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ROBOTIC RADICAL PROSTATECTOMY VS. OPEN RADICAL PROSTATECTOMY – A LITERATURE REVIEW

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INTRODUCTION

Worldwide, prostate cancer (PC)[1]is the second most common type of cancer in men. Prostate-specific antigen (PSA) enables early detection and treatment[2,3]. Perineal radical prostatectomy (PRP) provides excellent urinary structure exposure , but is not widely used[4]. Retropubic radical prostatectomy (RRP), the gold standard for oncological results, is traditionally used in localized PC[5,6].

Open radical prostatectomy (ORP) has its own difficulties, such as a narrow surgical field and voluminous bleeding[(6)]. Robot-assisted RP (RARP)[(7-9)] initially showed greater operative dexterity, physician comfort[(2,10,11)], patient quality of life, less intraoperative bleeding, and shorter hospital stays, with positive surgical margin (PSM) rates equivalent to those of RRP[(12-16)].

Radical prostatectomy (RP) aims at cure and minimal functional impairment (urinary incontinence-UI and erectile dysfunction-ED)[12] , being influenced by the surgeon's experience[8] , learning curve, performance[7,17,18] and annual surgical volume[19] , which varies between small and large hospitals[5,7] .

PRAR provides greater magnification and high precision in the operating field compared to PRA[20], favoring MCP rates[21,22]and preservation of neurovascular bundles (NVB)[21,23], benefiting sexual potency (SP)[24] , reducing bleeding[24-28] , hospitalization time[24,25,27,29,30] and postoperative pain[31,27] . Incisional hernia (IH), more commonly associated with PRAR, is rarely discussed[24]in the literature.

There is no consensus on the superiority of either technique in terms of oncological[8,11,31-33] and functional[33,34] outcomes. The presence of MCP is associated with biochemical recurrence (BCR) and the risk of progression of CP[35-37] . Functional outcomes impact quality of life[((5,3,31,38)) and]require a longer period of time for evaluation[22,39,40]. Greater bleeding and transfusion[41,42,30] are associated with worse outcomes regardless of the technique, with low intraoperative bleeding being related to greater medical experience[12] .

There is a lack of robust evidence of the superiority of PRAR[5,23,39,40] in localized CP, especially in functional outcomes[33,34] and oncological outcomes[32] , in the medium and long term[19,43] . The objective is to review the literature between 2014 and 2024, seeking publications that compare PRAR to PRA in localized CP, or describe PRAR outcomes. Functional, oncological, perioperative, and postoperative results and quality of life will be evaluated.

METHODOLOGY

An integrative review using a cross-sectional, retrospective, and qualitative approach was conducted in the BVS and PubMed databases, using the Boolean operator "AND" and the following descriptors: "prostate cancer," "radical prostatectomy," "robotic," "open surgery," and "outcomes." Observational studies, randomized controlled clinical trials, and non-randomized studies published from 2014 to 2024 in English, Portuguese, and Spanish, with full text, were included. Articles outside the scope of the study, without a clear theoretical basis, and those that compared only PRAR and laparoscopic PR (PRL) were excluded.

RESULTS

A total of 1,237 articles were found (682 in PubMed and 555 in BVS); 56 were selected (15 in PubMed and 41 in BVS), and 16 duplicates between the two data platforms were removed from the BVS database, in addition to nine repeated articles in that database (Figure 1).

Of the 56 articles, 46 are observational, 1 is a randomized controlled clinical trial, and 9 are non-randomized (Table 1). Three address PRAR exclusively, 29 compare PRAR to PRA, and 8 compare both to PRL. Five address PRAR alone, and one compares PRAR and PRA, all in terms of robotic technology. Nine address the effect of the learning curve in RARP, previous experience, and/or annual volume, solely on its results or comparing it to RAP. One compares RARP to technically modified RARP.

FUNCTIONAL RESULTS

IU was defined in the articles described in this study as: use of up to one sanitary pad/day[40,64] , no pads/day[59], or a gradation thereof[6,39,64] ; the concept of "urinary discomfort"[(,32] , international questionnaires[39,45,54] , and the inclusion of complaints of dysuria/stranguria were also used. For erectile function (EF), there were also different definitions, with the ability to maintain an erection for sexual intercourse for more than half the time being the most commonly used[40] .

Articles showed the superiority of PRAR in the urinary domain (UD) at 3[6.64] , 6[4.46,64] , 24[61] , and 36[30] months; of PRA at 3[63] and at 24[5] months, and indifference at: 3[34, 59] , 6[6, 34, 44, 45, 59, 62, 67] , 12[4, 6, 12, 31, 32, 34,39, 44, 46, 56, 57, 59, 62, -64, 67, 68] , 24 [4, 5, 32, 40, 44, 54, 59, 63] and 36[19, 62] months, and 8[60] and 10[36] years. In the sexual domain (SD), PRAR benefited: 3[23, 31, 68], 6[46, 69], 12[6, 32, 39, 46, 57, 62, 68, 69], 24[30, 40, 69] , 36[62, 69] months, and 8[60] years; PRA only at 24[32] months; with no difference at: 3[34, 59, 63], 6[34, 44, 45, 59, 62, 67], 12[31, 34, 44, 59, 63, 67], 24[5, 39, 44, 59, 63, 67] , 36[19] months, and 10[36] years. In high-risk patients, PRA[23, 61] benefited DU at 24 months.

Considering the annual number of PRARs prior to the study[62] (1-3 surgeries - low; 4-10 - medium; greater than or equal to 11 - high), there was better DU recovery in patients operated on by physicians in the first group compared to those in the last group at six months.There was less DS in those operated on by the latter group compared to those who had the procedure performed by those with medium volume, but this was not observed in the follow--up[62]. DS, which benefited at 24 months from PRA, ended up being impacted by volume[32], .

Considering the learning curve, PRAR, which was initially associated with worse results than PRA in terms of UD, improved it at 12 and 24 months, but not SD[7].

Results of non-comparative studies are shown in Table 2.

ONCOLOGICAL RESULTS

Residual disease is defined as the occurrence of measurable PSA levels above 0.25 ng/mL at 3 months of postoperative follow-up and/or adjuvant treatment (also called biochemical recurrence or BCR)[40]. The lowest residual disease rate in this review showed two results in favor of robotics and six indifferent to the approaches. On the other hand, the rate of recurrent cancer (PSA value above 0.25 ng/mL at 12 or 24 months after an undetectable PSA value at

