Original Article

Perioperative outcomes of robotic-assisted laparoscopic radical prostatectomy, laparoscopic radical prostatectomy and open radical prostatectomy: 10 years of cases at Ramathibodi Hospital

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Background: This study aims to compare the perioperative and pathological outcomes of open radical prostatectomy (ORP), laparoscopic radical prostatectomy (LRP), and robotic-assisted laparoscopic radical prostatectomy (RALRP) at Ramathibodi Hospital within Mahidol University in Thailand.

Methods: From January 2008 to July 2017, 679 RPs were performed. Patients' data were collected retrospectively to evaluate their perioperative and pathological outcomes. This data included the age, body mass index (BMI), serum prostate specific antigen (PSA) level, clinical stage, Gleason score (GS) from biopsy, operative time, estimated blood loss (EBL), perioperative complications, blood transfusion rate, adjacent organ injury rate, length of hospital stay, pathological stage, GS of the biopsy specimen, specimen weight (g), and marginal status of the patients.

Results: Of the 679 RPs performed, 128 (19.28%) were ORPs, 241 (36.30%) were LRPs, and 295 (44.43%) were RALRPs. Patients who underwent a RALRP had a significant advantage in EBL (1,600, 500, and 300 mL for ORPs, LRPs, and RALRPs, respectively), overall complications, and blood transfusion rate. As they are minimally invasive techniques, LRP and RALRP presented an advantage in terms of the length of hospital stay (an average of 9, 6, and 6 days for ORPs, LRPs, and RALRPs, respectively) and adjacent organ injury rate. ORPs also had the shortest operative time (160, 210, and 200 min for ORPs, LRPs, and RALRPs, respectively). However, the specimen weight and marginal status were similar in all of the techniques.

Conclusions: Minimally invasive RP techniques, such as LRPs and RALRPs, appear to be safe, have significantly better perioperative outcomes than ORPs, and have comparable pathological outcomes to those of ORPs.

Keywords: Prostate cancer; radical prostatectomy; laparoscopy; robot-assisted laparoscopic surgery; open surgery; perioperative outcome

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Introduction

Prostate cancer is the fifth most common cancer in Thai men (1), and the number of cases continues to rise despite the presence of improved healthcare and active screening. Radical prostatectomy (RP) is a standard of care in the treatment of clinically localised prostate cancer and is an option for the treatment of locally advanced prostate cancer. RP can be performed using open radical prostatectomy (ORP), laparoscopic radical prostatectomy (LRP), or robotic-assisted laparoscopic radical prostatectomy (RALRP) techniques. In the past decade, especially in Asia, the minimally invasive RP techniques LRP and RALRP have been significantly favoured, as they provide better visualisation of the surgical process and anatomy (2,3). In addition, instruments and techniques are being continuously improved, making the operation easier to perform and improving perioperative outcomes, such as the operative time, estimated blood loss (EBL), transfusion rate, adjacent organ injury rate (4-6), oncological outcomes (4,7), and functional outcomes (7,8).

Although there are abundant data from high-volume centres related to the outcomes of ORPs, LRPs, and RALRPs, according to our data, there are no studies that compare the outcomes of the three techniques specifically in Thailand. The objective of this study, therefore, was to evaluate and compare the perioperative and pathological outcomes of ORPs, LRPs, and RALRPs in a Thai context.

Methods

Population and surgical techniques

Between January 2008 and July 2017, 679 prostate cancer patients were treated using a RP at Ramathibodi Hospital in Thailand. Of these patients, 128 had undergone ORP, 241 had undergone LRP, and 295 patients had undergone RALRP. The remaining 15 patients were excluded from the study due to incomplete data. The principles of the Helsinki Declaration were followed during the study, and the confidentiality of the patients' data was guaranteed. The Committee for Research of the Faculty of Medicine, Ramathibodi Hospital, Mahidol University approved the study (date of approval: 01 October 2018, ID 07-61-70).

The ORPs were performed in a retropubic fashion using Vicryl No.1 to ligate dorsal venous complex, the LRPs were performed in an extraperitoneal fashion using CO_2 to create a pneumoperitoneum at abdominal pressure of 15 mmHg, and the RALRPs were performed in an intraperitoneal fashion using the da Vinci Surgical System Si. The operations were selected for each patient based on the collaborative decision of the patient and doctor.

The nerve-sparing RPs were performed in some cases, except in extensive cancer in the biopsy specimens, preoperative poor-quality erections, current and future lack of a sexual relationship, or other medical conditions that may adversely affect erections (e.g., diabetes mellitus, hypertension, psychiatric diseases, neurologic diseases, or medications that produce erectile dysfunction). However, we shared decision making with the patients and surgeon dependent.

Six instructor surgeons participated in this study. Two surgeons always performed ORPs while the other four surgeons performed all three techniques.

Baseline characteristics and preoperative parameters

The following data were collected from all patients: age, body weight (kg), height (cm), body mass index (BMI), prostate-specific antigen (PSA) level, underlying disease, clinical stage (TNM classification), and the Gleason score (GS) of the biopsy specimen.

