and adnexal torsion.A video clip is available online. Supplementary material related to this article can be found online at doi:10.1016/j.eurox.2023.100261.

Table 1
Patients Characteristics.

Age (years)	39.0 [28.0 – 54.0]
Body mass index (Kg/m^2)	23.0 [16.9–26.0]
Previous vaginal delivery	9 (52.9)
Previous caesarean section	2 (11.8)

Continuous variables are presented as median and [range], and dichotomous variables are presented as absolute numbers and percentages (%).

another (5.9%). Two patients (11.8%) required a blood transfusion, both following post-hysterectomy hemoperitoneum. No other postoperative complications occurred. Postoperative outcomes are summarized in Table 3.

4. Discussion

In this study, we assessed the feasibility and safety of performing vNOTES for gynecological emergencies. This surgical approach has largely proven its worth for elective gynecological interventions such as hysterectomies and benign adnexal surgeries [6–9,11], but limited data are currently available regarding its potential role in managing gynecological emergencies.

Some authors reported successfully using vNOTES to manage tubal ectopic pregnancy, adnexal torsion, ovarian cyst rupture, and pelvic inflammatory disease [1–3,8,12]. Similarly, we were able to manage gynecological (ectopic pregnancies, adnexal torsions, painful ovarian cysts, post-hysterectomy hemoperitoneum, and uncontrollable uterine bleeding) and non-gynecological (appendicitis) emergencies by vNOTES in 17 patients. As in other reports, we observed no perioperative complications associated with the procedure, and conversion to CL or laparotomy was never required. These results reinforce the evidence that vNOTES is a feasible and safe approach to managing gynecological emergencies.

Compared to CL, vNOTES for adnexal surgery seem to be associated with shorter operative time, shorter hospitalizations, less postoperative pain, and better cosmetic results [7,8,13]. The vNOTES approach seems beneficial even for adnexal interventions performed in an emergency setting. In 2022, Karakaş et al. reported a retrospective comparison between vNOTES and CL in gynecological emergency cases, and they observed shorter duration of surgery, shorter hospital stay, lower VAS scores after 6 and 12 h, and a lower dose of postoperative analgesic administration in the vNOTES group [1]. In our study, we observed similar results, with a median operative time of 38 min, a median postoperative hospital stay of 30 h, and a median postoperative VAS of 2 at 12, 24, and 48 postoperative hours. These results highlight the ease, the rapidity of execution, and the limited surgical morbidity of vNOTES, suggesting its potential benefits compared to CL for managing gynecological emergencies. In addition, vNOTES does not require transabdominal accesses, presenting better cosmetic results and reducing the risk of incisional hernia and scar infections.

vNOTES has also been associated with transvaginal hydrolaparoscopy for diagnosing and treating pregnancy of unknown location (PUL) [3]. This so-called “IMELDA approach” aimed to reduce even more surgical invasiveness, allowing proper hydrolaparoscopic pelvic inspections through a 4-mm vaginal incision in case of PUL. If a tubal pregnancy is confirmed, the colpotomy is extended, and the ectopic pregnancy is treated by vNOTES, while in case of a negative investigation, the procedure is terminated, and patients present only a 4-mm perforation in the pouch of Douglas that does not require suturing. Baekelandt et al. reported using this approach to investigate and treat PULs and ectopic pregnancies in 15 cases, suggesting that it can provide improved patient comfort and better cosmetic results [3].

The challenge of the vNOTES approach lies in the limited range of movement of instruments due to limited triangulation and limited exposure in case of large uteri or adnexal masses occupying the pelvis. Reported data suggests that, in a well-trained surgeon with endoscopic and vaginal competencies, sufficient vNOTES experience to perform emergency interventions could be reached after around 20 cases [14–16]. To overcome limited triangulation, articulating instruments could sometimes be used, especially for extrapelvic procedures such as appendectomy or infundibulopelvic section in the case of an ascended

Table 2
Indications for surgery, surgical procedure, and postoperative diagnosis.

