Original Article

Initial experience and short-term outcomes of single-port extraperitoneal transvesical robot-assisted radical prostatectomy: a two-center study

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Background: This study presents the procedure of single-port extraperitoneal transvesical approach to robot-assisted radical prostatectomy (SETvRARP) on the da Vinci Xi platform coupling with a 4-channel single port and evaluated the short-term outcomes in the first 72 prostate cancer (PCa) patients.

Methods: Seventy-two patients with localized PCa were enrolled. Each operation was conducted by the same single robotic surgery group in two centers using the da Vinci Xi system.

Results: The median operation time was 150 min, and the median estimated blood loss was 50 mL. All operations were successfully carried out without open conversion or transfusion. No ≥ Grade II complications were noted. Urethral catheters were routinely removed on postoperative day 7. Sixty-eight (94.4%) patients recovered to immediate urinary continence after surgery, with 72 (100%) patients achieving full continence on postoperative day 14. A positive surgical margin was observed in 15 (20.8%) patients. Postoperative urodynamic studies regarding peak urinary flow, bladder capacity, and residual urine were not statically different from the preoperative results. No biochemical recurrence was noted in all patients within the follow-up period. Postoperative erectile function was not statistically different from the preoperative results (P=0.1697).

Conclusions: SETvRARP using the da Vinci Xi system coupling with a 4-channel single port is a valid radical prostatectomy technique in well-selected PCa patients, resulting in superior postoperative recovery of urinary continence. Meanwhile, the outcomes in functional protection and cancer control need to be further investigated with a long-term follow-up duration.

Keywords: Prostate cancer (PCa); transvesical approach; single-port surgery; robot-assisted radical prostatectomy (RARP); urinary continence

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Introduction

Single-port robot-assisted radical prostatectomy (RARP) has gained growing popularity in many centers with the installation of the new da Vinci SP platform (Intuitive Surgical Inc., Sunnyvale, CA, USA) (1). Regardless of the surgical platform, the anterior approach still serves as the "gold standard" for the assessment of RARP outcomes (2,3). Nevertheless, other approaches continue to emerge with the aim of achieving the same or even superior functional outcomes, including the posterior approach (4), the lateral approach (5), and our recently reported transvesical approach (6-8). In 2008, Desai *et al.* (9) first described that the procedure of single-port transvesical RARP on male cadaver relying on the da Vinci-S platform (Intuitive Surgical, Sunnyvale, CA, USA) was successfully completed without addition of other ports or conversion to standard approach. As a result, the operative time (4.2 h) of this procedure was receivable, demonstrating the technical viability of single-port transvesical RARP. The application of transvesical RARP provided better choice for those with high body mass index, those who can't tolerate steep trendelenburg position, or those with extensive adhesion.

Herein, we firstly describe our detailed techniques for single-port extraperitoneal transvesical approach to robot-assisted radical prostatectomy (SETvRARP) on the da Vinci Xi platform coupling with a 4-channel single port and further assess the early functional and oncological efficiency of SETvRARP in the first 72 prostate cancer (PCa) patients. We present this article in accordance with the STROBE reporting checklist (available at https://tau.amegroups.com/article/view/10.21037/tau-23-98/rc).

Highlight box

Key findings
- SETvRARP using the da Vinci Xi system coupling with a 4-channel single port is a valid radical prostatectomy technique in well-selected PCa patients.

What is known and what is new?
- The anterior approach still serves as the "gold standard" for the assessment of RARP outcomes.
- We first described the detailed procedures for SETvRARP on the da Vinci Xi platform coupling with a 4-channel single port.

What is the implication, and what should change now?
- SETvRARP using the da Vinci Xi system coupling with a 4-channel single port is a valid radical prostatectomy technique in well-selected PCa patients. However, the long-term functional and oncological results need to be further investigated.

Methods

The study was conducted in compliance with the Declaration of Helsinki (as revised in 2013). This retrospectively designed study was performed strictly abiding by the guidelines and approval of the Ethics Committee of the First Affiliated Hospital of Nanchang University (approval No. 075 [2017]) and The Second Affiliated Hospital of Zhejiang University School of Medicine (approval No. 229 [2020]). Informed consent was taken from all the patients included in this analysis. In both medical centers, written informed consent including detailed descriptions of different techniques (multi-port and single-port techniques) and approaches (anterior, posterior, and transvesical approaches, with or without pelvic lymph node dissection) to conduct robot-assisted radical prostatectomy and clear indications of the alternative choices of PCa management (e.g., active surveillance) were presented to patients with naive localized PCa. Only those with total prostate-specific antigen (tPSA) <20 ng/mL, biopsy Gleason score ≤7, clinical stage ≤ T2c, and prostate volume <80 mL were included during this study periods between July 2019 and September 2021. In total, 31 and 41 patients receiving the single-port transvesical approach at the First Affiliated Hospital of Nanchang University and The Second Affiliated Hospital of Zhejiang University School of Medicine were enrolled in our retrospective study, respectively. The urinary continence of all patients was feasible prior to administration. A total of 12/72 patients had a previous history of abdominal surgery (hernia repair and appendectomy). All included PCa patients were classified into low- and intermediate-risk groups according to the D'Amico risk stratification system.

Perioperative variables including the patient's age, body mass index (BMI), serum tPSA, prostate volume calculated with transrectal ultrasound, transrectal prostate biopsy, pelvic magnetic resonance imaging, chest X-ray or computed tomography, bone scan, urodynamic study, sexual function assessed with International Index of Erectile Function (IIEF)-5 score (10), and Incontinence Quality of Life (IQOL) score (11) were collected for analysis.

