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# Vaginal Natural Orifice Transluminal Endoscopic Surgery for Gynecologic and Gynecologic Oncology Procedures

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## Abstract

Vaginal Natural Orifice Transluminal Endoscopic Surgery (vNOTES) is an exciting new procedure that combines the best of laparoscopic and transvaginal surgery. The skills of a laparoscopic surgeon are applied to this approach which offers several advantages over traditional laparoscopy. First, the recovery of a vaginal procedure is shorter and less painful. Second, there is no abdominal incision which avoids potential for wound infection, herniation, pain and unsightly scarring. Third, the surgeon is seated with more comfortable ergonomics than traditional laparoscopy. Fourth, the blood supply is controlled very early in the procedure reducing overall blood loss. Fifth, the specimen for removal is quite close to the operator which enables less crossing of instruments and allows larger scopes with better illumination to be used. Finally, where traditional laparoscopy progresses to a smaller and smaller surgical area as the operation proceeds deeper into the pelvis, vNOTES is continually moving out of the pelvis with greater room for specimen manipulation and visualization. Advantages over traditional transvaginal surgery include the ability to examine the entire abdomen, the safety of direct visualization of the pedicles for adnexal removal, and the ability to perform abdominal procedures including lymph node removal, omentectomy, appendectomy, and biopsies not previously available to the vaginal approach.

**Keywords:** vNOTES, minimally invasive surgery

## 1. Introduction

Vaginal Natural Orifice Transluminal Endoscopic Surgery (vNOTES) incorporates a number of different techniques and strategies to permit minimally invasive surgery through the natural orifice of the vagina. It is a hybridization of laparoscopic and transvaginal approaches with the advantages of each. While some of the earliest endoscopic techniques were performed through the posterior vagina and referred to as culdoscopy, only since the adaptation of multi-port single-incision laparoscopy to a transvaginal approach has the full value of this technique begun to be appreciated. Almost any laparoscopic procedure can now be performed transvaginally which can significantly reduce patients' postoperative discomfort, time to recovery, length of hospitalization, and without visible scar.

## **2. History of the technique**

The use of endoscopic procedures to visualize the abdomen is over 100 years old. Visualization of the pelvis through the vagina was developed by Decker who first reported the procedure in 1944 [1]. The term culdoscopy was used to describe placement of a scope into the posterior cul-de-sac with the patient in knee-chest position. This was originally used for diagnostic purposes but later modified for treatment of ovarian conditions, ectopic pregnancy and tubal ligation. However, the technique was never utilized by a wide audience of gynecologists, and abdominal and traditional transvaginal procedures continued to dominate the field. In the 1990s as fiber-optic cameras and improved instrumentation developed, abdominal laparoscopy came into vogue and has since exploded as a dominant method of performing gynecologic surgery along with its more recent counterpart, robotic surgery. Laparoscopy has replaced a large percentage of abdominal procedures permitting faster recovery, less pain, and better cosmetics for our patients. Unfortunately, as laparoscopic techniques and instrumentation continued to improve, the percent of hysterectomies performed transvaginally diminished. For example, the percent of hysterectomies performed vaginally dropped from 25% in 1998 to 17% in 2010 and continues to fall [2]. This despite the recommendation by the American College of Obstetricians and Gynecologists [3] and the AAGL [4] that transvaginal hysterectomy is the preferred method for benign gynecological disease as the optimum approach for patient safety and recovery. Younger gynecologists in academic and community settings are performing fewer transvaginal techniques. As a consequence, they are less likely to train resident physicians in transvaginal surgery.

The earliest utilization of a vNOTES approach was for general surgery procedures such as cholecystectomy and appendectomy [5]. In Asia in 2012, Ahn reported on the use of the single-port placed into the posterior vagina to remove the adnexa [6]. At the same time, the first series of vNOTES hysterectomies was published [7]. These authors utilized an Alexis retractor (Applied Medical, Rancho Santa Margarita, CA) placed into the anterior and posterior cul-de-sac with a surgical glove attached on the outer ring through which the glove fingers were used as laparoscopic ports. In Europe in 2013 Jan Baekelandt adapted the GelPoint device (Applied Medical, Rancho Santa Margarita, CA) to the transvaginal approach and has been the major developer and promoter of vNOTES surgery in the West [8, 9]. The GelPoint has the advantage of ease of set up, better ergonomics, and simplicity in specimen removal over a glove fastened to an Alexis. A group of American gynecologists (including the author of this chapter) trained with Dr. Baekelandt beginning in 2017 and brought the technique to the United States. To date, this core of vNOTES surgeons has trained approximately 100 gynecologists in this country. In 2019, a port specifically created for vNOTES (VPath, Applied Medical, Rancho Santa Margarita, CA) was developed and approved by the FDA.

