

Laparoscopic Versus Robot-Assisted Radical Prostatectomy: Outcomes for pT3-4N0-1M0 Prostate Cancer

Yi Yang

516321223@qq.com

Shenzhen Second People's Hospital, The First Affiliated Hospital of Shenzhen University

Xiaohong Han

Shenzhen Second People's Hospital, The First Affiliated Hospital of Shenzhen University

Jianli Cheng

Shenzhen Second People's Hospital, The First Affiliated Hospital of Shenzhen University

Xinhui Liao

Shenzhen Second People's Hospital, The First Affiliated Hospital of Shenzhen University

Jieqing Chen

Shenzhen Second People's Hospital, The First Affiliated Hospital of Shenzhen University

Zhongfu Zhang

Shenzhen Second People's Hospital, The First Affiliated Hospital of Shenzhen University

Jianting Wu

Shenzhen Second People's Hospital, The First Affiliated Hospital of Shenzhen University

Chenglong Wu

Shenzhen Second People's Hospital, The First Affiliated Hospital of Shenzhen University

Yuhan Liu

Shenzhen Second People's Hospital, The First Affiliated Hospital of Shenzhen University

Yiwei Guo

Shenzhen Second People's Hospital, The First Affiliated Hospital of Shenzhen University

Xingyuan Wang

Shenzhen Second People's Hospital, The First Affiliated Hospital of Shenzhen University

Haizhen Zhu

Shenzhen Second People's Hospital, The First Affiliated Hospital of Shenzhen University

Qiaolin Mei

Shenzhen Second People's Hospital, The First Affiliated Hospital of Shenzhen University

Hongbing Mei

Shenzhen Second People's Hospital, The First Affiliated Hospital of Shenzhen University

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Abstract

Purpose

To compare laparoscopic radical prostatectomy (LRP) with robot-assisted radical prostatectomy (RARP) for patients having pT3–4N0–1M0 prostate cancer (PCa) in terms of efficacy and safety.

Methods

Between August 2021 and July 2025, 70 cases with pT3-4N0-1M0 PCa at our hospital were enrolled in this study, comprising 35 LRP cases (LRP group) and 35 RARP cases (RARP group). All patients exhibited preoperative PSA levels > 20 ng/mL and received pelvic lymph node dissection (PLND) during the operation, with subsequent androgen deprivation therapy (ADT) postoperatively. Patients were followed for 12–60 months, with comparative analysis of perioperative parameters, continence recovery and biochemical recurrence (BCR) between the two groups.

Results

The two groups were well matched for all preoperative baseline characteristics. The RARP had a shorter operative time compared to the LRP ($p < 0.001$). There were no remarkable differences in estimated blood loss (EBL), positive surgical margin (PSM) rate, complication rates, or BCR between them. However, the RARP group showed significantly better continence recovery at 1, 3, and 6 months ($p < 0.05$) postoperatively. By 12 months, continence was similar between them ($p = 0.669$).

Conclusion

Both LRP and RARP are effective and safe for treating pT3-4N0-1M0 PCa. RARP is associated with shorter operative time and earlier continence.

Introduction

Globally, prostate cancer (PCa) remains one of the main reasons of cancer-associated morbidity and mortality among men [1]. Locally advanced (pT3-4) or node-positive (N1) disease poses significant therapeutic challenges, often necessitating multimodal management [2]. The combination of radical prostatectomy (RP), pelvic lymph node dissection (PLND), and androgen deprivation therapy (ADT) has gained increasing acceptance in these high-risk patients [3].

Laparoscopic radical prostatectomy (LRP) has been widely adopted for its clinical merits, such as diminished blood loss, shorter hospitalization, and faster recovery. Robot-assisted radical prostatectomy (RARP) offers comparable benefits, along with superior visualization and enhanced dexterity for more

precise dissection [4]. However, comparative outcomes between LRP and RARP specifically in the pT3-4N0-1M0 setting remain inadequately studied. Most existing literature focuses on localized disease, with limited direct comparisons in advanced cases [5, 6].

This study aims to compare functional and oncological outcomes between LRP and RARP in patients with pT3-4N0-1M0 PCa, thereby informing surgical decision-making for these high-risk cases.

