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Clinical application of vaginal natural orifice transluminal endoscopic surgery in hysterectomy

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Abstract

This study aimed to evaluate the effect of vaginal natural orifice transluminal endoscopic surgery in hysterectomy. A retrospective analysis of 80 patients who underwent hysterectomy at the Maternity & Child Care Center in Qinhuangdao, China from October 2022 to October 2024 was conducted. The patients were randomly divided into a transumbilical laparoendoscopic single-site surgery group and a vaginal natural orifice transluminal endoscopic surgery group. The surgical time of 40 cases of the vaginal natural orifice transluminal endoscopic surgery group tended to stabilize, and learning curve showed no marked fluctuations. The anal exhaust time, indwelling catheter time, hospital stay, and degree of pain in vaginal natural orifice transluminal endoscopic surgery group were less than the transumbilical laparoendoscopic single-site surgery group. On the first day after surgery, compared to the transumbilical laparoendoscopic single-site surgery group, the vaginal natural orifice transluminal endoscopic surgery group had higher superoxide dismutase and glutathione peroxidase levels and lower malondialdehyde and advanced oxidation protein products levels. We conclude that vaginal natural orifice transluminal endoscopic surgery has less postoperative pain than transumbilical laparoendoscopic single-site surgery, which reduces patients' postoperative stress responses and facilitates postoperative recovery. *(Afr J Reprod Health 2025; 29 [6]: 49-57).*

Keywords: Hysterectomy; vaginal natural orifice transluminal endoscopic surgery; trans-umbilical laparo-endoscopic single-site surgery; complications

Résumé

Cette étude visait à évaluer l'effet de la chirurgie endoscopique transluminale de l'orifice naturel vaginal sur l'hystérectomie. Une analyse rétrospective a été menée auprès de 80 patientes ayant subi une hystérectomie au Centre de maternité et de soins infantiles de Qinhuangdao, en Chine, d'octobre 2022 à octobre 2024. Les patientes ont été réparties aléatoirement en deux groupes : chirurgie laparoendoscopique transombilicale monosite et chirurgie endoscopique transluminale de l'orifice naturel vaginal. La durée opératoire de 40 cas du groupe chirurgie endoscopique transluminale de l'orifice naturel vaginal a eu tendance à se stabiliser et la courbe d'apprentissage n'a montré aucune fluctuation marquée. Le temps d'épuisement anal, la durée de la sonde à demeure, la durée d'hospitalisation et le degré de douleur dans le groupe chirurgie endoscopique transluminale de l'orifice naturel vaginal étaient inférieurs à ceux du groupe chirurgie laparoendoscopique transombilicale monosite. Le premier jour après l'intervention, comparativement au groupe de chirurgie laparoendoscopique transombilicale monosite, le groupe de chirurgie laparoendoscopique transluminale par orifice naturel vaginal présentait des taux plus élevés de superoxyde dismutase et de glutathion peroxydase, ainsi que des taux plus faibles de malondialdéhyde et de produits protéiques d'oxydation avancée. Nous concluons que la chirurgie laparoendoscopique transluminale par orifice naturel vaginal entraîne moins de douleurs postopératoires que la chirurgie laparoendoscopique transombilicale monosite, ce qui réduit les réactions de stress postopératoires des patientes et facilite la récupération postopératoire. *(Afr J Reprod Health 2025; 29 [6]: 49-57).*

Mots-clés: Hystérectomie ; chirurgie laparoendoscopique transluminale par orifice naturel vaginal ; chirurgie laparoendoscopique transombilicale monosite ; complications

Introduction

Hysterectomy is one of the most common gynaecological surgeries, majorly applied to benign gynecological diseases such as uterine leiomyoma, adenomyosis, cervical precancerous lesions, endometrial hyperplasia, and uterine prolapse[1]. Transabdominal and transvaginal routes are all feasible routes for hysterectomy. With the advancement of medical technology, traditional surgery has entered the era of laparoscopic surgery. Recent evidence suggests that laparoscopic

hysterectomy (LH) or vaginal hysterectomy has faster recovery, less postoperative pain, and fewer complications than traditional abdominal hysterectomy[2]. In comparison with traditional transabdominal porous laparoscopic surgery, trans-umbilical laparo-endoscopic single-site surgery (TU-LESS) has the advantages of minimal invasiveness, rapid recovery, and goodlooking surgical incision[3]. In recent years, with increasing maturity of minimally invasive concepts, TU-LESS has received wide application in hysterectomy[4].