## **3. Why perform vNOTES?**

VNOTES takes advantage of the laparoscopic expertise of today's surgeons and brings it to a transvaginal platform. This combines the best of vaginal and laparoscopic surgery. The surgeon has the visualization, instrumentation and panoramic abdominal perspective of laparoscopy combined with the reduced morbidity, rapid recovery and cosmesis of vaginal surgery. The majority of vNOTES procedures can be performed as an outpatient procedure and require minimal postoperative

pain medication. Most patients fully recover within two weeks of surgery, although vaginal rest continues as with any hysterectomy.

For the surgeon, the distance to the operative field is closer than with abdominal laparoscopy which translates in less collision of the instruments and permits larger scopes to be used with improved visualization. As opposed to abdominal laparoscopy where one works farther and farther down to the apex of a cone-shaped pelvis, vNOTES is constantly moving the uterus in a cephalad manner where there is more room to maneuver safely. This can be particularly advantageous with large myomatous uteri which can be manipulated farther into the abdomen as the case progresses. In addition, the major blood supply to the uterus is taken very early from a vNOTES approach which can significantly reduce blood loss. In patients with extensive adhesions from prior upper and mid abdominal surgery, vNOTES can avoid these adhesions altogether. The majority of surgeons perform this procedure while they and their assistants are seated and the ergonomics are far improved with minimal muscle strain over standard laparoscopy. This procedure is well adapted to the morbidly obese patient and can overcome surgical difficulties with standard laparoscopy including long distance to the pelvic organs, torque from traversing instruments through thick abdominal wall, and challenge of choosing appropriate port placement sites. The obese patient has the most to gain by avoidance of abdominal incisions and rapid recovery.

To date there has been one randomized trial comparing vNOTES hysterectomy with laparoscopic hysterectomy as an outpatient procedure. In this trial 70 women with benign indications for hysterectomy were randomized to either standard four incision laparoscopy for removal of the uterus or received four skin incisions without cutting through the fascia and had a vNOTES procedure [10, 11]. This permitted blinding for the patients and the investigators to which technique had occurred. There were no conversions in the study. The mean operative time for vNOTES was shorter than laparoscopy (41 minutes versus 75 minutes). More women left the hospital within 12 hours after vNOTES (77% versus 43%). Overall hospital stay was shorter for vNOTES and overall use of analgesics during the first seven days after surgery was less in the vNOTES group (eight versus 14 units). The vNOTES group also reported significantly lower Visual Analog Scores (VAS) for pain. There were also significantly fewer postoperative complications in women treated by vNOTES (9% versus 37%). In this elegant study, the outcome parameters clearly favored vNOTES over total laparoscopic hysterectomy.

#### **4. Technique**

vNOTES begins similar to a transvaginal hysterectomy. A circumferential incision is made in the cervix down to the level of the pubo-cervical fascia. The anterior and posterior aspects of the vaginal mucosa are dissected away from the cervix to gain access to the anterior and posterior cul-de-sacs. These spaces are entered, the uterosacral ligaments are clamped, cut and ligated. These pedicles may later be incorporated into cuff closure for vault support. An Alexis retractor is placed into the anterior and posterior space. The outer ring of the Alexis either has the cap attached or a glove attached depending on which one is available. The patient is placed in 20° Trendelenburg position and insufflation of the abdomen is performed. In general lower pressures and flow rates are sufficient for adequate visualization compared to abdominal laparoscopy. The remaining attachments to the uterus are on either lateral side. The laparoscope is introduced into the retractor, most frequently either a 0° or 30° 10 mm scope is used. A vessel sealing device is most commonly used along with a grasping instrument that may be a cautery instrument as well. Beginning on the patient's left side, the cervix is pushed medially and cephalad to give direct



visualization of the uterine vessels. These are cauterized and cut followed by resection of the broad ligament up to the fundus. The round ligament can be transected, but the adnexal attachments remain in place until completion of dissection of the right side.

