

A Modified Lateral Seminal Vesicle Approach Preserving the Bladder Neck in Laparoscopic Radical Prostatectomy Improves Urinary Continence Recovery

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AIM: The purpose of this study was to investigate the effect of laparoscopic lateral seminal vesicle approach to preserve the bladder neck during laparoscopic radical prostatectomy.

METHODS: Between September 2020 and December 2022, we retrospectively analyzed patients with T1–T3b stage prostate cancer treated at our institution using the laparoscopic lateral seminal vesicle approach. We recorded the bladder neck preservation success rate, cystourethral anastomosis time, urinary catheter extraction time, length of hospital stay, and urinary control scores, including urine pad use, at 1 week, 1 month, and 3 months post-catheter removal. Adverse events included rectal injury, bladder injury, ureteral injury and positive surgical margins.

RESULTS: There were 56 patients (mean age 70 ± 5.8 years) The success rate of bladder neck preservation was 100%. The median cystourethral anastomosis time was 11 (9–14) minutes. The median postoperative hospital stay was 10 (9–11) days. The urinary continence rate was 83.9% (47/56) in 1 week, 89.3% (50/56) in 1 month and 98.2% (55/56) in 3 months. One patient developed adhesions caused by invasion of both seminal vesicles, which damaged the rectal wall.

CONCLUSIONS: The laparoscopic lateral seminal vesicle approach can preserve the bladder neck completely during laparoscopic radical prostatectomy, improving postoperative urinary continence, with a high rate of immediate urinary continence, and significantly improving patients' quality of life.

Keywords: prostate cancer; laparoscopic radical prostatectomy; immediate urinary continence; seminal vesicle approach

Introduction

Prostate cancer ranks as the most prevalent malignant tumor among men in Europe and America [1]. Recent years have seen a yearly increase in prostate cancer incidence in China, attributed to the widespread adoption of prostate-specific antigen (PSA) screening. The incidence reached 10.23/100,000 in 2015, ranking sixth among male malignant tumors [2]. At present, radical prostatectomy (RP) is still the standard treatment for most patients with localized prostate cancer who are in good general condition and have a life expectancy of more than 10 years, but urinary incontinence after RP seriously affects the quality of life of patients [3]. The continuous progress of science and technology, have led to the advent of laparoscopic RP (LARP) and robot-assisted radical prostatectomy (RARP), and a greater understanding of the anatomy of the prostate and adjacent structures, resulting in the development of different surgical strategies based on either the 'preservation' or the 'recon-

struction' of the anatomical elements responsible for urinary continence and improved recovery of urinary continence after RP [4,5]. However, studies have shown that more than 80% of patients recover urinary continence 1 year after RARP, but nearly 50% of patients still need to use urine pads 3 months after RARP [6], which is both a great psychological and economic burden for patients. Early postoperative urinary continence recovery after RARP is an important clinical problem.

Although many studies have shown that the reconstruction or preservation of important structures such as the bladder neck [7], membranous urethral length [8], the neurovascular bundles around the prostate [9] and supporting structures of the pelvic floor [10] play a key role in the early recovery of urinary continence after surgery, the recovery mechanism has not been fully elucidated. Nevertheless, it has been observed that the seminal vesicle is the key to the success of the operation in RP [11]. The occurrence of intraoperative complications can be greatly reduced once the level of the seminal vesicles is confirmed [12]. However, there are few studies demonstrating how to find the seminal vesicle level accurately and keep the complete bladder neck structure for operation. We investigated efficacy of a lateral seminal vesicle approach in improving early recov-

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Table 1. Baseline characteristics.