Intraoperative variables including the console time, estimated blood loss, conversion event, and transfusion event were accurately gathered. The Clavien-Dindo system was employed to classify all perioperative complications (12). The patients were routinely promoted to ambulate on postoperative day 1 and gradually reintroduce a normal diet by the time bowel function had reinstated. The removals of urethral catheter were conventionally completed on postoperative day 7, and no other drainage was placed. The patients were all discharged 7 days after surgery.

All patients were followed up for a minimum of 3 months (3–12 months). Total PSA and continence were reevaluated at one week (2 weeks postoperatively) and 3 weeks (4 weeks postoperatively) after discharge and followed up for each 3-month interval within the first year. Two questionnaires (IIEF-5 score and IQOL score), urethrocystography, and urodynamic studies were conducted 3 months after surgery. Other studies were conducted when indicated. The incidence of tPSA >0.2 ng/mL on two consecutive measurements was defined as postoperative biochemical recurrence, while continence was conservatively defined as no pad applied or only 1 dry pad for preventative intervention.

Surgical techniques

All operations presented in this analysis were completed by the same robotic surgery team (one console surgeon and two bedside assistants) from two medical centers. All cases were carefully treated under general anesthesia by Pure SETvRARP without the use of an extra assistant port. A 30° lens (facing upwards throughout the whole procedure) was utilized. Given the low preoperative estimated risk for nodal involvement in these included instances, the dissections of pelvic lymph node were not implemented in this series. All of the surgical procedures were described as follows:

(I) Patient preparation. All patients were supplied with liquid diets on the day before the planned operation, followed by the establishment of two intravenous lines and one arterial line. Thirty minutes prior to the incision, each patient was given a broad-spectrum antibiotic intravenously.

(II) Patient position, single-port placement, and docking. After intubation, the patient was securely fixated in a slight reverse Trendelenburg position, the disinfected and draped regions covered from the lower abdomen to the upper thigh. The placement of catheter was sterilely completed. After emptying the residual urine, the bladder was overinflated with approximately 500 mL of saline so that it could be palpated at least 5 cm above the pubis. A 6 cm midline skin incision was made in the lower abdomen, whose midpoint was halfway between the umbilicus and the pubic symphysis (*Figure 1A*). Subcutaneous tissues, rectus abdominis, and prevesical fat tissue was sequentially dissected in a standard manner. A fine needle puncture was performed to confirm the location of the bladder before opening it vertically. After examining the intravesical structures under direct vision, eight evenly distributed stay sutures (e.g., 0 Vicryl on CT-1 needle) were placed to anchor the full-thickness bladder wall to the skin (*Figure 1B*). The operating table was finally adjusted to a supine or slight Trendelenburg position according to the patient's body habitus. An 8 cm single port was then placed and secured before docking in a standard manner (*Figure 1C*). Air pressure was maintained at 15 to 20 mmHg. Hot Shears™ Monopolar (Intuitive Surgical, Inc. USA) and Maryland Bipolar Forceps (Intuitive Surgical, Inc. USA) were inserted via the lateral channels under direct vision of the 30-degree lens placed in the caudal channel. The cephalic channel was used as the assistant port (*Figure 1D*).

(III) Dissection of the vas deferens and seminal vesicles. The interureteric ridge, ureteral orifices, and internal orifice of the urethra were identified (*Figure 2A*). A circumferential incision with a diameter of roughly 3 cm was made surrounding the internal urethral orifice over the mucosa and muscular layer (*Figure 2B*). The right vas deferens and seminal vesicle were primarily dissected via the lower half of the circumferential incision at 6 o'clock, which was then dissected laterally in a sharp or blunt manner suitably. The right vas deferens ampullae was generally the first "white tubular" structure exposed at approximately 5–6 o'clock. The blunt and sharp dissections were conjunctly used to mobilize a sufficient length of the right vas deferens (*Figure 2C*). Following dissection, cauterization, and transection of the right vas deferens, the whole isolation of right seminal vesicle was then completed with special caution by the time the feeding arteries were controlled at the tip where the pelvic plexus and right neurovascular bundle (NVB) ran in close proximity (*Figure 2D*). The left vas deferens and seminal vesicle were similarly dissected according the above process.