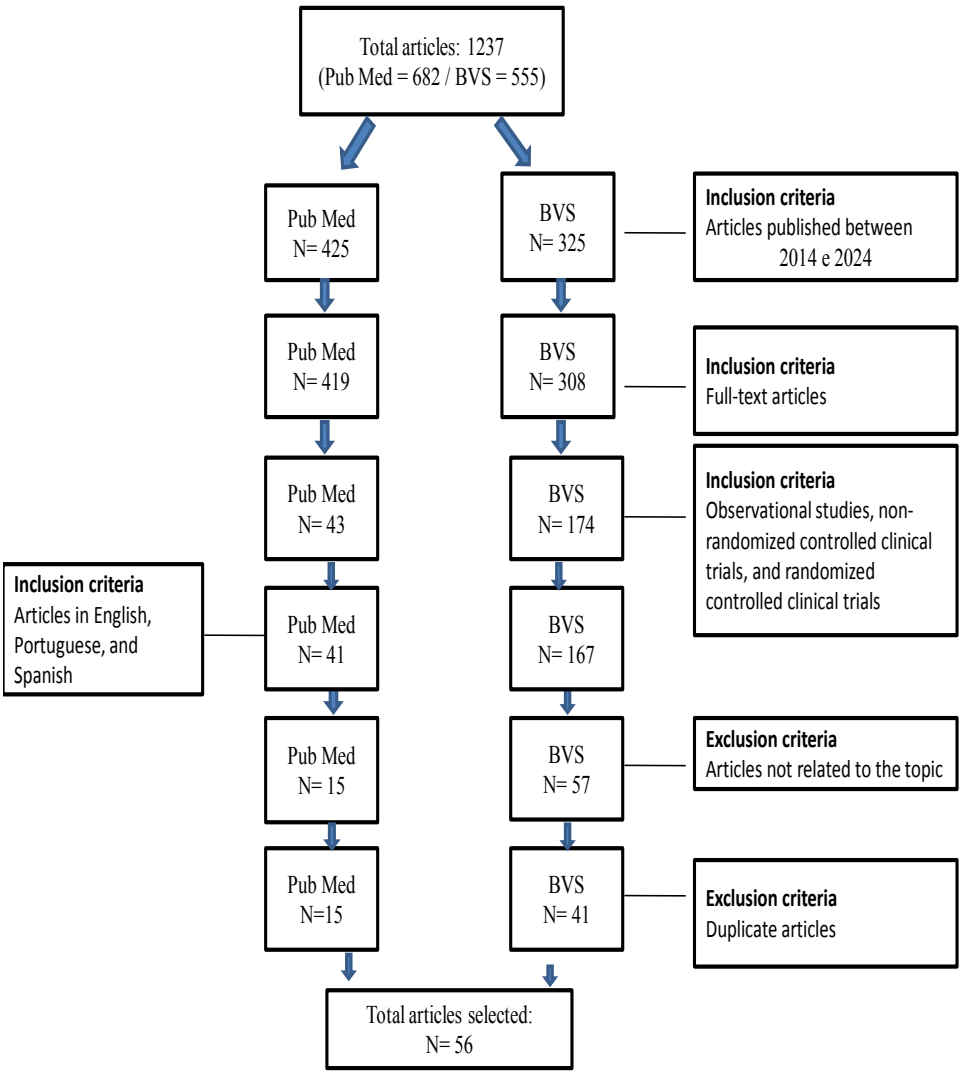

Figure 1. Flowchart of identification and selection of articles in the PubMed and BVS databases.

Source: Authors 2024.

Author/ Year	Title	Type of study	Main conclusions
Fan S et al 2023	Robot-Assisted Laparoscopic Radical Prostatectomy Using the Kang Duo Surgical Robot System *vs* the da Vinci Si Robotic System.	Observational (n= 32)	Similarity between the systems for oncological outcomes, length of hospital stay, blood loss, and DU at three months. Surgical time was shorter with the da Vinci Si system. There were no operative conversions.
Rechtman M et al. 2022	Comparison of urinary and sexual patient-reported outcomes between open radical prostatectomy and robot-assisted radical prostatectomy: a propensity score matched, population-based study in Victoria	Observational (n= 3826)	The approaches were indifferent in terms of DU at 12 months. In DS, there was a slight difference in favor of PRAR, but it was considered that there was no significant difference.
Bock D et al. 2022	Learning curve for robot-assisted laparoscopic radical prostatectomy in a large prospective multicenter study	Non-randomized controlled clinical study (n= 2672)	The impact of each surgeon's previous experience and the volume of surgeries performed by each surgeon in the study was evaluated. FE was positively impacted (up to 24 months) by the increase in surgical volume, but the same was not observed for IU, MCP, and BCR, the latter over four years.
Fan S et al. 2022	Robot-Assisted Radical Prostatectomy Using the KangDuo Surgical Robot-01 System: A Prospective, Single-Center, Single-Arm Clinical Study	Observational (n= 16)	MCP occurred in four (25%) patients.
Gudmundsdottir HH et al. 2022	Transition from open to robotically assisted approach on radical prostatectomies in Iceland. A nationwide, population-based study	Observational (n= 160)	PRAR benefited: intraoperative bleeding, Clavien complications ≤ III, and hospital stay, prolonged hospital stay (>2 days), and urinary catheterization times. The approaches were similar for: operative time, peroperative transfusion, readmission within 30 days, BCR-free survival, metastasis-free survival, death from CP within two years, and MCP.
Gray WK, Day J, Briggs TWR, Harrison S. 2022	An observational study of volume-outcome effects for robot-assisted radical prostatectomy in England	Observational (n= 35,629)	Length of stay and readmission within 90 days were impacted by the volume of PRARs performed (one year prior to and during the study). This was not observed for one-year mortality.

Sancı A et al. 2021	Perioperative adverse events and functional outcomes following open and robot-assisted prostatectomy in patients over age 70	Observational (n= 251)	Functional outcomes at 3, 6, 12, and 24 months were similar between techniques even after taking into account the degree of FNV preservation (no sanitary pads per day and sufficient erection for intercourse were the definitions used). PRAR reduced the rate of urine leakage through the anastomosis, drainage catheter removal time, bleeding, and postoperative pain in the immediate post . The medians for hospital stay, surgery time, and urethral catheter removal were shorter in PRAR. There were two cases of HI in PRA and no cases in PRAR.
Wu SY et al. 2021	Comparison of Acute and Chronic Surgical Complications Following Robot-Assisted, Laparoscopic, and Traditional Open Radical Prostatectomy Among Men in Taiwan	Observational (n= 1407)	PRAR compared to PRA reduced the risk of transfusion, length of hospital stay, hospital readmission, and severe/ moderate postoperative pain, UI, ED from 24 months onwards, and incidence of hernia from three years post-surgery.
Lantz A et al. 2021	Functional and Oncological Outcomes After Open Versus Robot-assisted Laparoscopic Radical Prostatectomy for Localized Prostate Cancer: 8-Year Follow-up	Non-randomized controlled clinical study (n= 3584)	Patients aged <75 years were included in the study. The techniques yielded similar results for BCR, residual disease, MCP, and all-cause mortality and IU after 8 years, even after taking into account the degree of preservation of the FNV or the heterogeneity of medical experience. In high-risk patients, PRAR was beneficial in the same period for: ED, PC-specific mortality, BCR, and MCP.
Nyberg M et al. 2021	Surgeon heterogeneity significantly affects functional and oncological outcomes after radical prostatectomy in the Swedish LAPPRO trial	Non-randomized controlled clinical trial (n= 4003)	The impact on PRAR and PRA of the annual surgical volume performed by the physician during the study, prior experience, and/or degree of NVP preservation was evaluated in a 24- -month follow-up. The difference in favor of PRA in terms of IU increased when annual volume was taken into account; when adjusted for pre-study experience, this difference between practices disappeared. With regard to ED, when previous surgical experience was taken into account, the initial similarity between the techniques became in favor of PRAR; and when the degree of preservation of the FNV or the surgical volume was taken into account, this difference was reduced. Regarding the combined rate - biochemical recurrence (BCR) and/or residual disease - neither previous experience nor surgical volume changed the similarity found between the approaches (at 2 years).

