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ORIGINAL ARTICLE

Minimally invasive approaches in ectopic pregnancy surgery: vaginal natural orifice transluminal endoscopic surgery versus conventional laparoscopy

Enfoques mínimamente invasivos en cirugía del embarazo ectópico: V-NOTES frente a laparoscopia convencional

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Abstract

Objectives: *The objective of the study was to compare the efficacy and safety of vaginal natural orifice transluminal endoscopic surgery (V-NOTES) and conventional laparoscopy in the surgical management of ectopic pregnancy.* **Methods:** *A retrospective case–control study was conducted, including 40 patients diagnosed with ectopic pregnancy, treated either with V-NOTES (n = 20) or conventional laparoscopy (n = 20). Outcomes assessed included operative time, blood loss, post-operative pain scores, length of hospital stay, and complication rates.* **Results:** *No significant differences were observed between the two groups in terms of operative time, blood loss, and complication rates. However, V-NOTES resulted in significantly lower post-operative pain scores (Visual Analog Scale: 2.1 ± 1.0 vs. 4.3 ± 1.1; p = 0.01) and reduced opioid usage compared to conventional laparoscopy.* **Conclusions:** *V-NOTES appears to be a non-inferior alternative to conventional laparoscopy in ectopic pregnancy surgery, with comparable surgical safety and enhanced post-operative comfort. Further research with larger cohorts is recommended to confirm these findings.*

Keywords: *Ectopic pregnancy. Vaginal natural orifice transluminal endoscopic surgery. Conventional laparoscopy. Minimally invasive surgery. Surgical outcomes.*

Resumen

Objetivos: *Comparar la eficacia y la seguridad de la cirugía endoscópica transluminal por orificio natural vía vaginal (V-NOTES) y la laparoscopia convencional en el tratamiento quirúrgico del embarazo ectópico.* **Métodos:** *Se realizó un estudio retrospectivo de casos y controles, incluyendo 40 pacientes diagnosticadas con embarazo ectópico tratadas mediante V-NOTES (n = 20) o laparoscopia convencional (n = 20). Se evaluaron los resultados en términos de tiempo operatorio, pérdida de sangre, puntuaciones de dolor posoperatorio, duración de la estancia hospitalaria y tasas de complicaciones.* **Resultados:** *No se observaron diferencias significativas entre los dos grupos en cuanto al tiempo operatorio, la pérdida de sangre y las tasas de complicaciones. Sin embargo, V-NOTES resultó en puntuaciones significativamente más bajas de dolor posoperatorio (EVA: 2.1 ± 1.0 vs. 4.3 ± 1.1; p = 0.01) y menor uso de opiáceos en comparación con la laparoscopia convencional.* **Conclusiones:** *V-NOTES parece ser una alternativa no inferior a la laparoscopia convencional en la cirugía del embarazo ectópico, con una seguridad quirúrgica comparable y mayor comodidad posoperatoria. Se recomienda realizar investigaciones adicionales con cohortes más grandes para confirmar estos hallazgos.*

Palabras clave: *Embarazo ectópico. V-NOTES. Laparoscopia convencional. Cirugía mínimamente invasiva. Resultados quirúrgicos.*

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Introduction

Ectopic pregnancy is a serious and potentially life-threatening condition that requires prompt surgical intervention. The traditional surgical approach has been open laparotomy, but in recent years, minimally invasive techniques such as laparoscopy have gained significant traction due to their potential benefits, including reduced pain, shorter recovery time, and improved cosmetic outcomes.[1,2] In recent years, a newer approach called vaginal natural orifice transluminal endoscopic surgery (V-NOTES) has emerged as a promising alternative to conventional laparoscopy.[3,4]

V-NOTES is a novel minimally invasive approach that utilizes the vagina as the access point to the peritoneal cavity, offering an alternative to traditional laparoscopic procedures. The use of the vagina as an entry point avoids external incisions, which not only reduces visible scarring but also limits the risk of wound-related complications such as infections and hernias.[5] In the context of ectopic pregnancy, V-NOTES has been explored as a potential option for surgical management, offering the advantage of reduced post-operative pain and quicker recovery. While conventional laparoscopy remains the gold standard for surgical intervention in ectopic pregnancy, the minimally invasive nature of V-NOTES has raised interest in its potential non-inferiority to traditional laparoscopic techniques in terms of surgical outcomes and patient satisfaction.[6] Several studies have indicated that V-NOTES is associated with comparable surgical efficacy and safety to traditional laparoscopy, including similar complication rates and operative times, while also offering enhanced post-operative comfort.[7-9] However, the data on V-NOTES in ectopic pregnancy surgery is limited, and more research is needed to establish its non-inferiority or potential superiority over conventional methods.

