Original Article

DOI: 10.4274/uob.galenos.2025.2024.12.3

Bull Urooncol 2025;24(1):19-24

From First to Final: How Surgical Experience Affects Robotic Radical Prostatectomy Outcomes

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Abstract

Objective: To evaluate the impact of surgeon experience on surgical outcomes in robotic-assisted radical prostatectomy (RARP) by comparing the first and last 50 patients in a clinical setting.

Materials and Methods: This retrospective study analyzed the first and last 50 patients who underwent RARP for localized prostate cancer at a City Hospital between November 2022 and October 2024. Complications were classified using the Clavien-Dindo classification system. Oncological outcomes were evaluated by assessing surgical margins and postoperative prostate-specific antigen (PSA) levels at 4-8 weeks. Functional outcomes, including continence and potency, were defined as follows: full continence was reported when patients used 0 pads per day without anticholinergic therapy, while potency was defined as the ability to achieve an erection sufficient for sexual intercourse.

Results: A total of 100 patients diagnosed with localized prostate cancer were included in this study, divided into two groups: the first 50 patients and the last 50 patients who underwent RARP. The last 50 patients demonstrated significant improvements in perioperative outcomes, including shorter hospital stays (p=0.01), urethral catheter removal times (p=0.03), drainage catheter removal times (p=0.04), and operative times (p=0.02). Complication rates were lower in the last 50 patients, with no grade 5 complications observed in either group. Grade 3 complication rates were 12% in the first 50 patients and 2% in the last 50 patients (p=0.01). Oncological outcomes improved, with positive surgical margins decreasing from 22% to 6% (p=0.02) and undetectable PSA levels increasing from 76% to 90% (p<0.01). In terms of functional outcomes, the continence rate was 88% in the last 50 patients compared to 76% in the first 50 patients (p<0.05).

Conclusions: This study demonstrates that surgical experience significantly improves outcomes in RARP for localized prostate cancer. The later cohort exhibited reduced complications, shorter catheter durations, and enhanced oncological and functional results, highlighting the importance of proficiency in achieving optimal patient care.

Keywords: Robotic-assisted radical prostatectomy, surgical experience, complications, oncological outcomes, functional outcomes

Introduction

Robotic-assisted radical prostatectomy (RARP) has emerged as a preferred surgical technique for the treatment of localized prostate cancer, offering several advantages over traditional open and laparoscopic approaches (1). These benefits include reduced intraoperative blood loss, decreased postoperative pain, faster recovery times, and improved visualization of the surgical field (2,3). Furthermore, the use of robotic systems provides enhanced dexterity and precision for the surgeon, allowing for meticulous dissection and nerve-sparing techniques that can contribute to better functional outcomes, such as continence and potency (4,5). Despite these advantages, the success of RARP largely depends on the surgeon's experience, highlighting the significance of the learning curve in achieving optimal outcomes (6). As surgeons become more proficient with the robotic system, improvements in surgical efficiency, complication rates, and oncological outcomes are expected (7,8). Therefore, evaluating the impact of the learning curve on patient outcomes is essential to better understand how surgical expertise influences the results of RARP.

The concept of the learning curve in robotic surgery refers to the period during which a surgeon acquires proficiency in the technique, evidenced by a reduction in operative time, decreased complication rates, and improved clinical outcomes over time (9). Numerous studies have demonstrated that the

Cite this article as: Sancı A, Durak HM, Karadağ OB, et al. From first to final: How surgical experience affects robotic radical prostatectomy outcomes. Bull Urooncol. 2025;24(1):19-24.

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Received: 12.12.2024 **Accepted:** 07.02.2025 **Epub:** 03.03.2025 **Publication Date:** 09.04.2025

learning curve in RARP can extend over the first 50 to 100 cases (10,11). During this period, surgeons typically experience a gradual reduction in operating time as they become more comfortable with the robotic platform, alongside a decrease in intraoperative complications and a trend towards better postoperative outcomes (12). However, the specific impact of this learning period on perioperative and oncological outcomes remains a subject of ongoing research. For instance, the learning curve may also influence the rates of positive surgical margins (PSM), which are crucial indicators of oncological efficacy (13). Understanding this relationship can provide insights into the time frame required for surgeons to achieve proficiency and maintain high standards in surgical practice.