Hagman A et al. 2021	Urinary continence recovery and oncological outcomes after surgery for prostate cancer analyzed by risk category: results from the LAParoscopic prostatectomy robot and open trial	Non-randomized controlled clinical study (n= 2650)	In the high-risk group, within 24 months, PRA benefited urinary continence recovery; PRAR benefited the MCP rate, and both were indifferent to BCR. However, BCR benefited from PRAR when all strata were observed together.
Timm B , et al. 2020	Are we failing to consent to an increasingly common complication? Incisional hernias at robotic prostatectomy	Observations on (n= 186)	HI rate (at the specimen removal site) = 8.6%; incidental hernia rate (at the lateral portal site) = 1.1%. Diagnosis occurred on average 12 months after surgery.
Reisz PA et al. 2020	Assessing the Quality of Surgical Care for Clinically Localized Prostate Cancer: Results from the CEASAR Study	Observational (n= 1069)	The rates of indicated pelvic lymphadenectomy, preservation of FNV, MCP, DU, and DS at 6, 12, and 36 months were similar among the three groups (low, medium, and high surgical volume). Comparing the low- and high-volume groups, there was better urinary continence at 6 months in the former group, but this difference did not persist at 12 or 36 months. Comparing PRAR and PRA, the former was beneficial for complications and sexual function at 12 and 36 months but not at 6 months; for the same segments, the techniques did not differ in terms of DU, as well as for the rates of indicated pelvic lymphadenectomy, preservation of FNV or MCP for pT2.
Kretschmer A et al 2020	Health-related quality of life after open and robot-assisted radical prostatectomy in low- and intermediate-risk prostate cancer patients: a propensity- -score-matched analysis	Observational (n= 418)	RPA benefited urinary continence recovery at 3 months, but not at 12 or 24 months, as well as quality of life, assessed on an equal time- . Regarding SD, the techniques were indifferent at the same assessment points.
Abdel Raheem A et al. 2020	Retzius-sparing robot-assisted radical prostatectomy versus open retropubic radical prostatectomy: a prospective comparative study with 19-month follow-up	Observational (n= 184)	Patients aged ≥ 70 years were excluded from the study. Those who underwent PRAR (Retzius-Sparing) benefited in terms of bleeding rates, risk of transfusion, postoperative pain, and length of hospital stay. Urinary continence (0-1 urinary protector per day) benefited from PRAR at 3 and 6 months, but not at 12 months. There was no difference between the techniques in terms of urethral catheter stay, Clavien-Dindo complications ≤ IIIb or up to 30 days, MCP, and BCR- -free survival at three years, as well as CP mortality within two years and adjuvant treatment in the postoperative period.

Kim KH et al. 2020	Single-port robot-assisted radical prostatectomy with the da Vinci SP system: A single surgeon's experience.	Observational (n= 20)	The da Vinci single-port system was used. There were no intraoperative and/or postoperative complications ≥ Clavien-Dindo grade II. In those followed up for more than 3 months, BCR was observed in one patient whose tumor classification was ISUP 5.
Roscigno M et al. 2019	Extended pelvic lymph node dissection during radical prostatectomy: comparison between initial robotic experience of a high-volume open surgeon and his contemporary open series.	l observation (n=264)	The Da Vinci Si robotic model was used. A surgeon experienced only in RPS performed all RPs. RPS was divided into four quartiles; comparing the first with the last, MCP and operative and lymph node dissection times were significantly reduced. Overall complications and the number of lymph nodes did not differ when comparing all quartiles. When comparing PRAR and PRA, MCP, operating time, number of lymph nodes, and their extended dissection were significantly higher in PRAR.
Preisser F et al. 2019	Impact of the estimated blood loss during radical prostatectomy on functional outcomes	Observational (n= 8,999)	High blood loss during RP was an independent predictor of ED at 12 months and UI seven days after catheter removal. Blood transfusion was an independent predictor of urinary continence at seven days and three months. At 12 months, both techniques were similar in terms of urinary continence, even when taking into account the risk of high blood loss.
Wallerstedt A et al. 2019	Quality of Life After Open Radical Prostatectomy Compared with Robot- -Assisted Radical Prostatectomy.	Non-randomized controlled clinical study (n=4,003)	There was no difference between the techniques in terms of quality of life at 3, 12, and 24 months.
Ng CF et al. 2019	Robot-assisted single-port radical prostatectomy: A phase 1 clinical study	Observational (n=20)	The da Vinci single-port system was used. There were no intraoperative complications or surgical conversions. Postoperative complications were Clavien grade I-II.
Desai A et al 2019	Contemporary Comparison of Open to Robotic Prostatectomy at a Veteran's Affairs Hospital	Observational (n= 244)	The first 50 PRAR patients compared to the last 53 robotic cases had shorter operating times, hospital stays, bleeding, and adverse effects. The operating time in the latter group was shorter compared to PRA. Comparing PRAR and PRA, robotics showed: reduction in blood transfusion, Clavien >II complications, hospital stay in 90 days, ICU readmissions, and urinary loss. Both were similar for urinary continence and FE at 12 months, MCP, and number of lymph nodes removed.

Shin DW et al. 2019	Health-Related Quality of Life Changes in Prostate Cancer Patients after Radical Prostatectomy: A Longitudinal Cohort Study.	Observational (n= 209)	The approaches were indifferent in terms of urinary continence recovery at 12 months; in terms of sexual activity, at three months it was significantly better in PRAR, however at 12 months, it was indifferent between them. Pain improvement at one year of follow-up was greater in PRA than in PRAR.
Pak S, Kim M, Ahn H. 2018	Changes in health-related quality of life after radical prostatectomy for prostate cancer: A longitudinal cohort study in Korea	Observational (n= 211)	The DU was similar in both approaches at 12 months. The DS was significantly higher in PRAR at three and 12 months.
Boeri L et al. 2018	Depressive symptoms and low sexual desire after radical prostatectomy: early and long-term outcomes in a real-life setting	Observational (n= 811)	FE recovery was greater in PRAR at all follow-up points: 6, 12, 24, and 36 months. Sexual desire was highly affected after PR, with greater impairment in those undergoing PRA at all assessment points. Those who underwent PRAR reported fewer depressive symptoms compared to those who underwent PRA at all follow--up points, as well as greater sexual and orgasmic satisfaction. Age, PRA, and postoperative ED were independent predictors of depression and impaired libido.
Sooriakumaran P et al 2018	Erectile Function and Oncologic Outcomes Following Open Retropubic and Robot-assisted Radical Prostatectomy: Results from the LAParoscopic Prostatectomy Robot Open Trial	Non-randomized controlled clinical study (n= 1,702)	EF recovery in high-risk patients was significantly greater in PRA at 24 months; in low/intermediate-risk patients, recovery was greater in PRAR at three months. The degree of preservation of the NVP and recovery of EF were strongly correlated with PRAR. MCPs were more frequent in PRAR compared to PRA in patients with pT2, and BCR was similar between both in the same period.
Koizumi A et al. 2018	Incidence and location of positive surgical margin among open, laparoscopic, and robot-assisted radical prostatectomy in prostate cancer patients: a single institutional analysis	Observational (n= 450)	Overall, the risk of MCP was lower in PRAR. For patients with risk ≤ pT2, PRAR and PRA resulted in similar outcomes.
Jafri SM, Nguyen LN, Sirls LT. 2018	Recovery of urinary function after robotic-assisted laparoscopic prostatectomy versus radical perineal prostatectomy for early-stage prostate cancer	Observational (n= 558)	PRAR benefited urinary function recovery at six months, however, at 12, 18, or 24 months, it was similar to perineal PR.
Lo IS et al. 2018	Robot-Assisted Extraperitoneal Radical Prostatectomy, Single Site Plus Two Model	Observational (n= 20)	Two patients belonging to the intermediate risk group and with MCN presented BCR within one year.

