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Robotic Perineal Radical Prostatectomy: Initial Experience with the da Vinci Si Robotic System

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Keywords
Prostate cancer · Robotic prostatectomy · Perineal route · Surgical technique

Abstract
Purpose: To investigate the feasibility and surgical technique of robotic perineal radical prostatectomy (RPRP). ***Materials and Methods:*** We retrospectively analyzed 6 consecutive patients diagnosed with prostate cancer from December 2018 to May 2019 who underwent RPRP at our center. Perioperative outcomes were recorded for safety and feasibility analysis. ***Results:*** Six patients successfully underwent RPRP with no conversion to open procedures. Operative time was 140 (interquartile range [IQR] 123.75–148.75) min, console time was 70 (IQR 62.5–70) min, with an estimated blood loss of 125 (IQR 100–187.5) mL. Patients were discharged 2 days postoperatively (IQR range 1–3) with pelvic drainages removed. The Foley catheter was removed 2 weeks after surgery. Postoperative pathology revealed 5 patients with locally advanced disease (apical margin-positive prostate cancer [pT3a]bNx). Two patients had a positive surgical margin (33.3%). No complications of Clavien grade 3 and above were recorded; 1 patient had a delay in wound-healing of 1 week. Postoperative continence was achieved for 2 patients immediately after Foley catheter removal, 2 recovered 1-month postoperatively, and 1 recovered within 3 months, and 1 still had mild incontinence at the latest follow-up 1-month postoperatively. ***Conclusion:*** RPRP is a safe and feasible alternative for the transperitoneal route in selected patients. Further investigation is required to assess its oncological and quality-of-life results.

Introduction

The surgical resection of prostate cancer can be traced back to as early as 150 years ago. Numerous approach routes, e.g., suprapubic, retropubic, perineal, transvesical, transrectal, and transurethral were attempted over time. Limited by the available surgical equipment and anatomical understanding in the early days as well as the high rate of surgery-related morbidity and complications, most of the above methods were abandoned before being made public [1]. Perineal radical prostatectomy (PRP) was first proposed by Dr. Kuchler in 1866 and served as the standard method for radical prostatectomy (RP), ever since the modified technique proposed by Young [2]. Retropubic radical prostatectomy (RRP), first reported in

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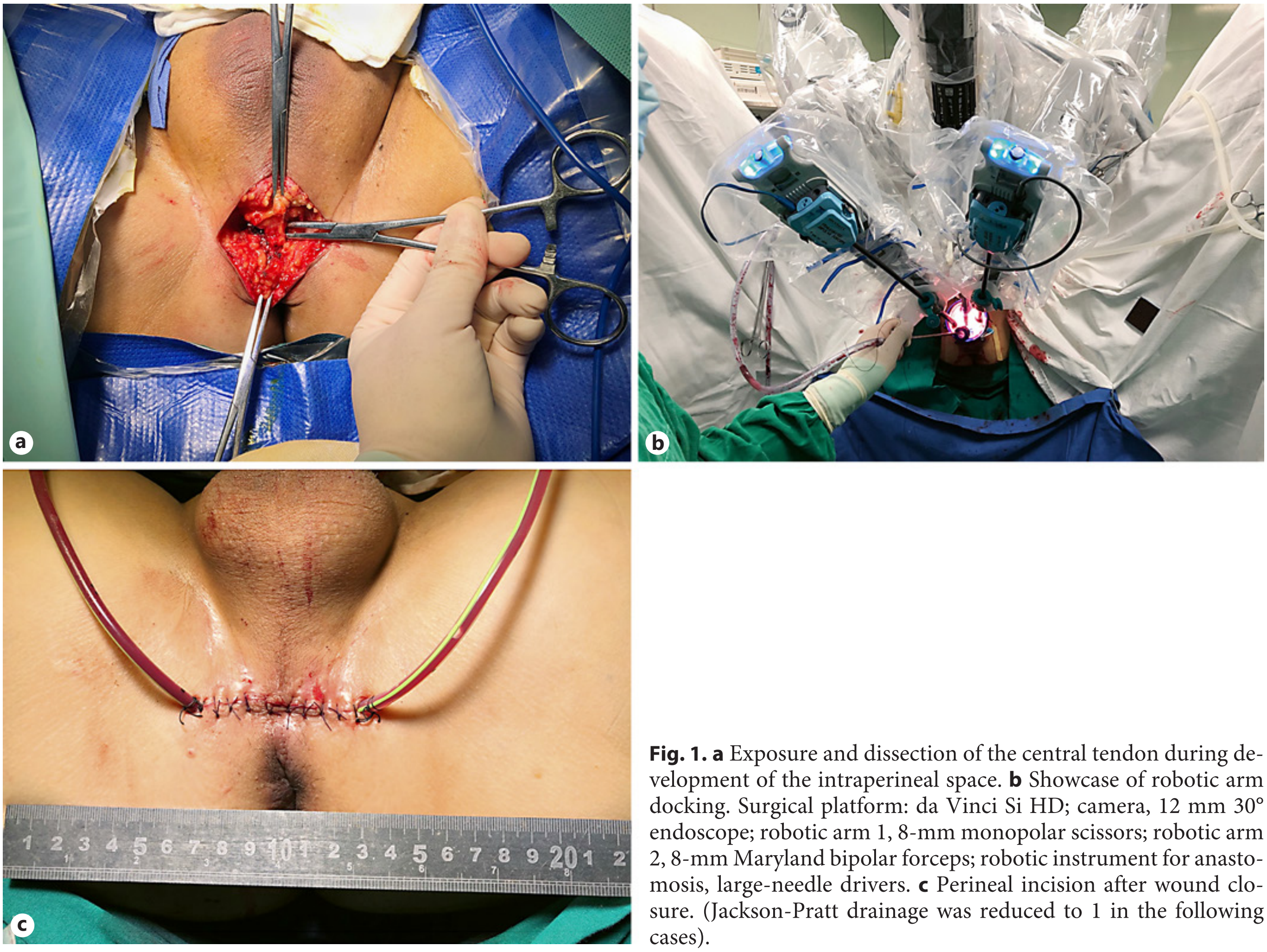

