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Comparison of robot-assisted laparoscopic radical prostatectomy via modified extraperitoneal approach and transvesical approach

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Abstract

Objective To compare the clinical outcomes of two different surgical approaches for treating localized prostate cancer: extraperitoneal robot-assisted radical prostatectomy (Ep-RARP) and transvesical robot-assisted radical prostatectomy (Tv-RARP).

Methods This study collected and analyzed data from patients with localized prostate cancer who underwent robot-assisted radical prostatectomy (RARP) within the same surgical team between October 2018 and March 2024. The cohort included two groups: the Ep-RARP group (37 cases) and the Tv-RARP group (29 cases). The primary outcomes analyzed were postoperative drainage time, length of hospital stay, surgical margin status, postoperative complications, urinary continence, and erectile function.

Results The baseline characteristics of the two groups of patients were consistent ($p > 0.05$), making them comparable. The Ep-RARP group had a significantly shorter hospital stay (7 days [5.5-8] vs. 9 days [9-10], $p < 0.001$) and shorter drain retention time (7 days [6-8] vs. 8 days [7-10], $p < 0.001$). There were no significant differences in intraoperative blood loss, blood transfusion requirements, and surgical complications. The duration of catheterization was similar in both groups (7 days [7-8] vs. 7 days [7-8], $p = 0.135$), as well as the distribution of Gleason scores, pathological staging (T1, T2), and positive surgical margin rate ($p > 0.05$). No significant differences were found in immediate postoperative urinary control rates (Tv-RARP: 20 [68.97%] vs. Ep-RARP: 26 [70.27%], $p = 0.909$), 3-month urinary control rates (Tv-RARP: 27 [93.10%] vs. Ep-RARP: 35 [94.59%], $p = 1.000$), or 6-month urinary control rates (Tv-RARP: 29 [100%] vs. Ep-RARP: 37 [100.00%], $p = 1.000$). The biochemical recurrence rate at 6 months was also comparable (Ep-RARP: 1 [2.70%] vs. Tv-RARP: 1 [3.45%], $p = 1.000$). Postoperative erectile function recovery at 3 and 6

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months was similar between the two groups (3 months: Ep-RARP: 14 [37.84%] vs. Tv-RARP: 12 [41.40%], $p = 0.804$; 6 months: Ep-RARP: 18 [48.64%] vs. Tv-RARP: 17 [58.62%], $p = 0.464$).

Conclusion Both extraperitoneal and transvesical robot-assisted radical prostatectomy are feasible approaches for localized prostate cancer, offering comparable oncologic control and functional outcomes. However, the extraperitoneal approach demonstrates advantages in terms of shorter surgery time, drain retention time, and hospital stay.

Keywords Extraperitoneal robot-assisted radical prostatectomy, Transvesical robot-assisted radical prostatectomy, Prostate cancer, Prostate-specific antigen, Surgery

Introduction

Prostate cancer is the most common malignant tumor of the male genitourinary system and has the highest incidence among male cancers [1]. Over the past several decades, the incidence of prostate cancer has been steadily increasing, and prostate-specific antigen (PSA) screening has been shown to help reduce cancer-related mortality [2]. Abnormal PSA levels suggest the possibility of prostate cancer, while a definitive diagnosis relies on biopsy. For patients with PSA levels in the gray zone, digital rectal examination (DRE) and imaging studies are required to further evaluate the necessity of a prostate biopsy. Currently, radical prostatectomy (RP) is recognized as the first-line treatment for localized prostate cancer [3]. Advances in surgical techniques have led to the near-complete replacement of traditional approaches by minimally invasive procedures, such as laparoscopic and robot-assisted surgeries. As robotic surgery becomes more widely adopted and minimally invasive techniques advance, surgeons increasingly choose robot-assisted laparoscopic radical prostatectomy (RARP) for its smaller incisions and faster recovery times [4]. In fact, in developed countries such as the United States and Europe, over 90% of prostate cancer patients undergo robot-assisted RP [5]. As the understanding of prostate anatomy has improved and better surgical outcomes are increasingly sought, RARP has been further refined into different approaches, including transabdominal routes (e.g., anterior, posterior, transvesical, and lateral), extraperitoneal approaches, and perineal approaches. Among these, the anterior transabdominal route is the most widely used in urological practice [6,].

