



## Case Report

## Pioneering case: Robotic single port (SP) transvaginal NOTES (RSP-vNOTES) for hysterectomy in ten steps

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## ARTICLE INFO

## Keywords:

Robotic SP  
Hysterectomy  
Transvaginal surgery  
NOTES

## ABSTRACT

Transvaginal Natural Orifice Transluminal Endoscopic Surgery (NOTES) has become popular since its inception in 2012, offering advantages by combining vaginal surgery principles with laparoscopic instruments for procedures like hysterectomy and myomectomy. The da Vinci Xi robotic system for transvaginal NOTES has been used successfully in over 300 cases, including advanced surgeries like sacrocolpopexy and endometriosis procedures. The new da Vinci SP platform, designed for single-port surgery, was employed in the first transvaginal NOTES hysterectomy on November 11, 2023, at Baylor College of Medicine. The surgical steps and outcomes of the procedure are detailed in this case report, showcasing the feasibility and success of utilizing the da Vinci SP system for transvaginal NOTES. The patient was discharged on the same day with an unremarkable post-operative course, and pathology results revealed adenomyosis and endometriosis after the comprehensive surgery.

Transvaginal Natural Orifice Transluminal Endoscopic Surgery (NOTES) has been gaining popularity from its inception in 2012. While drawing from the fundamentals of vaginal surgery, several advantages of Transvaginal NOTES become apparent by merging the natural orifice entry of the vagina with the manual extension of laparoscopic instruments, all the while utilizing enhanced visualization of the surgical field. Continued developments in traditional NOTES has evolved to allow for this approach in procedures such as hysterectomy, adnexal surgery, myomectomy, sacrocolpopexy, and high uterosacral ligament suspension. However challenges in suturing, dissection, and triangulation have limited its application in vaginal NOTES (vNOTES) procedures.<sup>1–6</sup>

To date, the author has successfully performed over 300 transvaginal NOTES cases using the robotic da Vinci Xi system, employing this platform across hysterectomy, myomectomy, sacrocolpopexy and all stages of endometriosis surgeries, including cases involving an obliterated cul-de-sac.<sup>7–16</sup> The newest edition to the da Vinci lineup includes the SP platform, specifically designed for single-port surgery. The SP platform offers distinct advantages, featuring an articulating camera and three articulating instruments delivered through one port. While there are a plethora of existing publications in gynecology on transumbilical surgery

for both benign and malignant indications, no report on the feasibility of transvaginal NOTES for gynecologic indications currently exists with the SP platform.<sup>17–21</sup> This case report aims to fill this gap by presenting our experience and outcomes in utilizing the Robotic SP for transvaginal NOTES (RSP-vNOTES).

On November 11, 2023, the Baylor College of Medicine team successfully conducted the inaugural RSP-vNOTES hysterectomy using the da Vinci SP system [Fig. 1]. The two preceding days were used as a simulation workshop in the operating room which equipped Dr. Xiaoming Guan (the primary surgeon) and his assistants to seamlessly complete this cutting-edge surgery. This case report aims to illustrate the ten key surgical steps involved in the procedure.

The patient was discharged home the same day following surgery after meeting all the post-operative discharge requirements. Her post-operative course was unremarkable. Pathology results showed adenomyosis and endometriosis after her total hysterectomy, bilateral salpingectomy, and endometriosis resection.

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Fig. 1. Surgical team.

### 1. Step 1: patient position: dorsal lithotomy

The patient is positioned in dorsal lithotomy using Allen stirrups, with arms tucked. Regular-sized Trenguard system (D.A. Surgical, Newbury, OH, USA) was also placed to ensure patient immobility for the duration of the case while in steep Trendelenburg. That the vagina and abdomen are both prepped and draped as a precautionary measure in the case conversion to abdominal laparoscopy becomes necessary during the procedure.

### 2. Step 2: temporary ureteral stent

Following patient draping, a 5 mm 30-degree cystoscope is employed to insert a 28-inch, 5-Fr open-ended ureteral catheter into each ureter. Focusing on one side, the stent is advanced approximately 15 cm. 5 cc of indocyanine green (ICG) is injected into the ureter and allowed to sit for 60 seconds before the stent is removed. The same stent is then used on the contralateral side, where 5 cc ICG is injected and allowed to sit for 60 seconds. The stent and cystoscope are then removed [Fig. 2].

### 3. Step 3: transvaginal surgery

The surgery commences vaginally, initiating access to the peritoneal cavity through a posterior colpotomy. Initially, the cervix is grasped with a Lahey clamp and injected circumferentially with dilute vasopressin (20 units in 20mL of normal saline) for hemostasis and hydrodissection. The vaginal mucosa is then incised circumferentially at the cervicovaginal junction using Bovie electrocautery.