Methods

Patient Selection

This retrospective analysis included 70 cases with pT3-4N0-1M0 PCa who received RP plus PLND between August 2021 and July 2025, categorized into LRP (n = 35) and RARP (n = 35) groups. All patients presented with preoperative prostate-specific antigen (PSA) > 20 ng/mL and negative findings for lymph node and bone metastasis on preoperative MRI and bone scan. All patients received a single dose of neoadjuvant goserelin at 3 months prior to surgery, followed by resumption of ADT with the same agent at 3 months postoperatively. Baseline clinicopathological characteristics are presented in Table 1. This retrospective study received ethical approval from the Ethics Committee of Shenzhen Second People's Hospital, The First Affiliated Hospital of Shenzhen University (No. 2026-298-01YJ) and complied with the Declaration of Helsinki. The requirement for informed consent was waived owing to the use of anonymized clinical data.

Surgical Procedures

All surgeries were carried out by a single primary surgeon, assisted by two rotating assistants. Both groups underwent surgery via the transperitoneal approach, with LRP performed using conventional laparoscopy and RARP using the Da Vinci Xi Surgical System. The PLND encompassed removal of the iliac (internal and external), obturator, and presacral lymph nodes [7].

Postoperative Management and Follow-up

For ADT, Goserelin at a dose of 10.8 mg was administered subcutaneously every 3 months to all patients. Treatment commenced at 3 months after surgery and was sustained for 2 years in node-negative (N0) cases, with a longer duration prescribed for N1 individuals [8]. Postoperative follow-up lasted at least 12 months for all cases.

Follow-up examinations were performed quarterly for N1 patients. For N0 patients, visits occurred every 3 months during the initial 2 years, and in the third year, follow-up is conducted every 6 months. After that, follow-up is carried out once a year. Each visit includes a physical examination as well as other biochemical indicators such as PSA and testosterone. Annual imaging with chest X-ray and bone scan was also performed.

Urinary continence was assessed by daily pad usage, with recovery defined as no longer requiring pad. Biochemical recurrence (BCR) was defined as two successive PSA levels > 0.2 ng/mL measured at intervals of at least one week [9]. If there is a BCR, then a further PSMA PET-CT will be conducted. Individualized regimens were developed based on each patient's condition.

Statistical Analysis

We used the Student's t-test or Mann-Whitney U test for continuous variables and the chi-square test for categorical variables. Statistical significance was defined as $P < 0.05$. SPSS version 26.0 was used in all of our analysis processes.

Results

Preoperative and Perioperative Outcomes

Baseline characteristics were similar. No remarkable differences were found between the LRP and RARP groups in age (70.1 vs. 70.9 years, $p = 0.494$), BMI (22.2 vs. 21.8 kg/m², $p = 0.114$), ASA score ($p = 0.621$), prostate volume (28.4 vs. 31.7 mL, $p = 0.069$), preoperative PSA level (42.0 vs. 42.6 ng/mL, $p = 0.902$), biopsy Gleason score ($p = 0.960$), or clinical stage distribution ($p = 0.743$) (Table 1).

Table 1
Preoperative parameters (LRP vs. RARP).

Parameter	LRP (n = 35)	RARP (n = 35)	P Value
Age, years	70.1 [64–75]	70.9 [66–79]	0.494
BMI, kg/m ²	22.2 [20.4–25.1]	21.8 [19.8–24.5]	0.114
ASA score, n			0.621
1	23	21	
2	12	14	
Prostate volume, ml	28.4 [17.3–48.6]	31.7 [18.7–45.0]	0.069
PSA, ng/mL	42.0 [21.6–91.0]	42.6 [21.9–100.5]	0.902
Biopsy Gleason Score, n			0.960
3 + 4	4	6	
4 + 3	12	10	
4 + 4	8	8	
4 + 5	5	5	
5 + 4	5	4	
5 + 5	1	2	
Clinical stage, n			0.743
T1c	6	8	
T2a	5	5	
T2b	9	7	
T2c	15	14	
T3a	0	1	

Values are expressed as n or mean [range]. Body mass index (BMI). American Society of Anesthesiology (ASA).