Fig. 1. **a** Exposure and dissection of the central tendon during development of the intraperineal space. **b** Showcase of robotic arm docking. Surgical platform: da Vinci Si HD; camera, 12 mm 30° endoscope; robotic arm 1, 8-mm monopolar scissors; robotic arm 2, 8-mm Maryland bipolar forceps; robotic instrument for anastomosis, large-needle drivers. **c** Perineal incision after wound closure. (Jackson-Pratt drainage was reduced to 1 in the following cases).

1945 by Millin et al. [3], significantly reduced surgical difficulties and complications, and soon became the mainstream RP option. PRP is still being performed worldwide from time to time as an alternative for selected patients, especially those with previous abdominal surgery or pelvic radiation, when surgical risks and complications can be significantly increased. However, abandoning surgery and keeping these patients under active surveillance can lead to disease progression and suboptimal survival [4].

In the new surgical era, perineal prostatectomy has regained public attention after the promotion of da Vinci robotic surgery and single-port laparoscopic innovations. The concept of robotic PRP (RPRP) was first reported by Kaouk et al. [5] and was deemed a safe and feasible procedure. Tuğcu et al. [6] reported perineal access for pelvic lymph node dissection (PLND), and a retrospective matched analysis from the same institution further investigated the potential superiority of RPRP due to the reduced operative time and blood loss, the shorter postoperative recovery time, and better short-term quality-of life outcomes [7]. However, the surgical skill required for RPRP is still challenging, especially regarding the relatively unfamiliar anatomy of the pelvic floor. Anatomical studies concerning the development of surgical access require further discussion. This study takes further steps in the discussion about perioperative preparations, surgical techniques, and clinical applications, with the intent of show-casing the value of RPRP for wider application.

Materials and Methods

Clinical Data

Six patients with a confirmed diagnosis of prostate cancer were hospitalized from December 2018 to May 2019. All 6 patients were all organ-confined after evaluation by means of multiparametric magnetic resonance imaging (MRI) and bone scintigraphy. No pa-