(IV) Posterior dissection. The posterior dissection used

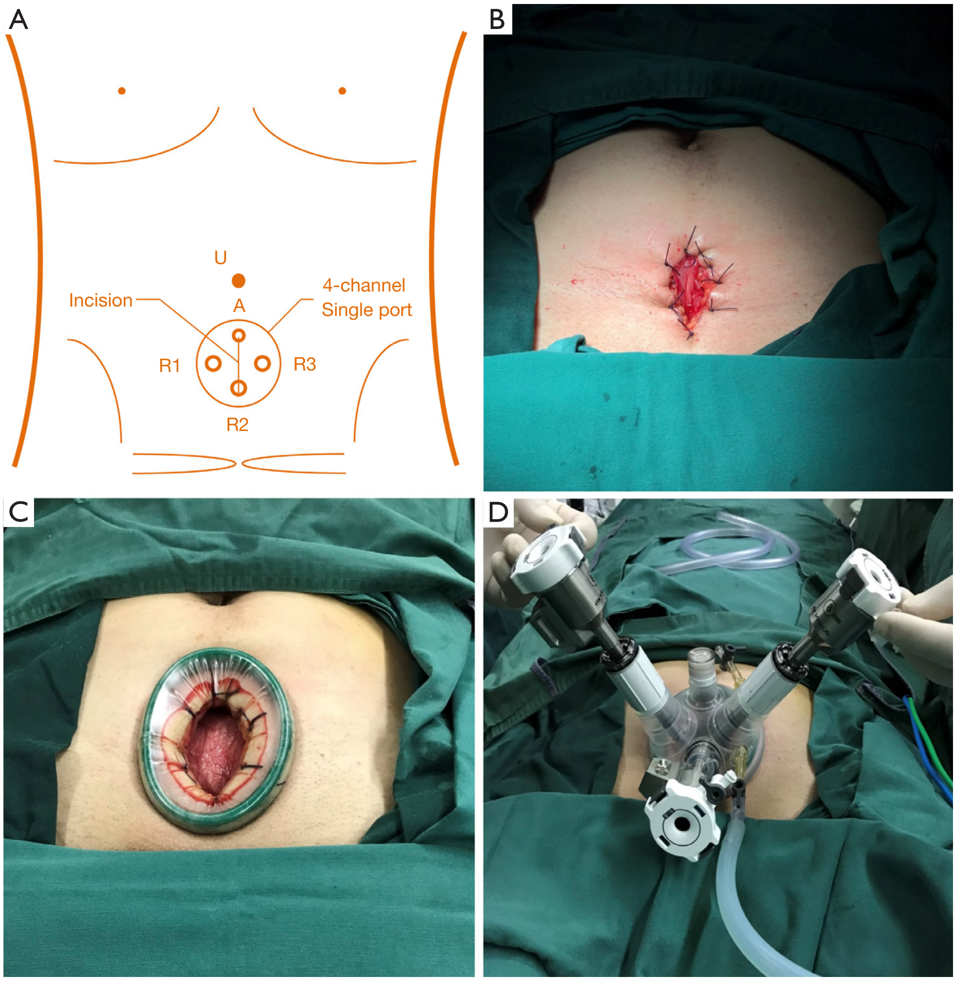

Figure 1 Establishment of single-port extraperitoneal transvesical access and trocar configuration. A 6 cm midline cystotomy incision whose midpoint overlaps with the midpoint between the umbilicus and the pubic symphysis was made after overinflating the bladder (U: umbilicus, A: assistant port, R1: robotic port 1, R2: robotic port 2; R3: robotic port 3) (A). The bladder wall was anchored to the skin by eight evenly distributed stay sutures (B), before a 4-channel single-port was installed to couple with the 3 da Vinci Xi robotic trocars (C,D).

the "retzius-sparing" technique as a reference. Denonvillier's fascia was visually exposed at this point. With both the vas deferens and seminal vesicles pushing upwards in virtue of the wrist of Maryland bipolar, an intrafascial plane was subsequently entered ventral to the Denonvillier's fascia. Dissection was then continued along the posterior aspect of the light-reflecting prostatic capsule (intrafascial plane) by stripping down the Denonvillier's fascia from it. Notably, NVBs ran posterolaterally, and the use of energy was strictly limited in the midline and only when necessary. Posterior dissection was continued mostly by blunt dissection approaching the prostate apex in an antegrade manner (*Figure 2E*). A blunt end suction through the cephalic channel pressing the Denonvillier's fascia dorsally or the seminal vesicles ventrally could be very helpful. Although a frozen section should be considered to rule out the possibility of tumor invasion when significant adhesion was encountered, the adhesion might sometimes be a consequence of transrectal biopsy.

(V) Lateral dissection. The lateral dissection used the "lateral approach" as a reference. On the right side, the entrance of the plane between the prostatic capsule and periprostatic fascia from 3 o'clock was completed combining blunt and sharp dissections, the right pedicle was exposed with tissue texture as

