Review

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Review

Feasibility and Clinical Application of Vaginal Natural Orifice Transluminal Endoscopic Surgery (VNOTES) in Early-Stage Ovarian Cancer: A Narrative Literature Review

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Abstract

Background: Vaginal Natural Orifice Transluminal Endoscopic Surgery (vNOTES) represents a novel evolution in minimally invasive gynecologic surgery, combining endoscopic visualization with a transvaginal access route. Although its safety and efficacy in benign conditions and endometrial cancer have been well established, evidence regarding its role in ovarian malignancies remains limited. Objective is to evaluate the feasibility, perioperative safety, and oncologic adequacy of vNOTES for the surgical management and staging of apparent early-stage ovarian cancer.Methods: A narrative literature review was performed following a PICO-driven framework. Databases including PubMed, Scopus, Cochrane CENTRAL, ClinicalTrials.gov, and Google Scholar were searched up to September 2025. Eligible studies included case reports, series, and comparative analyses reporting outcomes of vNOTES in early-stage ovarian cancer or borderline ovarian tumors. Data on feasibility, intra- and postoperative complications, tumor spillage, conversion rates, and oncologic outcomes were synthesized descriptively.Results: The current evidence base comprises several case reports and small series (totaling approximately 50 reported patients). Across studies, vNOTES enabled completion of standard staging steps—oophorectomy, hysterectomy, omentectomy, peritoneal biopsies, and selective lymphadenectomy—entirely via the transvaginal route in nearly all cases, with conversion rates approaching zero. Estimated blood loss was minimal (≤150 mL), median operative times ranged from 45–90 minutes, and hospital stay was typically ≤2 days. Complication rates were low, and intraoperative tumor spillage was rare (<5%). Short- to medium-term follow-up (≤3 years) revealed recurrence rates consistent with expected outcomes for early-stage disease and no disease-related deaths.Conclusions: Early evidence indicates that vNOTES is a technically feasible and safe approach for carefully selected patients with apparent early-stage ovarian cancer, achieving oncologically sound procedures with reduced postoperative pain, minimal morbidity, and excellent cosmetic outcomes. Nevertheless, its use should currently be limited to

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specialized centers with vNOTES expertise, pending confirmation of long-term oncologic equivalence through multicenter prospective studies.

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1. Introduction

Ovarian cancer is one of the leading causes of gynecologic cancer mortality amongst women because it is often diagnosed at an advanced stage. Only a small percent - approximately 20% - of ovarian cancers are detected in early stages (FIGO stage I–II), but early-stage disease carries a significantly better prognosis (5-year survival >90% for stage I) compared to advanced-stage disease (FIGO stage III–IV) (1). The management for presumed early-stage ovarian cancer consists of surgical staging and complete cytoreduction. The standard surgical staging includes a thorough exploration of the abdominopelvic cavity, peritoneal washings for cytology, total hysterectomy and bilateral salpingo-oophorectomy (in women who have completed childbearing), multiple peritoneal biopsies, omentectomy, resection of any visible tumor implants, and pelvic and paraaortic lymph node assessment (2). Historically, this staging procedure has been performed via exploratory laparotomy to allow comprehensive evaluation and minimize the risk of intraoperative rupture of an ovarian malignancy. However, over the past two decades, minimally invasive surgery (MIS) techniques have been increasingly used for staging in apparent early-stage ovarian cancer. Accumulating evidence indicates that laparoscopic or robotic staging can achieve similar oncologic outcomes compared to open surgery in properly selected patients when performed from expert in the field surgeons (3,4). Experienced centers have reported successful laparoscopic management of early-stage ovarian carcinoma with no compromise in oncologic safety (5–7). These advances in MIS have motivated the exploration of even less invasive surgical approaches for ovarian cancer.

Vaginal Natural Orifice Transluminal Endoscopic Surgery (vNOTES) is an innovative technique belonging to the MIS field that combines the advantages of endoscopic visualization with a transvaginal surgical approach. In the vNOTES procedure, the surgeon gains access to the peritoneal cavity through a colpotomy (an incision in the vaginal wall), allowing for laparoscopic instruments to be inserted via the vagina instead of transabdominal incisions. This approach eliminates visible abdominal scars and may reduce incision-related morbidity. Early clinical experience in benign gynecology has shown that vNOTES can offer several potential advantages over traditional laparoscopy, including reduced postoperative pain, shorter operative times, improved cosmetic outcomes, and faster recovery (8,9). For example, a review published from Lerner et al. in 2023 highlighted that vNOTES hysterectomy and adnexal surgeries were associated with lower pain scores and shorter hospital stays compared to conventional laparoscopy (10). vNOTES has rapidly gained adoption for various benign gynecologic procedures – including hysterectomy, salpingectomy, oophorectomy, ovarian cystectomy, myomectomy, and urogynecologic repairs – with high success rates and excellent patient satisfaction reported in multiple series (8). It has also been successfully utilized in challenging patient populations, such as those with high BMI or large uteri, reinforcing its versatility (11,12).

Given the favorable outcomes of vNOTES in benign gynecology, there is increasing interest in extending this approach to oncologic surgeries. In particular, vNOTES has been used in endometrial cancer staging, where it has shown promising results. Recent studies have demonstrated that comprehensive surgical staging for early-stage endometrial carcinoma, including hysterectomy, bilateral salpingo-oophorectomy, and pelvic lymphadenectomy or sentinel lymph node, can be accomplished via vNOTES, with perioperative outcomes comparable to classic laparoscopy (13–15). Wang et al. described a vNOTES hysterectomy with indocyanine green sentinel lymph node for endometrial cancer that achieved detection rates similar to the classic laparoscopic procedure (16). A recent retrospective comparative study from Turkey reported that vNOTES staging for early-stage

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endometrial cancer resulted in significantly lower postoperative pain scores and reduced opioid analgesic requirements compared to laparoscopy, with no differences in operative time or short-term oncologic outcomes (13). These findings suggest that vNOTES can be a safe and effective minimally invasive platform for gynecologic malignancies under the right circumstances.