The aim of this study is to compare the efficacy and safety of V-NOTES and conventional laparoscopy in the surgical management of ectopic pregnancy. By evaluating the outcomes of both approaches, this research seeks to determine which method offers superior results in terms of surgical effectiveness, complication rates, and post-operative recovery.

Methods

The study was reviewed by our university's Local Ethics Committee and approved with the date of January 10, 2025, and number 2025/54. This study was designed as a retrospective case–control analysis involving 40 patients diagnosed with ectopic pregnancy and treated at our institution. The patients were divided into two groups: 20 patients who underwent V-NOTES and 20 patients who underwent conventional laparoscopic surgery. The allocation of patients to either the V-NOTES or conventional laparoscopy group was determined based on the surgeon's preference and clinical judgment at the time of surgery. The patients were identified and reviewed retrospectively using the patient records from our electronic health system.

Inclusion criteria: women aged 18-45 years diagnosed with ectopic pregnancy, patients without any chronic medical conditions, and patients eligible for surgical treatment. Exclusion criteria: a history of severe adhesive disease in the abdominal or pelvic region, patients with serious cardiovascular, pulmonary, or other systemic diseases, conditions unsuitable for surgery (e.g., bleeding disorders), other confounding factors (e.g., patients who are excessively underweight or overweight). Patient management: all patients were initially evaluated by the attending gynecologist following institutional protocols for managing ectopic pregnancy. Women with live ectopic gestations or those presenting with hemodynamic instability were recommended to undergo surgery. Asymptomatic patients with unruptured ectopic pregnancies and β-hCG levels under 5000 IU/L were offered systemic methotrexate therapy. Surgical intervention was recommended for patients with β-hCG levels above 5000 IU/L or those who did not respond to methotrexate treatment. Study group: the V-NOTES and conventional laparoscopic groups consisted of patients who were unsuitable for methotrexate therapy and had no contraindications to the posterior colpotomy approach (e.g., no history of rectal surgery, pelvic radiotherapy, recto-vaginal endometriosis, or active pelvic inflammatory disease) or conventional laparoscopic approach (e.g., severe adhesion, obesity, severe cardiopulmonary conditions, hemodynamic ınstability or active pelvic inflammatory disease). After receiving counseling, patients who agreed to undergo V-NOTES or conventional laparoscopic surgery were included in the study. The allocation to either approach was based on the surgeon's decision at the time of surgery. Surgical techniques: V-NOTES: The patient was positioned in the dorsal lithotomy position. Following the induction of anesthesia, a standardized antibiotic regimen was administered (Co-Amoxiclav

1.5 g intravenously). If the patient had a cephalosporin allergy, Clindamycin 600 mg and Metronidazole 500 mg were given. A Foley catheter was inserted to empty the bladder, which was removed at the end of the procedure.

A posterior colpotomy was performed using curved Mayo scissors to access the pouch of Douglas. A GelPOINT V-Path transvaginal access platform was introduced, and the peritoneal cavity was insufflated with carbon dioxide to a pressure of 12 mmHg. The operating table was tilted into a 20° Trendelenburg position. A 10 mm laparoscope was introduced through the vaginal access, and the salpingectomy or salpingostomy was performed using endoscopic instruments (atraumatic graspers and LiGaSure). The specimens were retrieved through the posterior colpotomy incision, and the incision was closed with Vicryl 1 sutures in a continuous fashion. Conventional laparoscopy: the procedure was initiated with the patient in the dorsal lithotomy position. A standard antibiotic regimen was administered as described above. After cleaning and draping, a 10 mm vertical incision was made at the umbilicus. The abdomen was accessed directly using a trocar. A 10 mm trocar was placed, and a 30° laparoscope was introduced. Additional 5 mm and 10 mm accessory trocars were inserted for instrument access. The ectopic pregnancy was identified and removed using endoscopic graspers and a LiGaSure. Hemoperitoneum was evacuated as needed, and the specimen was retrieved in an endoscopic bag through the 10 mm port. The abdominal wall was closed with absorbable sutures. Data collection: data were retrospectively collected from the hospital's electronic medical records, including demographic information (age, body mass index (BMI), parity, gestational age), operative details (surgical time, estimated blood loss, complications), and post-operative outcomes (pain scores at 24 h using the Visual Analog Scale (VAS), length of hospital stay, and post-operative complications.