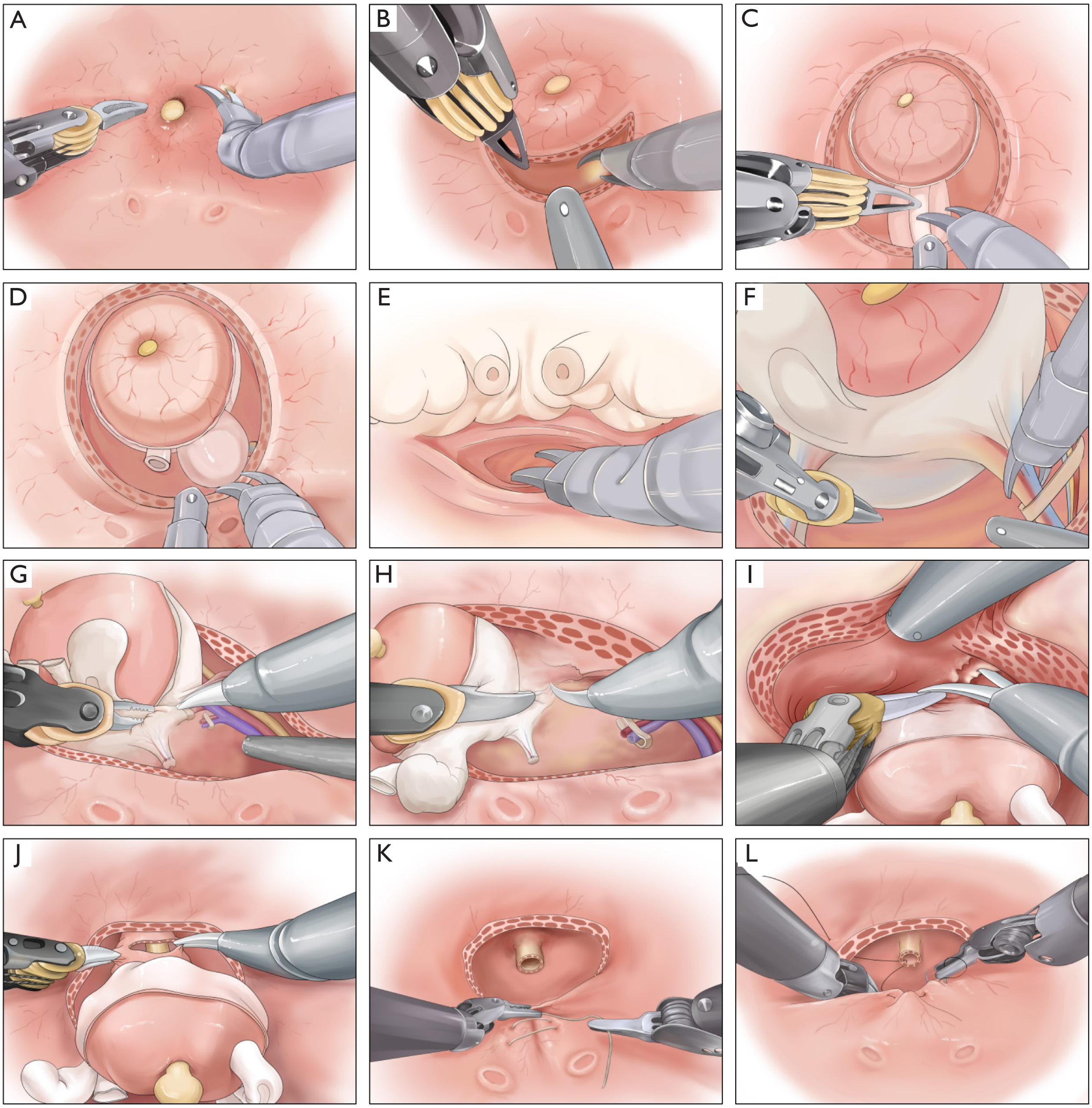

Figure 2 Surgical steps. Intravesical structures were identified (A) and a circumferential incision was made around the internal urethral orifice (B). Dissections of the vas deferens (C) and seminal vesicles (D) were carried out through the lower half of the circumferential incision. Intrafascial posterior dissection was continued towards the apex (E). Lateral dissection of prostatic pedicles (F) and NVBs (G) was carried out between the prostatic capsule and the periprostatic fascia in a nerve-sparing manner, before continuing with lateral dissection towards the apex (H). After a sufficient anterior dissection towards the apex (I), the urethra was exposed and transected (J). The bladder neck was shrunken in a racket style (K) before urethrovesical anastomosis (L). NVBs, neurovascular bundles.

a guide. At this time, the light-reflecting surface of the prostatic capsule could be visually exposed at the posterior and lateral direction. Next, a constant and gentle pushing of the prostate leftwards by the wrist of the Maryland bipolar in cooperation with the blunt-tip suction pushing tissues on the other side of the dissection plane rightwards, or vice versa, was performed. The lateral space should be sufficient to allow the right pedicle located at 4–5 o'clock with small Weck clips (5 mm clip applier), which were placed next to the prostatic capsule to protect NVB (*Figure 2F*). After the complete transection of the right pedicle, the antegrade dissection towards the apex in a blunt fashion to separate the prostate in close proximity to the prostate capsule from the periprostatic fascia laterally (*Figure 2G*). Energy should be avoided during this step undermine the probability of the NVB injury that traveled posterolaterally. The dissection plane between the prostatic capsule and the periprostatic fascia on the right side continued to be developed toward the apex (*Figure 2H*). The same maneuver was replicated on the left side.

(VI) Anterior and apex dissection. At this course, the tissues covered on the anterior aspect of the prostate were the only hindrance guarding the prostate from being rotated freely. Passing the upper half of the circumferential incision surrounding the internal urethral orifice, dissection was stepwisely carried out along the prostatic capsule and approaching the apex (*Figure 2I*). After that, all three key structures were then sequentially dissected. The dissection of dorsal vein complex (DVC) was primarily completed. Whether or not to control it using suture ligation was empirically determined by surgeon's preference, and this was usually avoided in our experience. After the DVC detachment from the anterior aspect of the prostate, the conjuncture of the apex and urethral external sphincter was slowly and carefully completed from lateral to medial using the tissue texture as a guide. After the detachment of external sphincter from the apex, the length of urethral stump should be sufficiently preserved after the rapid dissection of the ventral aspect of the internal sphincter of the urethra. The urethral catheter should be visually placed at this stage, and then pulled out slowly by the assistant till the tip of the catheter just right existed in the urethral stump. Cold scissors were used to transect the exposed lateral and dorsal aspect of the urethra (*Figure 2J*). After that, the specimen was completely detached and then taken out through the single port after undocking or left in the bladder before anastomosis.

(VII) Urethrovesical anastomosis. The whole prostatic fossa was inspected for hemostasis after lowering the intravesical air pressure to 5 to 10 mmHg. The bladder neck was shrunken using a 4-0 barbed polydioxanone suture on an RB-1 needle in a racket style (*Figure 2K*). Ascertaining the location of the urethral stump with the guidance of catheter, the performance of urethrovesical anastomosis was completed using the barbed suture previously used for shrinking the bladder neck, combined with other 4-0 barbed polydioxanone sutures on RB-1 needles running in opposite directions (*Figure 2L*). Prior to the placement of the strings on tension, absorbable hemostat material (for example, SURGICEL® Fibrillar) was appropriately placed laterally into the prostatic fossa. Notably, all sutures were placed in a completed outside-in fashion at the bladder and inside-out at the urethra. Once the exit points of the two sutures were aligned and both sutures emerged inside the bladder, they were not cut after the knot was tied Both sutures were then got across the bladder wall from the inside out and another two knots were tied intra-luminally before cutting the two sutures as close to the knots as possible. Externalizing the knots and suture ends may prevent bladder irritation and stone formation. Finally, a new 3-way urethral catheter was placed and further inflated with 20 cc of saline for immobilization. Constant bladder irrigation was avoided in all patients, and intermittent bladder irrigation was performed only when necessary.