The female vagina has unique advantages as a natural cavity tool, whereas conventional transvaginal surgery has the disadvantage of being unable to explore abdominal cavity due to poor surgical vision, which limits its clinical application[5]. In 1998, Moran introduced the concept of natural office transluminal endoscopic surgery (NOTES)[6]. Such surgery passes through natural channels of the human body, such as the mouth, anus, vagina, urethra, and visceral perforation, and enters abdomen to reach target tissue for surgical operation. The natural orifice transluminal endoscopic surgery hysterectomy (v-NOTESH), an emerging technology, combines conventional vaginal surgery and laparoscopic surgery, and has the advantages over conventional laparoscopic and vaginal hysterectomy[7]. For instance, v-NOTESH broadens the field of view for vaginal surgery and allows for clearer exploration of the adnexa and the pelvic cavity, which enables the easier removal of ovarian or fallopian tube lesions, eliminates complications related to abdominal incisions, mitigates postoperative pain, accelerates recovery, and shortens hospitalization time[8]. So far, an increasing amount of data has demonstrated the feasibility of v-NOTESH application for benign indications in gynaecology. Nevertheless, very few published randomized controlled trials have demonstrated that v-NOTESH is not inferior to traditional LH; however, the number of patients included was quite small[9]. V-NOTESH have been shown to provide better results in obese women (BMI > 30 kg/m^2)[10]. Thus, the application of v-NOTES in hysterectomy may have better minimally invasive properties. However, current research on v-NOTESH and TU-LESS is limited by small sample sizes and lacks sufficient data to compare their therapeutic effects when applied in benign gynecological diseases. The objective of this study was to compare the clinical effectiveness of v-NOTESH versus TU-LESS in the treatment of benign uterine diseases in non-prolapsed large uterus.

Methods

The study was a retrospective analysis of 80 patients who underwent hysterectomy at the Maternity & Child Care Center of Qinhuangdao from October 2022 to October 2024. They were randomly divided into a TU-LESS group and a v-NOTESH group, with 40 cases in each group. The inclusion criteria were: (1) meeting indications for total hysterectomy and accepting to undergo total hysterectomy; (2) history of sexual activity, but without specific reproductive requirements; (3) uterine enlargement ≤ size at 14 weeks of pregnancy; (4) gynaecological examination showing good uterine activity; (5) no previous history of pelvic or abdominal surgery; and (6) no vaginal stenosis.

The exclusion criteria were: (1) severe heart and lung diseases; (2) age > 65 years; (3) excessive obesity or emaciation; (4) abnormal coagulation function; (5) complicated with haematological and immunological diseases; (6) closure of uterine and rectal depression. Both groups were operated on by the same highly qualified physician skilled in TU-LESS and V-NOTES surgical techniques and experienced in vaginal surgery. Before surgery, the patient's medical history was carefully taken and routine physical examination was performed, including elicitation and tests for hematuria, vaginal discharge, total biochemistry, coagulation function, gynaecologic ultrasound examination, in order to eliminate surgical contraindications.

Patients underwent intestinal preparation the day before surgery, fasting for 8 hours and abstaining from alcohol for 6 hours before surgery. On the day of surgery, they received fluid replacement and skin preparation. Both groups received low molecular weight heparin 12 h before surgery to prevent venous thromboembolism (VTE), and antibiotics such as neomycin, gentamicin, erythromycin were given intravenously 0.5 h before surgery. The patient was placed in the lithotomy position and underwent endotracheal intubation and general anaesthesia. A Foley's catheter was inserted to empty the bladder. The TU-LESS group accepted TU-LESS. After anaesthesia and positioning, routine disinfection and draping was carried out, and pneumoperitoneum was raised with a pressure of 12 mmHg CO_2. The umbilicus

was cut longitudinally about 2.5 cm, and the abdomen and pelvis were observed with a 10 mm 30° endoscope and a single laparoscope. The uterine tube was used to fully expose the surgical field of view. Subsequently, the bilateral circular ligaments, fallopian tubes and periuterine tissues were resected, the fallopian tubes were removed, and the ligaments of the ovaries and fallopian tube mesentery were replaced. Next, the dilated ligaments were cut open and folded back into the peritoneum of the bladder. The bladder was pushed downwards to 0.5 cm below the cervix on both sides of the cervix. Both ascending isthmus branches and sacral ligaments of uterus were electrocoagulated, and circular electrocautery was performed on the vaginal fornix. Finally, the uterus was removed, while the vaginal stump was sutured. The laparoscope was then withdrawn and the navel was reshaped. The catheter was indurated and antibiotics such as cefazolin 1~ 2 g or cefuroxime 1.5 g were given to prevent infection.