By comparing the surgical outcomes of the first 50 and last 50 patients, this study aims to provide a clearer understanding of how increased surgical experience affects RARP outcomes.

Materials and Methods

Patient Characteristics

In this retrospective study, patients who underwent RARP for localized prostate cancer between November 2022 and October 2024 were evaluated. Ethical approval for the study was obtained from the Ethics Committee of Ankara Etlik City Hospital (approval number: AEŞH-BADEK-2024-1173, date: 11.12.2024).

During this time period, the surgeries were performed by a surgical team. This team consisted of two surgeons who operated on the first 50 and the last 50 patients. The patients were not randomized regarding the type of surgery to be performed. The advantages and disadvantages of open, laparoscopic, and robotic surgery were explained to them. Following the informed consent process, the surgical approach was jointly decided by the physician and the patient.

The study compared the first 50 patients and the last 50 patients who underwent RARP. The first 50 patients were included in the study because the literature emphasizes that 50 cases are needed to complete the learning curve. The last 50 patients were selected as a comparison group to achieve similar statistical outcomes and to assess performance after the completion of the learning curve. This methodology is supported by existing literature indicating that at least 50 cases are needed to accurately analyze the learning curve in robotic surgery (14,15). Patients with locally advanced prostate cancer and those who had previously received radiotherapy were excluded from the study.

Patient demographic characteristics, tumor pathology findings, perioperative and postoperative outcomes and complications, American Society of Anesthesiologists (ASA) scores, and functional follow-up parameters such as continence and erectile function were retrospectively retrieved and evaluated from the hospital's medical records.

Surgical Technique

The da Vinci® X system was used to perform RARP. The patient was placed in the Trendelenburg position, and a pneumoperitoneum was created with an intra-abdominal pressure of 14-16 mmHg. Five ports were placed, consisting of four robotic ports and one assistant port. The subsequent steps were similar to the standard defined surgical procedure (16). All patients had a drainage catheter and a urethral catheter inserted.

Prophylactic antibiotic therapy was administered to all patients. All patients received enoxaparin prophylaxis for 5-7 days. If there were no contraindications, each patient was advised to use a phosphodiesterase type 5 inhibitor for penile rehabilitation during the first visit. Additionally, after mobilization, information on pelvic floor muscle exercises was provided, and patients were encouraged to perform them.

Outcome Measures

The Clavien-Dindo classification system was used to categorize the adverse events associated with the surgeries performed. In this classification system, complications of grade 3 or higher correspond to major complications. Grade 1 complications refer to any deviation from standard postoperative recovery that does not require treatment, except for specific medications (e.g., antiemetics, analgesics, and antipyretics). Grade 2 complications include situations that require various medical treatments or blood transfusions. Patients requiring intervention under general anesthesia are classified as grade 3, while complications related to Trendelenburg position and pneumoperitoneum are considered severe complications, and are corresponding to grades 4 and 5 (17).

Oncological outcomes were assessed using surgical margins and prostate-specific antigen (PSA) levels measured 4-8 weeks postoperatively.

Functional outcomes were evaluated at 3-month follow-up intervals after surgery. Complete continence was defined as situations, where the patient did not use any pads daily, and there was no need for medical treatment. Erectile function was defined as the ability to achieve sufficient erection for sexual intercourse.

Statistical Analysis

Statistical analysis was conducted using SPSS version 25.0 for Windows. The chi-square (χ^2) test was used to evaluate categorical variables, while Fisher's exact test was employed for assessing small sample sizes. The Mann-Whitney U test was used for the analysis of non-categorical data. A p-value of <0.05 was considered statistically significant.

Results

Patient Characteristics

A total of 100 patients with localized prostate cancer were included in this study. Of these, the first 50 underwent RARP and the last 50 did as well. The mean age in the first 50, group was 68.2±3.5 years, and in the last 50, group, it was 69.1±4.0 years. The first 50 and last 50 groups had similar mean ages, pre-operative tumor characteristics, and ASA status. The baseline demographic characteristics, patient and tumor characteristics, and ASA statuses are summarized in Table 1.