Access to the peritoneal cavity begins with a posterior colpotomy made sharply with Metzenbaum scissors. The posterior peritoneum is sutured to the posterior vagina with 0-Vicryl, and tagged with a hemostat. Similarly, sharp entry into the anterior peritoneal cavity is achieved with Metzenbaum scissors, followed by suturing the peritoneum to the anterior vagina with 0-Vicryl, once again tagged with a hemostat. Both the anterior and posterior vaginal sutures serve as anchor points for later placement of the vaginal port [Fig. 3].

### 4. Step 4: port placement and trocar locations

The GelPort Mini Laparoscopic System (Applied Medical, Rancho Santa Margarita, CA, USA) is utilized.

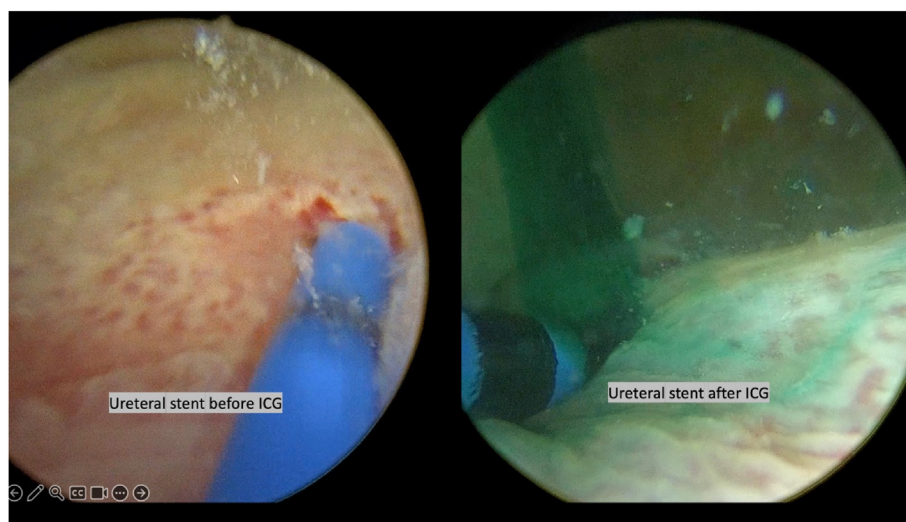


Fig. 2. Ureteral stent with ICG injection.

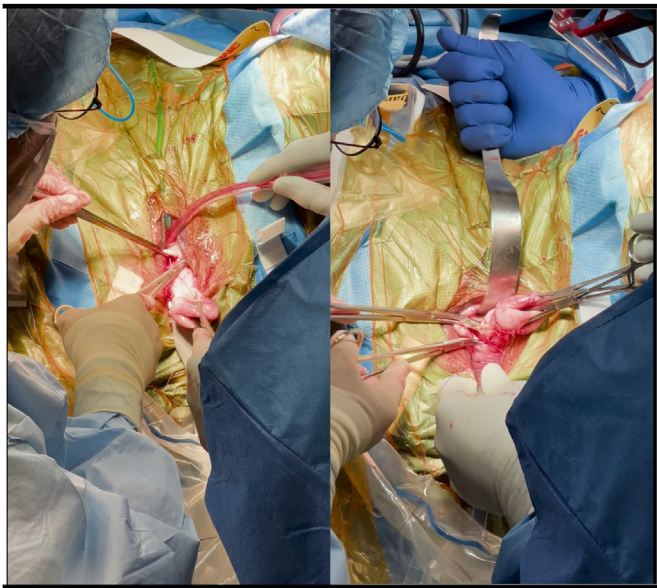


Fig. 3. Transvaginal hysterectomy portion.

The anterior portion of the GelPort Mini self-retracting ring is then placed using a Babcock clamp within the dissected anterior cul-de-sac. Once the interior ring of the GelPort Mini self-retracting ring is securely in place, the exterior ring is left loose. The SP single 25 mm trocar, equipped with three instrument channels, and one camera channel, is inserted through the mini GelPort. An additional 10 mm accessory port with the AirSeal system (ConMed, Largo, FL, USA) is inserted lateral to the SP trocar [Fig. 4].