Variables	Statistics data
BMI, kg/m ² , mean ± SD	22.63 ± 6.12
Age, years, mean ± SD	70 ± 5.8
Prostate weight, g, median (IQR)	25.67 (24.21–45.39)
Preoperative PSA, ng/mL, mean ± SD	12.1 ± 6.56
<4 ng/mL (n%)	3 (5.3%)
4–10 ng/mL (n%)	31 (55.4%)
>10 ng/mL (n%)	22 (39.3%)
Clinical risk, n%	
Low	20 (35.8%)
Intermediate	25 (44.6%)
High	11 (19.6%)
Gleason grade group n%	
6	23 (41%)
3 + 4	10 (17.9%)
4 + 3	10 (17.9%)
8	8 (14.3%)
9	5 (8.9%)

BMI, body mass index; IQR, interquartile range; PSA, prostate-specific antigen; SD, Standard Deviation.

ery of urinary continence in patients with localized prostate cancer undergoing LARP.

Materials and Methods

A retrospective study was conducted on T1–T3b prostate cancer patients treated at our hospital between September 2020 and December 2022 using the laparoscopic lateral seminal vesicle approach to preserve the bladder neck. This research was approved by the Ethics Committee of Wenling Hospital of Traditional Chinese Medicine. The inclusion criteria were as follows: All patients were diagnosed with prostate cancer by prostate biopsy before operation; No bone metastasis and distant metastasis found on bone scan and prostate magnetic resonance imaging (MRI); No organ dysfunction. The exclusion criteria were as follows: Other malignant tumors in the past or during treatment; Patients with organ dysfunction, or serious systemic disease; Patients who cannot tolerate RP; Patients with incomplete case data.

All patients were diagnosed by ultrasound-guided transrectal or transperineal prostate biopsy. Mean PSA before surgery was 12.1 ± 6.56 ng/mL. In 3 cases the PSA was ≤4 ng/mL, in 31 cases 4–10 ng/mL, and in 22 cases 10 ng/mL. The Gleason score preoperative biopsy was 6 points in 23 cases, 7 in 20 cases, (10 were 3 + 4, and 10 cases were 4 + 3), 8 in 8, and 9 in 5 cases. No seminal vesicle invasion and pelvic lymph node metastasis were observed on contrast-enhanced MRI of prostate before operation, and no bone metastasis was found on emission computed tomography (ECT) whole body bone scan before surgery, as presented in Table 1.

Surgical Technique

Preservation of the Bladder Neck through a Lateral Seminal Vesicle Approach

All patients were placed in a 20-degree Trendelenburg position under general anesthesia. The extraperitoneal approach was established with reference to previous literature [8,9,10]. The basic surgical procedure was the same as the routine procedure, except that the bladder neck was cut laterally from the prostate and bladder neck junction. Preservation of the bladder neck through a lateral seminal vesicle approach was performed. This procedure consisted of three steps: (1) We determined the prostate and bladder neck junction by pulling the water bag of the catheter; (2) We conducted deep dissection from the relatively loose tissue level between the two sides of the vesico-prostatic angle until the seminal vesicle level was exposed. Upon detecting the seminal vesicle, the assistant elevated it with forceps while the surgeon dissected and retracted the bladder tissue to reveal the lateral wall of the vesico-prostatic junction; (3) After identifying the position of the urethra in the bladder neck, the anterior wall and both sides of the urethra in the bladder neck were completely exposed, and the posterior wall of the urethra was further dissected from the 12 o'clock of the prostate and exposed. Thus, the posterior urethra could be completely preserved. During the operation, the bladder neck and urethra were sutured with 2-0 single-needle absorbable sutures. The lateral seminal vesicle approach made it easier to find the prostate- seminal vesicle angle, which was conducive to neurovascular bundle (NVB) preservation. As presented in Fig. 1.

In LARP, according to the preoperative risk stratification of patients, it is determined whether to preserve the NVB during surgery. The seminal vesicle angle can be found easily during lateral seminal vesicle approach, and the NVB interface can be found more clearly, which helpful in preserving the anatomical structure of NVB. In addition, we try our best to preserve the length of membranous urethra and suspend the retropubic urethra during operation.

