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Evaluation of Intraoperative Complications in Bilateral Tubal Ligation Operations Performed by Vaginal Natural Orifice Transluminal Endoscopic Surgery (v-NOTES) Method

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Abstract

Objectives: This study aimed to evaluate intraoperative complications, surgical outcomes, and overall safety of bilateral tubal ligation (BTL) performed for permanent sterilisation using the Vaginal Natural Orifice Transluminal Endoscopic Surgery (v-NOTES) method.

Materials and Methods: We retrospectively reviewed the data of 164 patients who underwent BTL using the v-NOTES method at our clinic between January 1, 2021 and July 31, 2025. The demographic data of the patient, the operative time, intraoperative complications, conversion rates to conventional laparoscopy, the length of hospital stay and postoperative pain scores were analysed. The primary endpoints were the appearance of major intraoperative complications and the need to convert to laparoscopy.

Results: The mean age of the 164 patients included in the study was 38.4 ± 4.7 years. The mean operative time was 36.2 ± 8.5 minutes. The overall rate of intraoperative complications was 2.4% (4/164). No major vascular or visceral organ injuries were observed. Two patients (1.2%) required conversion to conventional laparoscopy due to dense pelvic adhesions. The median length of hospital stay was 1 day, and postoperative pain scores were very low. No complications such as surgical site infections or incisional hernias occurred, owing to the absence of abdominal incisions.

Conclusions: BTL performed with the v-NOTES technique is a safe and effective method, offering low complication rates, short operative times, minimal postoperative pain, rapid recovery, and excellent cosmetic outcomes. Except for cases with suspected adhesions that obliterate the Douglas pouch, it should be considered a strong alternative to traditional methods for suitable patients seeking permanent sterilisation.

Keywords: v-NOTES, Bilateral tubal ligation, Natural orifice surgery, Intraoperative complications, Minimally invasive surgery, Scarless surgery

Introduction

Family planning is a fundamental component of women's health, and millions of women worldwide opt for permanent contraception methods. Among surgical sterilisation techniques, bilateral tubal ligation (BTL) is the most common and is traditionally performed by minilaparotomy or conventional laparoscopy. Although these approaches have high efficacy rates, they require abdominal incisions and are associated with potential risks such as postoperative pain, incisional scar tissue, wound infections, and hernias. Technological advances in surgery have paved the way for the development of minimally invasive techniques that aim to minimise these risks and improve patient comfort (1,2).

One of these innovative approaches is Natural Orifice Transluminal Endoscopic Surgery (NOTES), a technique that allows endoscopic operations within the abdomen through natural body orifices (vagina, mouth, rectum) without incisions on the abdominal wall. In gynecological surgery, v-NOTES (Vaginal Natural Orifice Transluminal Endoscopic Surgery), performed via the vaginal route, stands out for offering "scarless surgery." This method theoretically promises significant advantages, including less postoperative pain, a faster recovery period, superior cosmetic results, and the elimination of complications related to the abdominal wall (2,3).

The v-NOTES technique is gaining increasing popularity not only for complex procedures such as hysterectomy and adnexal surgeries, but also for more common operations such as BTL. Performing BTL with v-NOTES takes the minimally invasive nature of the procedure a step further, making it an attractive alternative for patients. However, as with the integration of any new surgical technique into clinical practice, the safety profile, the learning curve, and the potential risks of the v-NOTES method must be carefully analysed. Intraoperative complications, in particular, are a critical metric for evaluating the feasibility and safety of the technique (1,4).

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The purpose of this study is to perform a detailed examination of the rates of intraoperative complications, types of complications, and management strategies in BTL operations performed using the v-NOTES technique in our clinic. We will retrospectively analyse potential intraoperative issues such as vascular injuries, damage to adjacent organs (bladder, rectum), gas embolism, and conversion rates to conventional laparoscopy due to technical difficulties. The data obtained are intended to illuminate the safety profile of v-NOTES for BTL, provide scientific evidence to support surgeons in the adoption of this technique, and offer valuable information for patient counselling (4,5).

Key Messages

- v-NOTES offers a safe, fast, and patient-friendly tubal ligation with minimal pain and rapid recovery.
- Dense pelvic adhesions, particularly from prior surgery, remain the primary challenge and reason for conversion to laparoscopy.

Materials and Methods

Study Design

This retrospective cohort study was conducted by reviewing the data of patients who underwent BTL for permanent sterilisation using the v-NOTES method in the Department of Obstetrics and Gynecology, Harran University Hospital, between January 1, 2021 and July 31, 2025.