Perioperative outcomes

Perioperative outcomes included: operative time (minutes); estimated blood loss (EBL) (mL); perioperative complications, including transfusion rate; adjacent organ injury of the bladder, rectum, ureter, bowel, or blood vessel; and length of hospital stay (days), which was defined by subtracting the date of admission from the date of discharge.

Pathological outcomes

All specimens were evaluated by an experienced uropathologist, in accordance with the National Comprehensive Cancer Network (NCCN) guidelines, who reported the prostatic weight (g), pathological stage, GS of the specimen, and the marginal status. A positive surgical margin (PSM) was defined as cancer cells extending to the inked surface of the specimen (9).

Statistical analysis

A descriptive study was performed. The data were analysed using an unpaired *t*-test, a Kruskal-Wallis test, and a Chi-

square test to identify the statistical significance of the difference in means ± standard deviation, median (IQR), and proportions, respectively. Analysis was performed using Stata version 14, with a P value of <0.005 considered to be statistically significant.

Results

The demographic data and preoperative parameters are presented in *Table 1*. The ORPs, LRPs, and RALRPs were not statistically different in terms of median age (68, 68, and 68 years, respectively; P=0.716), median body weight (67.2, 66.4, and 68.1 kg, respectively; P=0.100), median height (165, 165, and 165 cm, respectively; P=0.391), median BMI (24.3, 24.2, and 24.6 kg/m^2, respectively; P=0.218), or median PSA (10.94, 10.60, and 11.82 ng/mL, respectively; P=0.319). The clinical stage, however, presented significantly different data in each group (P=0.008). The GS of the biopsy specimens in the RALRPs was statistically significantly higher than that of the ORPs and LRPs (7.04±1.01, 6.89±1.31, and 6.74±1.02, respectively; P=0.001); however, there was no difference between those of the ORP and LRP groups (P>0.005).

The perioperative outcomes (*Table 2*) show that the operative time was significantly lower in ORPs than in LRPs and RALRPs (160, 210, and 200 minutes, respectively; P<0.001), but there was no difference between the operative times of LRPs and RALRPs (P>0.05). Patients who underwent RALRPs had the lowest EBL by a significant margin (1,600, 500, and 300 mL for ORPs, LRPs, and RALRPs, respectively; P<0.001 for RALRPs *vs.* LRPs and P<0.001 for LRPs *vs.* ORPs). The lowest overall complications were also observed in patients who underwent RALRPs in comparison to the other two groups (81.25%, 29.05%, and 8.81% for ORPs, LRPs, and RALRPs, respectively; P<0.001), and the same was noted for transfusion rates (69.35%, 23.48%, and 5.10% for ORPs, LRPs, and RALRPs, respectively; P<0.001 for RALRPs *vs.* LRPs and P<0.001 for LRPs *vs.* ORPs). It was observed that the adjacent organ injury rate was highest in ORP cases (8.94%, 3.46%, and 0.68% for ORPs, LRPs, and RALRPs, respectively; P<0.001 for ORP *vs.* LRPs and RALRPs and P>0.05 for LRPs *vs.* RALRPs). When the length of hospital stay was analysed, although no statistical difference was found between the minimally invasive techniques (i.e., LRPs and RALRPs), it was significantly longer in the ORP technique (9, 6, and 6 days for ORPs, LRPs, and RALRPs, respectively; P<0.001 for ORPs *vs.* LRPs and RALRPs and P>0.05 for LRPs *vs.* ORPs).

The pathological outcomes (*Table 3*) show that the pathological stage was significantly different in each group (P=0.001). The GS of the specimens was significantly higher in the RALRP group than it was in the other two groups (7.10±1.03, 7.12±1.00, and 7.31±0.93 for ORPs, LRPs, and RALRPs, respectively; P=0.018 for RALRPs *vs.* LRPs and ORPs and P>0.05 for ORPs *vs.* LRPs). The specimen weight was not significantly different among the three techniques (39.3, 38.4, and 37.3 g for ORPs, LRPs, and RALRPs, respectively; P=0.669). PSM was also observed as not significantly different among the three groups (33.04%, 40.63%, and 39.15% for ORPs, LRPs, and RALRPs, respectively; P=0.383).

Discussion

RP is the standard of care in the treatment of clinically localised prostate cancer and is a treatment option in locally advanced prostate cancer. At Ramathibodi Hospital in Thailand, ORP was preferred by two experienced urologists because of the introduction of nerve-sparing ORP, developed by Walsh and Donker (10), and several modifications to the technique; good outcomes have been achieved through it, both pathological (11-13) and functional (11,13,14). However, after the standardisation of LRP techniques (15), the use of LRP has gradually grew, and it became the method of choice at Ramathibodi Hospital in 2007 (16).