##### 5. Step 5: transvaginal robotic SP docking

The robotic da Vinci SP (Intuitive Surgical, Inc. Sunnyvale, CA, USA) patient cart is maneuvered to the patient's right side. The singular SP robotic arm is docked to the patient-attached trocar. The fenestrated bipolar grasper, monopolar scissor, needle driver, along with the 3DHD wristed camera, are inserted with the camera in the level position. As the working arms enter through the SP trocar, they expand outward at the instrument elbows. The exterior ring of the self-retractor in the vagina is left loose due to the instruments needing a 10cm working space between the trocar and instrument tip for optimal articulation [Fig. 5].

##### 6. Step 6: robotic hysterectomy

The subsequent steps of the hysterectomy are carried out on the robotic SP platform with the camera in the downward position. Employing the fenestrated bipolar and monopolar scissors, meticulous attention is given to surgical triangulation with improved exposure aided by the assistance of a third articulating instrument. The bilateral broad ligaments, utero-ovarian ligaments, and mesosalpinx are sequentially cauterized and transected to complete the total hysterectomy and bilateral salpingectomy as one specimen [Fig. 6].

##### 7. Step 7: ovarian suspension

After the completion of the hysterectomy, the specimen is displaced into the lower abdomen. This grants the surgeon a unique opportunity to survey the entire abdominal cavity. At this point, additional procedures can be carried out on the robotic platform, such as oophoropexy to the respective lateral pelvic sidewall using 3-0 V-Loc barbed suture (Medtronic, Minneapolis, MN, USA), in addition to resection of endometriosis assisted by ICG, as clinically indicated [Fig. 7].

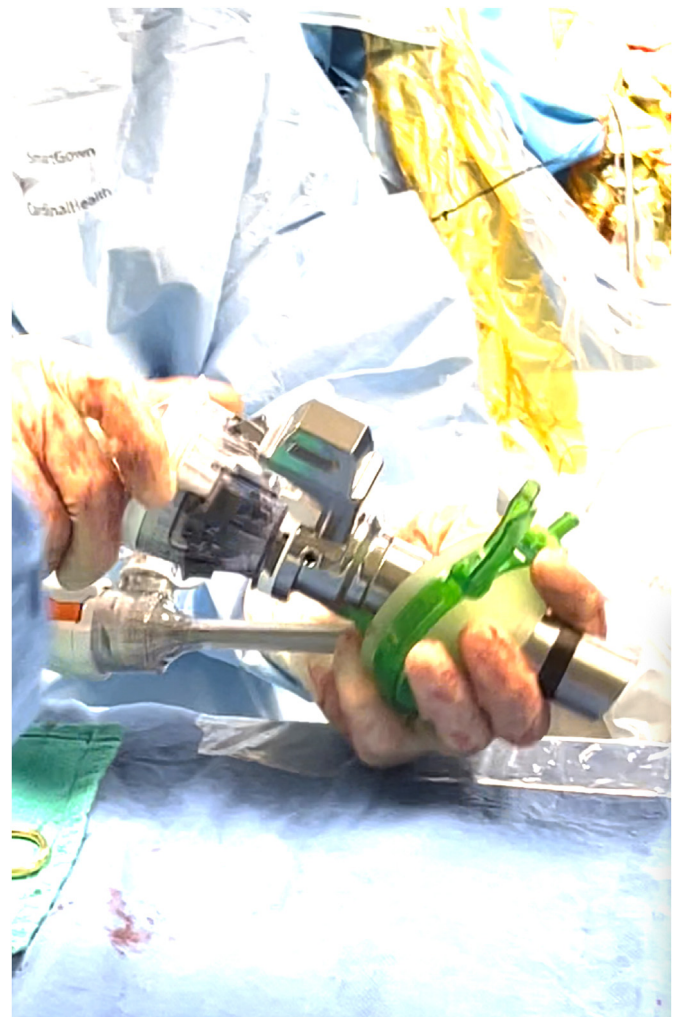


Fig. 4. SP trocar insertion.

##### 8. Step 8: abdominal wall omental adhesiolysis

The omentum was found to be adherent to the anterior abdominal wall and is released using monopolar scissors. Visualization is optimized by independently repositioning the endoscope, and maximizing the internal range of the SP robotic arm [Fig. 8].

##### 9. Step 9: undocking and specimen removal

Once all instruments are removed, the robot is undocked from the SP trocar, and the camera is separately reintroduced into the abdomen. The uterus is grasped with the cobra instrument through the accessory port. The mini Gelport is then removed, and the specimen is extracted from the body [Fig. 9].

##### 10. Step 10: vaginal cuff closure

The interior peritoneum and vaginal mucosa of the vaginal cuff are circumferentially reapproximated with 0-Vicryl suture in a continuous fashion. The vaginal opening is then closed horizontally in a continuous fashion using a 0 V-Loc barbed suture, mirroring the closure technique applied in traditional vaginal hysterectomy cuffs (Fig. 10).