Patient	Indication for surgery	Surgical procedure	Postoperative histopathological diagnosis
1	Post-hysterectomy hemoperitoneum	Hemoperitoneum drainage	-
2	Suspicion of ectopic pregnancy	Left salpingectomy	Left ectopic pregnancy
3	Suspicion of ectopic pregnancy	Left salpingectomy	Left ectopic pregnancy
4	Suspicion of ectopic pregnancy	Left "tubal milking" followed by left salpingectomy	Left ectopic pregnancy
5	Post-hysterectomy hemoperitoneum	Hemoperitoneum drainage	-
6	Suspicion of ectopic pregnancy	Right salpingectomy	Right ectopic pregnancy
7	Suspicion of right adnexal torsion	Detorsion and right ovarian cystotomy	Right hemorrhagic cyst of the corpus luteum with adnexal torsion
8	Suspicion of right adnexal torsion	Appendicectomy and right cystectomy	Acute perforated ulcerative gangrenous appendicitis
9	Suspicion of right adnexal torsion	Right ovarian cystotomy	No adnexal torsion, no pathology
10	Suspicion of ectopic pregnancy	Left salpingectomy	Right ectopic pregnancy
11	Suspicion of ectopic pregnancy	Diagnostic laparoscopy	No ectopic pregnancy, no pathology
12	Suspicion of left adnexal torsion	Left cystectomy	Left hemorrhagic cyst of the corpus luteum without adnexal torsion
13	Uncontrollable uterine bleeding with hemodynamic instability in a patient	Vaginal assisted NOTES hysterectomy	Myomas
14	Suspicion of ectopic pregnancy	Left salpingectomy	Left ectopic pregnancy
15	Suspicion of right adnexal torsion	Detorsion and right cystectomy	Adnexal torsion, no pathology
16	Suspicion of right adnexal torsion	Right ovarian cystotomy	Right hemorrhagic cyst of the corpus luteum without adnexal torsion
17	Suspicion of right adnexal torsion	Right cystectomy	Right hemorrhagic cyst of the corpus luteum without adnexal torsion

Table 3
Surgical procedure and perioperative outcomes.

Operative time	38 [18 - 72]
vNOTES port insertion (minutes)	6 [4 - 15]
Salpingectomy	28.5 [32 - 48]
Ovarian cystotomy	22.0 [23 - 38]
Cystectomy	32.0 [31 - 43]
Hemoperitoneum drainage	51 [45 - 57]
Vaginal assisted NOTES hysterectomy	41
Appendectomy	72
Preoperative hemoperitoneum	5 (29.4)
Volume (mL)	300 [200 - 1000]
Intraoperative estimated blood loss *(mL)*	30 [5 - 150]
Conversion to conventional laparoscopy/laparotomy	-
Intraoperative complications	-
Surgery regimen	
One-day surgery	4 (23.5)
Length of postoperative stay (hours)	30 [4 – 144]
Pain visual analog scale *(1 – 10)*	
12 hours postoperative	2 [0 – 5]
24 hours postoperative	2 [0 – 5]
48 hours postoperative	2 [0 – 5]
Use of opioids during the postoperative period	4 (23.5)
Postoperative complications	
Blood transfusion	2 (11.8)

Continuous variables are presented as median and [range], and dichotomous variables are presented as absolute numbers and percentages (%).

ovary caused by adnexal torsion [17]. From our personal experience, to improve visibility and surgical safety, in addition to the Tredelenburg position, we suggest using intrabdominal gauze to absorb blood and move sensible structures such as bowels, keeping a safe distance from the sectioned or coagulated tissues.

This study supports vNOTES as a feasible, safe, and valuable technique for managing gynecological emergencies. We acknowledge some limitations of this study, mainly resulting from its single-institution character, the limited number of patients included in the analyses, and the absence of a control group of patients treated by CL. However, considering the limited knowledge in this field, these results represent essential information for developing vNOTES in emergency settings. Although the surgical feasibility and safety of vNOTES seem increasingly evident, more studies are needed to prove its value in managing emergency cases, particularly through randomized control trials comparing vNOTES to CL.

5. Conclusion

This study demonstrated the feasibility of performing vNOTES procedures for managing gynecological emergencies such as tubal ectopic pregnancy, adnexal torsion, and painful ovarian lesions. Associated with data reported in the available literature, our results suggest potential benefits in treating gynecological emergencies by vNOTES over CL. However, stronger evidence from larger studies is needed to confirm it.

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CRediT authorship contribution statement

R Ferro: data collection, data analysis, manuscript writing. Y Hurni: protocol development, data collection, data analysis, manuscript writing. S. Seidler: performed surgeries, data collection, data analysis, manuscript editing. D Huber: performed surgeries, protocol/project development, data collection, data analysis, and manuscript editing.

Declaration of Competing Interest

The authors declare no conflict of interest.

Data availability statement

Data are available on request from the authors.

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Statement of prior presentation

This study has never been presented or published.

Patients consent for publication

Patients gave written consent.