Parameters, we recorded the following parameters: (1) successful preservation of bladder neck integrity, (2) cystourethral anastomosis time, (3) urethral catheter removal time, (4) length of hospital stay, (5) urinary continence score, followed by urinary pad use at 1 week, 1 month and 3 months after catheter removal, degree of urinary incontinence after surgery. Daily use of urinary pad ≤1 = normal, 2–3 = mild incontinence, and >3 = severe incontinence. Recovery of continence within one week was defined as immediate recovery of continence [13]. The continence ability was also determined by pad usage at three months post-surgery. (6) Adverse events, including rectal injury, bladder injury, ureteral injury and positive surgery surgical margins.

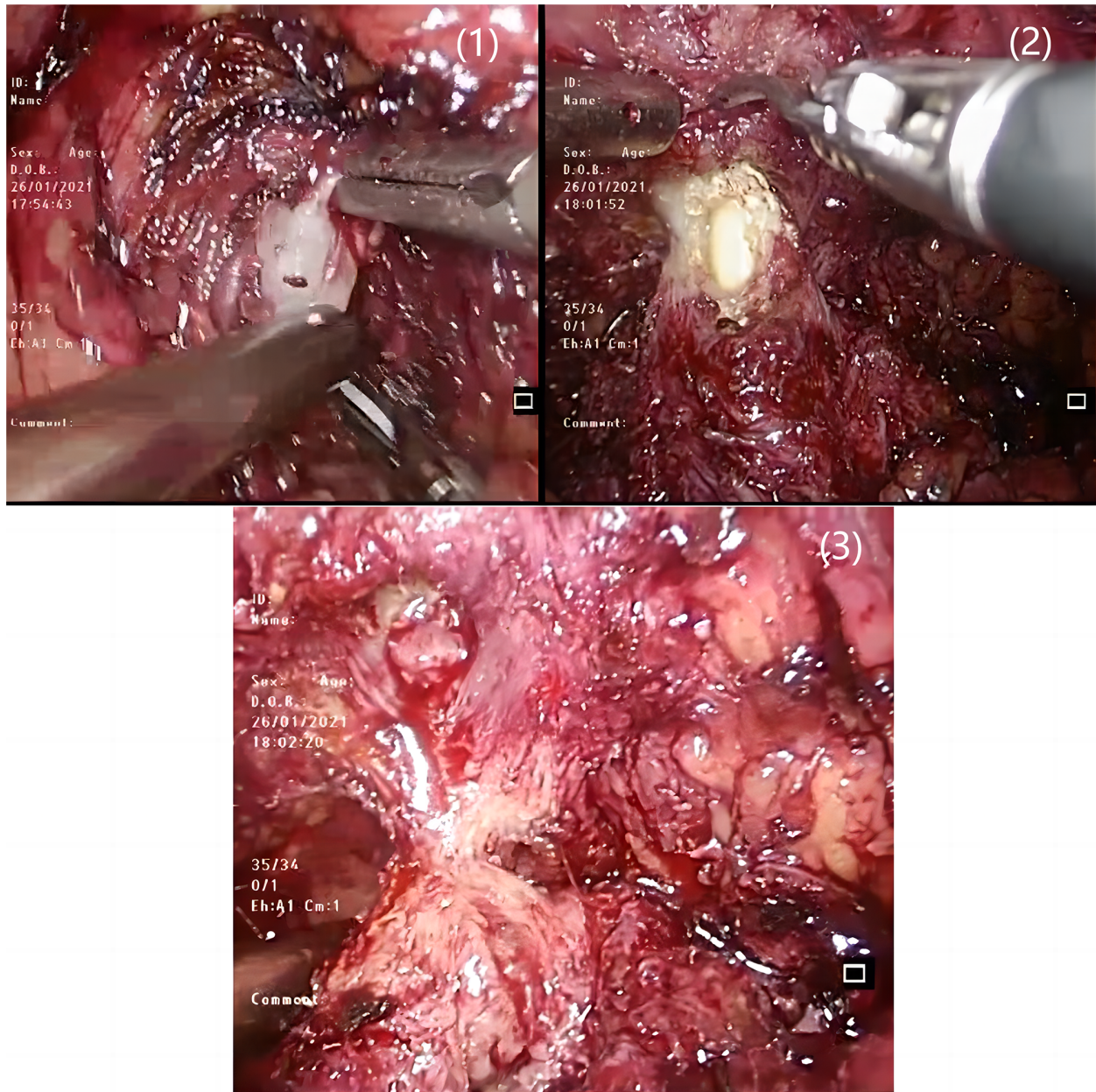


Fig. 1. Preservation of the bladder neck through lateral seminal vesicle approach. (1) Explore the right seminal vesicle; (2) Preserving small bladder neck; (3) The posterior urethra could be completely preserved.

Statistical Analysis

The data conforming to the normal distribution were expressed as $\bar{x} \pm s$ and 95% confidence interval (CI). Data measurement not conforming to the normal distribution was expressed as the interquartile range (IQR) or median (range), which were used to show patient characteristics and research results. The continuous variables were compared using the *t*-test or Manne-Whitney test. Fisher's exact or Chi-square test was used to evaluate the difference in the proportions between the groups of categorical variables. The SAS program version 9.4 (StataCorp, College Station, TX, USA) was used for statistical analysis. Statistically significant differences were indicated by $p < 0.05$.

Results

The preservation of the bladder neck by the lateral seminal vesicle approach was performed in 56 patients (mean age 70 ± 6.8 years) during LARP, and all those operations were successful. The success rate of bladder neck preservation was 100%. The median cystourethral anastomosis time was 11 (9–14) minutes. The median postoperative hospital stay was 10 (9–11) days. The urinary continence rate postoperatively was 83.9% (47/56) at 1 week, 89.3% (50/56) at 1 month and 98.2% (55/56) at 3 months. One patient recovered urinary continence at 3.5 months. No prostate and bladder injury occurred during surgery. The postoperative pathological results showed that the incision