Nyberg M et al. 2018	Functional and Oncologic Outcomes Between Open and Robotic Radical Prostatectomy at 24-month Follow-up in the Swedish LAPPRO Trial	Non-randomized controlled clinical trial (n= 4403)	The primary definition for urinary continence was use of up to 1 sanitary pad/day, and for ED it was insufficient erection for intercourse more than half the time. Regarding sexual potency, a significant difference was found in favor of PRAR at 24 months. r urinary continence, both techniques were similar, as well as for the combined rate of BCR/residual disease or recurrence of PC at 24 months.
Chang KD et al. 2018	Retzius-sparing robot-assisted radical prostatectomy using the Revo-I robotic surgical system: surgical technique and results of the first human trial.	Observational (n= 17)	Urinary continence was defined as the use of 0–1 pad/day. Three patients received blood transfusions; four MCPs were found; at three months, one patient had BCR and 15 had recovered urinary continence. There were no Clavien--Dindo complications above grade II.
Nossiter J et al. 2018	Robot-assisted radical prostatectomy vs laparoscopic and open retropubic radical prostatectomy: functional outcomes 18 months after diagnosis from a national cohort study in England	Observational (n= 2,019)	A slight but significant difference was found in sexual function in favor of PRAR compared to PRA, but this did not correspond to a clinically important difference. In terms of DU, PRAR and PRA were similar.
Thompson JE et al. 2018	Superior Biochemical Recurrence and Long-term Quality-of-life Outcomes Are Achievable with Robotic Radical Prostatectomy After a Long Learning Curve—Updated Analysis of a Prospective Single-surgeon Cohort of 2206 Consecutive Cases.	Observational (n= 2,206)	2,206 men were included, and only 1,045 self-reported on quality of life. PRAR was initially associated with worse outcomes than PRA for DU, DS, MCP, and BCR at 18 months; more favorable outcomes in these endpoints occurred after a substantial learning curve, with the exception of sexual function recovery, which was not impacted. There was little significance in the relationship between risk-MCP/learning curve and tumor staging, and there was no significance between risk-BCR/learning curve and pathological staging. Patients operated on by surgeons with high surgical volume may benefit from PRAR in terms of oncological and urinary outcomes.
Coughlin GD et al. 2018	Robot-assisted laparoscopic prostatectomy versus open radical retropubic prostatectomy: 24-month outcomes from a randomized controlled study	Randomized controlled clinical trial (n= 308)	Regarding DU and DS at 6, 12, or 24 months, both techniques were similar. BCR was lower in PRAR. The rate of cancer recurrence by imaging at 24 months and the risk of postoperative treatments were similar between the two techniques.

Kwon SY et al. 2017	Open radical prostatectomy reproducing robot-assisted radical prostatectomy: Involving antegrade nerve sparing and continuous anastomosis.	Observational (n= 322)	The same procedure as PRAR was used to perform PRA. Postoperative complications were similar (Clavien I and II), except for intraoperative bleeding, which was significantly lower in PRAR; surgery time was ly shorter in PRA; recovery of urinary continence at 3 months was significantly higher in PRAR, but at 6 and 12 months it was similar between the two approaches. ED at 12 months did not differ, nor did the rates of MCP and BCR at the same follow-up.
Antonelli A et al. 2017	Positive surgical margins and early oncological outcomes of robotic vs. open radical prostatectomy at a medium case-load institution	Observational (n=576)	A lower risk for MCP rates was found in PRAR, significantly related to MCP: pT>2, Gleason score>6, and the PRAR technique.
Nason GJ et al. 2017	Patient-reported functional outcomes following robotic-assisted (RARP), laparoscopic (LRP), and open radical prostatectomies (ORP)	Observational (n= 292)	Short-term functional outcomes were similar between PRA and PRAR when observed at 3, 6, 9, and 12 months. Urinary function recovered at 6 months, regardless of the surgical technique used. There was no recovery of erectile function at 3, 6, 9, and 12 months in both approaches.
Ong WL et al. 2016	Comparison of oncological and health-related quality of life outcomes between open and robot-assisted radical prostatectomy for localized prostate cancer – findings from the population-based Victorian Prostate Cancer Registry	Observational (n= 2,002)	Quality of life and DU were similar between the two techniques at 12 and 24 months. Patients who underwent robotic surgery generally had a lower risk of MCP (more pronounced up to pT2). BCR between 12 and 24 months remained significantly different in favor of PRAR, even after adjusting for surgical volume, and the same was true for MCP.
Abdollah F et al. 2016	Intermediate-term cancer control outcomes in prostate cancer patients treated with robotic-assisted laparoscopic radical prostatectomy: a multi-institutional analysis.	Observational (n= 5,670)	Survival rates: BCR-free, clinical recurrence-free, and cancer-specific-free were respectively: 83.3%, 98.6%, and 99.5% at five years; 76.5%, 97.5%, and 98.7% at eight years; 73.3%, 96.7%, and 98.4% at 10 years. The MCP rate decreased significantly in PRAR with the learning curve. Oncological results appear comparable to those found in the literature for PRA.
Gershman B et al. 2016	Patient-reported Functional Outcomes Following Open, Laparoscopic, and Robotic Assisted Radical Prostatectomy Performed by High-volume Surgeons at High-volume Hospitals.	Observational (n= 1,686)	The authors found no differences in DU and DS between PRA and PRAR at 30 months. Preoperative sexual function was the best predictor of postoperative ED.

Bier S et al. 2016	Return to Work and Normal Daily Life Activity after Open and Robot-Assisted Radical Prostatectomy—A Single Surgeon Analysis.	Observational (n= 302)	Surgical time was significantly longer and blood loss was lower in the PRAR group compared to the PRA group. The techniques were similar in terms of sexual function recovery (at 5 months) as well as quality of life at 3 and 6 months of follow-up, and the return to patient activities.
O'Neil B et al. 2016	The Comparative Harms of Open and Robotic Prostatectomy in Population-Based Samples	Observational (n= 2,438)	Comparing both techniques, PRAR contributed to better DU recovery at six months, but not at 12 months. As for DS, those who underwent robotic surgery had better results at both 6 and 12 months.
Pearce SM et al. 2016	Comparison of Perioperative and Early Oncologic Outcomes between Open and Robotic Assisted Laparoscopic Prostatectomy in a Contemporary Population Based Cohort	Observational (n= 26,662)	PRAR benefited: length of hospital stay, readmission rate, mortality risk (both within 30 days), residual disease, and risk of postoperative radiotherapy. PRAR had a protective effect for MCP, within the pT classification, only for pT2.
Niklas C et al. 2016	da Vinci and Open Radical Prostatectomy: Comparison of Clinical Outcomes and Analysis of Insurance Costs	Observational (n= 1,431)	PRAR benefited the risk of MCP, transfusion, hospital readmission within 30 days, length of hospitalization and urethral catheter stay, degree of LNE preservation, and complications up to 30 days (Clavien ≤ 3). There was similarity in mortality rate, intraoperative complications, and after 30 days. Surgical time was shorter in PRA.
Jackson MA et al. 2016	Experienced Open vs Early Robotic-assisted Laparoscopic Radical Prostatectomy : A 10-year Prospective and Retrospective Comparison.	Observational (n= 179)	PRAR benefited operative time and hospital stay. The techniques were similar for MCP rate, BCR, PC recurrence time in 10 years, recovery of urinary continence, and sexual potency in the same period.
Diaz M et al. 2015	Oncologic outcomes at 10 years following robotic radical prostatectomy	Observational (n= 483)	One hundred and eight patients had BCR at 10 years post-PRAR. BCR-free, metastasis-free, and cancer-specific survival rates at the same time point were 73.1%, 97.5%, and 98.8%, respectively.
Wallerstedt A et al. 2015	Short-term results after robot-assisted laparoscopic radical prostatectomy compared to open radical prostatectomy	Non-randomized controlled clinical study (n= 2506)	PRAR benefited: perioperative bleeding, length of stay, and risk of reoperation during the first hospitalization. Adverse effects were greater in PRA (greater significance for cardiovascular effects). Surgical time was shorter in PRA. Readmission at 90 days was similar between both.
Haglind E et al. 2015	Urinary Incontinence and Erectile Dysfunction After Robotic Versus Open Radical Prostatectomy: a Prospective, Controlled, Non-randomized Trial	Non-randomized controlled clinical study (n= 2,431)	PRAR benefited FNV preservation, number of lymph node dissections, perioperative bleeding, and hospital stay, showing modest preservation in EF. In PRA, the operative time was shorter. There was no significant difference regarding UI up to 12 months, use of additional treatments after surgery in the same period, and MCP.