The application of vNOTES in ovarian cancer, however, remains in its infancy. Many challenges arise in ovarian malignancies such as the need to avoid spillage of cystic tumors - to prevent upstaging - and the technical difficulty of accessing upper abdominal structures, such as the diaphragm or paraaortic lymph nodes, through transvaginal route (17,18). Most ovarian cancer surgeries historically require wide exposure, and even laparoscopic approaches have been adopted cautiously due to fear of missing metastatic disease or rupturing tumors. Current literature about vNOTES in ovarian cancer is limited to preliminary reports, but these early experiences are encouraging. Most published cases involving ovarian pathology have dealt with benign ovarian cysts or borderline tumors (11, 19–22), with only a few studies specifically focusing on invasive ovarian cancers. An example is the preliminary study by Hurni et al., which described transvaginal omentectomy and staging in a cohort of patients with suspicious adnexal masses, demonstrating the technical feasibility of vNOTES for performing key oncologic steps like omentectomy (23). Overall, the evidence base is poor, but it suggests that with careful patient selection and surgical expertise, vNOTES could be adopted to manage early-stage ovarian malignancies.

In this narrative literature review, we examine the feasibility and clinical application of vNOTES in patients with early-stage ovarian cancer. We review the available published case reports, case series, and comparative studies that have reported outcomes of vNOTES for ovarian malignancies, and we synthesize their findings regarding safety, efficacy, and oncologic feasibility-outcomes. We also search on relevant data from vNOTES in other oncologic gynecology cancers (such as endometrial cancer) and from benign ovarian surgery, to provide context and insight into the potential advantages and limitations of this surgical approach. The goal of this review is to summarize the current state of evidence, discuss practical and oncologic considerations for using vNOTES in early-stage ovarian cancer, and outline future directions for research and clinical practice in this evolving field.

2. Materials and Methods

All studies that examined the use of transvaginal natural orifice transluminal endoscopic surgery (vNOTES) for the surgical management or staging of apparent early-stage ovarian malignancies (including borderline ovarian tumors) were considered potentially eligible, provided that at least one prespecified outcome of interest was reported. The primary objective of this review is to evaluate the feasibility, perioperative safety, and oncologic results of vNOTES procedure when applied to patients undergoing surgery for suspected early-stage ovarian cancer. Feasibility reflects the completion of standard staging steps (peritoneal survey and washings, peritoneal biopsies, infracolic omentectomy, adnexectomy with or without hysterectomy, and pelvic nodal assessment when indicated) through transvaginal endoscopic route. Although vNOTES has a strong physiological rationale—direct pelvic access, avoidance of abdominal wall trauma, and potentially lower pain and quicker recovery—its application in gynecologic oncology remains unclear, heterogeneous in technique, and not standardized across surgical centers.

We used the PICO framework (24); the Population comprised adult patients undergoing gynecologic oncologic surgery for apparent early-stage ovarian malignancy or borderline ovarian tumor. The Intervention was vNOTES, defined strictly as transvaginal peritoneal access with endoscopic visualization and instrumentation through a vaginal single-port platform. The Comparator included conventional multiport laparoscopy, laparoendoscopic single-site surgery, robotic surgery, or open laparotomy when such a group was available; single-arm vNOTES series without a comparator were also eligible. Outcomes of interest were primary—completion of intended staging steps via vNOTES and conversion rates, perioperative—operative time, estimated blood loss, intra-/postoperative complications (Clavien–Dindo), cyst/tumor spillage, need for reintervention,

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length of stay, postoperative pain or opioid use, readmission within 30 days, oncologic upstaging, time to adjuvant therapy, recurrence, disease-free survival, and overall survival when reported.

Inclusion criteria were studies that explored vNOTES as the operative route for staging or definitive surgery in apparent early-stage ovarian malignancy/borderline tumor and reported at least one outcome listed above. Eligible designs included randomized trials (anticipated none), prospective or retrospective cohorts, comparative case–control studies, and case series with extractable quantitative data. Adult patients (≥18 years) were required. Studies enrolling mixed pathologies were eligible if ovarian cancer/borderline data were disaggregated or clearly described. Reports on vNOTES in benign adnexal disease were considered only for contextual benchmarking of perioperative metrics and not included in the core oncologic synthesis.

Exclusion criteria were studies limited to vaginal specimen extraction after conventional laparoscopy without true transvaginal endoscopic access; general NOTES or transgastric/transrectal access unrelated to gynecology; reports on non-surgical or palliative patients; case reports without outcome detail; opinion pieces, editorials, conference abstracts without full data, and unpublished thesis. Studies with insufficient outcome reporting, unresolvable duplication, or critical methodological flaws (e.g., non-comparable groups with no adjustment, unclear denominators) were also excluded.

We searched MEDLINE (via PubMed, 1966–2025), Scopus (2004–2025), ClinicalTrials.gov (2008–2025), Cochrane CENTRAL (1999–2025), and Google Scholar (2004–2025). The last search was performed on 12 September 2025. We also searched in reference lists of included articles and relevant reviews. Searches were limited to items published in the Latin alphabet (with pre-specified willingness to translate languages other than English, French, German, Italian, and Spanish using reliable online tools). The search strategy combined controlled vocabulary and free-text terms: “vNOTES” OR “vaginal natural orifice transluminal endoscopic surgery” OR “transvaginal NOTES” OR “natural orifice surgery”AND “ovarian cancer” OR “ovarian malignancy” OR “borderline ovarian tumor” OR “staging” OR “omentectomy” OR “peritoneal biopsy” OR “lymphadenectomy” OR “specimen containment” OR “spillage” OR “conversion” OR “length of stay”. For specificity, we did not include unrelated NOTES terms (e.g., transgastric) and required explicit transvaginal endoscopic access in the abstract or methods.

Two reviewers independently screened titles/abstracts and then full texts against eligibility criteria. Disagreements were resolved by discussion. Data extracted included study characteristics (design, setting, sample size), patient selection criteria, tumor characteristics, exact vNOTES technique (access platform, ancillary ports, containment strategy), staging components performed, comparator details (when present), and all outcomes of interest. Owing to heterogeneity in design and small sample sizes, no meta-analysis was attempted; instead, we conducted a narrative synthesis emphasizing convergent signals on feasibility, safety, and early oncologic outcomes, and we highlighted areas of inconsistency and gaps to inform future research. Formal risk-of-bias tools were not applied (most studies were small observational series), but we report design features relevant to internal validity (prospective vs retrospective, consecutive inclusion, clarity of denominators, and follow-up completeness).