Table 1. Baseline demographic patient and tumor characteristics			
Characteristic	**First 50 patients (n=50)**	**Last 50 patients (n=50)**	**p-value**
Age, mean (SD)	68.2 (3.5)	69.1 (4.0)	0.72
BMI, mean (SD)	27.5 (4.8)	27.2 (4.9)	0.65
Cardiovascular disease, n (%)	15 (30)	16 (32)	0.81
Diabetes, n (%)	12 (24)	13 (26)	0.79
PSA, mean (SD), ng/dL	7.3 (6.9)	7.5 (6.7)	0.67
Prostate weight, mean (SD), g	58.0 (22.5)	57.3 (21.0)	0.54
D'Amico clinical risk group, n (%)			0.78
Low	17 (34)	16 (32)	
Intermediate	25 (50)	26 (52)	
High	8 (16)	8 (16)	
Gleason grade group, n (%)			0.74
≤6	9 (18)	10 (20)	
7	28 (56)	27 (54)	
≥8	13 (26)	13 (26)	
Nerve-sparing status, n (%)			0.42
None	29 (58)	27 (54)	
Unilateral	15 (30)	17 (34)	
Bilateral	6 (12)	6 (12)	
Lymph node dissection,n (%)	38 (76)	37 (74)	0.89
ASA class, n (%)			0.56
Class 1	2 (4)	2 (4)	
Class 2	32 (64)	31 (62)	
Class 3	14 (28)	15 (30)	
Class 4	2 (4)	2 (4)	
SD: Standard deviation, BMI: Body mass index, PSA: Prostate-specific antigen, ASA: American Society of Anesthesiologists			

Perioperative Surgical Outcomes

In the last 50 patient group, the hospital stay duration (p=0.01), urethral catheter removal time (p=0.03), drainage catheter removal time (p=0.04), and operative time (p=0.02) were significantly shorter compared with the first 50 patient group. However, the estimated blood loss was similar between the groups. The perioperative surgical outcomes are summarized in Table 2.

Perioperative Adverse Events

No Clavien-Dindo grade 5 complications (death) were observed in either the first 50 patients or the last 50 patients. Newly diagnosed atrial fibrillation developed in one patient, who was among the last 50 patients. Grade 4 complications were not observed in any other patients in either group.

The rate of life-threatening complications, (grades 4 and 5) was 2.0% (1 out of the last 50 patients) in the last 50-patient group, and no grade 4 or 5 complications were observed in the first 50-patient group.

As a grade 3 complication, rectal injury requiring colostomy was observed in one patient from the first 50 patients (2.0%), along with anastomotic leaks requiring placement of a catheter with extra drainage holes at the proximal end of the balloon catheter in five patients (10.0%). In contrast, no anastomotic leaks were observed in the last 50 patients. One patient in the last 50 patients group, developed a hematoma that required endoscopic intervention (2.0%). The incidence of anastomotic leaks was significantly higher in the first 50 patients (p=0.01). Grade 3 and above complication rates were 12.0% (6/50) for the first group of 50 patients, and 2.0% (1/50) for the last group of 50 patients. There was a statistically significant difference in this parameter (p=0.01).

As a grade 2 complication, one patient in the last 50 patients group (2.0%) required erythrocyte suspension replacement due to port site-related bleeding. In the first group of 50 patients, two patients (4.0%) developed urinary tract infections, and one patient (2.0%) experienced epididymitis.

Pain requiring morphine, wound infection, lymphoedema, serum creatinine elevation, and portside hematoma were grade 1 complications that occurred at similar rates in both groups, and there was no statistical difference (p=0.08). The perioperative adverse events are summarized in Table 3.

Oncological Outcomes

The surgical margin was positive 11 patients (22.0%) in the first 50 patients, while this rate was 3 patients (6.0%) in the

Table 2. Perioperative surgical outcomes			
Outcome	**First 50 patients (n=50)**	**Last 50 patients (n=50)**	**p-value**
Hospital stay, median (d) (range)	4.5 (2-17)	3.0 (2-7)	**0.01**
Estimated blood loss, median (mL) (range)	110.0 (80-300)	90.0 (60-200)	0.10
Operative time, median (min) (range)	190.0 (190-320)	140.0 (120-180)	**0.02**
Urethral catheter removal time, median (d) (range)	12.0 (10-15)	8.0 (7-10)	**0.03**
Drainage catheter removal time, median (d) (range)	4.0 (2-6)	3.0 (2-4)	**0.04**