edge of the bladder neck was negative. Rectal wall damage in one patient, caused by seminal vesicle adhesion, was promptly repaired during surgery and resolved with postoperative intestinal drainage. In one patient, one ureter was separated as seminal vesicle tissue but this error was discovered in time and the ureter was undamaged. In one patient, pelvic hematoma occurred due to anticoagulants and venous thrombosis of the lower limbs. Two weeks after discontinuation of anticoagulant therapy there was spontaneous absorption of the hematoma.

Discussion

For more and more patients with early prostate cancer, surgery is still the main treatment at present [14]. Improving postoperative urinary continence and thus improving patients' quality of life is of key importance. Our study showed that LARP improves urinary continence recovery. The Vattikuti Institute prostatectomy (VIP) developed by Menon and colleagues [15]. based on RALP. In radical surgery, the technique separates anterograde from the seminal vesicle to the avascular layer between the prostate capsule and fascia, thus preserving the NVBs distributed on both sides of prostate. Ninety-six percent of 250 patients who had VIP recovered their normal urinary continence 6 months after discharge. VIP has proved its value in many years of clinical practice, mainly with robot-assisted laparoscopy [16]. There is a considerable learning curve when VIP is performed with laparoscopy alone.

The Retzius-sparing technique [17] enters via the posterior rectovesical pouch, carries out limited separation through an intrafascial approach, and preserves key anatomical structures including the pelvic fascia around the prostate, the pubic prostate ligament, and the NVBs [18], thus reducing injury of penile dorsal deep venous plexus and intraoperative bleeding. The recovery rate of urinary continence was over 90% 1 week after catheter removal, and up to 96%, 1 year after surgery.