This approach—PICO-driven selection, multi-database retrieval to 12 September 2025, strict vNOTES definition, and combined narrative synthesis with an embedded institutional experience—was chosen to provide a focused, practice-oriented appraisal of vNOTES for early-stage ovarian cancer while transparently acknowledging heterogeneity and current evidence gaps.

3. Results

A total of 12 eligible publications (5 case reports, 5 case series, and 2 retrospective cohort studies) describing approximately 50 patients were identified that reported the use of vaginal natural orifice transluminal endoscopic surgery (vNOTES) in the management or staging of apparent early-stage ovarian malignancies and borderline ovarian tumors.

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Across studies, completion of intended surgical staging—including oophorectomy, hysterectomy, omentectomy, peritoneal biopsies, and selective lymph node sampling—was achieved entirely via the transvaginal route in nearly all cases. Conversion rates to laparoscopy or laparotomy were <5%, primarily for dense adhesions or technical limitations.

Operative time ranged from 45 to 90 minutes, and estimated blood loss was minimal (median 50–150 mL). No major intraoperative complications were reported, and only minor postoperative events occurred, such as superficial vaginal cuff infection or transient fever (Clavien–Dindo Grade I–II).

Tumor spillage was extremely rare, reported in only one case (1.9%) among all published series, and all specimens were retrieved intact using protective endoscopic bags. Median length of hospital stay was 1–2 days, and most patients required no opioid analgesia postoperatively.

Short- to medium-term oncologic follow-up (up to 36 months) demonstrated no disease-related deaths and a recurrence rate of approximately 20%, consistent with expected outcomes for early-stage epithelial ovarian carcinoma managed with conventional laparoscopy or laparotomy.

Taken together, the evidence suggests that vNOTES provides a feasible, safe, and oncologically adequate approach for selected patients with early-stage ovarian cancer, yielding excellent perioperative recovery profiles and maintaining adherence to oncologic surgical principles.

4. Discussion

Early Experiences of Vnotes in Ovarian Cancer Surgery

The initial evidence supporting the feasibility of vNOTES for ovarian malignancies comes from a lot of case reports and small case series in the early 2020s. These pioneering reports established proof-of-concept that key elements of ovarian cancer surgery – such as omentectomy and adnexal removal – could be accomplished via a transvaginal endoscopic approach.

One of the first published accounts was by Lowenstein et al. in 2020, who reported a series of 5 patients undergoing surgical staging for presumed early ovarian cancer via vNOTES. All five patients had suspicious ovarian masses and underwent vNOTES infracolic omentectomy as part of their staging procedure (25). Notably, all cases were completed only transvaginally using a single-port device placed through a posterior colpotomy, without the need for any abdominal incisions or conversion to standard laparoscopy/laparotomy. The median time to perform the omentectomy in this series was 45 minutes, and the median estimated blood loss was only 150 mL. No intraoperative complications or conversions occurred. Patients began oral intake and ambulation soon after surgery, and the median hospital stay was 2 days. Lowenstein et al. concluded that vNOTES is a feasible technique for performing omentectomy in early-stage ovarian cancer, with low complication rates and improved cosmetic results - due to avoidance of any abdominal incisions - as well as lower SSI (surgical site infection) rates. This report was fundamental in demonstrating that even extrapelvic components of ovarian cancer staging (like omentum resection, traditionally considered challenging to reach without an upper abdominal incision) could be achieved through transvaginal route.

Subsequently, Hurni et al. published a pair of case reports in 2022 that further illustrated the use of vNOTES for comprehensive ovarian cancer staging (26). They described two patients – an 81-year-old and a 62-year-old women – who had suspicious adnexal tumors and underwent staging surgery exclusively through vNOTES. In the first case, a vNOTES approach was used to perform a total hysterectomy, bilateral salpingo-oophorectomy, pelvic peritoneal biopsies, and infracolic omentectomy with the final histology of low-grade serous carcinoma , while in the second case, a "hybrid" approach was employed (vNOTES combined with limited laparoscopic assistance) for a cystadenofibroma (benign tumor). Both surgeries were completed successfully with no intraoperative or postoperative complications. The authors reported that visualization of the pelvis and upper abdomen was adequately good, and all required staging steps could be performed either via the vNOTES port alone or with minimal assistance. They concluded that vNOTES was a "feasible and effective approach to surgically manage early-stage ovarian cancers" in carefully selected cases.

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Importantly, these case reports noted no oncologic compromise: peritoneal washings were obtained, visible surfaces were inspected for metastases, and specimens were removed intact through the vagina. These initial cases highlighted that even in elderly patients– who often benefit most from minimally invasive surgery due to frailty – vNOTES could be safely utilized for ovarian cancer staging (25,26).

Encouraged by these individual successes, investigators began assembling slightly larger series to evaluate more systematically vNOTES in the context of ovarian malignancies. Hurni et al. expanded their experience and in 2023 published a preliminary cohort of 14 patients with ovarian tumors. In this series, most patients underwent total hysterectomy and bilateral salpingo-oophorectomy via vNOTES procedure, along with infracolic omentectomy and peritoneal washings; a subset also had pelvic lymph node sampling or unilateral salpingo-oophorectomy depending on the indication (23).

Impressively, all planned staging procedures were completed entirely transvaginally, without any conversions to laparoscopy or open surgery. The median operative time for the whole procedure was not explicitly reported in the publication, but the time specifically to perform the omentectomy was very short (median ~9 minutes), reflecting the efficiency of specimen-oriented dissection via the transvaginal route once access is established. There were no intraoperative complications in this cohort, and only one patient experienced a postoperative complication – transient fever attributed to a vaginal cuff infection, managed conservatively. All other patients recovered fully, with the majority of them being discharged within 1–3 days. This study demonstrated that vNOTES could be used to perform not just omentectomy but a comprehensive staging operation in multiple patients with suspected early ovarian cancer, with outcomes comparable to those expected from conventional laparoscopy. The authors emphasized that proper patient selection was crucial; in their practice, patients with obvious advanced disease, significant adhesions (e.g. from prior surgeries or endometriosis), or very large tumors were not candidates for vNOTES in order to maximize the likelihood of success. In their discussion, Hurni et al. concluded that vNOTES oncologic staging was technically feasible and safe in early-stage ovarian cancer, but underlined that larger studies with long-term follow-up would be needed before this approach could be widely adopted.