(VIII) Specimen retrieval and wound closure: After undocking, the specimen was removed through the single-port in place if it was not retrieved before anastomosis. A 2-layer closure of the bladder wall was achieved using 3-0 Vicryl under direct vision. The bladder was filled with 100 cc of saline to verify watertight closure. The rectus abdominis, subcutaneous tissues, and skin were then closed in a standard manner. Pelvic lymph node dissection was not performed and no other drainage was placed.

Table 1 Patient demographics

Variables	Statistics
No. of patients	72
Age (years)	68.5±7.1
BMI (kg/m^2)	23.4±3.1
Preoperative serum tPSA (ng/mL)	12.0 [7.7, 19.4]
Prostate volume (mL)	37.4±23.5
Preoperative IIEF-5 score	11 [3.25, 19.25]
Preoperative IQOL score	100 [100, 100]
Preoperative urodynamic studies	
Maximal urinary flow (mL/s)	22.8 [20.9, 25.9]
Bladder capacity (mL)	317.0 [306.6, 343.0]
Detrusor contractility (voiding phase, mmH$_2$O)	39.6 [37.8, 43.4]
Residual urine (mL)	0 [0, 1.3]
Clinical TNM stage	
T1cN0M0	19 (26.4)
T2aN0M0	10 (13.9)
T2bN0M0	12 (16.7)
T2cN0M0	31 (43.1)
Biopsy Gleason score	7 [6, 7]
Gleason score =6	33 (45.8)
Gleason score =7	39 (54.2)
D'amico risk stratification	
Low-risk	27 (37.5)
Intermediate-risk	14 (19.4)
High-risk	31 (43.1)

Data were presented as mean ± standard deviation or median [interquartile range] or n (%). BMI, body mass index; tPSA, total prostate-specific antigen; IIEF, International Index of Erectile Function; IQOL, Incontinence Quality of Life.

Statistical analysis

The means and standard deviation (SD) were determined for the continuous variables in normal distribution, while those in non-normal distribution were presented as the median and interquartile range (IQR). Meanwhile, categorical variables were regularly expressed as frequencies and proportions. The paired Student's *t*-test was used to evaluate the preoperative and postoperative changes of IQOL, urodynamic variables, post-void residual urine, and erectile function. STATA version 12.0 software (STATA corp., College Station, TX, USA) was used to conduct all statistical analyses. For all tests, the threshold of significance was fixed at 5%.

Results

Demographics

Seventy-two patients suffering from naive localized PCa who underwent SETvRARP between July 2019 and September 2021 were included in this study. The patient demographics are summarized in *Table 1*. The patients were aged 68.5±7.1 years (mean ± SD) and had a BMI of 23.4±3.1 kg/m^2, a total PSA of 12.0 [7.7, 19.4] ng/mL, a prostate volume of 37.4±23.5 mL, a biopsy Gleason score of 7 [6, 7]. Furthermore, 33 (45.8%) and 39 (54.2%) patients had Gleason scores of 6 and 7, respectively. The median IIEF-5 score of patients was 11 [3.25, 19.25]. All patients were preoperatively continent and had a preoperative IQOL score of 100 [100, 100]. The preoperative urodynamic study showed a maximal urinary flow of 22.8 [20.9, 25.9] mL/s, bladder capacity of 317.0 [306.6, 343.0] mL, voiding phase detrusor contractility of 39.6 [37.8, 43.4] mmH$_2$O, and postvoid residual urine of 0 [0, 1.3] mL.

Operation

All 72 operations were successfully performed without conversion, transfusion, or other intraoperative complications (button-hole, major vessels, rectum, ureteral injury, etc.). The perioperative data are summarized in *Table 2*. The median operation time and estimated blood loss were 150 [130, 180] min and 50 [50, 100] mL, respectively.

Complications

Postoperatively, urinary leakage, persistent gross hematuria, fever, intra-abdominal infection, or urinary retention after catheter removal were not observed (*Table 2*). Continuous bladder irrigation was not performed but a 3-way urethral catheter was routinely placed. Asymptomatic urinary infection was noted in seven (9.7%) patients on postoperative day 2 and was managed with levofloxacin. There were no complaints of symptoms related to bladder outlet obstruction or hyperactivity within a minimal follow-up period of 3 months.

Table 2 Perioperative data

Variables	Statistics
No. of patients	72
Operation time (min)	150 [130, 180]
Estimated blood loss (mL)	50 [50, 100]
Open conversion	0 (0)
Transfusion	0 (0)
Other intraoperative complications	0 (0)
Postoperative pathology	
Pathological T stage	
T2	58 (80.6)
T3a	11 (15.3)
T3b	3 (4.1)
Specimen Gleason score	7 [6.25, 8]
Positive surgical margin	15 (20.8)
≥ Grade II postoperative complications	0 (0)
Urethral catheterization (days)	7
Hospital stay (days)	7

Variables were presented as n (%) or median [interquartile range].