The v-NOTESH group accepted v-NOTES. After completing routine disinfection and draping, a port was inserted through the vaginal NOTES dedicated channel to establish pneumoperitoneum. After the laparoscope was inserted, the uterus, bilateral appendages, pelvic and abdominal organs were explored up to the surface of the diaphragm. One side of the uterine wall was pinched from bottom to top and pulled towards the other side, exposing and coagulation-cutting the broad ligament, round ligament, ovarian intrinsic ligament, and one side of the fallopian tube mesentery in sequence. The pelvic width, roundness, pelvic funnel ligaments were exposed in turn, and electrocoagulation was performed. The other side was also treated, and the uterine specimen was taken from the vagina. Once pneumoperitoneum was formed again, the wound was cleaned and examined. After confirming that there was no bleeding from wound, the port was removed, and the vaginal stump was sutured continuously with a 1-0 absorbable suture. Both groups were continuously observed until discharge.

Observed indicators

(1) Surgical indicators: The surgical indicators in both groups, including surgical time and surgical bleeding volume. (2) Learning curve: The relationship between number of surgical cases and surgical time in v-NOTESH group was assessed by Pearson correlation analysis. (3) Postoperative recovery indicators: The postoperative recovery indicators in both groups, including postoperative exhaust time, indwelling catheter time, and hospital stay. The patients' pain levels received evaluation with the Numeric Rating Scale (NRS)[11], with NRS scores ranging 0-10. The higher the scores, the more severe the pain. (4) Oxidative stress response indicators: The oxidative stress response indicators in both groups before and one day after surgery were calculated. Five mL of venous blood was extracted from patients at above timepoints in the morning, followed by centrifugation for 10 min at 3000 r/min with radius of 8 cm), and the serum was extracted. The serum glutathione peroxidase (GPX), superoxide dismutase (SOD), malondialdehyde (MDA), and advanced oxidation protein products (AOPP) were measured with enzyme-linked immunosorbent assay (ELISA) using an ELISA reader. (5) Complications: The occurrence of bladder injury, incision infection, fever, vaginal stump hemorrhage, vesicovaginal fistula, urinary tract infection and other complications in both groups were recorded.

Statistical analysis

Statistical analysis received conduction using SPSS 27.0 and GraphPad Prism 9.0 software. Measured data that conformed to a normal distribution received expression as mean ± standard deviation (x ± s), followed by t-test for intergroup comparison. Count data received presentation in terms of number of cases and percentage (%), followed by chi square test for comparison between groups. The difference was statistically significant with $P < 0.05$.

Ethical considerations

This study received ethical approval from the Medical Ethics Committee of The First College of Clinical Medical Science, China Three Gorges University / Yichang Central People's Hospital on October 10, 2022, with the Ethical approval number 2022-056-02. All patients signed informed consent.

Results

Analysis of general data in both groups

There was no significant difference in general data between the two groups ($P > 0.05$; Table 1), indicating comparability.

Table 1: General data in both groups

General data		TU-LESS group	v-NOTESH group	χ^2/t	P
N		40	40		
Age (years)		46.75±5.25	45.36±5.17	0.639	0.525
BMI (kg/m^2)		23.45±3.15	24.11±3.23	1.155	0.251
Weight (kg)		56.01±3.41	56.27±3.38	0.65	0.518
Uterine size (cm)		8.78±1.01	8.72±1.05	0.353	0.725
Disease types [n (%)]	Uterine fibroids	22 (55.0)	23 (57.5)	0.399	0.819
	Endometrial atypical hyperplasia	7 (17.5)	5 (12.5)		
	Cervical intraepithelial neoplasia grade III	11 (27.5)	12 (30.0)		