Clinical Outcomes of Vnotes, Perioperative Feasibility and Oncologic Safety

More recent publications have started to provide data on clinical outcomes from vNOTES in cohorts of patients with confirmed ovarian malignancies. One of the largest series to date is a single-institution retrospective study by Fong et al. (2025) which specifically examined vNOTES outcomes in patients with malignant ovarian tumors (27). In this study, 19 patients underwent ovarian cancer surgery via vNOTES between 2021 and 2024. All patients had malignancies arising from or involving the ovary confirmed on final pathology, suggesting a mix of early-stage epithelial ovarian cancers, borderline tumors, and a few more advanced cases that had neoadjuvant chemotherapy. In the study 12 patients underwent primary staging surgery via vNOTES (for presumed early-stage disease), 4 patients had fertility-sparing surgery (e.g. unilateral oophorectomy) for malignant ovarian tumors, 1 patient underwent vNOTES restaging after an initial surgery elsewhere, and 2 patients had interval debulking surgery after chemotherapy performed through vNOTES. The breadth of indications in this series suggests that surgeons were pushing the envelope of vNOTES beyond just the simplest early-stage cases. Key findings from Fong et al. included only one intraoperative complication (a case of significant hemorrhage in a patient known to have a bleeding diathesis). There were no conversions to laparotomy and postoperative recovery was remarkably quick with most patients reporting minimal pain (median pain score 0/10 at 12 and 24 hours) and being discharged on postoperative day 1 or 2. No patients required readmission for postoperative complications in the immediate 30-day period. This indicates that vNOTES can be performed safely with low perioperative morbidity even in an oncologic setting.

Importantly, Fong and colleagues also reported that at a median follow-up of 26.4 months, 4 out of 19 patients (21%) had experienced a recurrence of their ovarian cancer, but there were no disease-

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related deaths in the cohort (27). The recurrences were not described in detail but the absence of any mortalities and the recurrence rate are in line with expectations for early-stage ovarian cancer treated with standard approaches. The authors concluded that vNOTES is "a feasible and versatile technique for ovarian cancer surgery, with low rates of intraoperative and postoperative complications, short length of stay, and favorable short- to medium-term oncological outcomes". This represents one of the strongest endorsements yet for the approach, coming from a center that had extended vNOTES even to selected interval debulking cases (which typically involve more extensive disease). While the number of patients remains small, this study provides encouraging evidence that performing ovarian cancer surgery via transvaginal route does not compromise short-term oncologic efficacy in the, as long as the principles of cancer surgery (complete resection, no gross residual disease, avoiding tumor spillage) are respected.

Another recent contribution to the literature is a case series by Kellerhals et al. (2024), which specifically focused on early-stage ovarian cancer and borderline ovarian tumors managed with vNOTES (28). In their report of 11 patients (7 with FIGO stage I ovarian or fallopian tube cancer and 4 with borderline tumors), all patients underwent comprehensive surgical staging using the vNOTES approach. The surgical steps mirrored standard open/laparoscopic staging including peritoneal washings, thorough inspection of all peritoneal surfaces, unilateral or bilateral salpingo-oophorectomy (with uterus preservation in fertility-sparing cases or total hysterectomy when indicated), multiple peritoneal biopsies, infracolic omentectomy, and in a few cases appendicectomy or pelvic lymph node biopsy as needed. Impressively, complete staging was achieved in all cases via vNOTES without any need for conversion to laparoscopy or laparotomy. The median operative time was 70 minutes (range 35–138 minutes), and median blood loss was only 50 mL. There were no major intraoperative complications (one patient had a minor intraoperative cyst rupture). All specimens were retrieved vaginally using protective measures (e.g., specimen bags) to minimize the risk of spillage and, thus, recurrent disease. In Postoperatively, only a few minor complications were noted (one case of superficial vaginal cuff infection and two cases of postoperative cystitis, all managed with antibiotics) but there were no severe complications (no events ≥ Grade III on Clavien-Dindo). All patients were discharged within a few days and had fully recovered. Although long-term oncologic follow-up from these series is not available yet since the cohort is recent, the authors reported that no recurrences had been observed in the short-term follow-up and that all patients were in excellent condition. The conclusion was that vNOTES appears to be a promising surgical approach for "highly selected patients with early-stage adnexal malignancies", offering the benefits of a minimally invasive procedure while successfully accomplishing the required oncologic procedures. Even though further research and longer follow-up are needed, their current data adds to the growing consensus that, at least in the short-term, the vNOTES technique does not seem to incur additional risk compared to traditional MIS for early ovarian cancer.

The outcomes reported in these series (23, 25–28) indicates that vNOTES, when performed in appropriately selected ovarian cancer patients, has low complication rates, short hospital stays, and postoperative recovery metrics that are equal or superior to those of conventional laparoscopy. Estimated blood loss is typically minimal, due to the excellent access to the pelvic vasculars through the vaginal route and the pneumoperitoneum which aids hemostasis. Pain scores are impressingly low; for instance, Fong et al. reported median 24-hour pain score of 0 (on 0–10 scale), and Hurni's case series noted that most patients required only non-opioid analgesia postoperatively (23,27). These outcomes align with the findings in benign gynecologic vNOTES cases, where patients often ambulate the same day and go home within 24 hours of surgery (29,30). In fact, one appealing aspect of vNOTES is the potential to convert traditionally inpatient oncologic surgeries into outpatient or overnight-stay procedures. This was hinted in benign cohorts ; for example, a pilot study of 213 patients undergoing vNOTES ovarian cystectomy for benign cysts found that same-day discharge was safe and feasible in the vast majority of cases (31). In Yoong et al.'s 2025 study comparing vNOTES to conventional laparoscopy for ovarian dermoid cysts, the mean length of stay for vNOTES patients was under 4 hours (essentially outpatient surgery) versus about 13 hours for laparoscopy

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(22). Moreover, the vNOTES group experienced significantly less postoperative pain (24-hour VAS 1.9 vs 4.0) and a faster return to normal daily activities (8 days vs 20 days) than the laparoscopy group. While that study included benign tumors, similar advantages in terms of pain and length of hospital stay have been noted in the oncologic vNOTES patients (23,27,28). Shorter recovery times can be especially crucial for cancer patients, as it may allow timelier initiation of any indicated adjuvant therapy (chemotherapy) and certainly improves patient's quality of life during treatment.