Table 3 Surgical outcomes

Variables	Statistics	P value[a]
No. of patients	72	
Oncology: postoperative total PSA (ng/mL)		
1 week	9.550 [5.525, 14.875]	–
1 month	0.059 [0.015, 0.181]	–
3 months	0.009 [0.001, 0.029]	–
Urinary continence		
Continent on removal of catheter	68 (94.4)	–
Continent at 2 weeks	72 (100)	–
IQOL (3 months post-op)	92.6 [84.6, 96.9]	0.0078
Urodynamic studies (3 months post-op)		
Maximal urinary flow (mL/s)	23.5 [22.0, 24.8]	0.6892
Bladder capacity (mL)	297.3 [247.8, 351.8]	0.2885
Detrusor contractility (voiding phase, mmH_2O)	38.8 [36.1, 41.1]	0.1972
Postvoid residual urine (mL)	0 [0, 0]	0.4846
Erectile function (3 months post-op)		
IIEF-5 score	12 [5, 18]	0.1697

Data were presented as n (%) or median [interquartile range]; urinary continence was defined as no pad required or 1 dry pad per day for precaution. [a], paired student *t*-test with preoperative values. PSA, prostate-specific antigen; IIEF, International Index of Erectile Function; IQOL, Incontinence Quality of Life.

Outcomes

All patients were encouraged to ambulate on the first day after surgery. In total, 58/72 patients passed gas and tolerated a semi-solid diet on the first day after surgery, while the remaining 14 patients returned to normal bowel function the following day. All patients were discharged 7 days after surgery when the urethral catheter was removed (*Table 2*).

Oncology

Preoperative assessment revealed 19 (26.4%) cases of cT1c, 10 (13.9%) cases of cT2a, 12 (16.7%) cases of cT2b, and 31 (43.1%) cases of cT2c, with a median (IQR) Gleason score of 7 [6, 7] (*Table 1*). As presented in *Table 1*, 27 (37.5%), 14 (19.4%), and 31 (43.1%) patients bore low-, immediate-, and high-risk localized PCa, respectively. Postoperative pathology showed 58 (80.6%) pT2 cases, 11 (15.3%) pT3a cases, and three (4.2%) pT3b cases [Gleason score 7 (6.25, 8)]. A positive surgical margin was observed in 15 (20.8%) patients who received active surveillance following a discussion with patients regarding subsequent options (*Table 2*). No patients received postoperative radiation therapy, and there was no incidence of biochemical recurrence during a median follow-up period of 3 [1, 6] months.

Functional outcomes

Removal of the foley catheter was routinely carried out on postoperative day 7. As a result, 68 (94.4%) patients reached immediate urinary continence, while the remaining four patients used 2–3 pads per day and returned to continence on postoperative day 14 (*Table 3*). All patients maintained urinary continence thereafter. The IQOL questionnaires were completed by all candidates 3 months after surgery, and the results revealed a significant difference compared to the preoperative scores [pre-op 100 (100, 100) *vs.* post-op 92.6 (84.6, 96.9), P=0.0078]. None of the patients experienced complaints of dysuria or other indications of bladder outlet obstruction (*Table 3*). Meanwhile, urethrocystography revealed that no urethral stricture or

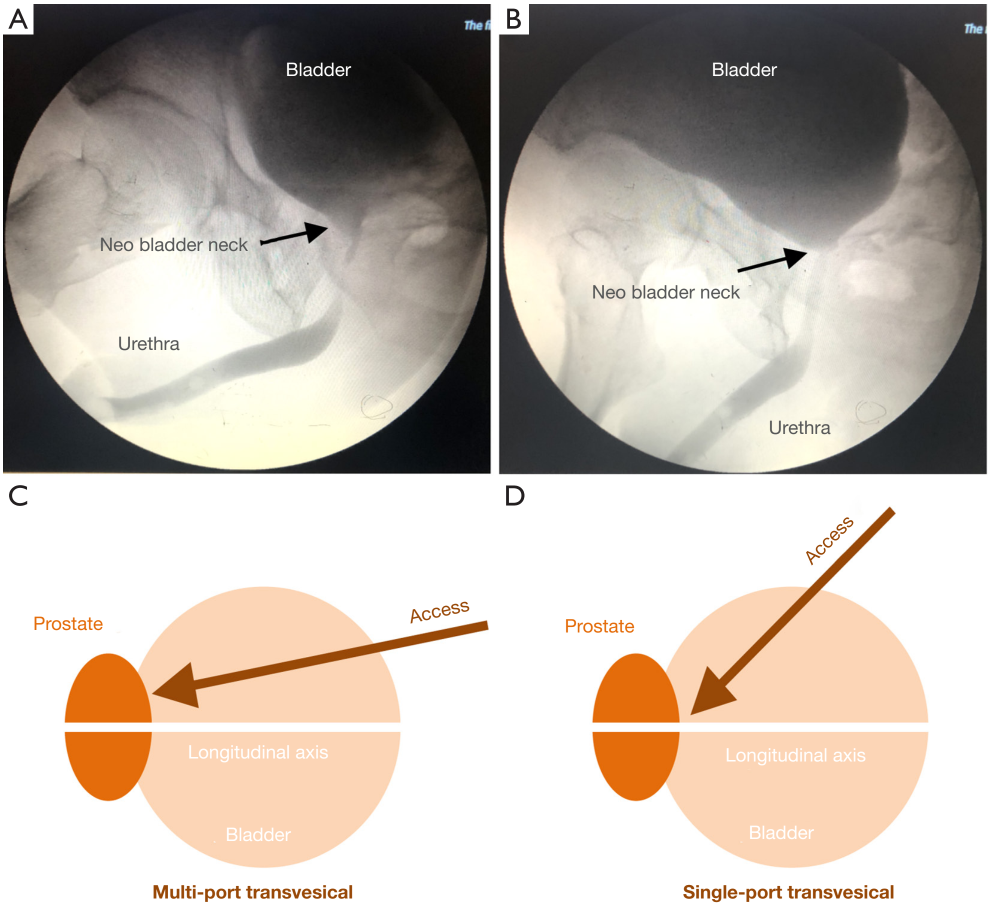

Figure 3 The outcomes and key points of anastomosis during the single-port extraperitoneal transvesical approach. (A,B) Postoperative urethrocystography: Three-month postoperative urethrocystography of the same patient demonstrated no urethral stricture or urinary leakage. (C,D) Illustration of the direction of access during transvesical radical prostatectomy: (C) multi-port transvesical approach; (D) single-port transvesical approach.

