Original article

Open anterograde anatomic radical prostatectomy: a resource-sparing alternative to robotic surgery in a university training center

Prostatectomía radical anatómica anterógrada abierta versus cirugía robótica: resultados comparativos de un centro académico de formación

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Abstract

Purpose: to compare perioperative and oncological outcomes between open anterograde anatomic radical prostatectomy (AORP) and robot-assisted radical prostatectomy (RARP), both performed following the same dissection principles, in a single academic training center.
Materials and methods: a retrospective cohort of 252 consecutive patients with localized prostate cancer undergoing radical prostatectomy at a public university hospital was analyzed. AORP was performed in 126 patients (2016–2019) and RARP in 126 (2021–2023). Evaluated outcomes included operative time, estimated blood loss, length of hospitalization, postoperative complications (Clavien–Dindo), and biochemical recurrence at 1 and 2 years. Non-parametric and categorical statistical tests were applied ($p < 0.05$).
Results: patients undergoing RARP were younger (median 61 vs. 63 years, $p = 0.009$) and presented with lower ISUP grades. RARP demonstrated longer operative times (203 vs. 140 minutes, $p < 0.001$), while blood loss, hospital stay, and complication rates were similar between groups. Biochemical recurrence rates were 9.6 % vs. 18.3 % at 1 year ($p = 0.069$), and identical at 2 years (18.3 % in both groups, $p = 1.000$).
Conclusions: in this retrospective cohort, no statistically significant differences were observed between AORP and RARP in estimated blood loss, length of hospital stay, postoperative complications, or biochemical recurrence during the two-year follow-up period. Although these findings should not be interpreted as evidence of equivalence, they support the feasibility and perioperative safety of AORP as an alternative to robotic radical prostatectomy, particularly in settings where access to robotic systems is limited or unavailable.

Keywords: prostate cancer, radical prostatectomy, robotic surgery, open anterograde technique, surgical training, cost-effectiveness

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Citation: Borges Carrerette F., Bouzas Rodeiro D., da Silva Polonia A. B., Chilao Guedes F. V., Rodrigues Óliveira A. *Open anterograde anatomic radical prostatectomy: a resource-sparing alternative to robotic surgery in a university training center. Rev Mex Urol. 2026;86(4)*:1-11.

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Recived: January 18, 2026
Accepted: July 1, 2026

Resumen

Objetivo: comparar los resultados perioperatorios y oncológicos entre la prostatectomía radical anatómica anterógrada abierta (AORP) y la prostatectomía radical asistida por robot (RARP), ambas realizadas siguiendo los mismos principios de disección, en un único centro académico de formación.

Materiales y métodos: se analizó una cohorte retrospectiva de 252 pacientes consecutivos con cáncer de próstata localizado sometidos a prostatectomía radical en un hospital universitario público. La técnica AORP se realizó en 126 pacientes (2016–2019) y la RARP en 126 pacientes (2021–2023). Los desenlaces evaluados incluyeron tiempo operatorio, pérdida sanguínea estimada, duración de la hospitalización, complicaciones posoperatorias (Clavien–Dindo) y recurrencia bioquímica a 1 y 2 años. Se aplicaron pruebas estadísticas no paramétricas y categóricas ($p < 0.05$).

Resultados: los pacientes sometidos a RARP eran más jóvenes (mediana 61 vs. 63 años, $p=0.009$) y presentaban grados ISUP más bajos. La RARP mostró tiempos operatorios más prolongados (203 vs. 140 minutos, $p<0.001$), mientras que la pérdida sanguínea, la estancia hospitalaria y las tasas de complicaciones fueron similares entre los grupos. Las tasas de recurrencia bioquímica fueron de 9.6 % vs. 18.3 % al año ($p = 0.069$) y fueron idénticas a los 2 años (18.3 % en ambos grupos, $p = 1.000$).

Conclusiones: el abordaje anatómico anterógrado abierto obtuvo resultados perioperatorios y oncológicos equivalentes a la cirugía robótica, a pesar de ser realizado predominantemente por residentes en un entorno de formación con recursos limitados. La AORP representa una alternativa quirúrgica segura, eficaz y costo-eficiente para la prostatectomía radical en contextos donde los sistemas robóticos no están disponibles.