References

[1] Karakaş S, Kaya C, Yildiz Ş, Alay İ, Durmuş U, Aydiner İE, et al. Comparison of vnotes technique with conventional laparoscopy in gynecological emergency cases. Minim Invasive Ther Allied Technol 2022;31(5):803–9.

[2] Ozceltik G, Yeniel AO, Atay AO, Itil IM. Transvaginal natural orifice transluminal endoscopic surgery for tubal stump pregnancy. J Minim Invasive Gynecol 2021;28 (4):750–1.

[3] Baekelandt J, Vercammen J. Imelda transvaginal approach to ectopic pregnancy: diagnosis by transvaginal hydrolaparoscopy and treatment by transvaginal natural orifice transluminal endoscopic surgery. Fertil Steril 2017;107(1):e1–2.

[4] Li CB, Hua KQ. Transvaginal natural orifice transluminal endoscopic surgery (vnotes) in gynecologic surgeries: a systematic review. Asian J Surg 2020;43(1): 44–51.

[5] Kapurubandara S, Lowenstein L, Salvay H, Herijgers A, King J, Baekelandt J. Consensus on safe implementation of vaginal natural orifice transluminal endoscopic surgery (vnotes). Eur J Obstet Gynecol Reprod Biol 2021;263:216–22.

[6] Baekelandt J, Kapurubandara S. Benign gynaecological procedures by vaginal natural orifice transluminal endoscopic surgery (vnotes): complication data from a series of 1000 patients. Eur J Obstet Gynecol Reprod Biol 2021;256:221–4.

[7] Baekelandt J, De Mulder PA, Le Roy I, Mathieu C, Laenen A, Enzlin P, et al. Adnexectomy by vaginal natural orifice transluminal endoscopic surgery versus laparoscopy: results of a first randomised controlled trial (notable trial). Bjog 2021; 128(11):1782–91.

[8] Kaya C, Alay I, Cengiz H, Baghaki S, Aslan O, Ekin M, et al. Conventional laparoscopy or vaginally assisted natural orifice transluminal endoscopic surgery for adnexal pathologies: a paired sample cross-sectional study. J Invest Surg 2021; 34(11):1185–90.

[9] Kaya C, Yıldız Ş, Alay İ, Karakaş S, Durmuş U, Güraslan H, et al. Comparison of surgical outcomes of total laparoscopic hysterectomy and vnotes hysterectomy for undescended-enlarged uteri. J Invest Surg 2022;35(4):918–23.

[10] Dindo D, Demartines N, Clavien PA. Classification of surgical complications: a new proposal with evaluation in a cohort of 6336 patients and results of a survey. Ann Surg 2004;240(2):205–13.

[11] Evangelisti G, Barra F, Centurioni MG, D'Alessandro G, Alessandri F, Ferrero S. Vaginal natural orifice transluminal endoscopic surgery (notes) for treating benign adnexal diseases: past results and future developments. J Invest Surg 2022;35(2): 409–10.

[12] Lamblin G, Chene G, Mansoor A, Katuta C, Bouvet L, Nohuz E. Ectopic pregnancy management by v-notes technique. J Gynecol Obstet Hum Reprod 2021;50(5): 102073.

[13] Yassa M, Kaya C, Kalafat E, Tekin AB, Karakas S, Mutlu MA, et al. The comparison of transvaginal natural orifice transluminal endoscopic surgery and conventional laparoscopy in opportunistic bilateral salpingectomy for permanent female sterilization. J Minim Invasive Gynecol 2021.

[14] Lauterbach R, Matanes E, Amit A, Wiener Z, Lowenstein L. Transvaginal natural orifice transluminal endoscopic (vnotes) hysterectomy learning curve: feasibility in the hands of skilled gynecologists. Isr Med Assoc J 2020;22(1):13–6.

[15] Wang CJ, Go J, Huang HY, Wu KY, Huang YT, Liu YC, et al. Learning curve analysis of transvaginal natural orifice transluminal endoscopic hysterectomy. BMC Surg 2019;19(1):88.

[16] Kim MS, Noh JJ, Kim TJ. Hysterectomy and adnexal procedures by vaginal natural orifice transluminal endoscopic surgery (vnh): initial findings from a korean surgeon. Front Med (Lausanne) 2020;7:583147.

[17] Hurni Y, Huber D. Omentectomy for oncological surgical staging by transvaginal natural orifice transluminal endoscopic surgery (vnotes): a preliminary study. Front Surg 2023;10.