urinary leakage occurred within 3 months after surgery (*Figure 3A,3B*). A urodynamic study performed 3 months after surgery exhibited no significant difference compared to baseline [maximal urinary flow: pre-op 22.8 (20.9, 25.9) *vs.* post-op 23.5 (22.0, 24.8) mL/s, P=0.6892; bladder capacity: 317.0 (306.6, 343.0) *vs.* 297.3 (247.8, 351.8) mL, P=0.2885; voiding phase detrusor contractility: 39.6 (37.8, 43.4) mmH_2O *vs.* 38.8 (36.1, 41.1) mmH_2O, P=0.1972; postvoid residual urine: 0 (0, 1.3) *vs.* 0 (0, 0) mL, P=0.4846] (*Table 2*).

At 3 months postoperatively, the IIEF-5 score was 12 [5, 18] {median [IQR]} and not statistically different from the preoperative IIEF-5 score 11 (3.25, 19.25), as determined by a paired comparison (P=0.1697, *Tables 1,3*).

Discussion

The application of single-port transvesical robot-assisted radical prostatectomy was first completed on a cadaver using the da Vinci-S robotic system coupling with a 4-channel R-port (9). It had been widely approved that the single-port approach excelled to the multi-arm approach thanks to the advantage of reducing the incidences of instrument clashing and manoeuvrability inside the bladder, demonstrating the potential significance of single-port approach when operating within narrow surgical fields (13). Consistent with our observations, the advantages of this approach include the complete avoidance of bladder mobilization or entering the retropubic space, which consequently minimizes the dissection trauma as the operation is strictly confined to the periprostatic region, and the exemption of a steep Trendelenburg position or any bowel retraction as the camera remains inside the bladder throughout the operation. Moreover, the rapid recovery of bowel function was also observed, as seen in other extraperitoneal pelvic surgeries (14). Not requiring extra drainage other than a urethral catheter may reduce postoperative discomfort both physically and psychologically. Since suction/irrigation and the application of clips can be carried out through the cephalic channel on the single port while the other three channels are occupied by the camera and two robotic arms (*Figure 1D*), there is no need for an extra assistant port, which is necessary in single-port RARP using the da Vinci SP system (1).

The two obvious disadvantages of the single-port extraperitoneal transvesical approach include the inability to perform pelvic lymph node dissection unless converting to the transabdominal approach and an intentional cystotomy incision on the bladder; however, this was shown to have a negligible adverse impact on bladder function in terms of maximal urinary flow, bladder capacity, and detrusor contractility based on preoperative and postoperative urodynamic studies (*Table 2*). Another weakness of this procedure is the failure to preserve the bladder neck, which has been demonstrated to be associated with the restoration of urinary continence in multiple studies (15-18). Although a high rate of immediate urinary continence after surgery was noted in our current series, which can be attributed to the preservation of other structures that contribute to urinary continence (e.g., retropubic structures), the short- and long-term impacts of not sparing the bladder neck on continence still need to be further investigated due to the limited number of cases and the relatively restricted follow-up period.

There is no denying that only a limited number of preoperatively defined localized cases were included and the follow-up interval was too short to come to any reasonable conclusion on the functional and oncological outcomes within long-term follow-up durations in our current study. Furthermore, an additional limitation of this study is the absence of comparative analysis with other established techniques of RARP Finally, due to the concerns of surgical margins and urinary leakage, we only restricted our inclusion criteria to low-median risk PCa patients with comparatively small prostate volumes. It had been reported that the positive surgical margin rates after radical prostatectomy ranged from 6.2% to 71.5%, and patients with positive surgical margins had worse BCR-free survivals than those without positive surgical margins (19). Kim *et al.* found that tumor location was not a risk factor of postoperative biochemical recurrence (19). However, it was notable that there was no significant correlation between positive surgical margin and cancer-specific survivals according to the long-term follow-up data (19). As such, further investigations are needed in the future to validate the feasibility of the technique in patients with either enlarged prostates or high-risk disease.

Some tips and tricks concerning the procedure, including the establishment of extraperitoneal transvesical access for a 4-channel single-port, intravesical carbon dioxide (CO_2) pressure control, dissection, anastomosis, and drainage are discussed below.

The direction, position, and length of the skin incision

The first question we asked ourselves when choosing an appropriate incision was whether to use a vertical midline incision or a transverse incision (a short Pfannenstiel incision). A centrally located short Pfannenstiel incision may provide the best cosmetic result while being sufficient to gain access to an overinflated bladder. However, on the one hand, when an incision is too caudally located, the angle between the longitudinal axis of the robotic instruments and the prostate-urethra axis might significantly limit the range of motion of Endowrists, even though the lens with 30-degree up will provide a sufficient view of the surgical field. In particular, urethrovesical anastomosis could be very difficult when the angle is large. On the other hand, the bladder detrusor comprised three muscle layers, which run in different directions (excluding the trigon): an inner layer of longitudinal muscle fibers, a middle layer of circular muscle fibers, and an outer layer of longitudinal muscle fibers. As such, a transverse incision would transect all three layers of fibers, while a longitudinal incision might only transect the middle layer of muscle fibers that runs circumferentially. In summary, a vertical midline incision that is not too close to the pubis might be a good choice. However, the incision cannot be placed too cephalically because (I) the base of the bladder is fixed and extension of the bladder roof is limited; and (II) too much cephalic retraction of the bladder might cause tension on the anastomosis, even though the base of the bladder is relatively fixed. Regarding the length of the incision, we believe that a 6 cm skin incision is sufficient for the placement of a 4-channel single port that has a diameter of 8 cm. We tried a smaller 4-channel single port (diameter: 6 cm) and converted to the larger port eventually due to too much collision between the instruments. A skin incision that is too short may also cause collision problems. Owing to the above concerns, we finally set the skin incision as 6 cm long, whose midpoint overlaps with the midpoint between the umbilicus and pubic symphysis (*Figure 1A*).