Palabras clave: cáncer de próstata, prostatectomía radical, cirugía robótica, técnica anterógrada abierta, formación quirúrgica, rentabilidad

Introduction

Radical prostatectomy remains a standard treatment option for localized prostate cancer in patients with a life expectancy greater than 10 years. With the evolution of surgical techniques, the robotic-assisted approach has gained prominence due to potential benefits in precision, ergonomics, and minimally invasive access. However, the high cost and limited availability of robotic platforms in many healthcare systems necessitate the exploration of effective open alternatives.[1–4]

The anterograde anatomic approach, when applied to open surgery, mimics the dissection sequence of the robotic technique, potentially providing similar functional and oncological outcomes without the associated technological expense.[4–8] This study aims to compare the perioperative outcomes, complication rates, and short-term oncologic control between open anterograde anatomic radical prostatectomy (AORP) and robotic-assisted radical prostatectomy (RARP), both performed with the same surgical dissection logic, in a public academic hospital.[9]

Patients and methods

This retrospective study included 252 patients with localized prostate cancer, confirmed by prostate biopsy and treated with radical prostatectomy at the Urology Service of Pedro Ernesto University Hospital, State University of Rio de Janeiro (HUPE-UERJ), Brazil. The first 126 consecutive cases treated with anterograde open radical prostatectomy (AORP) and the first 126 treated with robot-assisted radical prostatectomy (RARP) were included. AORP cases were performed between March 2016 and February 2019, while RARP cases were performed between October 2021 and January 2023.

The study received approval from the institutional Ethics Committee (Comitê de Ética em Pesquisa do HUPE/UERJ) in November 2015 (approval number: 1.335.683) and was conducted in accordance with the ethical standards outlined in the 1964 Declaration of Helsinki and its subsequent amendments. The study was registered in the Brazilian research registry Plataforma Brasil (CAAE: 41908815.9.0000.5259) on November 17, 2015, and in ClinicalTrials.gov (identifier: NCT02687308) on February 22, 2016. Informed consent was obtained from all participants, including consent for publication of anonymized data.

According to institutional practice, AORP procedures were performed by second-year urology residents under faculty supervision. In contrast, RARP procedures were performed by attending urologists during robotic training under the supervision of an experienced robotic proctor. AORP was conducted under spinal anesthesia with or without sedation, whereas RARP was performed under general anesthesia. Surgical steps followed the recommendations of the 2012 Pasadena Consensus Panel on robotic prostatectomy.9 The AORP technique used in this study has been described in detail in previous publications.[5–8]

Primary outcomes were assessed during a 24-month follow-up period and included:

1. Technical outcomes: operative time, estimated blood loss, intraoperative and postoperative complications (graded according to the Clavien–Dindo classification), and length of hospital stay.
2. Oncological outcomes: biochemical recurrence (BCR), defined as a postoperative serum PSA ≥ 0.2 ng/mL confirmed during follow-up.

Patients were monitored through routine postoperative consultations, serial PSA measurements, and evaluation for medical and surgical complications.

Statistical analysis

Statistical analyses were performed using Python (Python Software Foundation, Wilmington, DE, USA) with the scipy, numpy, and matplotlib libraries. The RARP and AORP groups were compared with respect to clinical, pathological, perioperative, and oncological variables.

Continuous variables were summarized as medians and interquartile ranges (IQR) and compared using the non-parametric Mann–Whitney U test, as data did not follow a normal distribution. Categorical variables were compared using Pearson's chi-square test or Fisher's exact test, as appropriate.

Biochemical recurrence rates were compared between groups at predefined follow-up intervals of 1 and 2 years using categorical statistical methods. Patients with incomplete data for a specific outcome were excluded only from that particular analysis.

Descriptive graphical analyses were performed using boxplots and bar charts to illustrate data distributions and group comparisons. Statistical significance was defined as a two-sided p-value < 0.05.

Results

Patient characteristics differed between the two groups (RARP and AORP) with respect to age and ISUP grade. Patients selected for robotic surgery tended to be younger and present with lower ISUP scores, a statistically significant difference. No significant difference was observed in preoperative PSA levels between groups

Pathological staging, assessed according to the TNM classification, showed a median pathological stage of pT2c in both groups. However, the interquartile range (IQR) was narrower in the RARP group (2.75–3.0) compared to the AORP group (3.0–4.0), indicating greater variability and a higher proportion of advanced pathological stages in the AORP cohort (p = 0.0002). These findings suggest that patients in the AORP group were more likely to present with locally advanced disease at the time of surgery (Table 1).