The key concern is whether vNOTES provides sufficient access and visualization to perform a proper cancer operation, and whether it might introduce any new risks (such as tumor spillage or port-site metastasis in the vagina). The available evidence indicates that surgeons have been able to follow general oncologic principles with this technique. In the reported series, thorough intraperitoneal inspection was performed in every case via vNOTES. Peritoneal washings for cytology were routinely collected (23, 25–28). Importantly, all tissue removal was done using protective measures to prevent dissemination: specimens (ovaries, cysts, omentum) were placed in impermeable endoscopic bags before being retrieved transvaginally. This is a critical step to avoid spillage in ovarian cancer surgery since rupture of a malignant cyst could upstage a tumor from FIGO stage I to stage IC (with implications for adjuvant chemotherapy) (2,17,32). In the combined published experience, the rate of intraoperative tumor rupture during vNOTES appears to be very low. Lowenstein et al. reported zero cases of spillage in their 5 patients. Likewise, Fong et al. reported no incidence of intra-abdominal tumor spillage – all ovarian masses were successfully bagged and removed intact in their series (25,27). Only Kellerhals et al. mention a single "minor ovarian spillage" event in 1 out of 11 cases (28). It is worth noting that spillage of malignant cells can theoretically lead to peritoneal dissemination. However, given that similar (or higher) spillage rates are reported even in traditional laparoscopy or laparotomy for ovarian masses (especially if cysts are large or adhesed), the vNOTES results so far are accepted (33). In fact, since the colpotomy allows removal of relatively large masses intact - potentially larger than what could be extracted through a small laparoscopic trocar site -, the incentive to morcellate or aspirate a cyst (with attendant spillage risk) is reduced. Comparative data in benign dermoids cysts appears to be in accordance with this idea – in Yoong's study, none of the vNOTES cases had intraperitoneal dermoid content spillage, whereas one-third of laparoscopic cases did (22). Thus, with the adoption of a meticulous technique, vNOTES does not appear to increase the risk of cyst rupture; if anything, the ease of specimen retrieval through a colpotomy may help avoid rupture (8,34).

Lymph node dissection is another oncologic aspect to consider. In early-stage ovarian cancer, standard surgical staging includes sampling of pelvic and paraaortic lymph nodes to detect occult metastases, although the necessity of full lymphadenectomy in low-risk early disease has been debated (33,35). In the vNOTES literature, pelvic lymph node dissection or sampling has been performed in selected cases, particularly for endometrial cancer staging via vNOTES (14,15). For ovarian cancer, most vNOTES series have not emphasized lymphadenectomy, likely because many cases were either borderline tumors or histologies (like low-grade or germ cell tumors) where lymph node spread is less common. In Fong et al.'s series, pelvic lymph node dissection was done in about a quarter of the primary staging cases, indicating that it is technically achievable via vNOTES (presumably by opening the retroperitoneum in the pelvis and dissecting nodes similarly to a laparoscopic approach) (27). However, none of the reports mention attempting a para-aortic lymph node dissection via vNOTES – this would be considerably more challenging given the reach limitations of standard laparoscopic instruments used through vaginal route. The transvaginal access naturally provides excellent exposure of the pelvis, but reaching above the pelvic brim to the para-aortic region - especially up to the renal vessels - might be beyond the operation limits of the technique in most cases (23). On the other hand, for tumors where para-aortic nodal assessment is deemed important, a hybrid approach or an alternative technique might be necessary. An emerging strategy is to use sentinel lymph node (SLN) mapping to avoid full lymphadenectomy. While SLN mapping is well-established in endometrial and cervical cancers, its role in ovarian cancer is still experimental (36). For ovarian cancer, no published vNOTES SLN data exist yet, but future studies

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may investigate this as a means to sample nodes with minimal dissection. In terms of pathology results, the vNOTES series have included a mix of tumor types. Many patients had early-stage epithelial ovarian carcinomas (the most common being low-grade serous or endometrioid carcinomas in reported cases) or borderline ovarian tumors (e.g. serous borderline tumors), and a few had other malignancies like granulosa cell tumors or metastatic ovarian involvement from another primary site (11,23,27,28).

Another point of interest is the use of vNOTES in special populations and complex cases. Obesity is a high-risk factor that complicates abdominal surgery, and indeed laparoscopic surgery in obese patients can be challenging due to reduced visualization and instrument reach limits. vNOTES offers a potential advantage here: by avoiding the abdominal wall, it bypasses the issues of thick tissue. A retrospective study by Wang et al. (2025) compared vNOTES to multi-port laparoscopy for benign ovarian tumor removal in obese patients (mean BMI ~32) (11). The results showed that vNOTES had shorter operative times and shorter hospital stays in obese patients with no increase in complications or cyst rupture rates compared to laparoscopy. While that study was about benign pathologies of ovaries, it indicates that vNOTES is being well-suited for obese patients. In the ovarian cancer series, many patients were of average BMI, but Hurni's 2023 report did include patients up to BMI 39 who underwent vNOTES omentectomy successfully (23). Burnett et al. also reported on the use of vNOTES in morbidly obese women (BMI >40) for benign gynecologic procedures with good outcomes (12). Therefore, vNOTES might actually expand the pool of patients who can benefit from minimally invasive surgery in oncology, since extreme obesity – which might preclude lengthy laparoscopic or robotic cases – may be accommodated via the vaginal route with potentially less cardiopulmonary strain. More specifically, lower insufflation pressures can be used and there is no need to incline steep Trendelenburg for upper abdomen access in some cases.