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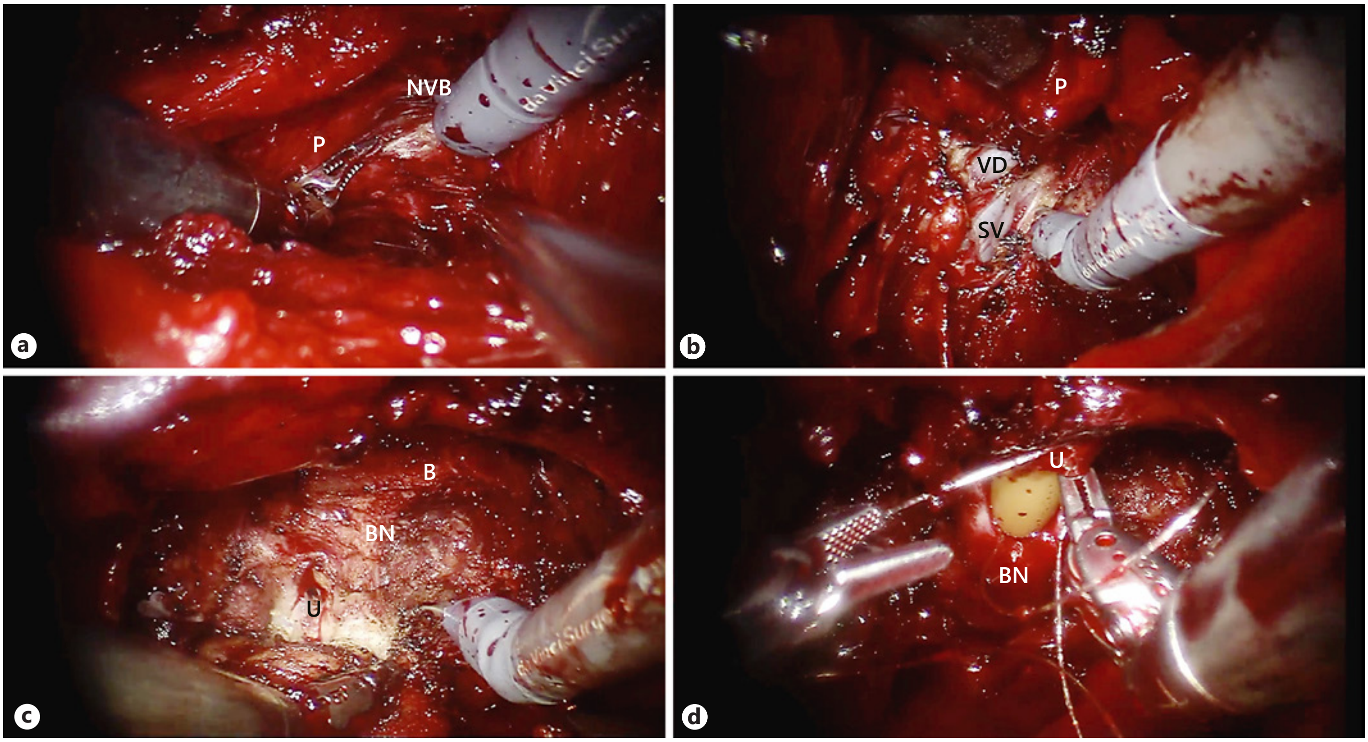

Fig. 2. a Dissection of the neurovascular bundles. **b** Dissection of the vas deferens and seminal vesicles. **c** Transection of the bladder neck. **d** Vesicourethral anastomosis. P, prostate; NVB, neurovascular bundles; VD, vas deferens; SV, seminal vesicle; B, bladder; BN, bladder neck; U, urethra.

tient required PLND after evaluation with Briganti's nomogram [8]. Surgery was performed with the da Vinci Si HD robotic surgical platform (Intuitive Surgical, Sunnyvale, CA, USA) by the same console surgeon with a previous caseload of 600 for RPRP, >20 of which were single-site cases. The assistants and scrubbing nurses were a fixed team and the procedures were believed to have passed the surgical learning curve [9]. All perioperative data were documented in PC-follow 5.0, the largest multi-institutional online prostate cancer database in China.

Surgical Techniques

The patients were required to have low-residue meals for 3 days before the surgery. A polyethylene glycol (PEG) and glycerine enema was administered 1 day preoperatively for bowel preparation. An exaggerated lithotomy position was adopted with a hip flexion of >90°, and a slight Trendelenburg position of 0–15°. Intrarectal iodine rinsing was applied after draping. A curved incision of 4–5 cm was made 2 cm above the anus and reached the ischial tuberosity bilaterally. After division of the subcutaneous tissue, the perineal body, or central tendon, had to be identified and transected (Fig. 1a). Then, after division of the recto-urethralis muscle and deep transverse perineal muscle, the membranous urethra and prerectal wall were located. Next, a 75 mm single-site quadri-channel surgical port (Freeport, SensCure Biotech Ltd., Ningbo, Jiangsu Province, China) was put in place. A 12-mm trocar was placed at 12 o'clock for the camera port; two 8-mm robotic trocars were placed at 3 and 9 o'clock, respectively; and a 10-mm trocar was placed at 6 o'clock (Fig. 1b). After the operation console was docked, an Airseal® insufflator (Surgiquest Inc., Milford, CT, USA) was connected for a stabilized pressure at 12 mm Hg. The membranous urethra was first identified, and the Denonvilliers' fascia was incised to control the lateral pedicles, followed by dissection of the neurovascular bundles (Fig. 2a), and then further exposure of the vas deferens and seminal vesicles (Fig. 2b). With the posterior plane of the prostate fully mobilized, the apical urethra could be transected. Then, the prostate was grasped and pulled down to dissect the anterior plane in a retrograde fashion, until the bladder neck was identified (Fig. 2c). After complete removal of the prostate, the intraoperative pressure was reduced to 5 mm Hg to perform vesico-urethral anastomosis with 3–0 two-way barbed sutures (Fig. 2d). A Jackson-Pratt drainage tube was placed before wound closure (Fig. 1c).