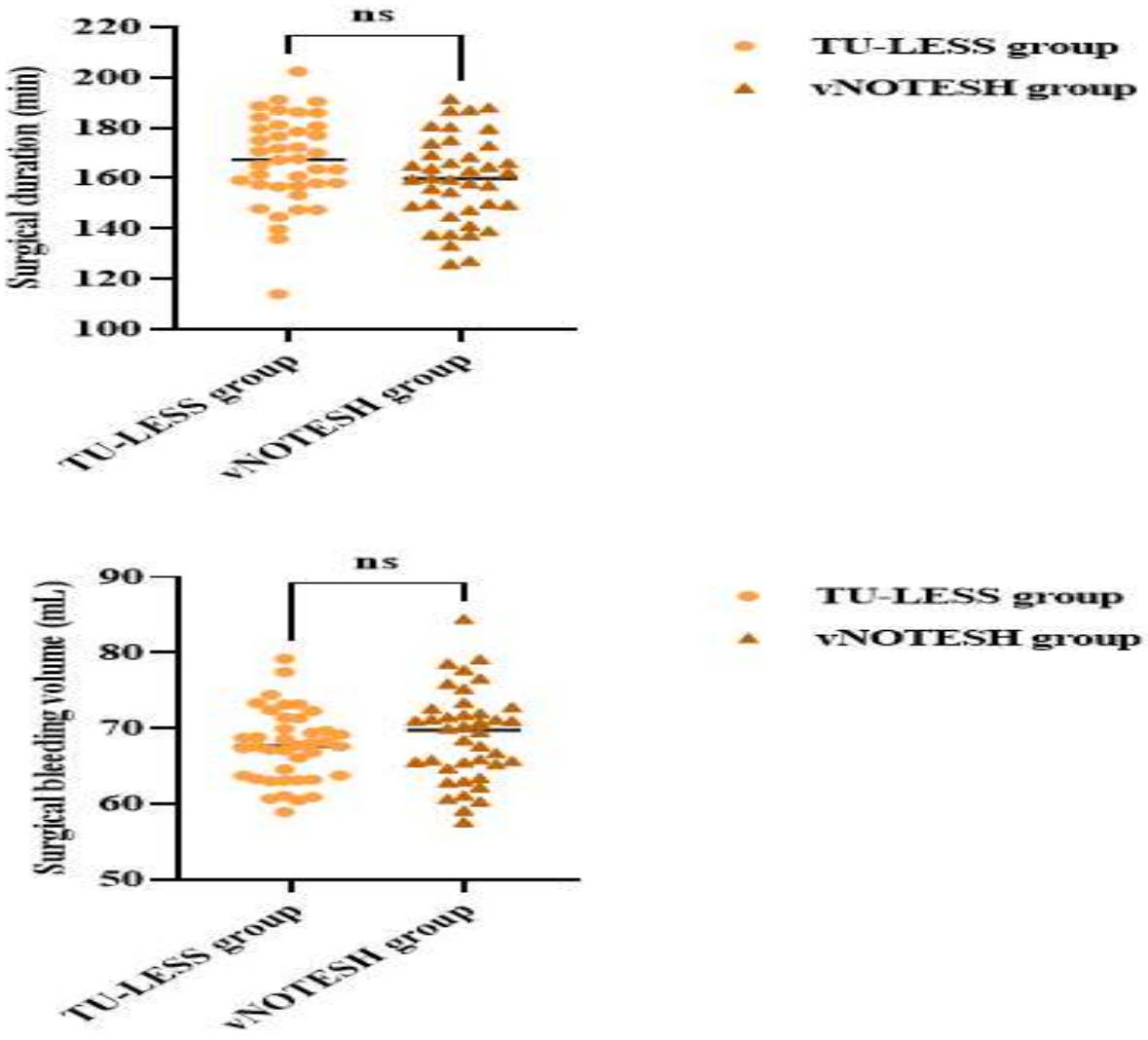

Figure 1: Surgical indicators of patients under hysterectomy. Note: Versus TU-LESS group, ns = no sign