Busch J et al. 2015	Matched comparison of robot-assisted, laparoscopic, and open radical prostatectomy regarding pathologic and oncologic outcomes in obese patients.	Observational (n= 582)	The mean three-year recurrence-free survival rate for PC was similar for the three surgical techniques, as was the MCP rate.
Ritch CR et al. 2014	Biochemical recurrence-free survival after robotic-assisted laparoscopic vs open radical prostatectomy for intermediate- and high-risk prostate cancer	Observational (n= 979)	The techniques were similar for the rates of pelvic lymph node dissection indication, MCP, BCR-free survival, and clinical progression, both of which were at 5 years.
Gandaglia G et al. 2014	Comparative effectiveness of robot-assisted and open radical prostatectomy in the post dissemination era	Observational (n= 5,915)	PRAR benefited transfusion risk and length of hospital stay. The risk of complications at 30 and 90 days was higher in PRAR (higher risk of respiratory complications, surgical wound complications, and miscellaneous medical or surgical complications). There was no significant difference between the approaches for readmission rates at 30 or 90 days.
Park J et al. 2014	Comparison of oncological outcomes between retropubic radical prostatectomy and robot-assisted radical prostatectomy: an analysis stratified by surgical experience	Observational (n= 1007)	Those undergoing PRAR were divided into three groups according to the increasing number of surgeries in the study. The MCP rate among pT2 patients showed no significant difference when comparing PRA with all PRAR groups; the latter group had a MCP similar to PRA (when 500 robotic procedures were reached). The three-year BCR-free survival rate was similar between both techniques for all pathological stages.
Shapiro EY et al. 2014	Comparison of robot-assisted and open retropubic radical prostatectomy for risk of biochemical progression in men with positive surgical margins.	Observational (n= 337)	The approaches did not show significant differences in BCR-free rates two years postoperatively.
Gandaglia G et al. 2014	How to optimize patient selection for robot-assisted radical prostatectomy: functional outcome analyses from a tertiary referral center	Observational (n= 609)	All patients underwent bilateral preservation of the NFV. Sexual function recovery at 24 months was significantly higher in PRAR for patients in the low/intermediate ED risk group (age ≤ 69, and Charlson comorbidity index ≤1); for men at high risk (age ≥ 70, and Charlson comorbidity index ≥2) there was no difference; the same was true for SD. For UI, PRAR was also superior to PRA at 24 months, except for patients at higher risk for UI, where no significant difference was observed. MCP was lower in PRAR; the number of patients undergoing pelvic lymphadenectomy was higher in PRA.

Busch J et al. 2014	Matched comparison of outcomes following open and minimally invasive radical prostatectomy for high-risk patients	Observational (n= 330)	Three matched cohorts with 110 patients in each. There were no differences in MCP between PRAR, PRA, and PRL. Regarding the BCR-free survival rate at three years, a difference was found in favor of PRAR compared to PRL, but not between PRAR and PRA. Regarding the higher number of dissected pelvic lymph nodes, the difference was in favor of PRA. There was no difference between the three techniques in terms of overall survival rate.
Koo KC et al. 2014	Robot-assisted radical prostatectomy in the Korean population: a 5-year propensity-score matched comparative analysis versus open radical prostatectomy	Observational (n= 344)	Two matched cohorts with 172 patients each. MCP rates were similar between PRA and PRAR for all tumor staging levels, urinary continence recovery at 12 months, BCR, and the following rates at 58 months: BCR-free survival, metastasis-free survival, PC-specific survival, and overall survival. The number of pelvic lymph nodes dissected was significantly higher in PRAR.
HU JC et al. 2014	Comparative effectiveness of robot-assisted versus open radical prostatectomy cancer control	Observational (n= 13,402)	RAR favored the MCP rate in patients undergoing radical prostatectomy in general, in those with low, intermediate, or high clinical risk, in pT2, and in intermediate and high D'Amico risk stages (but not in low risk); adjuvant therapy was also less frequently indicated in general in RAR.

RP: radical prostatectomy; ORP: open radical prostatectomy; RRP: retropubic radical prostatectomy; RARP: robot-assisted radical prostatectomy; LRP: laparoscopic radical prostatectomy; PRP: perineal radical prostatectomy; UD: urinary domain; SD: sexual domain; ED: erectile dysfunction; EF: erectile function; PMN: positive surgical margin (presence of tumor cells at the margin of tumor resection); NSM: negative surgical margin; IH: incisional hernia; BCR: biochemical recurrence after prostate cancer (prognostic marker used for patients with prostate cancer); PSA: prostate-specific antigen; ICU: Intensive Care Unit.

Table 1. Main conclusions of each article, according to each author, their classification regarding the type of study, and the respective year of publication

Source: Authors (2024).

3 months postoperatively)presented three results for homogeneity

Regarding the assessment of the BCR--free survival rate at two years, there was homogeneity between both techniques in seven results[25, 51 -53, 55, 56, 64] for this outcome. The lowest BCR rate had three results[32, 44, 61] in favor of robotics, and seven[5, 6, 23, 36, 40, 56, 60] indifferent to the techniques. The lowest MCP rate showed nine results[18, 21, 22, 32, 35, 37, 47, 48, 60] for PRAR, 11 results[6, 25, 36, 39, 50 -52, 55, 56, 62, 67] indifferent to both techniques, and one[23] in favor of PRA. The assessment of the lowest mortality rate due to CP in 18 months showed one[60] result for PRAR and four[25,,36,51,64] for the absence of statistical significance; in a 10-year follow-up[(36)] ,similarity between the techniques was found.

Analyzing the learning curve in robotics, Thompson demonstrated a reduction in the risk of BCR in men undergoing PRAR after reaching 200 surgeries (35% reduction for patients in general). However, he found no significant correlation between BCR risk/learning curve and pathological staging. For the relationship between MCP risk/learning curve and tumor staging, the authors found a small significance when comparing the final volume of the study with PRA (the odds ratio (OR) was 62% lower in PRAR for patients with pT2). Desai[67]found no difference in MCP between approaches in patients with pT2 related to the learning curve. In Abdollah[43],the MCP rate decreased significantly as the number of PRARs increased in the study. In Ong[32], adjustment for annual surgical volume did not affect the significant difference in favor of PRAR for the BCR rate over a one- to two-year interval, nor for the MCP rate. Park[52] divided the PRAR group into three subgroups; among pT2 patients, there was no significant difference in the comparison of PRA with all three subgroups in terms of MCP. The results are shown in Figure 3.

Results from descriptive studies are shown in Table 2.