Patient Selection

All patients who underwent v-NOTES BTL during the study period were assessed for potential inclusion.

Inclusion Criteria

- Age between 18 and 49 years.
- Request for permanent contraception after completing family planning.
- No contraindications for general anaesthesia.
- Anatomy suitable for vaginal surgery (adequate vaginal width and mobile uterus).
- Complete operative and follow-up records available.

Exclusion Criteria

- Suspicion of or current pregnancy.
- Presence of active cervicitis, vaginitis, or pelvic inflammatory disease.
- Vaginal stenosis or pelvic organ prolapse is severe enough to hinder the operation.
- Suspicion of severe adhesions that obliterate the rectouterine pouch (Douglas pouch), such as in advanced-stage endometriosis or due to multiple previous pelvic surgeries.
- Nulliparity.
- Patients with incomplete records or no follow-up data.

Data Collection

The demographic, clinical and surgical data of the included patients were retrospectively retrieved from the hospital's electronic information system and patient files and recorded in a standardised data collection form. The recorded data included patient age, gravidity, parity, body mass index (BMI), history of previous abdominal surgery, operative time (min), tubal ligation technique used (bipolar coagulation and cutting), intraoperative and early postoperative complications, and length of hospital stay (days). The median postoperative follow-up duration for the cohort was 26 months (range: 6–55 months).

Surgical Technique

All operations were performed under general anaesthesia by gynecologic surgeons with experience in at least 20 cases of v-NOTES, following a standard protocol.

- Preparation and positioning: After induction of general anaesthesia, patients were placed in a dorsal lithotomy position combined with a deep Trendelenburg position.
- Vaginal entry and port placement: The mucosa of the posterior fornix was tractioned by grasping the posterior lip of the cervix with a tenaculum. A solution of saline with 1:200 000 adrenaline was injected into the incision line for hydrodissection and haemostasis. A transverse colpotomy incision of approximately 2 cm was made in the posterior fornix to enter the peritoneal cavity (Pouch of Douglas). V-Port transvaginal access platform was inserted through this opening.
- Pneumoperitoneum: Once the silicone gel seal of the port was properly seated against the vaginal walls, carbon dioxide (CO_2) was insufflated through the port's insufflation lumen to create a pneumoperitoneum with an intra-abdominal pressure of 8-10 mm Hg.
- Tubal ligation procedure: A 5 mm, 30-degree laparoscope and pre-bent laparoscopic instruments (Maryland grasper and bipolar coagulator) were advanced into the abdomen through the port's channels. The uterus and adnexa were systematically evaluated. The fallopian tubes were gently grasped with an atraumatic grasper. An avascular portion of the isthmic segment of the tube was coagulated over an area of at least 3 cm with bipolar electrocoagulation and then cut with scissors. The procedure was repeated for both tubes.
- Conclusion of the operation: At the end of the procedure, haemostasis was checked in the abdominal cavity, particularly at the colpotomy line. After complete desufflation of the pneumoperitoneum, the v-NOTES port was carefully removed. The posterior colpotomy incision was closed using a 2-0 polyglactin suture with a continuous locking suture technique.

Variables and Endpoints

- Primary endpoints: The presence of major intraoperative complications (estimated blood loss > 100 mL, bladder or bowel injury) and the need to convert to conventional laparoscopy or laparotomy.
- Secondary endpoints: Total operative time (from the start of the colpotomy to its closure), length of hospital stay, postoperative pain scores at 6 and 24 hours (Visual Analogue Scale - VAS), specific complications of v-NOTES (vaginal cuff haematoma/infection), and infection of the surgical site.

Statistical Analysis

Data analysis was performed using IBM SPSS Statistics for Windows, version 22.0 (Armonk, NY: IBM Corp.). Descriptive statistics were presented as mean ± standard deviation (SD) or median (minimum-maximum) for continuous variables, and as numbers and percentages (n, %) for categorical variables. The relationship between potential risk factors (BMI, previous surgery, etc) and the development of complications was assessed using the chi-square or Fisher's exact test. The sample size was calculated to estimate the primary endpoint, the intraoperative complication rate, with sufficient precision. Based on complication rates of 1-5% for v-NOTES reported in the literature, a sample size of 164 patients was deemed adequate to estimate the rate with a margin of error of ±2.5% at a 95% confidence level. Furthermore, this sample size was also assessed to provide adequate statistical power (over 80% at a 5% significance level) to test whether an observed complication rate (~2.4%) is significantly different from a historical control rate of ~8% reported for conventional laparoscopy. A P value of < 0.05 was considered statistically significant.