Table 1. Preoperative characteristics of patients in the RARP and AORP groups

Variable	RARP 126		OARP 126		*p value*
	Median	IQR	Median	IQR	
Age in years	63	57 - 63	61	60 - 68	***0.0089***
PSA ng/mL	8.88	5.04 – 10.72	9.46	5.79 – 12.19	*0.407*
ISUP	3	2 - 3	3	3 - 3	***0.0463***
	RARP 115		**OARP 113**		***p value***
	N	%	N	%	
pT2a	5	4.3 %	6	5.3 %	
pT2b	10	8.7 %	6	5.3 %	< ***0.001***
pT2c	94	81.7 %	78	69.0 %	
pT3	6	5.2 %	23	20.4 %	

IQR: Interquartile Range (Q1–Q3)

Mann-Whitney U test

PSA: Prostate specific antigen RARP: Robotic assisted radical prostatectomy OARP: Open Anterograde Anatomic Radical Retropubic Prostatectomy

Operative time was significantly longer in the RARP group compared to the AORP group. The median operative time for RARP was 203 minutes (IQR: 178.0–229.0), versus 140 minutes (IQR: 120.0–152.5) for AORP (U = 10149.5, $p < 0.001$) (Table 2).

Median estimated blood loss was 300 mL in the RARP group and 350 mL in the AORP group. The IQR was identical between groups (200–500 mL), and no statistically significant difference was observed (U = 6003.0, $p = 0.318$). Despite a slightly higher median in the AORP group, the overall variability in blood loss was comparable between techniques.

The median length of hospital stay was 3 days for both RARP and AORP. The IQR was 3.0–4.75 days in the RARP group and 2.0–4.0 days in the AORP group. This difference was not statistically significant ($p = 0.171$) **(Table 2).**

Table 2. Perioperative outcomes in the RARP and AORP groups

Variable	RARP 126		OARP 126		*p value*
	Median	IQR	Median	IQR	
Operative time	203	178 - 229	140	120 - 152	*<0.001*
Estimated blood loss (ml)	300	180 - 400	350	200 - 400	*0.318*
Hospitalization days	3	3 – 4.75	3	2 - 4	*0.171*

IQR: Interquartile Range (Q1–Q3)

Mann-Whitney U test

PSA: Prostate specific antigen
RARP: Robotic assisted radical prostatectomy
OARP: Open Anterograde Anatomic Radical Retropubic Prostatectomy

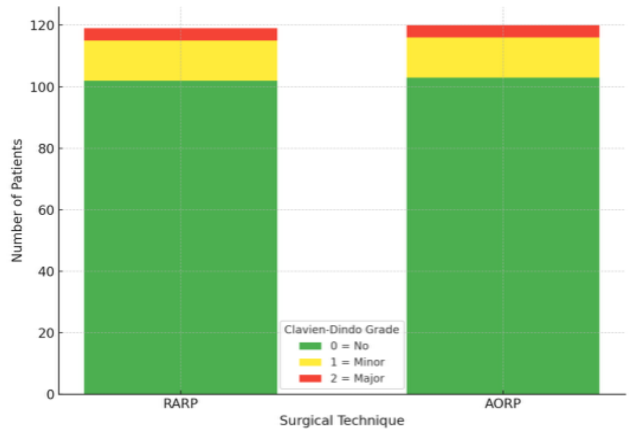
	RARP 119	OARP 120	
	Number %	Number %	*p value*
Complications (Clavien Dindo)	24 (20.2 %)	22 (18.3 %)	*0.812*
Minor < 3	21 (17.6 %)	18 (15 %)	
Major > 3	3 (2.5 %)	4 (3.3 %)	*0.719*

Chi-square test

RARP: Robotic assisted radical prostatectomy
OARP: Open Anterograde Anatomic Radical Retropubic Prostatectomy

Postoperative complications were similarly distributed between groups. Complete complication data were available for 119 patients in the RARP group and 120 patients in the AORP group. Overall complications occurred in 24 patients (20.2 %) in the RARP group and in 22 patients (18.3 %) in the AORP group. Minor complications occurred in 21 patients (17.6 %) and 18 patients (15.0 %), respectively, whereas major complications occurred in 3 patients (2.5 %) and 4 patients (3.3 %), respectively. No statistically significant difference was observed in the distribution of complication severity between the two surgical approaches (Figure 1).