Natural orifice surgery is gaining more widespread popularity in gynecologic procedures, particularly with advancements in robotic surgical platforms. The progression from traditional laparoscopic surgery (all straight instruments), to articulating laparoscopic surgery (involving one



Fig. 5. SP docking.

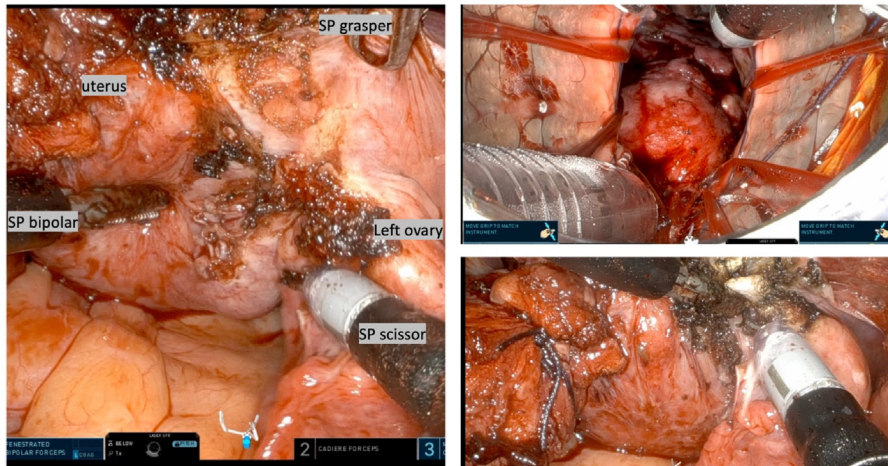


Fig. 6. Robotic SP vNOTES hysterectomy.

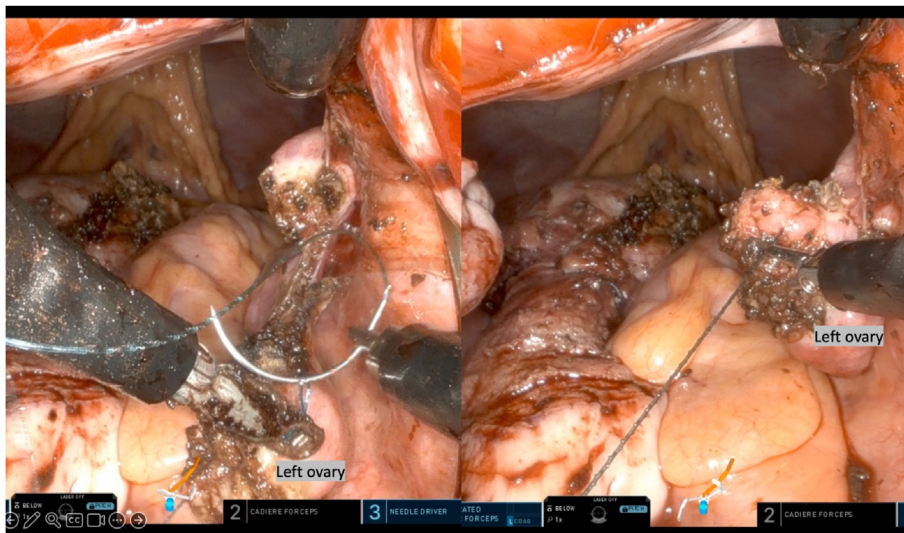


Fig. 7. Left ovarian suspension.

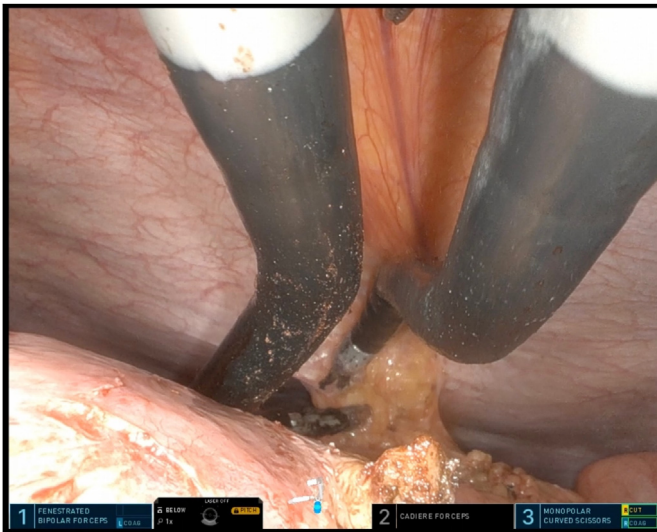


Fig. 8. Anterior abdominal wall adhesion.