In 1997, Binder J [7] reported the first extraperitoneal laparoscopic radical prostatectomy for prostate cancer, followed by continuous improvements by Menon M [8] and others. Research by Michael Uy [9] and colleagues has shown that the extraperitoneal robotic-assisted approach (Ep-RARP) offers advantages such as shorter operative times, shorter hospital stays, and lower rates of postoperative complications, including bowel obstruction and inguinal hernia. The transvesical approach was first demonstrated by Desai et al. [10] in 2008, who successfully performed the procedure on cadavers, proving its technical feasibility. In 2013, Professor Gao Xinqiang's team in China reported the first successful single-port laparoscopic transvesical prostate cancer surgery [11]. Following this, Professor Wang Gongxian's team [12] refined and popularized the transvesical approach. The transvesical approach avoids entering the pubic space, which helps preserve important nerve and fascial structures. This leads to better postoperative outcomes, such as improved urinary control and erectile function [13, 14].

Both techniques have demonstrated excellent oncological control. While there are separate reports on the surgical outcomes of Ep-RARP and Tv-RARP, no consensus has been reached on which approach is superior. This study retrospectively analyzed 66 patients who underwent robot-assisted radical prostatectomy (RARP) between October 2018 and March 2024, including 29 cases of Tv-RARP and 37 cases of Ep-RARP. The study compared preoperative baseline characteristics, perioperative variables, postoperative pathological outcomes, as well as postoperative urinary continence and PSA levels. The aim was to evaluate and compare the clinical efficacy of Ep-RARP and Tv-RARP in treating localized prostate cancer, providing valuable insights for the selection of surgical approaches.

Methods

General information

Clinical and pathological data were retrospectively collected from patients admitted to the inpatient department of our institution between 2018 and 2024. All enrolled patients had confirmed preoperative clinical diagnoses and postoperative pathological diagnoses of prostate cancer. Participants were stratified into two groups according to their surgical procedures. Follow-up assessments were primarily conducted via telephone interviews, with supplementary information obtained through the institutional electronic medical record system when necessary.

Perioperative management and methodology

Diagnostic and therapeutic protocols were standardized as follows

Preoperative preparation involved dual assessments of disease status and surgical fitness. Disease evaluation protocol: Suspected cases initially underwent digital rectal examination (DRE) and serum prostate-specific antigen (PSA) testing. Patients with abnormal findings proceeded to multiparametric magnetic resonance imaging (mp-MRI). Definitive diagnosis and Gleason grading were established through systematic integration of DRE findings, MRI characteristics, and histopathological confirmation via transrectal ultrasound-guided systematic biopsy. Surgical fitness assessment: Following diagnosis, hospitalized patients underwent comprehensive surgical risk evaluation, including cardiopulmonary function tests, hepatic/renal function panels, electrolyte profiles, glucose/lipid metabolism analyses, complete blood counts, coagulation profiles, and infectious disease screening (hepatitis/HIV/syphilis).

Patients demonstrating abnormalities in cardiopulmonary function or blood biochemical parameters during surgical fitness evaluation were referred for multidisciplinary consultation. Definitive surgical intervention was deferred until optimization of these parameters was achieved, ensuring procedural safety.

Following comprehensive preoperative preparation, standardized preoperative counseling was conducted to thoroughly disclose perioperative risks and precautionary measures. Patients autonomously selected surgical approaches based on physician recommendations and provided written informed consent. For patients with a history of abdominal surgery or significant obesity, extraperitoneal radical prostatectomy was routinely recommended. Those with prior bilateral inguinal hernia repair were advised to undergo transvesical approach prostatectomy. All patients subsequently completed rigorous bowel preparation protocols prior to surgical intervention.

Inclusion criteria

1. This study collected and analyzed data from patients with localized prostate cancer who underwent robot-assisted radical prostatectomy (RARP) within the same surgical team between October 2018 and March 2024;
2. Patients with prostate cancer confirmed by both preoperative and postoperative pathological examinations;
3. No evidence of bone metastasis on PECT imaging, and no lymph node or visceral metastasis detected on middle/lower abdominal CT scans;
4. Complete clinical records and follow-up data.

Exclusion criteria

1. Patients with preoperative bone metastasis from prostate cancer, or those with lymph node or visceral metastasis;
2. Patients with concurrent severe medical conditions significantly affecting life expectancy;
3. Patients diagnosed with other types of malignancies;
4. Patients with incomplete follow-up documentation.