Figure 1. Distribution of postoperative complications according to the Clavien–Dindo classification in the RARP and AORP groups



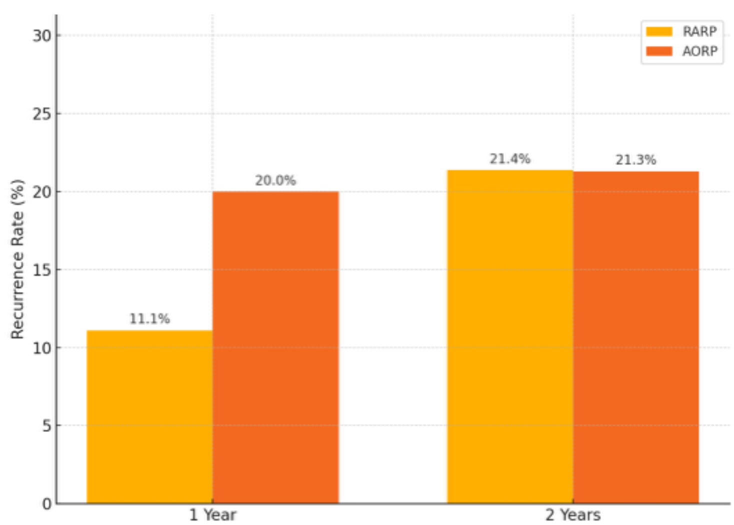
Abbreviations: AORP = Anterograde Open Radical Prostatectomy; RARP = Robot-Assisted Radical Prostatectomy.

Postoperative complications distributed between the AORP and RARP groups according to the Clavien–Dindo classification. Minor (Grade I–II) complications occurred in 18 patients (14.3 %) in the AORP group and 21 patients (16.7 %) in the RARP group. Major (Grade III–V) complications were observed in 4 patients (3.2 %) in the AORP group and 3 patients (2.4 %) in the RARP group.

At 1-year follow-up, biochemical recurrence was identified in 9.6 % of RARP patients and 18.3 % of AORP patients. Although recurrence appeared more frequent in the AORP group, the difference did not reach statistical significance (p = 0.069, Fisher's exact test).

At 2 years, biochemical recurrence was observed in 18.3 % of patients in both groups, with no statistically significant difference between them (p = 1.000) (Figure 2).

Figure 2. Biochemical Recurrence Rates at 1 and 2 years



Abbreviations: AORP = Anterograde Open Radical Prostatectomy; RARP = Robot-Assisted Radical Prostatectomy.

Bar chart comparing biochemical recurrence rates at 1 and 2 years between robot-assisted radical prostatectomy (RARP) and anterograde open radical prostatectomy (AORP). While a trend toward lower 1-year recurrence was observed in the RARP group, the difference was not statistically significant ($p = 0.069$). At 2 years, no statistically significant difference in biochemical recurrence was observed between groups ($p = 1.000$).

Discussion

The present study evaluated perioperative and short-term oncological outcomes of Open Anterograde Anatomic Radical Prostatectomy (AORP) and Robot-Assisted Radical Prostatectomy (RARP) in a university training center. To our knowledge, this is the first direct comparison between these approaches. AORP was developed to reproduce, through an open approach, key principles of robotic radical prostatectomy, including anterograde dissection, early vascular pedicle control, preservation of anatomical structures, and running vesicourethral anastomosis. In this retrospective cohort, no statistically significant differences were observed between groups in estimated blood loss, length of hospital stay, postoperative complications, or biochemical recurrence during the two-year follow-up period.

These findings should be interpreted in light of important baseline imbalances. Patients undergoing RARP were younger and had more favorable pathological characteristics, whereas the AORP group included a higher proportion of locally advanced tumors. These differences may have confounded perioperative and oncological comparisons. Therefore, the results should be considered exploratory and not definitive evidence of comparative effectiveness.

Operative time was significantly longer in the RARP group, but both cohorts were affected by learning-curve effects. RARP procedures were performed during the initial implementation of robotic surgery at our institution, including docking and setup time. Conversely, the AORP cohort represented the initial institutional experience with this technique, and most procedures were performed by second-year urology residents during their first exposure to radical prostatectomy under direct supervision. Thus, the observed difference in operative time may reflect both platform-related factors and differences in training and institutional implementation.