Definition of Perioperative Parameters

Prostate volume was calculated with 0.52*D1*D2*D3 (D1–3 being the 3 dimensions of the prostate measured on MRI. Postoperative continence was defined as using no pads or 1 security pad per day, with a pad weight gain of <50 g. The drainage tube was removed when daily drainage was ≤30 mL on 2 consecutive days. The Foley catheter was removed on postoperative day 14. The duration of surgery was defined as the skin-to-skin time.

Table 1. Patient demographics

Patient No.	Age, years	BMI	Prostate volume, mL	Baseline PSA, ng/mL	Biopsy Gleason score	Clinical stage	D'Amico risk stratification
1	54	26.67	43.056	4.276	3 + 4 = 7	cT2bN0M0	intermediate
2	65	27.55	19.150	9.94	3 + 3 = 6	cT1cN0M0	low
3	72	25.26	18.655	9.096	3 + 4 = 7	cT2bN0M0	intermediate
4	68	26.17	24.96	10.73	4 + 3 = 7	cT2aN0M0	intermediate
5	69	25.1	42.912	13.75	4 + 3 = 7	cT2aN0M0	intermediate
6	66	23.32	41.6	14.46	3 + 4 = 7	cT2bN0M0	intermediate

BMI, body mass index; PSA, prostate-specific antigen.

Table 2. Perioperative and follow-up parameters

Patient No.	Operative time, min	Console time, min	EBL, mL	Postoperative LOS, days	Pathological Gleason score	PSM	Pathological stage	Continence recovery
1	145	70	80	4	3 + 4 = 7	negative	pT3aNx	1 month
2	135	60	200	3	3 + 3 = 6	negative	pT3aNx	instant
3	175	90	150	3	3 + 4 = 7	positive (apical)	pT3bNx	3 months
4	150	70	400	1	4 + 3 = 7	negative	pT3aNx	1 month
5	120	70	100	1	4 + 3 = 7	negative	pT2cNx	n.a.
6	90	45	100	1	3 + 4 = 7	positive (apical)	pT3bNx	instant

EBL, estimated blood loss; LOS, length of stay in hospital; n.a., not available; PSM, positive surgical margin.

Results

Patient demographics are listed in Table 1. The patients were 65.7 ± 6.22 years of age with a mean body mass index of 24.9 ± 6.31 kg/m^2. Preoperative radiological examinations showed organ-confined disease for all patients, with 1 at a low risk and the other 5 at an intermediate risk based on the D'Amico classification. All 6 operations were carried out smoothly, without conversion to open surgery or redo surgery. Median operative time was 140 (interquartile range [IQR] 123.75–148.75) min and console time was 70 (IQR 62.5–70.0) min. Estimated blood loss was 125 (IQR 100–187.5) mL with no blood transfusions. Two patients had a positive surgical margin on the apical junction. Median postoperative hospital stay was 2 (IQR 1–3) days; 3 patients were discharged the day after surgery and sent home without major discomfort. The patients were followed for a median of 3.5 (range 1–7) months. Two of 6 patients were continent immediately after removal of the Foley catheter, 2 were pad-free within 1 month of surgery, 1 was continent 3 months postoperatively, and the remaining patient had mild incontinence at the 1-month postoperative follow-up (Table 2). Potency was not evaluated due to the low International Index of Erectile Function (IIEF) score of all patients at baseline. Postoperative pathology showed 3 patients with extracapsular invasion and 2 with seminal vesicle invasion. All 6 patients reported a pain scale of 0/10 at 3 days postoperatively.

Discussion

Due to limited surgical space and relatively unfamiliar anatomical access, RPRP has not gained wide publicity to date, with only 2 centers having reported their initial outcomes. With the development of next-generation surgical robots and single-site access equipment, we are now able to markedly reduce the difficulty of the surgery and further explore its clinical value. Our previous study on transperitoneal single-site robotic prostatectomy [10] gave us experience in streamlining the surgical procedures with the use of the most widely installed da Vinci Si HD model. First, a 30° endoscope is used, that faces upwards for the entire procedure to minimize external robotic collision. Also, due to the innate intraoperative space of the perineal route, an Airseal® insufflator is used to stabilize intraoperative pressure with a continuous air circulation system, especially when using suction. However, different from the transperitoneal route, in which the trocars are mostly placed away from the surgical field with help of the insufflated abdomen, the trocars are very close to the surgical field in perineal access, so extra caution should be exercised to avoid reflux of drainage to the insufflator.