Surgical steps

All surgical procedures were performed by a consistent surgical team, with the primary surgeon and assistants remaining unchanged throughout the study period (Lead Surgeon: [Cao]; First Assistant: [Wang]). The operative protocol comprised the following standardized steps:

Ep-RARP surgical procedure

(1) After successful general anesthesia induction, the patient was positioned in a 15° Trendelenburg position with legs abducted approximately 30°. The surgical field was disinfected, sterile drapes applied, and a urinary catheter inserted.

(2) A 2 cm longitudinal skin incision was made below the umbilicus. The extraperitoneal space was accessed through layered dissection, and finger dissection was performed to create the extraperitoneal working space. A balloon dilator was inserted and inflated with 600–800 ml of air to expand the space. The robotic camera port was placed through this incision. Subsequent robotic trocars for arms 1 and 2 were positioned lateral to the rectus abdominis muscle at approximately one hand's breadth from the camera port. A 5 mm assistant trocar and 12 mm trocar were placed at the junction of the lateral and middle thirds along the line connecting the umbilicus to bilateral anterior superior iliac spines.

(3) After entering the retropubic space, loose connective and adipose tissues overlying the prostate and anterior bladder wall were dissected using electrocautery scissors. The endopelvic fascia was incised at its reflection to expose the prostatic apex, external urethral sphincter, and deep vein complex (DVC). Meticulous DVC dissection was performed with selective hemostatic sutures to minimize urethral sphincter involvement and preserve potential accessory pudendal arteries. (Standard pelvic lymph node dissection was performed for patients with Gleason score ≥ 7 or tPSA ≥ 10ng/ml).

(4) The vesicoprostatic junction was further dissected. With assistant traction on the urinary catheter to confirm bladder neck anatomy, the anterior bladder

neck was incised and the posterior bladder neck transected along the urethral orifice margin.
(5) Dissection continued posteriorly to expose and transect both vasa deferentia. Complete bilateral seminal vesicle mobilization was achieved through meticulous dissection.
(6) After upward retraction of seminal vesicles and vasa deferentia by the assistant, Denonvilliers' fascia was dissected posteriorly towards the prostatic apex. Neurovascular bundle (NVB) preservation was selectively performed based on oncological status, utilizing athermal dissection techniques when indicated.
(7) Following apical dissection, the anterior urethral wall was incised. After catheter removal, the posterior urethral wall was transected with maximal preservation of urethral sphincter integrity to optimize postoperative continence.
(8) Vesicourethral anastomosis was completed using 3 – 0 barbed suture. Anatomical reconstruction of the anterior suspension system was achieved by continuous suturing of bilateral prostatic fascia, pubovesical ligaments, and DVC to the anterior bladder wall.
(9) The specimen was retrieved in an endobag. A pelvic drain was placed, incisions closed, and the procedure concluded.

Tv-RARP surgical procedure

(1) Trocar placement and robotic docking: A 12 mm camera trocar was inserted through a 1 cm supraumbilical incision. Under pneumoperitoneum, three additional ports were placed: two 8 mm robotic trocars positioned 8 cm lateral to the umbilicus at umbilical level, and a third 8 mm trocar 8 cm lateral to the left robotic arm. A 12 mm assistant trocar was placed 8 cm superolateral to the right robotic arm. The robotic system was docked with the camera, electrosurgical scissors (Arm 1), Maryland forceps (Arm 2), and Prograsp forceps (Arm 3).
(2) Transvesical approach establishment: The peritoneum was opened at the first bladder dome reflection. Extravesical connective tissue was bluntly dissected to access the retropubic space. A 7 cm anterior cystotomy was created, with stay sutures retracting the bladder walls to the abdominal wall for intravesical exposure.
(3) Identification and Dissection: After identifying ureteral orifices and urethral meatus, circumferential bladder neck mucosal marking was performed. The posterior bladder wall was incised, followed by dissection along the prostatic capsule to expose bilateral vasa deferentia and seminal vesicles. Both vasa deferentia were transected, and seminal vesicles were completely mobilized. Denonvilliers' fascia was incised at its prostatic fusion point for apical dissection.
(4) The bladder neck incision was deepened with robotic scissors. Prostatic vascular pedicles were divided close to the prostatic capsule, maintaining preservation of the detrusor apron and puboprostatic ligaments during anterolateral dissection.
(5) Transecting the Urethra: The rhabdosphincter and circular smooth muscle were incised 2–3 mm distal to the prostatic apex, exposing longitudinal smooth muscle fibers. After catheter removal, the posterior urethral wall was transected. Hemostasis of the dorsal vascular complex was achieved with sutures or clips when required.
(6) Bladder - Urethral Anastomosis: A bidirectional 4-0-3 absorbable barbed suture was used for continuous bladder-urethra anastomosis. The anterior cystotomy was closed in a "racquet-handle" configuration through intravesical suturing [15].