On the other end of complexity, one series by Kale et al. (2022) even described using vNOTES in combination with standard laparoscopy for advanced gynecologic cancers or large uteri in obese patients (37). In those cases, vNOTES was part of a multi-modal minimally invasive strategy to achieve what otherwise would require laparotomy. This hints at a future paradigm where vNOTES could be one component in a "hybrid" minimally invasive approach – for example, using vNOTES for pelvic work and specimen retrieval, and adding one or two laparoscopic ports for tasks like high paraaortic node dissection if needed. One of Hurni's 2022 cases did indeed benefit from a hybrid approach (combined vNOTES + laparoscopy) (26). The flexibility to mix techniques increases the likelihood that a patient can avoid a full open surgery.

Technical Considerations and Limitations of Vnotes in Ovarian Cancer

While the early results are promising, there are important technical considerations and limitations to acknowledge for vNOTES in ovarian cancer. First and foremost is patient selection in order to find the best candidates. Criteria for selecting vNOTES cases generally include imaging suggesting disease confined to the ovaries (early-stage) with no bulky upper abdominal metastases, tumor size that is moderate and retrievable vaginally (often <10–12 cm in diameter), no suspicion of dense pelvic adhesions (which could make transvaginal entry hazardous) and absence of contraindications to the vaginal approach (11,22,23,28). For example, Hurni and Huber did not perform vNOTES in patients with a history of extensive endometriosis or previous pelvic irradiation, since scarring in the rectovaginal space can impede safe colpotomy. They also excluded any patient with suspected stage III–IV disease on imaging or very large adnexal masses. In practice, this means that vNOTES for ovarian cancer might be best suited for cases like presumed stage I ovarian cancers (e.g., an isolated adnexal mass with normal tumor markers and no evidence of spread on imaging), borderline tumors and prophylactic or risk-reducing adnexectomies (e.g., BRCA mutation carriers, where vNOTES has indeed been used for prophylactic BSO) (30,38). Patients must also be comfortable with the transvaginal route and give their informed consent. The preoperative discussion should include information that the surgery will be performed through the vagina, which some patients may find surprising or concerning if not counseled. However, surveys have shown high

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acceptance and even preference for a no-scar approach when patients understand it, and sexual function outcomes after vNOTES hysterectomy appear equivalent to other approaches (with vaginal cuff well-healed) (11,22).

Another limitation is access to the upper abdomen and retroperitoneum. As mentioned before, pelvic lymphadenectomy is feasible via vNOTES, but paraaortic lymphadenectomy is challenging. If a patient's surgical management truly requires sampling high paraaortic nodes, surgeons might opt for a traditional laparoscopic or robotic approach instead of vNOTES alone, or consider a combined approach (28,39). There is also a learning curve to operating with instruments all passed through the narrow vaginal single-port. Achieving triangulation and maneuverability takes practice, and early in the learning curve surgeons might experience longer operative times. Published learning curve analyses in benign cases suggest that after roughly 20–30 vNOTES cases, operative efficiency improves significantly (40–42). In oncology cases, the learning curve may be extended because the procedures are more complex. Therefore, initial vNOTES ovarian cancer surgeries should be attempted by surgeons already experienced in vNOTES for benign indications or under proctorship of an expert. The availability of dedicated vNOTES port devices (such as the GelPOINT® vPath) and long laparoscopic instruments is also crucial for success. Many early adopters, such as Baekelandt and Lee, fashioned homemade glove-ports for vNOTES, but now commercial ports make setup quicker and more reliable (9). Fong et al. described using an Alexis wound retractor with a surgical glove to create a port that accommodated a 30° laparoscope and 3 working instruments. With such a setup, surgeons can replicate virtually all maneuvers of standard laparoscopy, including suturing the vaginal cuff at the end of the case (27).

One technical challenge specific for ovarian tumor cases is specimen handling and extraction. Large ovarian masses may need to be drained to be removed – which is obviously contraindicated if the tumor is suspected to be malignant. Thus, vNOTES surgeons must be prepared to extend the colpotomy if needed to deliver an intact mass. The vaginal apex is fairly distensible and, by making both anterior and posterior colpotomies (essentially similar to a vaginal hysterectomy approach), the opening can accommodate sizable specimens. Published vNOTES series have removed uteri up to 1 kg and ovarian cysts more than 10 cm by enlarging the colpotomy and using contained extraction devices (27,34,43,44). In oncologic cases, morcellation is avoided; instead, the entire ovary or cyst is placed in a bag and the bag opening is brought out through the vagina so that the specimen can be carefully worked out without spillage. Surgeons have reported success with this method for dermoid cysts (to avoid chemical peritonitis) and the same principle applies for malignancies (22). The vaginal incision is then closed with standard sutures. In all reviewed cases, the vaginal cuff was closed at the conclusion of the procedure, and healing has been uneventful. There have been no reports of tumor implantation at the colpotomy site to date.

Finally, there are system-level and training considerations. vNOTES is still not part of the standard surgical approach in many Gynecologic Oncology units. It requires not only surgeon training but also the availability of appropriate equipment and sometimes a supporting team familiar with vaginal surgery and laparoscopy (40). A crucial aspect is emergency preparedness – for instance, if severe bleeding occurs, the team must be ready to either add laparoscopic ports or convert to laparotomy rapidly. Fortunately, in the reported series, conversions were exceedingly rare (essentially zero in most series) and blood loss was modest, reflecting that with proper case selection catastrophic issues are unlikely (11,22,23,27). Nonetheless, having a low threshold to abandon the vNOTES approach if oncologic completeness or safety is in doubt is prudent.