Attention is then focused on the right side of the uterus where the cervix is again manipulated medially and cranially and the uterine vessels are secured. One dissects the broad ligament of the right side and then one can resect both the round ligament and the adnexa (or utero-ovarian pedicle if the adnexa is to be preserved). Finally the left adnexa are managed in a similar fashion. This will free the uterus of all its attachments and it can be delivered through the vagina. Any portion of the tubes and ovaries can be removed with the uterus. The abdomen is then explored and ancillary procedures can be performed if necessary including omentectomy, peritoneal biopsies, appendectomy, lysis of adhesions, or umbilical hernia repair to name a few. As with abdominal laparoscopy any concern for specimen spill can be avoided with the use of endoscopic bags.

In some circumstances surgeons will perform a total vaginal NOTES whereby the retractor is placed into the vagina and circumcision of the cervix, entry into the anterior and posterior cul-de-sac, and the remainder the procedure are all performed by laparoscopic techniques through the vagina without placing the retractor into the peritoneal cavity. This technique may be helpful in women with a very high cervix (no descent) or a narrowed vagina such as may occur in post-menopausal or virginal women.

VNOTES techniques can also be utilized for adnexal surgery without removal of the uterus. In this situation an incision is made in the posterior cul-de-sac of the vagina between the uterosacral ligaments. A smaller Alexis retractor is then placed into the posterior cul-de-sac through which the laparoscope and instruments are introduced and surgery performed. This can be used for salpingectomy, oophorectomy, ovarian cystectomy, resection of ectopic pregnancy, or myomectomy.

## **5. Instrumentation for vNOTES**

The instruments for performing vNOTES are similar to those used with transabdominal single incision laparoscopy. The V-Path Alexis retractor (Applied Medical, Rancho Santa Margarita, CA) has been approved by the FDA specifically for this procedure. Most surgeons utilize a 10 mm laparoscope. Because the field of surgery is so close to the retractor, the camera does not interfere with the other instruments and the larger aperture produces better lighting and visualization. A 0° or a 30° scope can be used depending on individual preference. Alternatively, some surgeons have access to 3D laparoscopes which provide better depth of field. Flexible laparoscopes do not appear to be advantageous for this procedure as they often collide with the pelvic tissues. Other instruments utilized during vNOTES include a vessel sealing instrument, a bipolar cautery instrument, and a grasping instrument such as a laparoscopic Maryland forcep depending on the individual surgeon's preference. Endoscopic bags can be used for specimen retrieval. Smoke evacuators and suction/irrigation are rarely necessary with the vNOTES approach as blood loss is generally minimal and smoke rarely interferes with visualization. The operative costs are no different than a standard single-incision laparoscopy.

## **6. Contraindications to vNOTES**

Most contraindications to vNOTES must be considered relative based on the expertise of the surgeon. If one considers contraindications to abdominal

laparoscopic surgery 20 years ago (prior surgery, endometriosis, obesity) one sees that with the evolution of techniques these are no longer applicable. Factors such as parity, prior cesarean delivery, lack of uterine descent, uterine size and concern for malignancy are not necessarily contraindications to vNOTES procedures. Most surgeons would avoid operating on women who have had low colorectal surgery, known obliteration of the posterior cul-de-sac, or prior pelvic radiation to reduce the risk of injury with the posterior entry. In addition, cervical myomas, depending on the position and size, may contribute to anatomic difficulties in placement of the retractor.

## 7. Current applications

### 7.1 Hysterectomy

Over 400 hysterectomies performed by vNOTES have been reported in the literature since 2012. There is a global registry that has currently amassed about 1800 cases from 40 vNOTES surgeons around the world with the majority including hysterectomy. Virtually any uterine pathology has undergone vNOTES hysterectomy including uteri greater than 2000 g. Uterine descent is not necessary for this procedure nor is prior cesarean delivery a contraindication. This approach can be used in morbidly obese women who will experience the most benefit from not having an abdominal incision. Myomectomy can also be performed from a vNOTES approach utilizing either the anterior or posterior cul-de-sac depending on the anatomic location of the myoma. Again the procedure itself is identical to that performed using transabdominal laparoscopy. The attached **video 1** demonstrates a vNOTES hysterectomy with bilateral salpingectomy.

### 7.2 Adnexal surgery

In women who wish to preserve their uterus but have an adnexal mass, vNOTES can be performed through the posterior cul-de-sac. The adnexal surgery may include removal of the fallopian tubes for sterilization, resection of ectopic pregnancy, ovarian cystectomy, or salpingo-oophorectomy. It is also possible to utilize this approach for diagnostic laparoscopy. This saves the patient from an abdominal incision and reduces the postoperative pain. The attached **video 2** demonstrates removal of an adnexal mass while leaving the uterus in place.