One limitation of the perineal route is that surgeons are relatively less familiar with the pelvic anatomy, and this may lead to cavernous nerve injury and rectal penetration; also, there is anatomical variation in different individuals, according to the literature [11]. Taking the surgical techniques of Laydner et al. [12] and Tuğcu et al. [13] as our reference, we were able to identify key anatomical landmarks before placement of the single-site port. The perineal body, or central tendon of the perineum, was first identified after dissection of the subcutaneous tissue. Then, the recto-urethralis muscle should be divided and suspended to the skin for better surgical exposure. On the deeper planes, the deep transverse perineal muscle should be identified and divided before gaining access to the membranous urethra of the prostate, as suggested by Zhai et al. [11]. Also, when developing the surgical access, the surgeon should keep close to the posterior plane of the prostate once the membranous urethra has been identified, with the help of a digital rectal examination during the procedure whenever necessary. In the case of rectal injury, intraoperative suture with 3 layers should be performed, with intrarectal gas infusion to ensure watertight closure of the rectal wall. When performing vesico-urethral anastomosis, difficulties may be encountered due to less mobilization of the bladder being possible, especially in patients with a large-volume prostate. We believe that this procedure is best for small to intermediate volumes (i.e., <40 mL), and if tension is encountered, a Foley catheter can be inserted with a balloon inflated inside the bladder. The intraoperative pressure can also be reduced to 5 mm Hg, to allow for better traction and apposition during anastomosis. Although all patients were evaluated with Briganti's nomogram to rule out the necessity for PLND, and there were no suspicious findings on MRI, 5/6 patients showed extracapsular extension on postoperative pathology. The high percentage of stage upgrade may have resulted from the small sample size, but it may also suggest that the nomogram itself may not be the most suitable for Chinese patients, and also that we should explore the feasibility of PLND by the perineal route in future attempts for selected patients. Nevertheless, the necessity of performing PLND in organ-confined prostate cancer patients is yet to be determined, since convincing data from randomized trials as to its survival benefit is still lacking [14].

There are several advantages to performing RPRP. First, our initial experience showed a satisfactory, if not better, continence recovery compared with conventional routes. Two patients had instant continence recovery after catheter removal, and the majority can regain continence 2–3 weeks after the operation. This is due to the fact that the procedure is Retzius-sparing, and bilateral intrafascial dissection can be performed for neurovascular dissection. Anterior intrafascial dissection can also be performed, creating minimal disturbance to periurethral supporting structures. Second, as previous open PRP suggested, the surgery is performed extraperitoneally with zero disturbance to the intra-abdominal organs. Two patients in our study had a history of major abdominal surgery, and RPRP can serve as a patient-friendly and safer approach, and this is also the case for obese patients. Also, the perineal route provides faster postoperative recovery, with less patient-reported pain and a reduced use of narcotics. Patient positioning requires a slight Trendelenburg position with a 0–15° head-down tilt, in which case the anesthesiological risks can be reduced. Socioeconomic studies also show less cost, with 1 robotic arm spared. A better esthetic outcome is also obvious, without significant incision-related complications. Future prospective and comparative studies are on the way to exploring the clinical value of RPRP.

This study has several limitations. Conclusions were drawn from a small-sample retrospective study and require further validation with prospective controlled studies comparing RPRP with conventional multiport transperitoneal access. The relatively high positive surgical margin rate (33%) may be partly explained by the limited number of cases, and also because 5 out of 6 patients were pathologically locally advanced.

Conclusions

RPRP is a safe and feasible procedure which may serve as an alternative, especially for patients with prior abdominal or pelvic surgery or radiation therapy. Prospective randomized controlled studies should be carried out to further validate its clinical value.

Statement of Ethics

This study was approved by the Changhai Hospital Ethics Committee (CHEC2018-162) following guidelines for human studies. All patients gave their written informed consent.

Disclosure Statement

The authors declare no conflicts of interest regarding this study.

Funding Sources

There are no funding sources to declare.

Author Contributions

Y.C., Y.S., and S.R.: study conception and design. W.X., X.L., Y.Z., and M.J.: acquisition of data. Y.C. and Y.X.: analysis and interpretation of data. Y.C. and W.X.: drafting of manuscript. Y.Z., Y.S., and S.R.: critical revision.

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