Regarding perioperative outcomes, the RARP group demonstrated shorter operative time than LRP (199.3 vs. 248.9 min, $p < 0.001$). Estimated blood loss (71.1 vs. 80.3 mL, $p = 0.678$), blood transfusion rate (0% in both arms, $p = 1.000$), nerve-sparing rate (0% in both arms, $p = 1.000$), pathologic Gleason score distribution ($p = 0.834$), and pathologic stage distribution ($p = 0.970$) were comparable between them. Postoperative recovery parameters, including postoperative hospital stay (8.6 vs. 8.8 days, $p = 0.755$) and catheterization duration (25.8 vs. 26.3 days, $p = 0.382$), were also comparable. Complication

rates showed no difference ($p = 0.617$), with only minor complications (Clavien I–II) observed, including one case of anastomosis leakage and one urinary infection in the LRP group, and one urinary infection in the RARP group; major complications (Clavien III–IV) were limited to anastomotic stricture (2 cases in LRP vs. 1 in RARP) (Table 2).

Table 2
Perioperative parameters (LRP vs. RARP).

Parameter	LRP (n = 35)	RARP (n = 35)	P Value
Operation time, min	248.9 [180–310]	199.3 [120–270]	<0.001
EBL, mL	80.3 [50–250]	71.1 [20–200]	0.678
BTR, n	0	0	1.000
Nerve sparing, n	0	0	1.000
Pathologic Gleason Score, n			0.834
3 + 4	4	2	
4 + 3	7	9	
4 + 4	12	11	
4 + 5	6	5	
5 + 4	5	5	
5 + 5	1	3	
Pathologic stage, n			0.970
T3a	15	16	
T3b	18	17	
T4	2	2	
PSM, n (%)	10 (28.6)	6 (17.1)	0.255
Positive lymph nodes, n (%)	3 (8.6)	4 (11.4)	1.000
PHS, d	8.8 [7–16]	8.6 [7–14]	0.755
PCD, d	26.3[21–28]	25.8 [21–28]	0.382
Complications, n			0.617
Minor (Clavien I-II)			
Urinary infection	1	1	
Anastomosis leakage	1	0	
Major (Clavien III-IV)			
Anastomotic stricture	2	1	
BCR, n (%)	3 (8.6)	2 (5.7)	1.000

Values are expressed as n or mean [range]. Estimated blood loss (EBL). Blood transfusion rate (BTR). Positive surgical margin (PSM). Postoperative hospital stays (PHS). Postoperative catheterization duration (PCD).

Pathological and Functional Outcomes

The PSM rate was 28.6% (10/35) in the LRP group and 17.1% (6/35) in the RARP group, with no remarkable difference ($p = 0.255$). The rate of positive lymph nodes was also comparable, at 8.6% (3/35) for LRP versus 11.4% (4/35) for RARP ($p = 1.000$) (Table 2).

In terms of functional recovery, the RARP group exhibited significantly superior continence rates at 1 month (60.0% vs. 25.7%, $p = 0.004$), 3 months (82.9% vs. 45.7%, $p = 0.001$), and 6 months (88.6% vs. 68.6%, $p = 0.041$) postoperatively. However, by 12 months, the continence rates converged (94.3% vs. 88.6%, $p = 0.669$) (Table 3).

Table 3
Postoperative continence outcomes (LRP vs. RARP).

Continence (Month)	LRP (n = 35)	RARP (n = 35)	P Value
Baseline, n (%)	35 (100)	35 (100)	1.000
Postoperative, n (%)			
1	9 (25.7)	21 (60.0)	0.004
3	16 (45.7)	29 (82.9)	0.001
6	24 (68.6)	31 (88.6)	0.041
12	31 (88.6)	33 (94.3)	0.669

Oncological Outcomes

BCR occurred in 3 patients (8.6%) in the LRP group and 2 patients (5.7%) in the RARP group, with no remarkable difference between the two groups ($p = 1.000$) (Table 2).

Discussion

This study compared LRP and RARP in cases with pT3-4N0-1M0 PCa. Both approaches were safe and effective, yet RARP demonstrated significant advantages in operative time and early urinary continence recovery, with comparable intermediate-term oncological outcomes. These findings suggest that while robotic assistance offers certain perioperative and functional benefits, both minimally invasive techniques remain viable options for this high-risk population when combined with PLND and immediate ADT.