Comparison with Conventional Approaches: Vnotes Vs. Laparoscopy Vs. Laparotomy

Direct comparative studies between vNOTES and other surgical approaches for ovarian cancer are not yet available, due to the limited numbers. However, we can glean some comparisons from the data in benign surgery and extrapolate to the cancer setting. Compared to multi-port laparoscopy, vNOTES seems to offer shorter operative times in many cases (11,45). This is somewhat counterintuitive at first, since one might expect a new technique to take longer; however, vNOTES

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hysterectomy has also been shown in meta-analyses to have reduced operative duration relative to laparoscopy. The operative time reduction comes from quicker access (no need for multiple trocar placements or closure of abdominal incisions) (46). In Yoong's study, vNOTES cystectomy was almost twice as fast as laparoscopic cystectomy on average (22). In oncology, shorter operative time can translate to reduced anesthesia exposure and lower risk of complications like venous thromboembolism. With regard to pain and recovery, the absence of any abdominal wall trauma in vNOTES offers a clear advantage – it eliminates trocar site pain and virtually eliminates the risk of trocar-site hernias or infections. Patients ambulate sooner and require less analgesia (11,12,26). From a cosmetic standpoint, vNOTES is obviously superior to both laparoscopy (which leaves small scars) and laparotomy (which leaves a large scar); this might seem a trivial benefit in oncology, but younger patients and those undergoing risk-reducing surgery do value cosmesis, and studies have found improved body image and satisfaction with scarless surgery.

On the other hand, conventional laparoscopy and robotics have their own strengths. Robotic surgery, for instance, offers superior dexterity and might allow more facile suturing or complex dissections than straight-stick vNOTES laparoscopy (6,18). In recognition of this, there is active development in robotic transvaginal surgery. A notable innovation is the combination of the Da Vinci single-port (SP) robotic system with transvaginal access, dubbed RSP-vNOTES. Early reports show that robotic single-port vNOTES is feasible for hysterectomy and adnexal surgery, with the robotic platform providing wristed instruments through the vaginal port (47). Guan et al. (2024) described their experience with robotic SP-vNOTES hysterectomy, noting that this approach could leverage the precision of robotics in the confined transvaginal workspace and may shorten the learning curve for vNOTES novice. Over 300 gynecologic cases (mostly benign) have already been performed using the Da Vinci SP via transvaginal route at some centers (47,48). Applying robotics to vNOTES for ovarian cancer could, in theory, facilitate tasks like pelvic lymph node dissection or extensive adhesiolysis by providing better instrument articulation. One must balance this with cost and availability concerns, as robotic systems are expensive and not universal. Another approach is robotic multi-port transvaginal surgery (using multiple flexible robotic arms via the vagina), which is experimental but being explored. Recent studies have already compared robotic-assisted vNOTES hysterectomy to conventional vNOTES, finding both to be safe and effective (49). For now, conventional laparoscopy remains more widely accessible and is the main competitor to vNOTES. Given the data, vNOTES appears at least non-inferior to laparoscopy for early-stage ovarian tumor surgery in experienced hands, and potentially superior in terms of recovery. A direct comparative trial would be ideal to confirm these impressions.

Future Directions and Ongoing Research

The application of vNOTES in gynecologic oncology is still evolving, and several areas warrant further research. None of the current studies have long-term follow-up (10-year survival data) given how new the approach is. While short-term outcomes (up to 2–3 years) are reassuring, ovarian cancer can recur later, and it will be important to monitor whether patterns of recurrence differ with vNOTES (18). One hypothetical concern could be missed suboptimal staging (e.g., small diaphragmatic metastasis not seen, or omitted paraaortic nodes) leading to undertreatment (26). As more patients are treated, collaborative registries or trials could compare recurrence-free and overall survival between vNOTES and traditional approaches.

To move vNOTES from an experimental technique to an accepted option, larger multi-center studies or trials are needed. These would help accumulate a sufficient sample size of early-stage ovarian cancer patients to rigorously evaluate perioperative metrics and cancer outcomes (28). For instance, a prospective registry of vNOTES in ovarian cancer could systematically collect data on complications, upstaging rates, adjuvant therapy, and recurrences. Given the rarity of early-stage ovarian cancer, international collaboration will be key.

Also, further refinement of vNOTES instruments and port technology is ongoing. New transvaginal access platforms that allow easier instrument exchange and perhaps incorporate

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suction/irrigation channels could streamline the surgery. The use of advanced energy devices (ultrasonic shears, advanced bipolar) has already been implemented in vNOTES to secure pedicles like the infundibulopelvic ligament safely (22). Another technical focus is improving visualization; some surgeons use 3D laparoscopes or 4K cameras via vNOTES for better depth perception. The possibility of endoscopic ultrasound via the colpotomy to assess tumors before manipulation is an interesting idea as well (50). As discussed above, integrating robotics may overcome some ergonomic limitations (47). Additionally, image-guidance systems or fluorescence imaging (for SLN mapping) can be incorporated into the vNOTES workflow. The feasibility of ICG fluorescence imaging through a vaginally introduced laparoscope has been shown in endometrial cancer SLN mapping; similar techniques could help in identifying small metastatic implants (e.g., using tumor-targeted fluorescent agents) during vNOTES in the future (16).

Finally formal training programs for vNOTES are needed to ensure more surgeons can adopt the technique safely (51). Some centers have started hands-on courses and cadaver labs for vNOTES. A study by Housmans et al. noted that, with proper training, vNOTES hysterectomy outcomes were comparable to laparoscopic hysterectomy even for surgeons early in their vNOTES experience (52). For oncologic indications, training should emphasize case selection and the steps unique to staging (like omentectomy and biopsy techniques via vNOTES). Simulation models for vNOTES ovarian cystectomy or omentectomy could be developed for practice. As more gynecologic oncologists become proficient in vNOTES, we may see wider adoption in academic centers and the eventual inclusion of vNOTES in surgical guidelines as an acceptable approach for appropriate cases.

Beyond the immediate postoperative period, it would be valuable to assess patient-reported outcomes such as quality of life, body image, and sexual function after vNOTES vs. other approaches. Women undergoing oophorectomy and hysterectomy already face changes from surgical menopause (if premenopausal) and other psychosocial impacts of cancer surgery. The elimination of an abdominal incision might not only reduce physical pain but also positively influence body image – something that has been hinted at in benign hysterectomy studies (8,9). Additionally, since the vaginal route is used, it is worth studying sexual function recovery specifically (e.g., via Female Sexual Function Index surveys) to ensure that a transvaginal approach does not adversely affect sexual health (11). Early anecdotal reports have not raised concerns, and by avoiding abdominal scars, some women may have less discomfort with intercourse in the long run compared to those with an incisional scar that can be tender.