The maximum urethral length preservation technique [19] is often utilized in RARP. The functional urethra is a part of posterior urethra, which can increase resting pressure and tension of the urethra. Combined with the function of the external sphincter of urethra, the closing pressure of urethra is higher than bladder pressure, which is of great significance for restoring urinary continence after radical prostatectomy. A bladder neck preservation technique was first reported by Freire *et al.* [20] in robotic surgery. By combining blunt and sharp separation, the integrity of muscle fibers at the distal end of bladder neck was preserved, thus forming a cherry mouth-shaped bladder neck and protecting circular muscle fibers at the bladder neck [21]. Thermal damage to surrounding tissues is also reduced during surgery by limiting the use of thermal energy instruments. Freire *et al.* [20] reported that compared with the standard operation control group, this technique can improve urinary continence recovery rate from 26.5% to 65.6% (p

< 0.001) 4 months after surgery, but there was no significant effect on long-term urinary continence. Subsequently, Emad Rajih *et al.* [22] reported on bladder neck preservation, analysing the data of 322 patients with localized prostate cancer who underwent RARP in a Canadian center from October 2006 to May 2015. The 0-pad control rates in January, March, June, December and 24 months were 126/322 (39%), 187/321 (58%), 222/312 (71%), 238/294 (80%) and 233/257 (91%), respectively, after bladder neck preservation (Hazard Ratio [HR] 0.71; 95% CI 0.5–0.99; $p = 0.04$), suggesting that this technique is helpful to accelerate urinary continence recovery after RP.

In the present study, the small bladder neck was preserved, and only single needle anastomosis was needed. The median cystourethral anastomosis time was 11 (9–14) minutes. The urinary continence rate was 47/56 (83.9%) at 1 week, 50/56 (89.3%) at 1 month and 55/56 (98.2%) at 3 months, with one patient who recovered urinary continence at 3.5 months. Compared with the other reports [17,18,19,20], the urinary continence rate has been greatly improved which is mainly related to the combination of various surgical techniques such as suspending the posterior pubic urethra and preserving NVBs instead of preserving the bladder neck. In one case, the recovery of urinary control was slightly longer after operation, which was related to the larger prostate and the larger preserved diameter of neck. There was no prostate tissue or bladder injury during the procedure. Postoperative pathological results showed that the incision edge of bladder neck was negative. One patient had a damaged rectal wall due to adhesions caused by invasion of the seminal vesicle, which was treated with primary repair and drainage and postoperative intestinal drainage. Therefore, MRI scans must be carefully read before surgery. If seminal vesicle invasion or bladder neck invasion occurs, avoiding a transseminal vesicle approach or adopting a unilateral seminal vesicle approach is also of great help to find the bladder neck. This patient's pathological stage was T4, so the tumor was closely adhered to rectum, which led to difficulty in identifying the seminal vesicle and iatrogenic damage to the rectum during surgery. In one patient, one ureter was separated as seminal vesicle tissue, but was found to be undamaged, because the lower ureter is often displaced in patients with a large middle lobe of prostate, which was easy to be damage during surgery. One patient developed pelvic hematoma due to venous thrombosis of the lower limbs postoperatively, which was gradually reabsorbed after 2 weeks. We suggest that the lateral seminal vesicle approach can reduce complications and improve surgical safety.

Compared with traditional surgical methods, the seminal vesicle approach has the advantages of preserving the bladder neck: In traditional laparoscopic radical prostatectomy, the bladder neck is severed from 12 o'clock. First, the adipose tissue around the upper edge of the bladder neck is cut, and then the boundary between the prostate and the bladder

neck is gradually searched after severance. Then, the bladder neck is cut at 12 o'clock until the catheter is exposed [23]. Then we dissect the bladder neck and posterior wall on both sides, and separate the vas deferens and the seminal vesicle to the dorsal side. Because the boundary between bladder neck and prostate is not obvious, it is easy to approach the prostate when looking for layers, so it is easy to enter prostate tissue, which easily leads to positive incision margin and residual tumor. If it is far away from the prostate gland, the bladder neck may be very large, and it is easy to damage the sphincter in the bladder neck, which is not conducive to the recovery of urinary continence. In addition, it is necessary to narrow the bladder neck during the procedure, and the ureteral orifice may be damaged when the posterior wall of the bladder neck is severed, and it is easy to suture the ureteral opening when anastomosing the bladder neck. The traditional method is particularly difficult for patients with the middle lobe of prostate protruding into the bladder. After opening the bladder neck, only the middle lobe of the prostate protruding into the bladder can be seen. The 6 o'clock position of the bladder neck cannot be seen, and the complete bladder neck cannot be preserved.