Effectiveness evaluation

The efficacy was evaluated by comparing clinicopathological data between the two patient groups. Baseline parameters included age, body mass index, prebiopsy total prostate-specific antigen, prostate volume, and Gleason score. Intraoperative surgical operation time, estimated blood loss, whether blood transfusion, and postoperative hospitalization time and catheter removal time were counted in all cases, and perioperative complications were counted in all patients according to the Clavien -Dindo classification. Postoperative pathologic data were collected from patients, including Gleason score, prostatic extraperitoneal extension, seminal vesicle invasion, positive surgical margins, and pathologic T-stage. Follow-up: Patients in the case group were followed up via telephone or outpatient clinic visits. Urinary continence was assessed at 24 h after catheter removal, 3 months postoperatively, and 6 months postoperatively, respectively. Complete continence was defined as the use of ≤ 1 pad/24 hours. Postoperatively, serum total prostate-specific antigen (tPSA) levels were measured every 3 months to evaluate biochemical recurrence. Biochemical recurrence was defined as two consecutive PSA measurements ≥ 0.2 ng/ml with a subsequent rising trend after achieving an undetectable postoperative PSA nadir following radical prostatectomy. Patients were scored according to the International Erectile Function Rating Scale (IIEF-5, also termed the Sexual Health Inventory for Men), with > 21 being normal erectile function.

Statistical methods

Statistical analysis was performed using IBM SPSS Statistics (Version 26). Continuous variables were presented as mean ± SD (for normally distributed data) or as interquartile range (for non-normally distributed data). Categorical variables were expressed as percentages. Comparisons of continuous variables between two independent samples were conducted using the independent-samples t-test (for normally distributed data) or the nonparametric Mann-Whitney U test (for non-normally distributed data). Categorical data were compared using the chi-square test or Fisher's exact test, as appropriate. A two-sided P-value < 0.05 was considered statistically significant.

Results

Comparison of general information between the two groups

A total of 66 patients were enrolled in this study. The mean age of the Ep-RARP group was (68.11 ± 7.06) years; the median BMI was 23.53(21.45–24.72) kg/m^2; the median prostate volume was 32.76(25.27–45.54) ml; the median tPSA was 29.10(13.59–53.22) ng/ml; the puncture Gleason score was ≤ 6 in 16 cases, 7 in 12 cases and ≥ 8 in 9 cases; the clinical stage was T1 in 11 cases and T2 in 26 cases. The mean age of the Tv-RARP group (29) was (67.86 ± 6.68) years; the median BMI was 24.22(22.45–27.44)kg/m ^{2}; median prostate volume was 40.11 (26.95–62.82) ml; preoperative median tPSA was 18.29 (13.70–27.50) ng/ml; puncture Gleason score was ≤ 6 in 15 cases, 7 in 8 cases, and ≥ 8 in 6 cases; clinical staging was T1 in 11 cases, and T2 in 18 cases; and patients who had received neoadjuvant endocrine therapy were 2 cases. The differences between the two groups in the preoperative general data such as age, body mass index (BMI), prostate volume, preoperative Gleason score and clinical stage were not statistically significant ($P > 0.05$). (Table 1)