Table 3. Perioperative adverse events categorized according to the Clavien-Dindo classification system			
Clavien-Dindo classification	**First 50 patients (n=50)**	**Last 50 patients (n=50)**	**p-value**
Grade 1, n (%)			0.8
Pain requiring morphine	9 (18.0)	8 (16.0)	**0.01**
Fever	6 (12.0)	4 (8.0)	0.91
Wound infection	3 (6.0)	0 (0.0)	-
Lymphoedema	8 (16.0)	6 (12.0)	0.66
Serum creatinine elevation	3 (6.0)	0 (0.0)	-
Portside hematoma	0 (0.0)	1 (2.0)	-
Grade 2, n (%)			
Erythrocyte suspension replacement	0 (0.0)	1 (2.0)	-
Urinary tract infection	2 (4.0)	0 (0.0)	-
Epididymitis	1 (2.0)	0 (0.0)	-
Grade 3, n (%)			
Rectal injury (requiring colostomy)	1 (2.0)	0 (0.0)	-
Anastomotic leaks (requiring catheter placement)	5 (10.0)	0 (0.0)	**0.01**
Hematoma (requiring endoscopic intervention)	0 (0.0)	1 (2.0)	-
Grade 4, n (%)			
Atrial fibrillation	0 (0.0)	1 (2.0)	-
Grade 5, n (%)			
Death	0 (0.0)	0 (0.0)	-

last 50 patients. There was a statistically significant difference between the two groups (p=0.02). In the first 50 patients, undetectable PSA levels were present in 38 (76%), while in the last 50, 45 (90%) had undetectable PSA levels. There was a statistical difference between the two groups (p<0.01). The improvement in undetectable PSA levels from the first group to the last group is 14%. The oncological outcomes are summarized in Table 4.

Functional Outcomes

The rates of full continence (patient-reported 0-pad-per-day usage without anticholinergic therapy) were measured at 76% (38/50) in the first 50 patients' group and approximately 88% (44/50) in the last 50 patients' group. There was a statistically significant difference between the two groups (p<0.05). Both groups exhibited similar rates of potency for sufficient erection for intercourse, with the first group of 50 patients showing a rate of 22% (11/50) and the last group of 50 patients showing 24% (12/50). The functional outcomes are summarized in Table 5.

Discussion

The results of this study on RARP provide significant insights into the surgical outcomes, oncological efficacy, and functional recovery in patients with localized prostate cancer. The comparison of the first 50 patients with the last 50 patients highlights the importance of the learning curve associated with the RARP technique. The notable differences in perioperative outcomes, complication rates, and functional results between these two groups underscore the evolving nature of surgical expertise in robotic surgery.

Our study found that the hospital stay duration, urethral catheter removal time, drainage catheter removal time, and operative time were significantly shorter in the last 50 patients, compared to the first 50 patients. These findings are consistent with previous literature that emphasizes the learning curve's effect on improving surgical efficiency and reducing complications over time (18). As surgeons gain experience with robotic systems, they typically experience a gradual reduction in operating time, leading to shorter hospital stays and quicker recovery for patients (19). This aligns with the work of Bock et al. (20), who reported that with increased surgical experience, patients

Table 4. Oncological outcomes			
Outcome	**First 50 patients (n=50)**	**Last 50 patients (n=50)**	**p-value**
Positive surgical margin, n (%)	11 (22.0)	3 (6.0)	**0.02**
Undetectable PSA levels, n (%)	38 (76.0)	45 (90.0)	**0.01**
PSA: Prostate-specific antigen			

Table 5. Functional outcomes			
Outcome	**First 50 patients (n=50)**	**Last 50 patients (n=50)**	**p-value**
Full continence, n (%)	38 (76.0)	44 (88.0)	**0.05**
Potency for sufficient erection, n (%)	11 (22.0)	12 (24.0)	0.80

demonstrated a marked decrease in both operative time and postoperative complications.

The reduction in major complications observed in the group of the last 50 patients (of grade 3 and above complications) compared to the first group is particularly noteworthy. The incidence of such complications in the first group was 12.0%, whereas it dropped to 2.0% in the last group, reflecting the surgeon's enhanced proficiency and improved surgical technique over time. This reduction is corroborated by findings from several studies that illustrate how accumulating experience leads to lower complication rates in robotic surgeries (21).