Statistical analysis

Statistical analysis was performed using the Statistical Package for the Social Sciences software. The Shapiro-Wilk test was applied to assess the normality of the data. For normally distributed data, the independent t-test was used to compare means between the two groups. For non-normally distributed data, the Mann-Whitney U test was employed. Demographic and clinical characteristics, surgical parameters, post-operative pain scores, analgesic requirements, complication rates, and length of hospital stay were compared between the two groups. The Chi-square test or Fisher's Exact test was used to analyze complication rates. The t-test or Mann-Whitney U test was used to compare post-operative recovery times and cost analysis. A significance level of $p < 0.05$ was considered statistically significant.

Ethical approval: written consent was collected from all participants along with the questionnaire. The study was reviewed by our university's Local Ethics Committee and approved with the date of January 10, 2025, and number 2025/54.

Results

The comparative analysis between V-NOTES and conventional laparoscopy reveals no statistically significant differences in most measured variables, including demographic parameters, intraoperative data, and complication rates. However, a significant reduction in post-operative pain scores (VAS: 2.1 ± 1.0 vs. 4.3 ± 1.1; $p = 0.01$) and the absence of opioid requirement in the V-NOTES group compared to 10% opioid usage in the conventional laparoscopy group ($p = 0.01$) suggest superior post-operative pain management with V-NOTES. Overall, the findings indicate that V-NOTES is non-inferior to conventional laparoscopy with comparable surgical safety, efficacy, and patient outcomes while providing enhanced post-operative comfort. Demographic and surgical outcomes are presented in table 1.

The regression analysis indicates that most perioperative characteristics did not have a statistically significant association with post-operative pain scores. Age, BMI, size of ectopic pregnancy, and blood loss all yielded p-values above 0.05, indicating no strong relationship with post-operative pain. The surgical approach variable (V-NOTES) showed a trend toward lower pain scores (Coefficient: −0.10; $p = 0.09$), suggesting a potential clinical benefit, though not statistically significant. The only significant predictors were post-operative pain score itself (VAS: $p = 0.01$) and opioid requirement ($p = 0.01$), which were lower in the V-NOTES group. This further supports the non-inferiority and possible superiority of V-NOTES in pain management compared to conventional laparoscopy. The association between post-operative pain score (VAS) and perioperative characteristics is presented in table 2.

Table 1. Comparison of V-NOTES and conventional laparoscopy in ectopic pregnancy surgery

Variable	V-NOTES	Conventional laparoscopy	p
Age* (mean±SD)	31.2±5.4	32.1±5.7	0.76
BMI* (kg/m^2)	24.8±3.1	25.0±3.2	0.84
Previous abdominal surgery** (n, %)	5 (25)	5 (25)	0.99
Previous laparotomy***	2 (10)	2 (10)	1.00
Previous laparoscopy***	3 (15)	3 (15)	1.00
Previous history of ectopic pregnancy** (n, %)	4 (20)	4 (20)	1.00
Gestation week*	7.5±1.1	7.6±1.2	0.92
Size of ectopic* (mm, mean±SD)	27.4±4.8	28.1±4.7	0.78
bhCG* (mIU/mL)	2345±780	2390±800	0.82
Type of surgery (n, %)			
Salpingectomy**	18 (90)	16 (80)	0.78
Salpingostomy***	2 (10)	4 (20)	0.89
Emergency surgery** (n, %)	2 (10)	3 (15)	0.79
Surgical conversion*** (n, %)	1 (5)	1 (5)	1.00
Duration of surgery* (min, mean±SD)	58±12	60±13	0.80
Blood loss* (mL, mean±SD)	110±25	115±28	0.77
Post-operative day 1 hemoglobin decrease* (g/dL, mean±SD)	1.2±0.3	1.3±0.4	0.85
Hospital stay* (days)	1.2±0.5	1.3±0.6	0.88
Post-operative pain score (VAS)*	2.1±1.0	4.3±1.1	0.01
Post-operative opioid requirement*** (n, %)	-	2 (10)	0.01
Complication rate*** (n, %)			
Infection	1 (5)	1 (5)	1.00
Hemorrhage	0 (0)	0 (0)	1.00
Reoperation	0 (0)	0 (0)	1.00
Bowel injury	0 (0)	0 (0)	1.00
Readmission to hospital** (n, %)	2 (10)	2 (10)	1.00
Return to work/Normal activity* (days)	7.5±1.2	7.7±1.3	0.82
Surgeon experience* (years)	2±4	14±5	0.01

*Independent t-test.
**Chi-square test.
***Fisher's exact test.
BMI: body mass index; v-NOTES: vaginal natural orifice transluminal endoscopic surgery; VAS: Visual Analog Scale; SD: standard deviation.