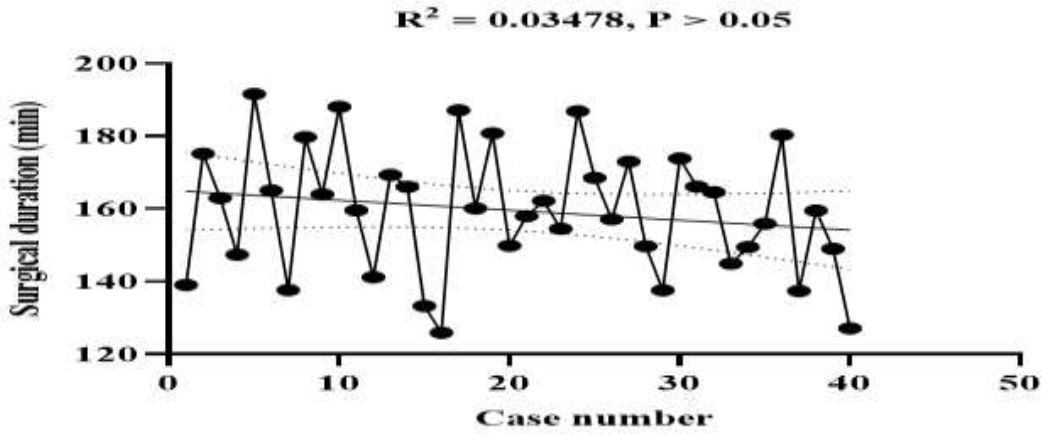

Figure 2: Learning curve of v-NOTESH group.

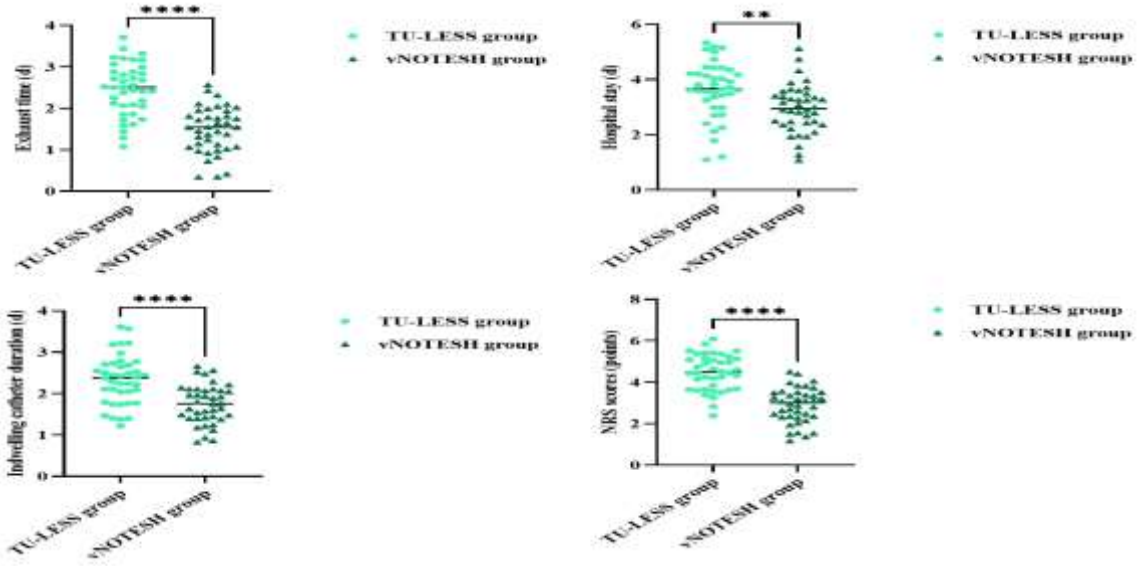

Figure 3: Postoperative recovery indicators of patients under hysterectomy. Note: Versus TU-LESS group, **P < 0.01, ****P < 0.0001.

Comparison of surgical indicators of patients under hysterectomy in both groups

There was no significant difference in operation time and blood loss between the two groups (P > 0.05; Figure 1).

Analysis of learning curve of v-NOTESH group

The surgical time of 40 cases in v-NOTESH group tended to stabilize, and learning curve depicted no marked fluctuations (Figure 2).

vNOTES ameliorates postoperative recovery indicators of patients under hysterectomy

Compared with the TU-LESS group, the v-NOTESH group had shorter exhaust time, indwelling catheter time and hospital stay, as well as lower NRS scores (P < 0.05; Figure 3).

vNOTES ameliorates postoperative oxidative stress indicators of patients under hysterectomy

Before surgery, SOD and GPX levels in both groups were reduced a day after surgery.