Table 1. Demographic and Clinical Characteristics of the Patients

Variable	Value (n=164)
Age (years, mean ± SD)	38.4 ± 4.7 (range: 29–48)
Gravidity (median, min-max)	4 (2–9)
Parity (median, min-max)	3 (2–7)
BMI (kg/m², mean ± SD)	28.1 ± 3.5 (range: 21.5–39.0)
BMI < 25 (Normal)	45 (27.4%)
BMI 25-29.9 (Overweight)	88 (53.7%)
BMI ≥ 30 (Obese)	31 (18.9%)
History of previous abdominal surgery (n, %)	
None	108 (65.9%)
Yes (Caesarean section or other)	56 (34.1%)
ASA score (n, %)	
ASA I	92 (56.1%)
ASA II	72 (43.9%)

SD: Standard Deviation; BMI: Body Mass Index; ASA: American Society of Anesthesiologists.

Table 2. Intraoperative and Postoperative Outcomes

Variable	Value (n=164)
Operative time (min, mean ± SD)	36.2 ± 8.5 (range: 22–65)
Estimated blood loss (mL, mean ± SD)	15.4 ± 5.1 (range: 5–50)
Longest hospital stay (days, median, min-max)	1 (1–3)
Postoperative pain score (VAS, 0-10)	
At 6 hours (mean ± SD)	2.8 ± 1.1 (range: 1–5)
At 24 hours (mean ± SD)	1.5 ± 0.8 (range: 0–4)
Abdominal surgical site infection (n, %)	0 (0%)
Vaginal cuff complication (n, %)	
Infection	1 (0.6%)
Haematoma	1 (0.6%)

SD: Standard deviation; VAS: Visual analogue scale.

Results

During the study period, the records of 172 patients scheduled for BTL were reviewed using the v-NOTES method. After excluding 8 patients, (4.6%) who met the exclusion criteria (5 with missing data, 3 with active vaginitis), 164 patients were included in the analysis.

The demographic and baseline clinical characteristics of the patients are summarised in Table 1. The mean age of the patients was 38.4 ± 4.7 years and the mean BMI was 28.1 ± 3.5 kg/m². A total of 34.1% (n = 56) of the patients had a history of at least one previous abdominal surgery (most commonly cesarean section).

The operative and postoperative results are presented in Table 2. The mean operative time was 36.2 ± 8.5 minutes. The estimated mean blood loss was very low (15.4 ± 5.1 mL). The vast majority of patients (95.1%) were discharged on the same or the next day after the operation, with a median hospital stay of 1 day.

Intraoperative complications, the primary endpoint of our study, were observed in 4 of the 164 patients (2.4%). The observed complications and their management strategies are detailed in Table 3. No major vascular or visceral organ injuries (bladder, bowel) occurred in any patient.

In total, 2 patients (1.2%) required conversion to conventional laparoscopy due to technical difficulties (dense adhesions and inadequate visualization). Both patients had a history of previous pelvic surgery. The conversion rate was higher in patients with a history of previous abdominal surgery (3.6%, 2/56) compared to those with no such history (0%, 0/108), although this difference was not statistically significant (P=0.057, Fisher's exact test). This finding suggests a potential trend toward a higher risk of conversion in patients with prior surgical history, though it did not reach the threshold for statistical significance.

There was no significant difference in the rate of intraoperative complications between obese (BMI ≥ 30) and non-obese patients (3.2% vs. 2.3%, P=0.781).

In the early postoperative period, one patient was hospitalised. (0.6%) developed a vaginal cuff

Table 3. Details of Observed Intraoperative Complications and Their Management (n=4)

Case No.	Complication	Management	Outcomes
1	Failure to enter the abdomen due to dense adhesions in the Douglas pouch.	The procedure was aborted and converted to conventional laparoscopy. The laparoscopic BTL was successfully completed.	Uncomplicated recovery.
2	Obliteration of the Douglas pouch due to endometriosis, which leads to inadequate visualisation.	The abdomen was entered, but the visualisation of the tubes was not safe. Converted to conventional laparoscopy.	Laparoscopic BTL and adhesiolysis were performed. Uncomplicated recovery.
3	Bleeding of the mesosalpinx during right tubal ligation (<50 mL).	Intraoperative haemostasis was achieved with bipolar coagulation.	No blood transfusion required. The procedure was completed successfully.
4	Thermal injury suspected to the rectal serosa from electrocautery.	The patient was treated conservatively; no surgical repair was needed.	No postoperative complications developed.