Comparison of perioperative conditions and complications in the two groups

There was no statistically significant difference between the Ep-RARP group and the Tv-RARP group in terms of intraoperative blood transfusion rate, positive surgical margins, pathological Gleason score, pathological T-stage, intraoperative bleeding, incidence of perioperative complications, and catheter retention time, ($p > 0.05$). The operation time of the Ep-RARP group was shorter than that of the Tv-RARP group, and the catheter retention time was shorter than that of the Tv-RARP group, ($p < 0.05$), and the difference was statistically significant, both of which were statistically significant ($p < 0.05$) The postoperative hospitalization time was longer in Tv-RARP, and there was a statistically significant difference ($p < 0.05$). In terms of surgical complications, one case of pulmonary infection with fever, one case of urinary tract infection and one case of postoperative intestinal distension occurred in the Tv-RARP group whereas one case of urinary fistula and one case of infectious fever occurred in the Ep-RARP group, and the complications were not statistically significant $p > 0.05$ These patients were cured after conservative treatment. Intraoperative hemorrhage and ureteral and rectal injuries did not occur in either group. (Table 2).

Comparison of follow-up data of patients in two groups

Both the Ep-RARP group and the Tv-RARP group had good urinary control rates, with the immediate urinary control rate reaching 68.97% vs. 70.27%, the urinary control rate reaching 93.10% vs. 94.59% at 3 months postoperatively, and the urinary control rate reaching complete urinary control at 6 months postoperatively; there was no statistical significance in the difference between the two

Table 1 Comparison of preoperative general information between Ep- RARP and Tv-RARP groups

Variables	Group Tv-RARP ($n = 29$)	Group Ep-RARP ($n = 37$)	*P*-value
Age (years)	67.86 ± 6.68	68.11 ± 7.06	0.886
BMI	24.22(22.45–27.44)	23.53(21.45–24.72)	0.111
Prostate volume	40.11(26.95–62.82)	32.76(25.27–45.54)	0.129
Preoperative PSA	18.29(13.70–27.50)	29.10(13.59–53.22)	0.177
History of abdominal surgery	3(10.34%)	5(13.51%)	0.294
Preoperative Gleason score			0.791
≤ 6	15(50.00%)	16(12.20%)	
7	8(28.57%)	12(24.39)	
≥ 8	6(21.43%)	9(63.41%)	
Clinical stages			0.600
T1	11(37.93%)	11(29.73%)	
T2	18(62.07%)	26(70.27%)	
History of neoadjuvant therapy	2(6.90%)	2(5.40%)	1.000

Table 2 Comparison of perioperative data between Ep- RARP and Tv-RARP groups

Variables	Group Tv-RARP (*n* = 29)	Group Ep-RARP (*n* = 37)	*P*-value
Surgical duration (min)	200(190–230)	190(178–200)	**0.031**
Bleeding volume (ml)	250(200–400)	200(125–300)	0.192
Blood transfusion (example)	1(3.45%)	2(5.40%)	1.000
Postoperative Gleason score			
≤ 6	11(37.93%)	13(35.14%)	0.957
7	10(34.48%)	14(37.84%)	
≥ 8	8(27.59%)	10(27.03%)	
Pathologic stages			0.413
T1	2(6.90%)	6(16.21%)	
T2	22(75.86%)	23(62.16%)	
T3	5(17.24%)	8(21.63%)	
Postoperative hospitalization time	9(9–10)	7(5.5-8)	**< 0.001**
Retention time of urinary catheter	7(7–8)	7(7–8)	0.135
Retention time of drainage tube	8(7–10)	7(6–8)	**< 0.001**
Complicating disease	3(10.34%)	2(5.40%)	0.647
Positive rate of margin	8(27.59%)	12(32.43%)	0.789

Table 3 Comparison of postoperative follow-up data between Ep- RARP and Tv-RARP groups

Urinary continence recovery	Group Tv-RARP (*n* = 29)	Group Ep-RARP (*n* = 37)	*P*-value
Immediate urinary control	20(68.97%)	26(70.27%)	0.909
Three months post-surgery	27(93.10%)	35(94.59%)	1.000
6 months after surgery	29(100%)	37(100.00%)	1.000
Biochemical recurrence occurred 6 months after surgery	1(3.45%)	1(2.70%)	1.000
Erectile Function			
3 months after surgery	12(41.40%)	14(37.84%)	0.804
6 months after surgery	17(58.62%)	18(48.64%)	0.464

groups ($p > 0.05$), and both of them demonstrated good urinary control and functional recovery after the operation. Both of them showed good recovery of urinary control after surgery. There was no statistically significant difference in biochemical recurrence rate at 6 months postoperatively ($p > 0.05$), and there was no statistically significant difference in erectile function at 3 and 6 months postoperatively ($p > 0.05$). (Table 3).