In the present study, operative time was remarkably shorter in RARP than LRP (199.3 vs. 248.9 minutes, $p < 0.001$). This may be attributed to the enhanced dexterity and three-dimensional visualization provided by the robotic system, which facilitates the complex dissection required for locally advanced disease. The EBL, transfusion requirements, and postoperative hospital stay were similar between the two groups. It means that, when performed by experienced surgeons, LRP achieves perioperative outcomes comparable to RARP. These results are consistent with earlier reports showing comparable EBL and complication rates between the two techniques [10].

RARP demonstrated significantly better continence rates at 1, 3, and 6 months after surgery, although this advantage was no longer evident at 12 months. The early continence benefit conferred by RARP may be related to the precision of robotic instrumentation in preserving periurethral supportive structures during apical dissection [11]. The continence rates observed in our high-risk cohort were lower at all time points than those typically reported for low- or intermediate-risk patients, which aligns with previous work demonstrating that high-risk disease status independently predicts delayed continence recovery [12]. Although robotic assistance facilitated earlier return to continence, the continence rates at 12 months were similar between the two groups, a finding consistent with another study [13].

In our study, the PSM rate of LRP group was 28.6%, while the RARP group was 17.1%. Although this difference failed to reach statistical significance, the numerical trend favoring RARP is clinically noteworthy. Achieving negative margins in pT3-4 disease is inherently challenging due to the propensity for extraprostatic extension and seminal vesicle invasion, which often place the tumor in close proximity to the surgical resection plane [14]. Our PSM rates are comparable to those in previous reports, which range from 14% to 50% for minimally invasive approaches in high-risk prostate cancer [15].

BCR occurred in 8.6% of LRP and 5.7% of RARP, with no remarkable difference. Considering the high-risk nature of the cohort, these BCR rates are remarkably low, which may be attributed to several interrelated factors. First, all patients underwent PLND, a procedure that not only provides accurate nodal staging but may also confer therapeutic benefit. For instance, one study of intermediate- and high-risk patients reported a 5-year BCR-free survival rate of 72% with RP and PLND [16], and extended dissection has been associated with improved biochemical outcomes in patients at intermediate risk or higher [17]. Nevertheless, the therapeutic value of PLND remains controversial [18]. While some studies found no significant improvement in BCR-free survival [19], decision analysis recommended PLND as standard for patients with intermediate- or high-risk disease [20]. Second, all patients received immediate postoperative ADT, consistent with evidence supporting multimodal therapy for locally advanced disease. A 20-year follow-up study demonstrated that RARP achieved 20-year cancer-specific survival of 72.7% in non-organ-confined high-risk patients, underscoring the durability of surgical control when combined with appropriate systemic therapy [21]. Nevertheless, other studies have shown that approximately one in ten high-risk patients died from prostate cancer within 10 years irrespective of treatment modality, suggesting that the risk of progression persists even with optimal initial management [22].

Our research still has some limitations, such as small sample, short follow-up, and postoperative ADT, which hinder assessment of the standalone oncological value of each surgical technique. Larger studies with longer follow-up are required.

Conclusion

Both LRP and RARP with PLND and immediate ADT are effective and safe for pT3-4N0-1M0 prostate cancer. RARP offers advantages in operative efficiency and early urinary continence recovery. Given the comparable intermediate-term oncological outcomes, treatment selection should be tailored to individual patient characteristics, surgical proficiency, and institutional capabilities.

Declarations

Ethics approval and consent to participate

This retrospective study was conducted in accordance with the Declaration of Helsinki and approved by the Ethics Committee of Shenzhen Second People's Hospital, The First Affiliated Hospital of Shenzhen University (Approval No. 2026-298-01YJ). Owing to the retrospective design and the use of anonymized clinical data from which individual subjects could not be identified, the Ethics Committee granted a waiver of informed consent. Therefore, formal consent to participate was not required.

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Declaration

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Author Contribution

All authors contributed to the study conception and design. Material preparation, data collection and analysis were performed by Xiaohong Han, Jianli Cheng, Xinhui Liao, Jieqing Chen, Zhongfu Zhang, Jianting Wu, Chenglong Wu, Yuhao Liu, Yiwei Guo, Xingyuan Wang, Haizhen Zhu, Qiaolin Mei and Hongbing Mei. The first draft of the manuscript was written by Yi Yang and all authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

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