Estimated blood loss and hospital stay were similar between groups. Although robotic surgery has generally been associated with lower blood loss and shorter hospitalization than conventional open retropubic prostatectomy,[1,3,10–13] previous comparisons have predominantly involved the traditional retrograde open approach. Several features of AORP may contribute to the present findings, including early vascular pedicle control, preservation of the endopelvic and Denonvilliers' fasciae, nerve-sparing dissection when feasible, delayed urethral transection, preservation of the bladder neck, and a running vesicourethral anastomosis. These results suggest that anatomical dissection and reconstructive principles may influence perioperative recovery independently of the surgical access route.

The conceptual basis of AORP is that adherence to anatomical and oncological principles may be as relevant to surgical outcomes as the operative platform itself. Previous studies comparing AORP with conventional retrograde open prostatectomy demonstrated favorable perioperative and functional outcomes, including reduced blood loss and earlier recovery of urinary continence.[5–8,14–18] Although functional outcomes were not assessed in the present study, the current findings support the feasibility and reproducibility of AORP within a university training environment.

No statistically significant differences were observed in the frequency or severity of postoperative complications according to the Clavien–Dindo classification.[19] These findings suggest that both approaches can provide acceptable perioperative safety when performed within structured training programs and under appropriate supervision. They also highlight the importance of surgical standardization, high-volume surgical practice, structured perioperative care pathways, and institutional experience in minimizing adverse events.

No statistically significant difference in biochemical recurrence was observed during the two-year follow-up period. Recurrence was numerically lower in the RARP group at 1 year, although this difference did not reach statistical significance and was no longer present at 2 years. Because the study was not designed as a non-inferiority or equivalence trial and the cohorts differed in baseline pathological characteristics, these findings should not be interpreted as evidence of oncological equivalence. Rather, they indicate acceptable short-term oncological control with both approaches in this cohort. Prospective studies with balanced groups, longer follow-up, standardized functional assessments, and time-to-event analyses are needed to define their relative long-term outcomes.

Study limitations

This study has several limitations. Its retrospective, non-randomized design may have introduced selection bias, particularly because the groups differed at baseline. Patients undergoing RARP were generally younger and had less advanced disease, whereas the AORP cohort included a higher proportion of locally advanced tumors. In addition, the non-contemporaneous study periods—2016–2019 for AORP and 2021–2023 for RARP—may have introduced temporal bias related to changes in imaging, patient selection, perioperative care, and institutional experience.

The procedures were also performed in different educational settings. AORP was predominantly carried out by second-year urology residents under faculty supervision and involved multiple surgeons with relatively low individual surgical volumes. In contrast, RARP was performed by experienced attending urologists during robotic training under the supervision of an experienced proctor. Differences in surgeon experience, training level, and operative volume may therefore have influenced outcomes independently of the surgical approach.

Functional outcomes, including urinary continence, erectile function, quality of life, catheterization time, and return to normal activities, were not assessed because these data were not uniformly available. Positive surgical margin status was also incomplete and could not be reliably analyzed. Moreover, no formal economic evaluation was performed; therefore, conclusions regarding cost-effectiveness cannot be drawn from the present study.

Finally, oncological follow-up was limited to two years, and recurrence was assessed at fixed time points rather than through time-to-event analysis. Future prospective studies should include balanced contemporaneous cohorts, standardized functional and quality-of-life assessments, positive surgical margins, formal economic evaluation, and longer oncological follow-up.

Conclusion

In this single-center retrospective study, no statistically significant differences were observed between AORP and RARP in estimated blood loss, length of hospital stay, postoperative complications, or biochemical recurrence during the two-year follow-up period.

Although the study design does not permit conclusions regarding equivalence or non-inferiority, the findings support the feasibility and perioperative safety of AORP as an alternative to robotic radical prostatectomy, particularly in academic training centers and healthcare systems where access to robotic platforms remains limited.

Use of artificial intelligence

The authors used ChatGPT (OpenAI, San Francisco, CA, USA) exclusively to assist with language editing, manuscript organization, and code generation for data visualization. All statistical analyses, data verification, interpretation of results, and scientific conclusions were independently performed, reviewed, and validated by the authors.

Funding

No external funding was received.

Conflict of interest

The authors declare no conflicts of interest.

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