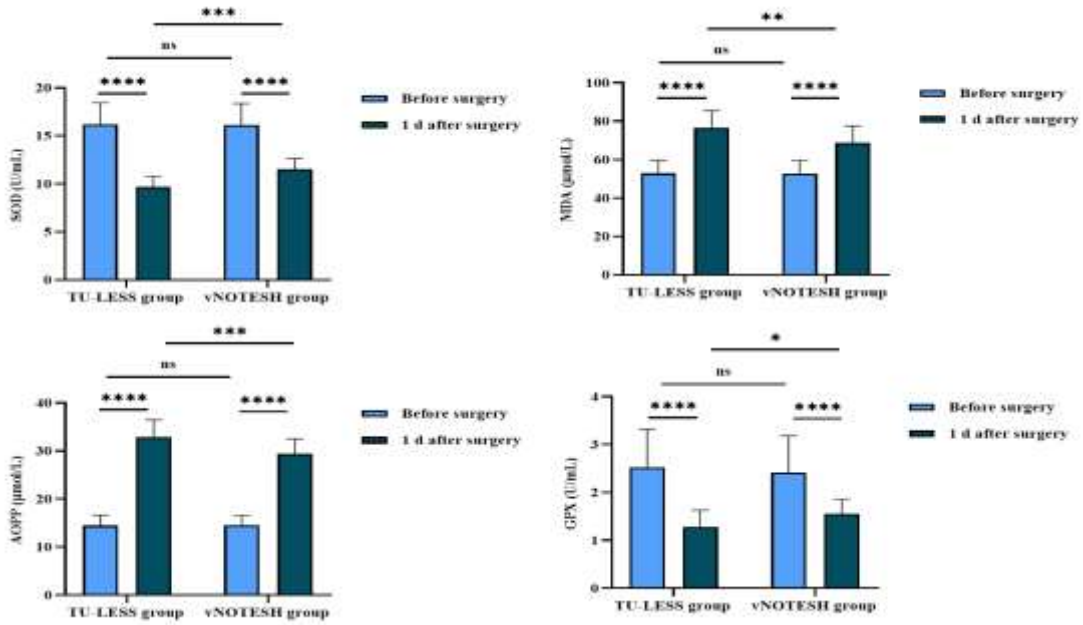

Figure 4: Postoperative oxidative stress indicators of patients under hysterectomy. Note: Versus TU-LESS group, ns = no significance, *P < 0.05, **P < 0.01, ***P < 0.001, ****P < 0.0001.

Table 2: Surgical indicators of patients under hysterectomy [n (%)]

Groups	Bladder injury	Incision infection	Fever	Vaginal stump hemorrhage	Vesicovaginal fistula	Urinary tract infection	Total incidence
TU-LESS group (n=40)	1 (2.5)	0 (0.0)	0 (0.0)	0 (0.0)	1 (2.5)	1 (2.5)	3 (7.5)
v-NOTESH group (n=40)	0 (0.0)	1 (2.5)	0 (0.0)	0 (0.0)	0 (0.0)	1 (2.5)	2 (5.0)
χ^2							0.213
P							0.644

Those in the v-NOTESH group were higher relative to the TU-LESS group. Before surgery, MDA and AOPP levels in both groups were elevated one day after surgery. Those in the v-NOTESH group were lower relative to the TU-LESS group (P < 0.05; Figure 4).

Comparison of surgical indicators of patients under hysterectomy in both groups

The total complication rate of the two groups was not statistically significant (P > 0.05; Table 2).

Discussion

Emerging minimally invasive surgical techniques are changing the way we operate on a daily basis, bringing more benefits to patients. In recent years, minimally invasive techniques have gradually transited from porous laparoscopy to single-hole laparoscopy, and natural endoscopic surface scarless surgery. Compared with other surgical approaches, the transvaginal laparoscopic approach has the advantages of concealed approach, simple closure, and goodlooking incisions. Additionally, vaginal vault has almost no nerve innervation, and vaginal surgery has less interference with intestines, so patients have less postoperative pain, faster exhaust, get out of bed earlier, and high satisfaction. The efficacy and safety of vNOTES in the treatment of common benign gynecological diseases has been widely accepted by gynecologists and has been carried out in early gynecological malignancies.

In this study, there was no significant difference in operative time and blood loss between the two groups, indicating that v-NOTESH and TU-

LESS had better surgical results in hysterectomy. TU-LESS performs surgery on umbilical stoma, gradually incising umbilical fossa tissue layer by layer according to steps of open surgery, which can reduce puncture damage and risk of traditional multi-port laparoscopic surgery, avoid puncture hole bleeding, and reduce intraoperative hemostasis time. v-NOTESH combines TU-LESS with traditional vaginal surgery, using laparoscopy for exploration, overcoming the visual field limitations of traditional vaginal surgery. Moreover, v-NOTESH utilizes natural vaginal orifice for surgical operations, avoiding the increase of surgical incision, reducing surgical trauma, and completing the separation of the highly adhesive part and the treatment of the surrounding ligament under the direct vision of the laparoscope, reducing intraoperative bleeding and shortening the operation time[12,13].

