



Transvaginal natural Orifical transluminal Endoscopy for sacrocolpopexy: A case series report

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ARTICLE INFO

Keywords:

Traditional transvaginal natural orifice transluminal endoscopic surgery
Robotic transvaginal natural orifice transluminal endoscopic surgery
Sacrocolpopexy
Pelvic organ prolapse
Operative outcomes

ABSTRACT

Background: To describe the surgical technique and operative outcomes of transvaginal natural orifice transluminal endoscopic surgery (V-NOTES) for sacrocolpopexy with or without robotic surgical system in patients with pelvic organ prolapse (POP).

Methods: Patients with POP undergoing traditional transvaginal natural orifice transluminal endoscopic surgery (TV-NOTES) or robotic transvaginal natural orifice transluminal endoscopic surgery (RV-NOTES) for sacrocolpopexy performed by one surgeon from Sep 2020 to Jan 2023 in our hospital were included in this study. The baseline demographics and operative outcomes were collected and analyzed. In addition, some surgical skills were presented. The operative outcomes of V-NOTES for sacrocolpopexy performed by three beginners were also presented.

Results: Eight patients who underwent TV-NOTES, and two patients who underwent RV-NOTES were included in this study. The mean operative time was 180 ± 49 min, and the estimated blood loss was 107 ± 82 ml for these ten cases. Particularly, the operative time of the two patients who underwent RV-NOTES was 275 and 132 min, while the estimated blood loss (EBL) was 100 and 50 ml respectively. During the follow-up period, no mesh exposure and recurrence were observed. In addition, five cases of TV-NOTES for sacrocolpopexy by beginners were all successfully completed.

Conclusion: Both TV-NOTES and RV-NOTES appeared to be feasible and safe for sacrocolpopexy.

1. Introduction

Pelvic organ prolapse (POP) refers to the descended position and dysfunction of pelvic organs due to the weakness of pelvic floor muscles and fascial tissues. It not only causes a series of discomforts, like lower urinary tract symptoms and defecation problems, but also imposes great psychological burden on the patients. In a woman's lifetime, the incidence of undergoing POP surgeries is up to 20% [1,2], and this rate would continue to rise with the aging of population [3,4].

Laparoscopy initiated the era of minimally invasive surgery, while transvaginal natural orifice transluminal endoscopic surgery (V-NOTES) was a further step to the field. Nowadays, V-NOTES have been successfully applied in gynecological benign lesions, even malignant diseases [5–11]. According to the recommendations of American College of Obstetricians and Gynecologists, V-NOTES should be performed “whenever is feasible” [12]. Sacrocolpopexy is considered to be the gold standard procedure for POP [13]. As

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V-NOTES provides better visibility and precise procedures than vaginal approach, and less wound-related complications and better cosmetic effects than transabdominal laparoscopy, it is gradually applied in sacrocolpopexy [8,14,15]. However, challenges still exist for traditional V-NOTES (TV-NOTES), especially in the sacral promontory dissection and mesh anchoring to the anterior longitudinal ligament [14]. In this case, robotic-assisted V-NOTES (RV-NOTES) could play to its strength with its enhanced vision and greater range of instruments' motion [16,17]. Even though, both TV-NOTES and RV-NOTES for sacrocolpopexy have limited clinical application as it requires advanced surgical techniques. Therefore, we conducted this study to describe our surgical technique and the operative outcomes of TV-NOTES and RV-NOTES for sacrocolpopexy, and tried to provide some experience in this field.

2. Methods

2.1. Study design

Patients with POP who underwent TV-NOTES or RV-NOTES for sacrocolpopexy performed by Dr Lin from Sep 2020 to Jan 2023 were included. All patients were clinically followed up from two months to two years. The baseline demographics, surgical procedure and operative outcomes were recorded. Also, we had collected the data of TV-NOTES for sacrocolpopexy performed by three beginners. Recurrence was defined as any POP-Q (Pelvic Organ Prolapse Quantification) \geq stage II. All participants gave written informed consent.