BTL: Bilateral tubal ligation.

infection, which was successfully treated with oral antibiotics. Another patient (0.6%) was found to have an asymptomatic 3 cm vaginal cuff hematoma, which resolved spontaneously with conservative follow-up. Since there were no abdominal incisions, no patient experienced complications such as surgical site infection, incisional hernia, or scar tissue.

Discussion

Surgical sterilisation has a significant place in family planning, and BTL remains one of the most frequently performed procedures for this purpose. In contrast to traditional approaches, v-NOTES is a revolutionary technique that introduces the concept of "scarless surgery" into gynecological practice by eliminating abdominal incisions. In this study, we retrospectively reviewed intraoperative complications and surgical outcomes of 164 BTL cases performed using the v-NOTES method at our clinic. Our primary finding suggests that v-NOTES BTL, when performed by experienced surgeons, is a safe procedure with a very low intraoperative complication rate of 2.4%. This rate is consistent with previously published prospective and randomized studies reporting low complication incidences for v-NOTES procedures, ranging from 1% to 5% (4,6).

The mean operative time in our study was 36.2 ± 8.5 minutes. This duration is consistent with other v-NOTES BTL series in the literature. For example, Baekelandt et al reported a mean operating time of 35 minutes for v-NOTES BTL (4), while Koulakmanidis et al found operating times ranging from 30 to 40 minutes (7). Compared to conventional laparoscopic BTL, the v-NOTES technique can offer similar or shorter operative times, mainly due to faster abdominal access and the elimination of multiple port placements. These findings suggest that v-NOTES not only maintains safety, but also provides a time-efficient alternative, especially once the learning curve is overcome (8,9).

The intraoperative complication rate, the focus of this study, was very low at 2.4% (4/164). Importantly, no life-threatening events such as major vascular injury or full-thickness bowel or bladder damage occurred. Major complications for v-NOTES BTL are also infrequent in the literature. Minor complications in our series, including suspected thermal injury to the rectal serosa in one case and minor mesosalpingeal bleeding in another, are consistent with those reported in other minimally invasive gynecologic procedures and were managed with conservative or simple endoscopic techniques. Similarly, Dilbaz et al reported bleeding as the most common complication in their BTL series (1.5%), all successfully controlled laparoscopically (10). These findings indicate that bleeding risk is manageable in minimally invasive approaches. The low complication rate may also be attributed to the direct transvaginal entry through the Pouch of Douglas, which avoids major anterior abdominal wall vessels and the bladder, representing a key anatomical advantage of v-NOTES (11,12).

The most significant intraoperative challenge in our series was the conversion to conventional laparoscopy in two patients (1.2%) due to dense pelvic adhesions. This rate is consistent with the 1–5% conversion rates reported in v-NOTES series in the literature (8,13). Both patients had a history of previous pelvic surgery, confirming that obliteration of the Pouch of Douglas is a major limiting factor for v-NOTES procedures. This finding underscores the importance of careful preoperative patient selection, particularly evaluating the history of prior pelvic surgery or endometriosis, to maximize the success of the technique. Although our data suggest a trend toward higher conversion rates in patients with previous abdominal surgery, this difference did not reach statistical significance ($P=0.057$), likely due to the small number of events. Therefore, caution is warranted when interpreting this finding, and larger studies are needed to confirm whether previous surgery is an independent risk factor for conversion.

It is important to emphasise that the strict inclusion and exclusion criteria applied in our study were part of a deliberate methodological approach. When evaluating the safety profile of a new surgical technique, it is standard and ethically appropriate to initially select ideal low-risk candidates to establish a baseline for safety and feasibility. Therefore, the favourable results reported in this study

reflect the performance of v-NOTES BTL under optimal conditions. The extension of this technique to more complex scenarios—such as patients with a higher BMI, previous abdominal surgery, or suspected moderate adhesions—can be explored in future studies as the collective surgical experience with v-NOTES increases (14,15).

Furthermore, all procedures in our series were performed by surgeons who had surpassed the initial learning curve, with a minimum of 20 previous cases. This factor is crucial, as the learning curve for v-NOTES is well-documented to influence both complication rates and operative times (16, 17). As highlighted by the literature, achieving proficiency requires a structured pathway to navigate challenges such as spatial orientation and instrument handling (8). Consequently, our favourable results reflect the outcomes achievable in a centre with established expertise. These findings may not be directly generalisable to surgeons in the early phase of their v-NOTES learning curve, underscoring the importance of structured, proctored training programs and simulation to ensure patient safety and procedural efficiency for the safe implementation and widespread adoption of this technique.