In terms of oncological outcomes, the PSM rates and undetectable PSA levels exhibited significant improvements from the first group to the last group. The rate of PSM decreased from 22.0% in the first group to 6.0% in the last group, which is a crucial indicator of oncological success. This improvement is consistent with findings from the literature, which indicate that surgeons' experience correlates with reduced rates of PSM, enhancing overall oncological efficacy (22,23).

The increase in undetectable PSA levels from 76% in the first group to 90% in the last group further emphasizes the positive impact of surgical experience on oncological outcomes. The observed 14% improvement aligns with similar studies that document enhanced oncological results as surgical proficiency increases (4,5). However, it is essential to consider that while our study shows promising results, variations in patient selection, tumor characteristics, and follow-up durations among different studies may lead to disparities in findings.

Functional outcomes, including continence and potency, are critical for evaluating the success of RARP. In our study, the rates of full continence improved from 76% in the first 50 patients to approximately 88% in the last 50 patients, demonstrating a statistically significant difference between the groups. These findings are in line with the literature, which reports that robotic-assisted techniques can yield favorable functional outcomes compared to traditional approaches (5).

The improvement in potency rates was also noteworthy, while not statistically significant, with the first group exhibiting a potency rate of 22% compared to 24% in the last group. Although these rates appear modest, they reflect the surgeon's ongoing efforts to utilize nerve-sparing techniques effectively, which are pivotal in preserving sexual function postoperatively (24). It is important to note, that literature on functional outcomes in RARP often highlights variability based on patient characteristics, including age, comorbidities, and baseline sexual function, which may influence recovery rates differently across studies (4). The low rates of potency can be attributed to several factors: the patients' age over 65, their high comorbidity rates, and the selection of a strict criterion for the assessment of erectile function.

The results of this study corroborate many findings in the existing literature while also highlighting some differences. For instance, while our study demonstrates a significant decrease in PSM with experience, other studies have reported varying results, with some indicating minimal changes after a specific number of cases (22). This discrepancy may be attributed to differences in surgical techniques, patient demographics, and follow-up protocols.

Moreover, the improvement in functional outcomes in our study is comparable to findings from other institutions employing RARP; however, variations in definitions of continence and potency across studies may lead to inconsistencies in reported rates (4,5). Our operational definitions of continence as patient-reported zero-pad-per-day usage and potency as sufficient erection for intercourse are consistent with standards used in many similar studies (4,5).

This study is not without limitations. The retrospective design inherently carries the risk of bias, and the lack of randomization in selecting patients for RARP could impact the generalizability of our findings. Additionally, the relatively small sample size and limited follow-up duration may not sufficiently capture the long-term outcomes of RARP, including oncological and functional results. Validated forms were not used to assess functional outcomes. This may affect the reliability of the results, and we recommend the use of such forms in future studies involving a larger patient population. Future prospective studies with larger cohorts and extended follow-up periods are warranted to validate these findings and further explore the long-term effects of surgical experience on patient outcomes.

In conclusion, this study highlights the benefits provided by robotic surgery in the learning process. The significant improvements observed in surgical efficiency, complication rates, oncological efficacy, and functional recovery from the first to the last group underscore the importance of surgical experience in achieving optimal patient outcomes. These findings contribute to the growing body of literature advocating for the integration of robotic-assisted techniques in urology, emphasizing the need

for ongoing education and training to maximize the benefits of robotic surgery for patients.

Ethics

Ethics Committee Approval: Ethical approval for the study was obtained from the Ethics Committee of Ankara Etlik City Hospital (approval number: AEŞH-BADEK-2024-1173, date: 11.12.2024).

Informed Consent: Following the informed consent process, the surgical approach was jointly decided by the physician and the patient.

Footnotes

Authorship Contributions

Surgical and Medical Practices: K.S., A.N.K., Concept: A.S., H.M.D., Design: A.S., O.B.K., F.Ç., Data Collection or Processing: O.B.K., F.Ç., Analysis or Interpretation: M.Y., K.S., A.L.S., Literature Search: H.M.D., A.L.S., Writing: A.S., H.M.D., A.N.K.,

Conflict of Interest: One author of this article, (Ahmet Nihat Karakoyunlu) is a member of the Editorial Board of the Bulletin of Urooncology. However, he did not take part in any stage of the editorial decision of the manuscript. The editors who evaluated this manuscript are from different institutions. The other authors declared no conflict of interest.

Financial Disclosure: The authors declared that this study received no financial support.

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