### 7.3 Pelvic support

Support of the vaginal cuff can be readily achieved through vNOTES. At the completion of the hysterectomy the visualization of the ureters permits very high plication of the uterosacral ligaments. An excellent demonstration of this technique can be seen in the following video by Dr. Howard Salvay <https://www.youtube.com/watch?v=yYpVuXEbxg>. Sacrocolpopexy can also be performed using vNOTES, as demonstrated in a published series of 26 cases with correction of significant pelvic organ prolapse utilizing a Y-mesh to placate the sacral promontory to the anterior and posterior upper vagina [12]. This resulted in excellent postoperative results though long-term follow-up is still pending.

### 7.4 Additional gynecologic procedures

This approach is ideal for risk-reducing surgery in that the entire ovary and fallopian tube can be removed with a portion of the infundibulopelvic ligament

and a pelvic washing for cytology can be obtained. In standard transvaginal surgery for adnexectomy adequate visualization to safely remove the entire tube and ovary is not always possible. The vNOTES approach also avoids an abdominal scar for a prophylactic surgery.

## **7.5 Non-gynecologic procedures**

In most circumstances laparoscopic appendectomy is a relatively straightforward procedure and can be safely accomplished by a vNOTES approach. Abdominal wall adhesions can be visualized and safely taken down which may alleviate some patients' symptoms of abdominal discomfort. Small umbilical hernias can be closed primarily or repaired with mesh against the abdominal wall through this approach.

## **8. Oncology applications**

### **8.1 Endometrial cancer**

Women with endometrial cancer are often obese and have multiple medical comorbidities. There are many reports of performing transvaginal hysterectomy on those patients who may not tolerate an abdominal procedure. However, that approach does not always permit visualization and removal of the tubes and ovaries. Nor does it allow for sampling of the lymph nodes. VNOTES permits removal of the tubes and ovaries, a pelvic washing can be performed, the entire abdomen can be explored, and lymph nodes can be removed. Multiple reports in the literature document the ability to perform Sentinel lymph nodes by this approach as well as pelvic lymphadenectomy and even aortic lymphadenectomy [13–16]. Given that the recommendation currently for staging endometrial cancer is to utilize a minimally invasive technique, vNOTES can provide an additional method to achieve this goal.

### **8.2 Ovarian cancer**

In general ovarian cancer debulking is not performed with a minimally invasive technique; however, there are exceptions. When patients are treated with neo-adjuvant chemotherapy and have an excellent response, robotic or laparoscopic approach can be performed to remove any small residual disease. Early stage disease can also be staged by a minimally invasive route. A vNOTES approach can remove adnexal masses, the omentum, lymph nodes, and perform a full exploration of the abdominal cavity. The diaphragm can be reached with the appropriate instruments through the vagina to perform biopsies and visualization. Bulky disease in the pelvis would be a contraindication to a vNOTES approach as the likelihood of successfully entering the pouch of Douglas will be low.

### **8.3 Cervical cancer**

There are no reports in the literature currently on utilizing vNOTES to treat cervical cancer. Theoretically a radical vaginal hysterectomy could be performed with vNOTES and pelvic lymph nodes can be removed so it is only a matter of time before some surgeons become skilled enough at this technique to perform such an operation. While there is currently controversy regarding a possible decreased survival with a minimally invasive radical hysterectomy [17], data on a radical vaginal approach does not appear to have a deleterious effect on outcome [18].

## 9. Conclusions

vNOTES has been shown to be a safe and feasible alternative approach to most gynecologic procedures. The technique is still in its infancy and is analogous to the early use of laparoscopy for advanced gynecologic surgery. There are distinct advantages with this approach including decreased pain, shorter recovery, and optimal cosmetics over standard laparoscopy. There is no doubt that vNOTES will be adopted by the surgical field. Instrumentation specific for vNOTES is beginning to be brought to the marketplace. Patient satisfaction with the technique will also drive more surgeons to these procedures. With vNOTES a gynecologist is able to offer the best aspects of laparoscopy with the ideal approach through the vagina.

### Video materials

Video 1. vNOTES hysterectomy with bilateral salpingectomy. <https://youtu.be/RvQcZfWEKdc>

Video 2. vNOTES adnexal removal. <https://youtu.be/fVxE3tErnwU>

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