Cystotomy

To couple with the skin incision as mentioned above, the bladder is overinflated with saline until it is palpable at least 5 cm above the pubic symphysis. Through the urethra catheter that is preplaced in a sterilized manner, the bedside assistant may use a 50 mL syringe to drain saline from a bowel and gradually inflate the bladder. A 3-way stopcock (e.g., BD Connecta 3-Way Stopcocks) can be extremely helpful to avoid any spillage of fluid and allows the assistant to complete this process smoothly and independently. After reaching behind the rectus abdominis through the incision, we routinely use a fine needle to confirm the location of the bladder, thereby eliminating the risk of any bowel injury. When the bladder is opened sufficiently, eight stay sutures are used to anchor the bladder wall to the skin in order to (I) assist the placement of the single port; (II) maintain the air seal; and (III) avoid CO_2 entering the abdominal cavity if it is accidentally entered when establishing the transvesical access.

Intravesical CO_2 pressure

An AirSeal® System (CONMED) can be extremely helpful for surgeries in such a limited space in terms of maintaining stable air pressure and a clear unclouded view. Unlike the routine 12 to 15 mmHg pressure, we use a higher pressure (15 to 20 mmHg) for dissection because (I) the hypercapnia caused by CO_2 absorbance through the bladder mucosa and comparatively limited dissection area may not present too many concerns from the anesthesiologists' aspect; and (II) the hemostatic benefit provided by higher air pressure may significantly reduce the necessary use of cautery and bleeding from the DVC. Prior to urethrovesical anastomosis, the air pressure is reduced to 5 to 10 mmHg to expose any potential bleeding points and possibly reduce the anastomotic tension.

Dissection and anastomosis

Similar to the Retzius-sparing approach, the initial dissection in this technique commences posteriorly. Having prior experience with the Retzius-sparing approach can significantly expedite the learning process as we experienced in multi-port transvesical RARP (6). After posterior dissection, the lateral approach technique was used to identify and isolate the pedicles and neurovascular bundles by using the posterior dissection plane as a reference. Compared to the multi-port transvesical technique whose ports are placed comparatively more cephalically, the angle between the access line and the longitudinal prostate-bladder axis is larger when using the single-port transvesical technique (*Figure 3C,3D*). As such, a 30-degree lens (facing upwards) is necessary based on our experience, especially for apex/urethra dissection and anastomosis. Before anastomosis, we could either leave the detached specimen in the bladder or undock and take it out. We favor the latter since taking out the specimen through the single port with an opening diameter of 8 cm and undocking/redocking would only take 2 to 3 min, and considering the supine or slight Trendelenburg position, a specimen inside such a limited intravesical space may impede a smooth anastomotic procedure, especially when the specimen is large. As initially described by Desai *et al.* (9), a racket-style shrinkage of the bladder neck is performed prior to anastomosis in order to (I) pull the ureteral orifices away from the anastomosis; (II) ensure a water-tight anastomosis in a mucosa-to-mucosa and point-to-point fashion; and (III) reduce the risk of urinary leakage into the prostatic fossa.

The anastomotic technique closely resembles the anterior approach with which we are familiar. We routinely used two barbed sutures running in opposite directions to complete the anastomosis, which is safe, efficient, and effective for a water-tight anastomosis (20). The final knot of the two sutures was placed outside the bladder to prevent the knot from irritating the trigone, which may result in dysuria following the removal of the urethral catheter. The "dead space" around the anastomotic site was regularly filled with fibrin-based hemostatics. Throughout a minimum follow-up period of three months, no evidence of bladder outlet obstruction or persistent inconsistency lasting more than two weeks was observed. Also, urethrocystography revealed that there was no urethral stricture or urinary leakage at 3 months after surgery (*Figure 3A,3B*).

Drainage

According to our previous experience, the 2-layer running sutures are sufficient to ensure a water-tight closure of the bladder (6). Therefore, we believe that pelvic drainage (unless pelvic lymph node dissection is performed) or a cystotomy tube is not necessary. A 20-Fr 3-way urethral catheter is routinely used in our practice in cases where continuous bladder irrigation is needed due to hemorrhage, which has not yet occurred. Bocciardi recently reported that the utilization of a suprapubic cystotomy catheter for bladder drainage demonstrated reduced patient discomfort compared to a urethral catheter (21). However, it is difficult to determine whether an extra puncture required for the cystotomy tube outweighs its benefit at this point.

Conclusions

SETvRARP using the da Vinci Xi system coupling with a 4-channel single port is a valid technique of radical prostatectomy in well-selected PCa patients, providing promising postoperative urinary continence and rapid bowel function recovery. However, further investigation is necessary to evaluate the long-term functional and oncological outcomes.

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Footnote

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Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. The study was conducted in compliance with the Declaration of Helsinki (as revised in 2013). This retrospectively designed study was conducted in accordance with the guidelines and approval of the Ethics Committee of the First Affiliated Hospital of Nanchang University (approval No. 075 [2017]) and The Second Affiliated Hospital of Zhejiang University School of Medicine (approval No. 229 [2020]). Informed consent was taken from all the patients.

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