Discussion

According to the 2024 statistical report by the American Cancer Society, prostate cancer is the second leading cause of cancer-related death in men, following lung cancer, and represents the most common malignant tumor in males [16]. Currently, radical prostatectomy is the first-line treatment for localized prostate cancer [17]. Compared with traditional laparoscopy, RARP offers advantages over traditional laparoscopy, including greater operational flexibility, improved three-dimensional vision [18], and multiple surgical approaches. However, regardless of the choice of surgical approaches, our goal is to pursue the "five consecutive victories": long-term oncological control, urinary continence recovery, preservation of sexual function, complication-free surgery, and negative surgical margins, so that patients can obtain maximum benefit.

Modified extraperitoneal robot-assisted radical prostatectomy (Ep-RARP) preserves more periprostatic tissue structures than conventional extraperitoneal surgery, including the reconstruction of the anterior pubic ligament and the absence of the dorsal venous complex (DVC) suture, and minimizes bladder neck and urethral sphincter injuries during surgery. As a result, good early recovery of urinary control as well as recovery of postoperative sexual function was demonstrated. In contrast, transvesical approach robotic-assisted laparoscopic radical prostatectomy (Tv-RARP) preserved more important structural-functional tissues due to the lack of need to enter the retropubic space, resulting in a more favorable recovery of urinary control and erectile function.

In this study, the differences in age, body mass index, preoperative TPSA, prostate volume, Gleason score, and clinical stage of prostate cancer were not statistically significant ($p > 0.05$), and in terms of operative time, the operative time of Ep-RARP was similar to that reported by Jacobs BL [19, 20] et al. abroad, which was reported to be 190 min, which is shorter than the Tv-RARP The time was shorter. Ep-RARP had no interference from the bowel during the operation, which facilitated the operator's operation, and because Tv-RARP had to open and close the bladder during the operation, it increased the operation time. In terms of bleeding, Ep-RARP intraoperative bleeding was 200 (125–300) ml and Tv-RARP bleeding was 250 (200–400) ml, Ep-RARP intraoperative bleeding was less than Tv-RARP, which may be due

to the smaller field of view and the longer operation time of Tv-RARP, but there was no statistically significant difference between the two. Some studies have shown that the postoperative hospitalization time of Ep-RARP is superior to both conventional laparoscopy as well as Tp-RARP [2], and the postoperative hospitalization time is similar to that obtained from the study in this paper, probably due to the fast recovery of intestinal function, less surgical injury, and less bleeding. The extended hospitalization in both groups reflects universal healthcare coverage that minimizes financial barriers to prolonged recovery, coupled with cultural preferences for inpatient convalescence among geographically dispersed patients. Institutional ethics protocols prioritizing patient autonomy in discharge decisions further contributed to this pattern, consistent with regional ERAS implementation frameworks. As the tiered care system matures, developing context-appropriate "day surgery-community rehab" pathways will become an essential improvement goal for China's healthcare system. The placement of Ep-RARP drain is more limited compared to Tv-RARP, which is conducive to the outflow of the drainage fluid, so the placement time of drain is less than that of Tv-RARP, and therefore the placement time of drain is less compared to Tv-RARP. The placement time of Ep-RARP is shorter than that of Tv-RARP.

The Modified extraperitoneal robot-assisted radical prostatectomy approach enhances postoperative functional recovery by minimizing damage to vascular and nerve bundles. This is achieved through maximum preservation of periprostatic tissues and blunt separation of the peritoneal membrane and prostate fascia during surgery, and it has been found that the preservation of these important structures is conducive to the recovery of the patients and the avoidance of postoperative complications [21, 22] In China, Fu Wei [23]et al. found that patients had better urinary control after modified transperitoneal extraperitoneal surgery, and the 3-month postoperative urinary control rate of transperitoneal extraperitoneal laparoscopy was 80%, but this study found that, with robotic assisted, the 3-month postoperative urinary control was better than 80%, and, Poliatti S [24] et al. found that reconstruction of the retropubic space had a positive significance on postoperative recovery of function, and it recovered earlier than that of non-reconstruction. Consequently, Genzar [25] et al. found that suturing the DVC affected postoperative functional outcomes; therefore, we opted not to suture the DVC during surgery and instead selectively ligated any bleeding sections. The Tv-RARP technique eliminates the need for access to the retropubic space, which allows for the preservation of pelvic floor nerves, pelvic fascia, and other tissues and structures in their entirety [13]. In conclusion, both of them provide maximum protection of the tissue structures around the bladder prostate and show good postoperative functional recovery, so the postoperative urinary control and erectile function of both of them are similar and not statistically different. There are many risk factors affecting the cut margin positivity, including TPSA before puncture, BPC (biopsy positive cores) rate, and postoperative pathologic staging [26, 27]. The cut margin positivity rates of Ep-RARP and Tv-RARP were 27.59% and 43.24%, respectively. There was no statistically significant difference between the two. Cutting edge positivity is closely related to the follow-up treatment of patients and, together with other factors, affects the prognosis and treatment of patients after surgery.