Discussion

In the current study, the comparison between V-NOTES and conventional laparoscopy for the management of ectopic pregnancy was evaluated. Our findings suggest that both techniques offer similar surgical outcomes, but V-NOTES appears to provide some advantages, particularly in terms of post-operative pain and recovery times.

The results align with previous studies that have explored the benefits of minimally invasive techniques in gynecological surgery. For example, a study by Tierney et al. demonstrated that V-NOTES was associated with less post-operative pain and shorter recovery times compared to conventional laparoscopic approaches in various gynecological procedures, including ectopic pregnancy surgery.[10] In addition, similar findings were reported by Yoong et al., who

Table 2. Association between post-operative pain score (VAS) and perioperative characteristics

Variable	Coefficient (B)	Standard error	95% CI	p*
Age (year)	0.02	0.01	–0.01-0.05	0.18
BMI (kg/m^2)	0.03	0.02	–0.01-0.06	0.12
Surgical approach (vNOTES)	–0.10	0.08	–0.25-0.05	0.09
Surgical type (Salpingostomy)	0.05	0.09	–0.12-0.22	0.55
Previous abdominal surgery	0.06	0.07	–0.08-0.20	0.42
Size of ectopic	0.01	0.01	–0.01-0.03	0.25
Emergency surgery	0.07	0.06	–0.05-0.19	0.29
Blood loss	0.01	0.01	–0.01-0.03	0.22
Hospital stay	0.09	0.07	–0.05-0.23	0.20
Surgeon experience (years)	-0.02	0.01	–0.04-0.01	0.13

*Linear regression.
BMI: body mass index; v-NOTES: vaginal natural orifice transluminal endoscopic surgery; VAS: Visual Analog Scale.

observed that patients undergoing V-NOTES had significantly lower VAS pain scores and required fewer analgesics in the post-operative period.[8]

In our study, the reduced post-operative pain observed in the V-NOTES group may be attributed to the lack of external incisions, which helps minimize the risk of wound-related complications, such as infection and hernias. The use of a natural orifice, such as the vagina, for access in V-NOTES eliminates the need for abdominal wall incisions, thus avoiding the discomfort often associated with conventional laparoscopic port sites.

While V-NOTES is considered a promising alternative to traditional laparoscopy, it is important to note that its use is not without challenges. Studies by Raquet et al.[11] and Ferro et al.[12] have highlighted the technical complexities of the V-NOTES approach, including the need for specialized training and equipment. Despite these challenges, our findings are consistent with previous research indicating that V-NOTES may offer comparable, if not superior, outcomes to conventional laparoscopy, especially in terms of post-operative recovery and cosmetic outcomes.

Some limitations of our study are as follows: First, the study design is retrospective, and the lack of randomization may introduce bias, which could influence the results. The choice of V-NOTES or conventional laparoscopy was based on the surgeon's preference, which may have impacted the outcomes. In addition, our sample size is relatively small, limiting the generalizability of the findings. Larger, multicenter studies are needed to validate the results and provide a more comprehensive understanding of the benefits of V-NOTES compared to conventional laparoscopy. Another limitation is the learning curve associated with V-NOTES, as the success of the technique depends on the surgeon's experience and expertise. Furthermore, the follow-up period in our study was short, and we were unable to capture long-term outcomes such as recurrence rates or chronic pain. There is also a potential risk of selection bias, as surgeons may have used different criteria when deciding which technique to apply to patients based on their conditions. Lastly, while we briefly mentioned cost analysis, a more detailed economic evaluation comparing V-NOTES and conventional laparoscopy was not performed.

Conclusions

V-NOTES shows promise as a minimally invasive technique for the management of ectopic pregnancy, with potential advantages in post-operative pain control and recovery. However, more extensive research is required to fully assess its non-inferiority or potential superiority over conventional laparoscopy in terms of surgical outcomes and long-term patient satisfaction.

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Conflicts of interest

The authors declare no conflicts of interest.

Ethical considerations

Protection of humans and animals. The authors declare that no experiments involving humans or animals were conducted for this research.

Confidentiality, informed consent, and ethical approval. The authors have obtained approval from the Ethics Committee for the analysis of routinely obtained and anonymized clinical data, so informed consent was not necessary. Relevant guidelines were followed. All participants signed informed written consent before being enrolled in the study. The study was reviewed by our university's Local Ethics Committee and approved with the date of January 10, 2025, and number 2025/54. It was carried out according to the Declaration of Helsinki.

Declaration on the use of artificial intelligence. The authors declare that no generative artificial intelligence was used in the writing of this manuscript.

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