One of the most notable advantages of the v-NOTES technique is improved patient comfort during the postoperative period. In our study, VAS pain scores at 6 and 24 hours postoperatively were 2.8 and 1.5, respectively. These low pain scores likely reflect the absence of abdominal wall trauma and reduced peritoneal irritation. Continually, multiple studies comparing v-NOTES with conventional laparoscopy report significantly lower postoperative pain scores in the v-NOTES group, along with a decreased need for analgesics (18,19). In addition, the majority of our patients were discharged in a median of 1 day, which not only improves patient satisfaction, but also reduces the burden on healthcare resources.

Another notable advantage of the v-NOTES technique is its superior cosmetic result. The absence of abdominal wall incisions allows it to be classified as "scarless surgery," which may be particularly attractive for young patients with cosmetic concerns. In our series, no complications related to incisions, such as surgical site infection, haematoma, seroma, incisional hernia, or keloid formation, were observed. Specific potential risks associated with v-NOTES, such as vaginal cuff infection and haematoma, occurred in one single patient each (0.6%) and were successfully managed with conservative measures. These complication rates are comparable to those reported for other transvaginal procedures, such as vaginal hysterectomy, indicating that they can be effectively mitigated with proper surgical technique and prophylaxis (12,20).

Limitaions of the Study

Our study has several limitations that must be acknowledged. First, its retrospective design is susceptible to selection bias and incomplete data recording. Second, as a single-centre study with experienced surgeons, the generalisability of our findings to other institutions with varying levels of experience may be limited. Most importantly, the absence of a control group (e.g., patients undergoing conventional laparoscopic BTL) prevents a direct comparison and objective quantification of the proposed advantages of v-NOTES, such as reduced pain or faster recovery. Furthermore, as a single-center study involving experienced surgeons and strict patient selection criteria, the generalizability of our findings should be interpreted with caution; complication and conversion rates may vary in settings with less surgical experience or when applied to broader patient populations. Future prospective randomised controlled trials are essential to definitively establish the role of v-NOTES in relation to conventional laparoscopy for tubal sterilisation. Furthermore, our analysis focused primarily on intraoperative and early postoperative outcomes. Long-term data regarding contraceptive efficacy, such as failure rates or the incidence of ectopic pregnancy, were not systematically collected, and this remains an important area for future longitudinal studies.

Conclusions

This study demonstrates that BTL performed with the v-NOTES technique is a procedure with a high intraoperative safety profile when careful patient selection is applied and sufficient surgical experience is present. The observed low complication rate of 2.4% and the absence of any major vascular or visceral organ injuries in our series support the reliability of the technique. It was determined that the most critical factor for the success of the procedure is the preoperative prediction of dense adhesions that may develop in the Pouch of Douglas, particularly due to previous pelvic surgery or endometriosis; indeed, this was the primary reason for our conversions to conventional laparoscopy. In conclusion, v-NOTES with BTL offers significant patient-centered advantages such as the absence of abdominal incisions, minimal postoperative pain, a short hospital stay, and excellent cosmetic results. While this study does not aim to prove superiority, these features establish v-NOTES as a viable and patient-friendly alternative to traditional surgical methods for suitable patients seeking permanent sterilization.

Authors' Contribution

Conceptualization: Yusuf Ziya Kizildemir.
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Writing–original draft: Yusuf Ziya Kizildemir, Ömer Tammo.
Writing–review & editing: Yusuf Ziya Kizildemir, Ömer Tammo.

Conflict of Interests
The authors declare that they have no potential competing interests in the research, authorship, or publication of this study.

Availability of Data and Materials
Data supporting the findings of this study are available from the corresponding author on a reasonable request.

Ethical Issues
This study was approved by the Harran University Clinical Research Ethics Committee on 1 August 2025 (Approval number: HRÜ/2025/08-14). The research was carried out according to the ethical principles of the Declaration of Helsinki of the World Medical Association. Due to the retrospective nature of the study and the use of fully anonymised data, the ethics committee waived the requirement to obtain separate informed consent from the patients.

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Declaration of AI and Generative Tools in Writing
During the preparation of this manuscript, generative artificial intelligence tools such as Paperpal were used to improve grammar, edit sentence structure, improve text fluency, and format the content according to academic standards. AI was used as a writing assistant; the conceptual framework, data analysis, interpretation, and scientific conclusions of the article are entirely the intellectual product of the authors. The authors assume full responsibility for the entire work, including the accuracy and integrity of the content.

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