PERIOPERATIVE RESULTS

The significant reduction in intraoperative bleeding using the robotic technique is reported in ten articles[6, 18, 25, 29, 39, 45, 48, 59, 64, 67] , in the risk of transfusion in five [30, 18, 48, 64, 67], in vesicourethral catheter time in three [25, 48, 59] , in hospitalization in ten [18, 25, 29, 30, 39, 47, 48, 59, 64, 67] , in operative time in two [6, 59] and in the highest degree of preservation of the LNF in two[39,48,54] . Two others were indifferent to: risk of transfusion[25] and vesicourethral catheter time[64]

RPA benefited operative time[29, 36, 37, 45, 48, 67] and the number of patients with extended pelvic lymphadenectomy[54] , or there was homogeneity for the first[25] and second outcomes[51] . PRAR favored the number of lymph nodes dissected in three articles,[37, 39, 56] PRA in one,[55] and there was similarity between both in another[67] . The median operative time and extended lymphadenectomy time were shorter in PRA: (PRA=123 min; PRAR=225 min[37], 278 min[67]); (PRA=31 min; PRAR=43 min).[37]

Considering surgical volume and/or experience, PRAR benefited: length of stay[8] and hospital readmission within 90 days[8] but not mortality within one year[8] . Considering the learning curve[67] in PRAR, there was less intraoperative bleeding, adverse events, transfusion, and Clavien complications (≤IIIb), as well as shorter operating time, hospitalization time, and ICU stay. Neither hospitalization time nor the 90-day hospital readmission rate were impacted by

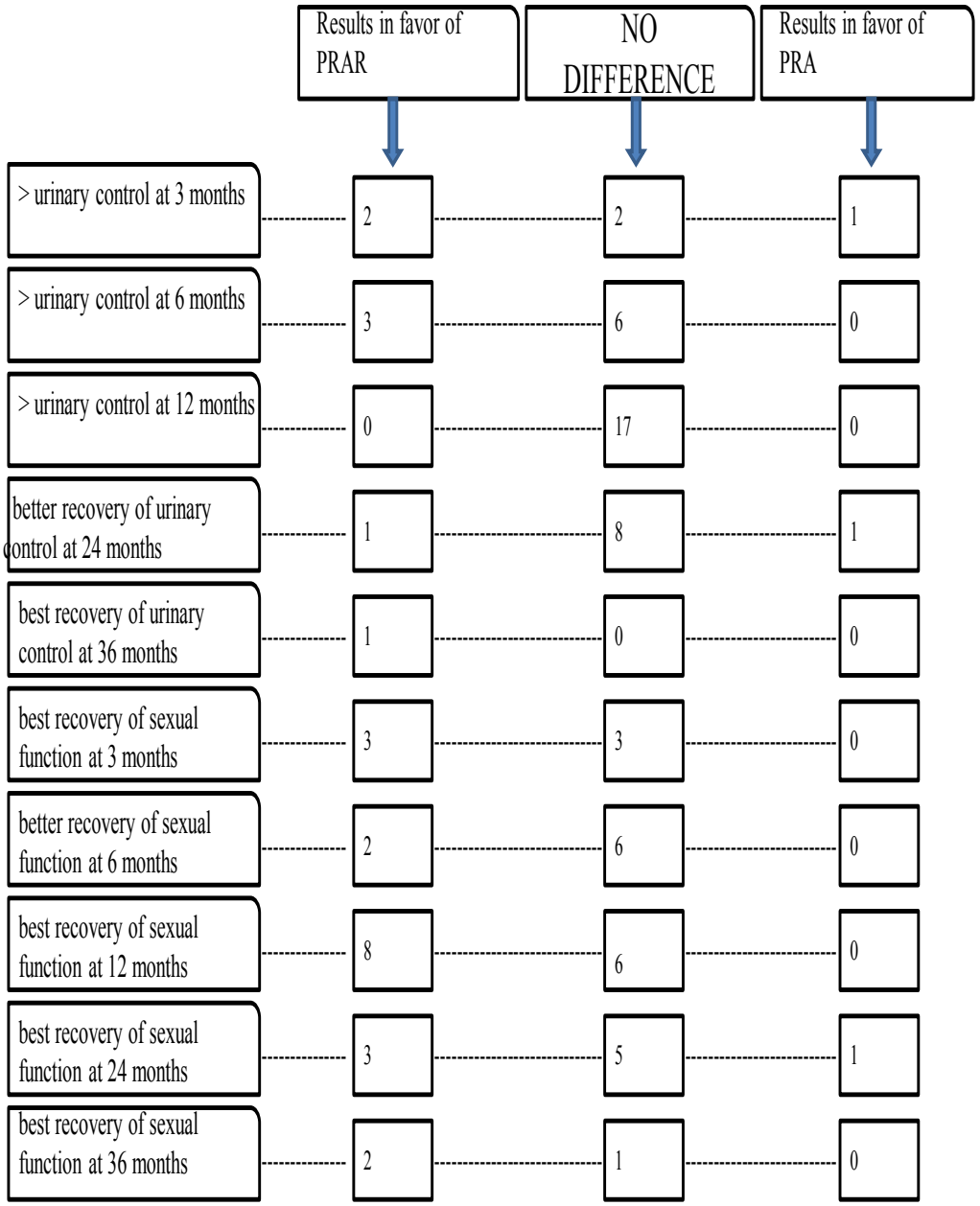

Figure 2. Postoperative outcomes in the urinary and sexual domains according to the frequency of these results in the studies, distributed according to the existence or absence of statistical significance in favor of a surgical technique.

Source: Authors (2024).