2.2. Surgical technique

The patient was placed in a steep Trendelenburg position after administering general anesthesia. Following vaginal hysterectomy,

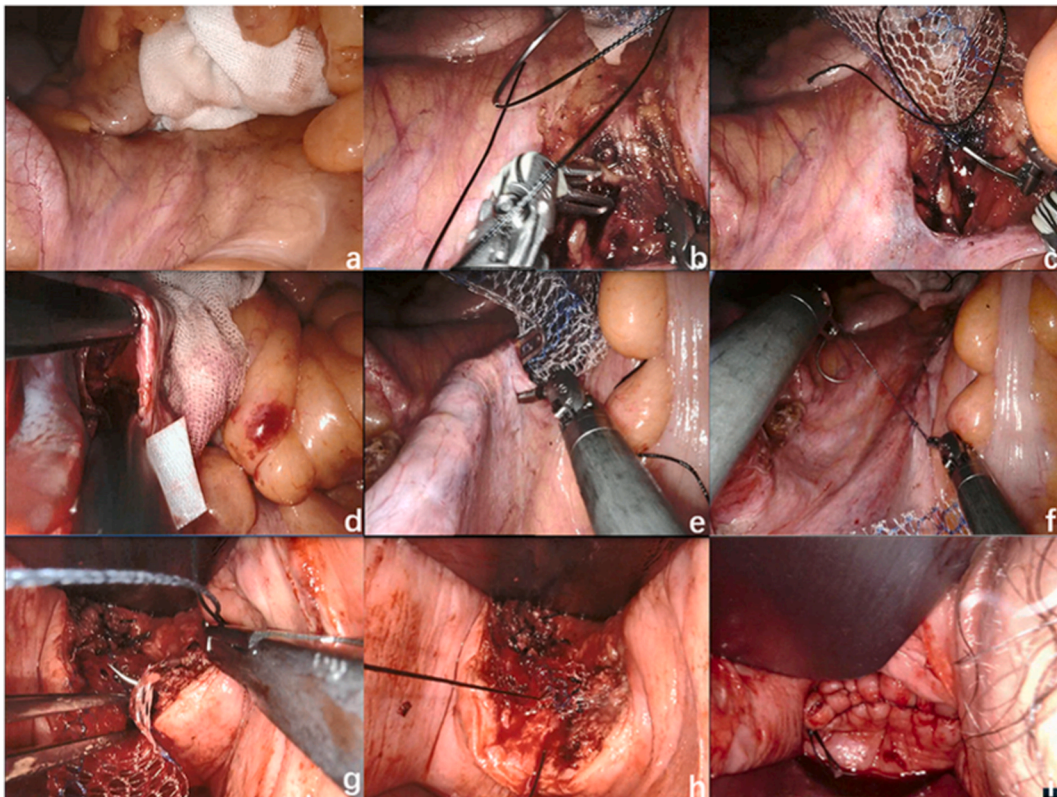


Fig. 1. Critical steps of V-NOTES for sacrocolpopexy

- 1a: The anterior sacral area was exposed
- 1b: The pre sacral fascia was incised
- 1c: The anterior longitudinal ligament was exposed
- 1d: The mesh was sutured to anterior longitudinal ligament
- 1e: The “tunnel” from the vaginal cuff to the sacral promontory was established
- 1f: The mesh was delivered through the tunnel
- 1g: The pre-sacral fascia and peritoneum was sutured
- 1h–i: The mesh was sutured to the vaginal cuff
- 1j: Vaginal cuff was closed.

the laparoscopic platform was established. For those who underwent RV-NOTES, the da Vinci Xi robotic platform was docked and aligned with the patient's center to avoid repeated adjustment during surgery. The following surgical procedures were similar in RV-NOTES and TV-NOTES groups. Firstly, expose the pre-sacral area and incise the fascia to the anterior longitudinal ligament (Fig. 1a–c). Subsequently, the mesh's "long arm" was sutured to anterior longitudinal ligament (Fig. 1d). Then, establish a "tunnel" from the vaginal cuff to the sacral promontory along the inner side of the right rectum sacral ligament (Fig. 1e), and deliver the individually trimmed "Y" mesh through the "tunnel" (Fig. 1f). After suturing the pre-sacral fascia and peritoneum (Fig. 1g), the mesh's short arms were sutured to the vaginal cuff with tension-free sutures flatly (Fig. 1h–i). Finally, vaginal cuff was closed (Fig. 1j). During the surgery, if the surgical field is limited because of colon obstruction, the suspension needle could be used to expose the surgical area by hooking up the mesocolic band (Fig. 2, video 1, our previous study had described this technique [18]).