In addition, the total complication rate was not statistically significant in the two groups, indicating that both surgical methods are safe and feasible for hysterectomy. However, it is worth noting that 1 case of vesico-vaginal fistula and 1 case of bladder injury occurred in the TU-LESS group after surgery, which may be related to the repeated use of energy devices for electrocoagulation and hemostasis during the operation. As a result, energy meter use was reduced and no bladder injury occurred during v-NOTESH surgery, but the overall complication rate for both was not statistically significant. It has been demonstrated that patients undergoing hysterectomy treated with V-NOTESH and TU-LESS procedures have similar surgical duration[14]. Furthermore, patients with uterine diseases treated with v-NOTESH have higher intraoperative blood loss than those in TU-LESS group[15]. The results of our study were not completely consistent with the above reports, which may be related to the differences in patient age, self-disease status, and physicians' surgical methods. Therefore, the surgical efficacy and complications of TU-LESS and v-NOTESH assisted hysterectomy need to be further validated.In terms of surgical approach, doctors have an absolute advantage in performing v-NOTESH during gynecological surgery, because the familiar anatomical structure brings great convenience to the surgery. In addition, v-NOTESH can be performed while sitting, which can relieve doctors' fatigue from standing for long periods of time[16]. However, from a technical perspective, v-NOTESH has drawbacks such as "chopstick effect" and "linear field of view"[17]. Compared with TU-LESS surgery, V-Notesh needs more assistants and has higher requirements for surgeons. Not only do they need to have good conventional and single-port laparoscopic techniques, but they also need to be proficient in vaginal surgery.

Studies have shown that for the learning curve, at least 20 v-NOTESH cases need to be completed, while proficiency in the technique requires around 80 cases[18]. The learning curves of 40 patients with v-NOTESH were stable, and the operation time fluctuated around 30 minutes, mainly due to the surgeons' many years of vaginal surgery experience and the early foundation of TU-LESS. This study showed that as long as there was a solid foundation for vaginal surgery, v-NOTESH did not take longer than traditional laparoscopic surgery.

In our study, compared with the TU-LESS group, the v-NOTESH group had shorter exhaust time, indwelling catheter time and hospital stay, as well as lower NRS scores. In contrast, compared with the TU-LESS group, the v-NOTESH group had higher SOD and GPX levels as well as lower MDA and AOPP levels. These results suggest that when compared with TU-LESS, the use of v-NOTESH in hysterectomy is more beneficial to patients' postoperative recovery, reduces the surgically induced oxidative stress response, and reduces postoperative pain. The main cause of pain after laparoscopic surgery is excessive accumulation of CO2 in the pneumoperitoneum, which stimulates the phrenic nerve and aggravates the pain. Differences in innervation play a major role in the degree of incision pain[19]. TU-LESS is an umbilical approach with many nerve endings and sensory nerves around the umbilicus, resulting in significant postoperative pain. v-NOTESH is a reverse pelvic dissection in which there are a large number of somatic nerves in the anterior and distal walls of the vagina, and sparse distribution of nerves in the posterior fornix of the vagina, thus reducing the patient's nerve sensitivity. In addition, v-NOTESH is closer to the uterus, has a shorter surgical radius, does not pass through the gastrointestinal tract, and has less interference with the patient's pelvic and abdominal environment, which is conducive to rapid postoperative recovery and relief of

postoperative pain[20]. More importantly, v-NOTESH has excellent cosmetic effects and no scars on the abdomen.

Strengths and limitations

The study's design stands out as a strength, in addition to various observation indicators. The main limitation is lack of follow-up data. Our study provides an alternative surgical method for patients with benign gynecological diseases.

Conclusion

Application of v-NOTESH and TU-LESS in hysterectomy has good surgical effects and few postoperative complications. However, v-NOTESH has less postoperative pain than TU-LESS, which is beneficial for reducing patients' postoperative stress responses, facilitating postoperative recovery, safe and feasible. v-NOTESH is more in line with concept of rapid postoperative recovery and will be the future trend of gynecological surgery development.

Authors contributions

Chenghong Xie and Huarong Cao: conceived and designed the study, collected and analysed the data, and prepared the manuscript. All authors mentioned in the article approved the manuscript

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