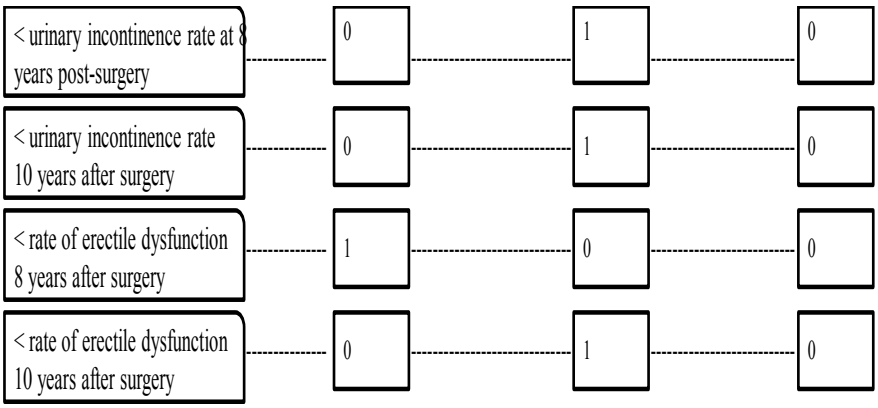

Figure 2. Continuation of Figure 2

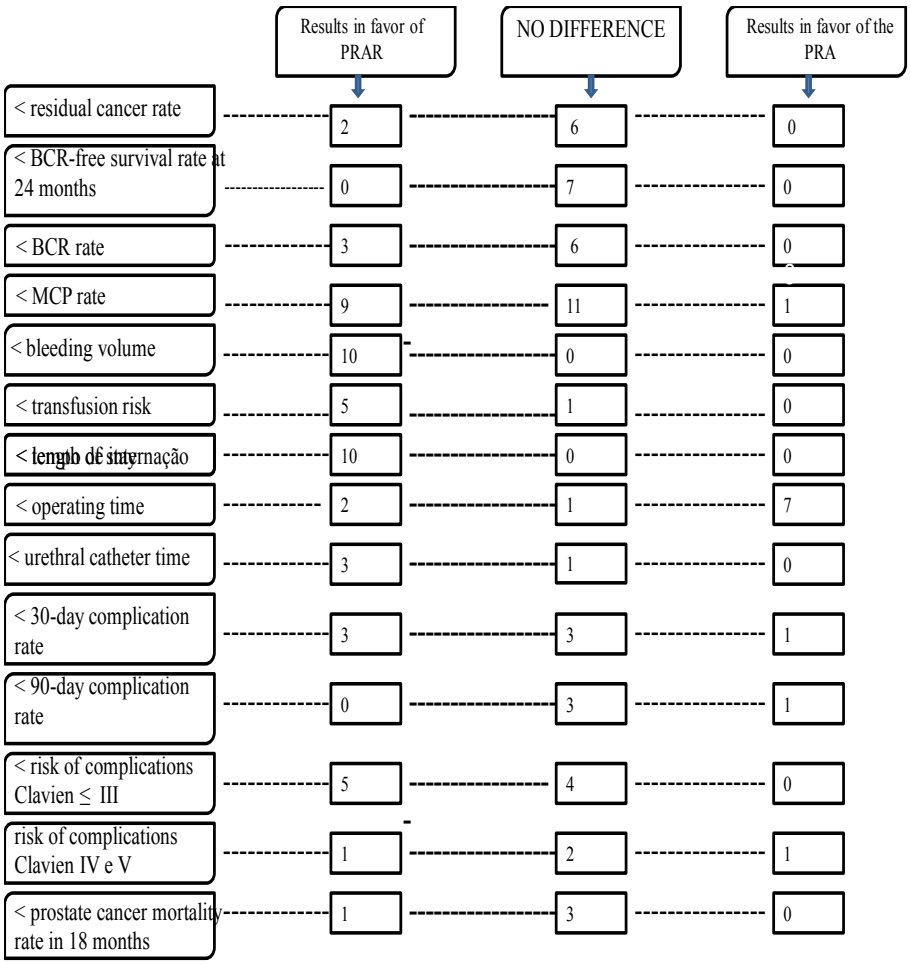

Figure 3. Main oncological, perioperative, and postoperative outcomes according to the frequency of these results in the studies, distributed according to the existence or absence of statistical significance in favor of a surgical technique or the absence of significance between both

Source: Authors (2024).

the learning curve. Considering the annual surgical volume, the rates of indicated lymphadenectomy and MCP (in pT2), and preservation of FNV, DU, and DS (at 6, 12, and 36 months) did not change. There were fewer short- and long-term complications and better sexual function (SF) in PRAR (12 and 36 months). For follow-up at these intervals, the approaches were indifferent. The main outcomes are shown in Figure 3. Results from descriptive studies are shown in Table 2.

POSTOPERATIVE RESULTS

PRAR was beneficial for Clavien-Dindo complications ≤ III, for IV or V, and complications at 30 days, in five [25, 29, 48, 62, 67], one [47], and three [30, .47, 48] studies in each group, respectively; PRA was beneficial in zero, one[59] and one[18] studies,respectively; and the similarity between the two was in four[6, 18,37, 64] , two[48, 51] and three[(25, 48, 67)] studies, respectively. For complications at 90 days: none in favor of PRAR, one in favor of PRA[18] and two for similarity[29, 67] .

PRAR benefited immediate moderate to severe pain[59, 64] and PRA at 12 months[31, 66] . In another study[30] , PRAR reduced immediate severe pain, and moderate remained unchanged after the first week. Urinary leakage through the urethrovesical anastomosis[59] and the time to removal of the ureterovesical catheter[64] were similar between the two, or there was a benefit of robotics in one[66] and two studies[48,59] for these outcomes, respectively. RPA favored quality of life[62, 63] at three months, but not at 12 months; two studies showed indifference at 12 [months((29))] and 12 and 24 months[32] , and another at three and six months[45] .

PRA compromised sexual desire (6, 12, 24, and 36 months)[69], with greater orgasmic satisfaction and sexual intercourse in PRAR, with fewer depressive symptoms, in equal periods. PRA and postoperative ED were independent predictors for depression and libido impairment. The recovery of DU and DS in the postoperative period was related to quality of life.

IH rates ranged from 1.3% in PRA to 0% in PRAR, and 9.5% to 5.4% over three years, respectively. In a non-comparative study, the HI rate in PRAR at twelve months was 8.6% and the incidental rate was 1.1%. The outcomes of other descriptive studies are shown in Table 2.

DISCUSSION

The data in the world literature on functional and oncological outcomes in RP are not robustly consistent with each other. They may be influenced by the surgeon's experience, annual surgical volume, perioperative complications, tumor and patient characteristics, data collection instruments and their validation, follow-up time, criteria for defining the results used in the studies, among others, representing biases for the outcomes.

For functional outcomes in patients in general, the studies in this review point to similarity between robotic and open surgical techniques ( ) or to the superiority of PRAR. The recovery of DU at three months and DS at 12 months has very similar cumulative frequencies between PRAR and the homogeneity of results, which is not repeated in the other evaluation points (Figure 2). In the first randomized controlled study at the beginning of the robotic era, Yaxley, 2006,

Model Robotic Author/year Results	KangDuo-SR-01 (Fan S et al. 2022) n=16	Single Site Plus Two Model (Lo IS et al. 2018) n=20	da Vinci SP (Kim KH et al. 2020) n=20	da Vinci SP (Ng CF et al. 2019) n=20	Retzius Sparing Revo-i (Chang KD et al. 2018) n=17
Functional n(%)					
-urinary domain recovery	14 (87.5)	9 (45)	10 (50)	-----	15 (88)
.using 0-1 protector/day	----	----	----	-----	3 (17.6)
.using 0 pads/day	1 month	4 months	3 months	-----	12 (70.5)
.temporal evaluation point	-----	-----	4/7* (57)	-----	3 months
-sexual domain recovery			3 months s		-----
. temporal assessment point					
Oncological					
MCP n(%)	4 (25)	8 (40)	7 (35)	11 (55)	4 (23.5)
.in pT2	0	5 (25)	1 (5)		3 (19)
BCR n(%)	1 month	2 (10)		5 (25)	1 (6)
.temporal evaluation point		3 months		3 months	
operative time (for total n)	-----	-----	245	----	186
median (min)	-----	294±39	----	209±35	
mean (min)					
operative time with lymph node dissection (n)	-----		260	----	-----
median (min)	-----	-----	-----	201 (6)	-----
mean (min)		----			
operative time without lymph node dissection (n)	-----	------	200	----	-----
median (min)	-----	------	-----	212 (14)	-----
mean (min)					

length of stay median (days) (days)	5	13±4	7	----- 5	4
Vesicourethral anastomosis time Median (min) mean (min)	14			-----	26
console time median (min) mean (min) **with lymph node removal** median (min) mean (min) **without lymph node removal** median (min) mean (min)	87		190 210 165		92
urethral catheter dwell time median (days) mean (days)			8 -----	----- 9 ± 2	
estimated bleeding volume median (mL) mean (mL)	50	---- 577±368	200 ----	---- 296±221	200 320±321
Preoperative Glisson <7 n (%) =7 >7	 1 (6.25) 13 (81.25) 2 (14.5)	 ----- ----- -----	 ----- ----- -----	 12 (60) 4(20) 4 (20)	 ----- ----- -----
preoperative clinical stage T0 n (%) T1c T2a T2b T2c	 0 0 2 (12.5) 0 6 (37.5)	 ---- ---- ---- ---- ---- ----	 ---- ---- ---- ---- ---- ----	 0 19 (95) 0 0 0 1	 ---- ---- ---- ---- ---- ----

Postoperative Gleason score <7 n (%) =7 >7	----- ----- ----- -----	3 (15) 10 (50) 7 (35)	20 (100) 0	9 (45) 7 (35) 4 (20)	5 (29) 8 (47) 5 (29)
Postoperative stage T0 n (%) T1c T2a T2b T2c	---- ---- ---- ---- ----	1 (5) 0 2 (10) 0 11 (55)	---- ---- ---- ---- ----	0 0 3 (15) 1 (5) 7 (35)	0 6 (35) 4 (23.5) 1 (6) 3
technical conversion, n	0	0	0	0	0
No. (%) Lymph nodes dissected	0	15 (75)	19	8 ± 7	0
Clavien-Dindo complications	I and II	----	I and II	I and II	I and II
transfusion, n	0	1	0	----	3
transfusion rate	0	(5)	0	----	(18)

tx=rate; n= number of patients; (*) men who were sexually potent prior to the study.