Supplementary data related to this article can be found online at <https://doi.org/10.1016/j.heliyon.2023.e23606>

2.3. Statistical analysis

Descriptive statistics were generated for the operative outcomes. Statistical analysis was performed using SPSS 19.0 software.

3. Results

Eight patients who underwent TV-NOTES and two patients who underwent RV-NOTES for sacrocolpopexy were included in this study. As shown in Table 1, all patients had stage II or greater apical prolapse and were accompanied by mild or moderate anterior or posterior compartment prolapse. All patients had vaginal hysterectomy ± salpingo-oophorectomy firstly before V-NOTES for sacrocolpopexy. The mean operative time was 180 ± 49 min and the estimated blood loss was 107 ± 82 ml for the ten patients. The postoperative hospital stays and visual analogue score (VAS) were 4 (3–5 days) and 2 (2–3 points) respectively. There was no conversion to laparotomy or transabdominal laparoscopy. Only two patients who underwent TV-NOTES had a postoperative fever but recovered quickly after administering antibiotics. There was great improvement in the POP-Q values and patients' subjective feelings postoperatively. Mesh exposure and recurrence were not observed in any patient (Table 1).

We also analyzed the operative outcomes of TV-NOTES for sacrocolpopexy performed by three beginners who learned the experience of Dr Lin. The operative time of the five patients was 350, 400, 245, 325, and 195 min, while the estimated blood loss was 50, 500, 50, 300 and 150 ml respectively. One case had a postoperative fever and recovered after administering antibiotics, and the case had mesh exposure in the one month follow-up period and reoperated (Table 2).

4. Discussion

Laparoscopic sacrocolpopexy is the preferred procedure for POP. Thanks to the rapid development of minimally invasive techniques, V-NOTES, even RV-NOTES for sacrocolpopexy were performed for the treatment of POP. V-NOTES have the advantages of cosmetic appearance and decreased pain [19,20]. Furthermore, it did not increase the risk of complications even in difficult surgeries [21,22]. However, there is also some limitation such as the absence of triangulation and "chopsticks effect" of the laparoscopic instruments [20,23]. Robotic platform could provide three-dimensional visualization, instruments' greater range of motion, and accurate surgical procedures [17,24],

while its expensive costs limited its clinical application [25]. In our experience, both TV-NOTES and RV-NOTES for sacrocolpopexy were successfully completed. To our knowledge, this may be the first study to present the operative outcomes of TV-NOTES and RV-NOTES for sacrocolpopexy in the same institution.

The major concern about V-NOTES for sacrocolpopexy is mesh exposure and recurrence [26,27]. In the present study, there was only one case of mesh exposure operated by the beginners and no recurrence. This was in consistent with the conclusion of previous studies [14,15,28–31]. Li [32] reported that the recurrence rate in the patients who underwent sacrocolpopexy in the TV-NOTES group was significantly lower than the laparoscopic group (2.17 % vs 6.98 %). These results may encourage surgeons to perform V-NOTES for sacrocolpopexy. In our experience, the following surgical skills may be helpful to reduce the rate of mesh exposure and recurrence. a) the "Y" mesh should be trimmed individually. According to our experience, the length of the "Y" mesh's long arm was determined according to the measured distance between the sacral promontory and the vaginal vault, while the length of the two short "arms" was



Fig. 2. The process of hooking up mesocolic band.

Table 1
The baseline data and operative outcomes of TV-NOTES and RV-NOTES by Dr Lin.