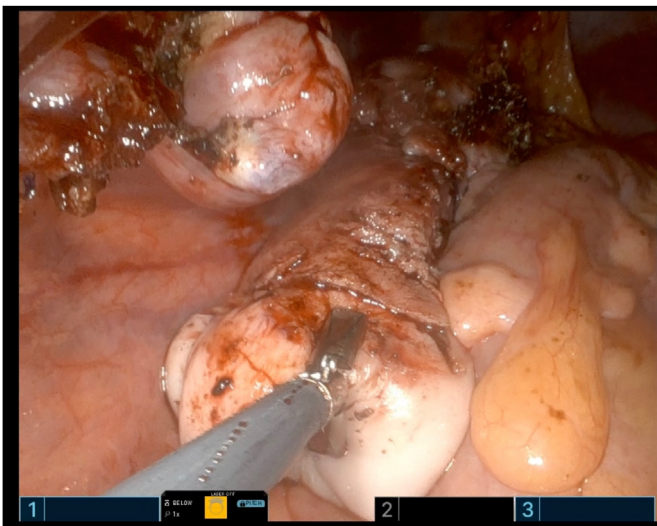


Fig. 9. Uterine specimen removal.

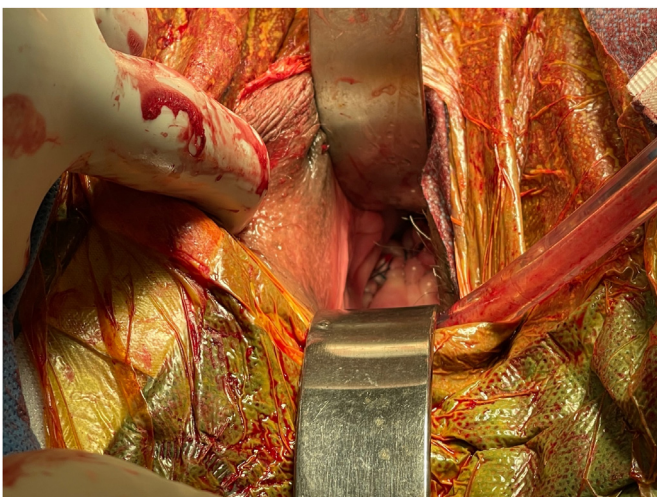


Fig. 10. Vaginal cuff closure.

articulated instrument), to the robotic da Vinci Xi platform (featuring robotic wristed instruments), has now led to the next level of robotic surgery with the SP platform. This platform offers "wristed" movement through the functionality of robotic elbows.

However, while transabdominal single-site surgery using the SP platform is becoming widely adopted in urological and some gynecologic procedures,<sup>17–21</sup> exploration of transvaginal NOTES for the SP platform has not been reported. Based on its design for single-port surgery, the SP platform holds great potential as a tool for transvaginal NOTES in gynecology. This case report marks the inaugural utilization of the SP platform for transvaginal NOTES surgery. Further studies with larger sample sizes and potentially comparative analyses are imperative to confirm the feasibility and safety of employing this advanced platform.

#### Declarations of interest

Professor Xiaoming Guan is an editorial board member for Intelligent Surgery and was not involved in the editorial review or decision to publish this article. All authors declare that there are no competing interest.

#### Ethical statement

This study's IRB was waived from Baylor College of Medicine. Written informed consents were obtained from the patient.

#### Source of funding

None.

#### Statement of prior presentation or publications and /or abstract/poster presentation

None.

#### Data availability statement

Data is available upon reasonable request.

#### CRediT authorship contribution statement

**Xiaoming Guan:** Conceptualization, Data curation, Methodology, Resources, Writing – original draft, Writing – review & editing. **Daniel Lovell:** Conceptualization, Writing – original draft, Writing – review & editing. **Emily Sendukas:** Conceptualization, Writing – review & editing.

#### Acknowledgments

Richard Link, Baylor College of Medicine, urologist; Chunghua Zhang, MIGS surgeon, OBGYN, The Huaian Maternity and Child Clinical College of Xuzhou Medical University; Manille Alcantra, Cristy Gonzalez, Andy Nguyen, Dean Buhay, Martha Rodriguez, Anisha Jefferson, Nicole Varisco. Tracy Delco, Staff at Baylor CHI Saint Lukes Hospital.

#### Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.isurg.2023.11.003>.

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