Table 2. Functional, oncological, perioperative, and postoperative results of descriptive studies involving the PRAR approach, without comparison with another technique.

Source: Authors (2024)

apud Fossati, 2016, found no significant differences between the techniques.

Preservation of the neurovascular bundle (NVB) is considered a predictor of better functional outcomes[23, 54, 71]. Its degree of preservation and the recovery of erectile function (EF) were strongly correlated with PRAR[23]after adjustments for age and tumor characteristics, even in their different definitions[5]. This is corroborated by Pessoa[73], who observed that DS recovery is closely correlated with the preservation of this bundle. In Hagling[[39]],although SVN preservation was greater in PRAR, this approach was only modestly beneficial in terms of EF compared to PRA, and there was no significant difference between the two in relation to urinary incontinence (UI) at 12 months. In Couglin et al.[44], the only randomized controlled trial in this review, there was no significant difference in SVN preservation between the two approaches, and the authors found no difference between the two for UD or SD at 6, 12, or 24 months. For Abdel et al., urinary continence recovery was greater in PRAR at three and six months, but not at 12 months, with no significant difference in LNF preservation between patients. In Gandaglia[54], all patients in the study underwent bilateral preservation of the NPF in RP; recovery of EF at 24 months was significantly greater in the PRAR group for patients under 70 years of age, with low comorbidity, and with SD and DU functions preserved prior to surgery. In this study, patients aged ≥ 70 years, with a Charlton index ≥ 2 and worse scores for functional domains, showed no significant difference between the approaches. In two other studies with patients aged 70 years or older[[59, 60]],the indifference to techniques regarding FE remained even after taking into account the degree of preservation of FVN, which can be explained by the condition of FE prior to surgery. It has been reported that age at the time of surgery exponentially predicts UI, with an estimated increasing loss of 6% per year[[13,, 60]]. Ficaria et al.[13] , in a review and meta-analysis, highlighted that the main preoperative predictors for urinary function recovery are: age, body mass index, and lower urinary tract symptoms. The same author, in another review and meta-analysis, concluded that the main predictors for FE[14] are age, erectile condition prior to surgery, and degree of preservation of the NSV. These independent associations for functional outcomes corroborate the findings in our study[19] . In a study[60] where urinary continence had been significant in PRAR at 12 months, it was not maintained at 8 years of follow-up, even taking into account the degree of preservation of the NSF. One explanation for this is certainly the aging suffered by this cohort. In Kwon[6], the PRA technique was modified, employing the same tissue reconstruction used in PRAR. The two techniques showed similar functional results at 6 and 12 months. Ficarra concluded that the modification of the PRAR technique, with complete muscle-fascial reconstruction, was associated with better urinary continence among patients. Interestingly, for patients at high oncological risk, two studies showed that PRA was superior to PRAR, with a significant difference at 24 months for the recovery of functional outcomes.

High bleeding volume in RP proved to be an independent predictor of worse results for FE and continence, regardless of the approach[12]; however, after one year of follow-up, there was no significant difference in urinary continence between the two

techniques, even when taking into account the risk of high bleeding.

For oncological outcomes, the accumulation of results (Figure 3) focused on the absence of statistical significance between the two techniques, although PRAR had no frequency different from zero, except for the two-year BCR-free survival rate. For perioperative outcomes, PRAR significantly benefited the length of hospital stay, which is possibly due to lower rates of surgical wound complications[41] , postoperative pain, vesicourethral catheterization time, risk of blood transfusion, and risk of complications within 30 days, as corroborated by Bezerra[70] in a recent review. Shorter postoperative catheterization time reduces minor complications, such as fever and urinary tract infection, which in this review were grouped under the Clavien-Dindo classification or as complications within 30 days. Regardless of the fact that the operative time is predominantly shorter in RAP, RARP benefited the number of dissected lymph nodes[37, 67], probably due to better exposure and magnification of the field.

The surgeon's learning curve in RARP, annual surgical volume, and previous surgical experience may impact the outcomes in the studies. In this review, six studies[5, 7, 32, 58, 62, 67]observed the effect of the learning curve on SD[32, 58, 67] and the impact of physician volume/experience on DU recovery[5, 7, 58, 62, 67] and erectile dysfunction[5, 58] . The benefit of RAP for urinary continence, when taking volume into account, did not remain when adjusting for the surgeon's experience in the PRAR technique[5]. Regarding erectile dysfunction, when previous experience was taken into account, the non-existent difference between the two techniques became in favor of PRAR. Other authors evaluated the impact of experience/learning curve/volume in PRAR on oncological outcomes[5,7,37,52,58] , perioperative and postoperative outcomes [8, 32, 37, 62] finding a positive effect – for BCR rates[7] and MCP [52] –, and/or indifferent – for BCR-free survival rates[52] and BCR rates at four years[58] . In Nyberg[5], regarding the combined rate of BCR and residual disease, neither experience nor volume were able to modify the indifference between the approaches in two years. On the contrary, Thompson[7]demonstrated a reduced risk of BCR in PRAR after 200 cases, which is corroborated by Sayyid and Klaassen[72]in a recent review. The learning curve significantly reduced operating time[37], a finding corroborated by Sayyid and Klassen[72]), as well as lymph node dissection time, but had no effect on the number of lymph nodes dissected and complications in general. These same authors found robust evidence of the impact of surgical volume on intraoperative bleeding and cavernous nerve preservation[72]. Plossard[74], in turn, observed the impact of surgical volume on length of hospital stay and postoperative complications, regardless of the approach. Van Den Broeck[75] , in a recent review, observed the same inverse relationship between perioperative complications and hospital medico- surgical volume. Regarding quality of life, there were no results demonstrating the superiority of one technique over the other at 12 months.

FINAL CONSIDERATIONS

In this review, the frequencies of functional outcomes after PR accumulated in greater numbers for the similarity between PRA and PRAR. For oncological results, a similar pattern occurred, except for the lower MCP rate, where a significant accumulation was observed both in favor of

PRAR and indifference between both techniques. The only outcome whose results accumulated in favor of PRA was operating time. For postoperative quality of life, there were no results demonstrating superiority between the techniques at 12 months. Several factors may affect the observations of post-PR outcomes, and there is room in the literature for studies on possible biases. Important contributions may come from studies that include a comparative analysis between PRAR and PRA, with an emphasis on the use of different robotic technologies employed in the procedures.

ABBREVIATIONS:

PC: Prostate cancer

PSA: Prostate-Specific Antigen

PRP: Perineal radical prostatectomy

RRP: Retropubic radical prostatectomy

OAR: Open radical prostatectomy

RARP: Robot-assisted radical prostatectomy

SNM: Surgical Negative Margin

PSM: Positive Surgical Margin

PR: Radical prostatectomy

UI: Urinary incontinence

ED: Erectile dysfunction

NVB: Neurovascular bundle

SP: Sexual potency

IH: Incisional hernia

BCR: Biochemical recurrence

UD: Urinary domain

SD: Sexual domain

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