	T-1	T-2	T-3	T-4	T-5	T-6	T-7	T-8	R-1	R-2
Age	44	52	68	58	52	35	45	47	57	36
BMI	26.7	25.7	28	19	28.4	22.5	27.3	24.1	29	23.5
Gravity	2	3	5	4	4	3	2	2	3	2
Parity	1	1	2	2	1	2	1	2	1	2
Menopause	no	yes	yes	yes	yes	no	no	yes	yes	no
Diabetes	no	no	yes	no	yes	no	no	no	yes	no
Previous abdominal surgeries	no	no	yes	no	yes	no	no	no	yes	no
Prolapse stage (Anterior, Apical, Posterior)	II, III, -	-, II, -	III, IV, III	III, IV, III	II,III,-	II,III,I	II,III,II	III,IV,III	I, II, I	II, III, I
Preoperative POP-Q scores										
Aa	-2	1	-3	0.8	1	-0.5	-2	0.5	0	-2
C	3	4	-8	-2	3	2	1	2	6	1
Ap	-3	2	-3	-2	-3	-1.5	-1.5	-1.5	0	-1
TVL	8	7	8	7	8	7	8	7	7	8
Sacrocolpopexy	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Hysterectomy	yes	yes	yes	yes	yes	no	yes	yes	yes	yes
Urethral suspension surgery	no	no	no	no	yes	no	no	no	no	no
colporrhaphia anterior-posterior	no	no	no	no	no	yes	no	yes	no	no
Bilateral adnexectomy	yes	yes	unilateral	no	yes	no	yes	yes	yes	yes
Pelvic floor reconstruction	yes	no	no	no	no	no	no	no	no	no
Intraoperative surgery	no	no	no	no	no	no	no	no	no	no
Hematoma	no	no	no	no	no	no	no	no	no	no
Conversion to open or multiport laparoscopy	no	no	no	no	no	no	no	no	no	no
Estimated blood loss (ml)	70	50	100	50	100	200	50	300	100	50
Operative time (min)	186	220	167	175	230	120	155	137	275	132
Postoperative stay (Days)	4	3	4	4	5	5	3	3	4	5
VAS pain score	2	2	3	2	3	2	3	3	2	1
Urinary tract infection	no	no	no	no	no	no	no	no	no	no
Constipation	no	no	no	no	no	no	no	no	no	no
Complications	no	no	fever	no	fever	no	no	no	no	no
Follow-up time (months)	30	10	9	12	6	2	2	2	19	20
Postoperative POP-Q scores										
Aa	-3	-3	-3	-3	-3	-3	-3	-3	-3	-3
C	-5	-4	-3	-5	-4	-5	-4	-5	-3	-6
Ap	-3	-3	-3	-3	-3	-3	-3	-3	-3	-3
TVL	6	6	7	6	6	6	7	6	6	6
Mesh exposure	no	no	no	no	no	no	no	no	no	no
Recurrence	no	no	no	no	no	no	no	no	no	no
Reoperation	no	no	no	no	no	no	no	no	no	no

T-1 refers to patient 1 with TV-NOTES, R-1 refers to patient 1 with RV-NOTES, BMI: Body Mass Index, VAS: visual analogue score.

about 0.5 cm shorter than the distance from the vaginal vault to the caudal point of the bladder and rectum bulge. b) The mesh should be affixed to the most superior point of the anterior surface of S1, and down to the bulge’s caudal point as distant as possible. c) The mesh should be sutured as flat as possible. d) Expose the surgical field fully. In obese patients whose abdominal adipose or colon limiting the surgical field, our invented suspension needle could be used to expose the operative field. Our previous experience had indicated that suspension needle was safe and effective in reducing the operative time [18].

In 2018, Liu [15] and Chen [28] reported one case whose TV-NOTES for sacrocolpopexy was completed in 190 min and 120 min successfully. In Liu’s [14] and Lu’s [29] case series reports, the median operative duration was 184 min and 125.9 min in patients who underwent TV-NOTES for sacrocolpopexy. In our experience, the mean operative time was 180 ± 49 min (Table 3). It could be found that there was great variation of the operative time. The underlying causes may be different surgical procedures. Some underwent sacrocolpopexy alone, while others had hysterectomy, salpingectomy, or oophorectomy besides sacrocolpopexy. Of course, different surgical techniques or equipment also contribute to the variation. In 2021, Dr. Guan [30,31] integrated a robotic platform with V-NOTES for sacrocolpopexy, which were completed in 242, 227, and 257 min respectively. In the present study, the operative time of two RV-NOTES cases were 275 and 132 min respectively. Although the operative time of RV-NOTES appeared to be longer than TV-NOTES, we believe it would be declined with increased experience as robotic platform provided enhanced vision, accurate procedures and better ergonomics.

5. Conclusion

Although these findings are from our initial experience with limited cases, we might speculate that TV-NOTES or RV-NOTES for sacrocolpopexy is a promising surgical treatment for POP. Further studies with large sample size were required to identify its effectiveness and safety.

Table 2
The baseline data and operative outcomes of TV-NOTES by beginners.