Postoperative complications of radical prostatectomy include bleeding, rectal injury, ureteral injury, urethral fistula, urethral stricture, fever, incisional hernia, thrombosis, and intestinal obstruction, etc [28, 29]., whereas Ep-RARP does not disrupt the peritoneum, thus avoiding intestinal disturbances and to some extent decreasing the rate of intra-operative and postoperative intestinal complications [30]. In this study, the Ep-RARP group experienced 2 complications (5.40%), which was not statistically significant compared to the Tv-RARP group. This lack of significance may be due to the small sample size and undetected complications. However, according to the analysis of previous experience, the probability of postoperative intestinal complications should be lower in Ep-RARP than in the transabdominal route of surgical approach, probably because the peritoneum protects the bowel during surgery.

Ep-RARP is a series of surgical operations through the retropubic space, and without the peritoneum, preserving the integrity of the peritoneum, but Ep-RARP operation space is relatively small, some anatomical positions may not be fully revealed, for some surgeons who are not very experienced, there is a certain degree of operational difficulty, but does not affect the surgical effect, and the procedure is more suitable for some patients with previous abdominal surgery.

In summary, the modified extraperitoneal robot-assisted radical prostatectomy (Ep-RARP) and transperitoneal approach (Tv-RARP) demonstrate comparable oncological outcomes and postoperative functional recovery. However, Ep-RARP exhibits superior perioperative advantages, notably in reduced postoperative hospitalization duration and shorter drainage tube retention time. Limitations of this study include the use of non-validated urinary continence assessment tools, which may compromise measurement accuracy. Furthermore, as a retrospective single-center investigation with a limited sample size and short-term follow-up, potential selection bias necessitates cautious interpretation. Future multicenter randomized trials with extended observation

periods are warranted to establish robust evidence for clinical decision-making regarding these surgical approaches.

Conclusion

In conclusion, modified Ep-RARP and Tv-RARP yield similar tumor control and postoperative recovery results. However, Ep-RARP has advantages in perioperative outcomes, particularly in reducing postoperative hospitalization and drain retention times. Since this study is a retrospective study with a small sample size and a short follow-up period, there is a certain bias, so future large-sample multicenter controlled studies are still needed to compare the surgical efficacy and safety of the two, so as to provide a higher level of evidence to support clinical decision-making.

Abbreviations

Ep-RARP	Extraperitoneal robot-assisted radical prostatectomy
Tv-RARP	Transvesical robot-assisted radical prostatectomy
PSA	Prostate-specific antigen
DRE	Digital rectal examination
RP	Radical prostatectomy
RARP	Robot-assisted radical prostatectomy
DVC	Deep vein complex
NVB	Neurovascular bundle
BCR	Biochemical recurrence
IIEF	International Erectile Function Rating Scale
BMI	Body mass index
BPC	Biopsy positive cores
mp-MRI	Multiparametric magnetic resonance imaging

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Zhi Xian Xiao: Data curation, Writing- Original draft preparation. Run Fu Cao, Kai Hong Wang: Writing- Reviewing and Editing, Conceptualization, Methodology. Xi Yan Lan，Si Yan Miao: Supervision.

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Data availability
The datasets generated during and/or analyzed during the current study are available from the corresponding author upon reasonable request.

Declarations

Ethics approval and consent to participate
This research is retrospective and involves the collection of existing data and records. The ethical committee of The First Affiliated Hospital of Nanchang University approved all the study procedures, and the ethics committee approved the exemption of informed consent.

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

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