Advantages of preserving the bladder neck through seminal vesicle approach are as follows: ① The confluence of the seminal vesicles on both sides can better preserve the integrity of the sphincter in bladder neck and help improve urinary continence after operation. ② If the bladder neck is small, only with a single needle anastomosis is needed, because the labial muscle layer behind the bladder neck is thick and the bladder neck is not easy to tear during surgery, thus, anastomotic leakage rarely occurs post-operatively. ③ After seminal vesicle exposure, rectal injury can be reduced, and the seminal vesicle angle can be better searched to preserve NVB structure. The method of preserving the bladder neck through a lateral seminal vesicle approach is superior to the traditional method of bladder neck dissection in several ways. We emphasize the importance of reading the MRI scan carefully before surgery and judging the approximate position of seminal vesicle [24]. During the operation, the size of the bladder neck can be controlled to facilitate bladder neck urethral anastomosis without worrying about rectal damage. In addition, in case of a large middle lobe of prostate, after the boundary between the posterior lip of bladder neck and prostate is clear, the bladder neck can be severed from both sides to avoid damaging the ureter, and the intact bladder neck can also be preserved. However, the difficulty of preserving the bladder neck through a seminal vesicle approach is mainly manifested in the following aspects: ① It is difficult to locate the seminal vesicle accurately, and there is no clear anatomical sign during the operation, so there is a considerable learning curve. In a future study, we will further explore how to accurately locate the seminal vesicles. ② For patients with seminal vesicle adhesion after puncture, the operation is difficult, so care should be taken during the

operation to avoid damaging the rectum. ③ For patients with obvious middle lobe protrusion into the bladder, it is easy to enter prostate tissue and even damage the ureteral orifice when the bladder neck is severed. This is also an issue that our center will focus on in the future.

The lateral seminal vesicle approach can locate seminal vesicle more accurately, so as to both determine the position of and control the size of the bladder neck more accurately, avoid rectal and ureteral orifice injury, reduce the possibility of tumor residue, help restore urinary continence better, greatly improve immediate urinary continence after operation, and also significantly improve the quality of life of patients.

Our study has some limitations. ① This study is only an observational study carried out in a single center, without a control group. There are many subjective factors in the surgical strategy during the operation, and there is a choice bias. ② In addition, the sample size of this study is small, and the multi-center sample size cannot be achieved, and the follow-up time is short. Larger studies are needed. ③ This technique of preserving the bladder neck through a lateral seminal vesicle approach has a considerable learning curve and a very good knowledge of anatomy is required, and the operation time is long when it is first performed. There are still some difficulties in keeping intact the bladder neck in patients with larger prostate glands, which need to be further explored.

Conclusions

The technique of preserving the bladder neck through a laparoscopic lateral seminal vesicle approach has a considerable learning curve, a high success rate and few complications during surgery, and is a promising new technique. More cases need to be studied in multiple centers to verify the promotion of this improved method for improving recovery of urinary continence after LARP.

Availability of Data and Materials

The data that support the findings of this study are available on request from the corresponding author.

Author Contributions

XZ and JO designed the study and performed the experiments, QL acquired the data, JX analyzed the data, XZ and JO prepared the manuscript. All authors revised the manuscript critically for important intellectual content. All authors read and approved the final manuscript. All authors have participated sufficiently in the work and agreed to be accountable for all aspects of the work.

Ethics Approval and Consent to Participate

This study was approved by the Ethics Committee of Wenzhou Hospital of Traditional Chinese Medicine affiliated to Zhejiang University of Traditional Chinese Medicine (Pro-

gram No. 2018C312020). Signed written informed consents were obtained from the patients or guardians. The study is in accordance with the Declaration of Helsinki.

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Conflict of Interest

The authors declare no conflict of interest.

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