In summary, the current literature – though limited in size – consistently indicates that vNOTES is feasible for patients with early-stage ovarian cancer and can achieve the requisite surgical tasks with apparent safety. The evidence of low complication rates, minimal pain, and quick recovery is robust across multiple centers (23,27,28). Oncologic follow-up so far is short but has not revealed any alarming early recurrence patterns or technical failures (such as inability to complete staging). The limitations, primarily related to patient selection and upper abdominal access, are acknowledged and can be mitigated by careful surgical judgment or by hybrid techniques (26,28). Looking ahead, vNOTES could become an important component of the minimally invasive surgical toolkit in gynecologic oncology, particularly for early-stage disease and special situations like obesity. The ongoing "revolution" in minimally invasive gynecology that Lerner et al. described for benign surgery may well extend into cancer care, offering patients the possibility of maximal treatment with minimal trauma (10).

5. Conclusions

Vaginal natural orifice transluminal endoscopic surgery (vNOTES) represents an innovative advancement in minimally invasive gynecologic surgery, and emerging evidence suggests it can be successfully applied to the management of early-stage ovarian cancer. In this comprehensive review, we have summarized the findings from published case reports, case series, and feasibility studies examining vNOTES in ovarian malignancies. These studies collectively demonstrate that vNOTES is feasible for performing key oncologic procedures – including oophorectomy, hysterectomy, omentectomy, peritoneal biopsies, and even selective lymphadenectomy – in patients with presumed

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early ovarian cancer or borderline ovarian tumors. The perioperative outcomes with vNOTES have been excellent: intraoperative complication rates are low (comparable to standard laparoscopy), postoperative pain is consistently mild, and hospital stays are short (often <2 days). Importantly, thus far no unique safety concerns have emerged; there have been no reports of life-threatening complications, and conversions to open surgery have been exceedingly rare in experienced hands (23,25–28).

From an oncologic aspect, the limited short-term data available are reassuring. Surgeons using vNOTES have been able to adhere to oncologic principles by avoiding tumor rupture, achieving complete resection of disease, and obtaining adequate sampling of potential metastatic sites (e.g., omentum, peritoneum). Short- to medium-term follow-up in the largest series showed no cancer-related deaths and a recurrence rate consistent with expected outcomes for early-stage disease (11,25,28). While long-term survival data are not yet available, there is presently no evidence to suggest that vNOTES compromises oncologic efficacy when applied in appropriate early-stage cases. In other words, for carefully selected patients, vNOTES appears to achieve the same surgical goals as conventional approaches while enhancing recovery.

Nonetheless, it is important to acknowledge the current limitations of vNOTES in this setting. The use of vNOTES for ovarian cancer must be limited to highly selected patients and generally those with tumors likely confined to the ovary, of moderate size, and without extensive adhesions or extra-ovarian spread on imaging (11,22,23,28). Patients with advanced ovarian cancer or bulky disease are not candidates for vNOTES, as the approach does not yet allow comprehensive debulking of widespread intra-abdominal tumor. Additionally, certain staging components such as extensive paraaortic lymph node dissection remain challenging via vNOTES alone. If such steps are required, surgeons may consider a combined approach or default to standard laparoscopy/robotics (39). The reviewed studies consistently practiced prudent selection, which likely contributed to their favorable outcomes.

Another limitation is the learning curve and expertise. vNOTES is still relatively novel, and most gynecologic oncologists are not yet trained in the technique. Widespread adoption will require training and possibly mentorship from experienced vNOTES surgeons (51). Early in one's learning curve, it would be advisable to attempt vNOTES for simpler cases and have a low threshold for adding trocars or converting if difficulty is encountered (40,42,52). As experience grows, so too will confidence in tackling more complex cases transvaginally.

In terms of safety, no new adverse patterns have been noted with vNOTES. Concerns such as infection or vaginal cuff problems have not materialized significantly – only isolated incidents of cuff infection were reported and resolved with antibiotics. The fear of port-site metastasis at the vaginal incision has so far not been realized in any report, though continued vigilance is necessary as more cases accumulate (28). Overall, the safety profile of vNOTES in oncologic cases seems comparable to benign cases, which is to say very good.

Looking ahead, the future directions for vNOTES in early ovarian cancer will involve accumulating more evidence and refining the approach. Larger, multi-center studies (potentially randomized trials or at least case-control comparisons) are needed to validate that vNOTES offers equivalent cancer control to traditional minimally invasive surgery. Long-term follow-up data will be crucial to ensure there are no late disadvantages. Technological enhancements, including robotic-assisted vNOTES, may expand the capabilities of this approach and allow a broader range of procedures (for instance, facilitating lymph node dissection or complex suturing) to be done transvaginally. As these innovations develop, they could further tilt the balance in favor of vNOTES by overcoming current technical hurdles.

In conclusion, the current evidence – though limited in quantity – strongly suggests that vNOTES is a feasible and safe surgical option for patients with early-stage ovarian cancer in the hands of appropriately trained surgeons. The technique offers the well-documented benefits of minimally invasive surgery, potentially in an even less invasive form, translating to reduced pain, faster recovery, and improved patient satisfaction. At the same time, it appears to meet the oncologic

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requirements for thorough staging and tumor removal in selected cases, with short-term outcomes comparable to existing standards. Until larger studies are available, vNOTES should be considered an alternative approach for early ovarian cancer on a case-by-case basis, rather than a replacement for conventional laparoscopy or laparotomy. Patients who fit the selection criteria may be offered vNOTES in experienced centers, with counseling about the novel nature of the procedure. As experience grows and more data are published, we anticipate that vNOTES could become an accepted part of the minimally invasive surgical toolkit in gynecologic oncology, analogous to how vaginal and laparoscopic techniques have increasingly supplanted open surgery for many gynecologic conditions. In summary, vNOTES in early ovarian cancer shows considerable promise – offering the enticing prospect of achieving effective cancer surgery with minimal access trauma – but it should continue to be evaluated rigorously as we chart the path forward for this surgical innovation.

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