Surgeon	T-9	T-10	T-11	T-12	T-13
	Beginner 1	Beginner 1	Beginner 2	Beginner 3	Beginner 3
Age	45	58	47	69	40
BMI	25.9	25.4	23.8	22.2	25.1
Gravity	7	6	1	4	4
Parity	2	4	1	2	1
Menopause	yes	yes	yes	yes	no
Diabetes	no	yes	no	yes	no
Abdominal surgeries	no	no	no	no	no
Prolapse stage (Anterior, Apical, Posterior)	no,II,II	no,IV,IV	no,IV,IV	III,III , II	III,III , II
Preoperative POP-Q scores					
Aa	-3	3	3	-0.5	-1
C	4	4.5	4	2	2
Ap	-1	2	2	-1.5	-1.5
TVL	7	8	8	7	8
Sacrocolpopexy	yes	yes	yes	yes	yes
Hysterectomy	yes	no	no	no	no
Cervectomy	no	no	no	yes	no
Urethral suspension or folding surgery	no	no	yes	no	no
Colporrhaphia anterior-posterior	posterior	posterior	no	yes	no
Adnexal surgery	bilateral	bilateral	no	unilateral	bilateral
Pelvic floor reconstruction	yes	no	yes	no	no
Intraoperative surgery	no	no	no	no	no
Hematoma	no	no	no	no	no
Conversion to open or multiport laparoscopy	no	no	no	no	no
Estimated blood loss (ml)	50	50	500	300	150
Operative time (min)	350	245	400	325	195
Postoperative stay (Days)	5	4	7	4	4
VAS pain score	3	3	4	4	3
Urinary tract infection	no	no	no	no	no
Constipation	no	no	no	no	no
Complications	no	no	fever	no	no
Follow-up time (months)	4	4	3	3	1
Postoperative POP-Q scores					
Aa	-3	-3	-3	-3	-3
C	-3	-4	-8	-4	-4
Ap	-3	-3	-3	-3	-3
TVL	7	7	7	6.5	7
mesh exposure	no	no	yes	no	no
Recurrence	no	no	no	no	no
Reoperation	no	no	yes	no	no

Table 3
The summary of studies about TV-NOTES or RV-NOTES for sacrocolpopexy.

Reference	Country	Research type	Research time	Operation type	No of patients	Operative time (min)	Estimated blood loss (ml)
Chen [11]	China	Case	2018	TV-NOTES	1	120	50
Liu, J [7]	China	Case	2018	TV-NOTES	1	190	-
Liu, J [6].	China	Case series	2017-2018	TV-NOTES	23	184 (158.5-202.5)	30.87 ± 20.8
Lu, Z [13]	China	Case series	2018-2021	TV-NOTES	111	125.9 ± 25.9	82.5 ± 39.6
Li, J [14]	China	Case series	2017-2019	TV-NOTES vs laparoscopy	46 vs 43	134.50 ± 32.21 vs 132.67 ± 40.41, <i>p</i> = 0.81	95.43 ± 54.60 vs 96.98 ± 50.64, <i>p</i> = 0.89
Guan, X [15]	China	Case	2021	RV-NOTES	2	242	-
Guan, X [16]	Houston, Texas	Case	2021	RV-NOTES	1	227, 257	-
The present study	China	Case series	2021-2022	TV-NOTES and RV-NOTES	10	180 ± 49	107 ± 82 ml

Funding statement

The authors received no funding from an external source.

Additional information

No additional information is available for this paper.

Ethics declarations

This study was reviewed and approved by [Ethics Committee of Chengdu Women and Children's Central Hospital], with the approval number: [202330]. All participants/patients (or their proxies/legal guardians) provided informed consent to participate in the study. All participants/patients (or their proxies/legal guardians) provided informed consent for the publication of their anonymised case details and images.

Data availability

All raw data were included in this manuscript.

CRedit authorship contribution statement

Youwen mei: Writing - original draft, Methodology, Formal analysis, Data curation. **Li He:** Writing - original draft, Formal analysis, Data curation, Conceptualization. **Yan Li:** Methodology, Data curation. **Chengling Zhang:** Methodology, Data curation. **Qiannan Hou:** Methodology, Data curation. **Yonghong Lin:** Writing - review & editing, Methodology, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Abbreviations

POP	pelvic organ prolapse
RV-NOTES	robotic transvaginal natural orifice transluminal endoscopic surgery
TV-NOTES	traditional transvaginal natural orifice transluminal endoscopic surgery
POP-Q:	pelvic organ prolapse quantification
VAS	visual analogue score
BMI	body mass index

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