In 2013, RALRP was then also adopted at the hospital, displacing the other two procedures due to its many advantages. RALRP provides a clear, three-dimensional (3D) view of the operative field and facilitates suturing and dissection by substituting large-scale hand movement with tiny instrument movement, which reduces vibration and frees the grasp to allow for shaft rotation movement at the tip (EndoWrist, Intuitive Surgical). This can be particularly useful for surgeons who do not have advanced laparoscopic skills. However, RALRP does have some limitations, such as the lack of haptic feedback, a high initial and procedural cost, and a steep learning curve (17,18). Despite this, it has been observed that EBL is lowered when surgeons have better visualisation of the anatomy with a 3D view and magnification, the ability to more accurately and perform fine movements of instruments, and the ability to perform a tamponade effect within a vessel using CO_2, all of which are possible using RALRP (19,20). In our data, the median EBL was significantly lower in RALRPs than it was in LRPs

Table 1 Demographic data and pre-operative parameters of ORP, LRP and RALRP

Demographic data	ORP (n=128)	LRP (n=241)	RALRP (n=295)	P value
No. of patients (%)	128 (19.28)	241 (36.30)	295 (44.43)	–
Median age (years), median [IQR]	68 [62–73]	68 [63–72]	68 [63–72]	0.716
Median body weight (kg), median [IQR]	67.2 [62–73.4]	66.4 [59–73]	68.1 [61.7–74.8]	0.100
Median height (cm), median [IQR]	165 [161–169]	165 [162–169]	165 [162–170]	0.391
BMI (kg/m^2), median [IQR]	24.3 [22.8–26.9]	24.2 [21.9–26.4]	24.6 [22.5–26.9]	0.218
PSA pre-op/PSA level (ng/mL), median [IQR]	10.94 [7.15–23.16]	10.60 [7.43–21.18]	11.82 [8.00–20.80]	0.319
HT, n (%)	74 (58.27)	149 (61.83)	184 (62.37)	0.718
DM, n (%)	22 (17.32)	59 (24.84)	81 (27.46)	0.085
DLP, n (%)	43 (33.86)	88 (36.51)	118 [40]	0.449
Clinical stage, n (%)				0.008***
T1a	0 (0)	4 (1.72)	1 (0.34)	
T1b	0 (0)	0 (0)	3 (1.02)	
T1c	112 (88.19)	208 (89.27)	237 (80.89)	
T2	0 (0)	(0)	(0)	
T3a	8 (6.30)	7 (3.00)	18 (6.14)	
T3b	6 (4.72)	14 (6.01)	34 (11.60)	
T4	1 (0.79)	0 (0)	0 (0)	
GS from biopsy, mean ± SD	6.89±1.31†	6.74±1.02†	7.04±1.01	0.001*
GS ≤6, n (%)	51 (42.15)	104 (44.44)	86 (29.76)	
GS = 3+4, n (%)	24 (19.83)	51 (21.79)	75 (25.95)	
GS = 4+3, n (%)	17 (14.05)	41 (17.52)	54 (18.69)	
GS = 8, n (%)	14 (11.57)	23 (9.83)	43 (14.88)	
GS = 9, 10, n (%)	15 (12.40)	15 (6.41)	31 (10.73)	
Cases per year, n (%)				
2008	13 (10.16)	32 (13.28)	0 (0)	
2009	19 (14.84)	22 (9.13)	0 (0)	
2010	7 (5.47)	28 (11.62)	0 (0)	
2011	6 (4.69)	19 (7.88)	0 (0)	
2012	17 (13.28)	29 (12.03)	0 (0)	
2013	17 (13.28)	23 (9.54)	31 (10.51)	
2014	12 (9.38)	30 (12.45)	50 (16.95)	
2015	18 (14.06)	22 (9.13)	62 (21.02)	
2016	12 (9.38)	26 (10.79)	92 (31.19)	
2017	7 (5.47)	10 (4.15)	60 (20.34)	

Table 1 (*continued*)

Table 1 (*continued*)

Demographic data	ORP (n=128)	LRP (n=241)	RALRP (n=295)	P value
Participant surgeons, n				
2008	4	2	0	
2009	4	2	0	
2010	4	2	0	
2011	4	2	0	
2012	4	2	0	
2013	4	2	2	
2014	4	2	2	
2015	4	2	2	
2016	6	4	4	
2017	6	4	4	

†, P>0.05. *, comparison of groups by unpaired *t*-test. ***, comparison of groups by Chi-square test. BMI, body mass index; PSA, prostate-specific antigen; HT, hypertension; DM, diabetes mellitus; DLP, dyslipidaemia; GS, Gleason score.

or ORPs (P<0.001 for RALRPs *vs.* LRPs and P<0.001 for LRPs *vs.* ORPs) and a lower rate of transfusion was also found (P<0.001 for RALRPs *vs.* LRPs and P<0.001 for LRPs *vs.* ORPs).

Additionally, in our study, the adjacent organ injury rate was found to be significantly lower in the LRP and RALRP groups than in the ORP group (P<0.001 for ORPs *vs.* LRPs and RALRPs and P>0.05 for LRPs *vs.* RALRPs). This can be explained by the better visualisation of the periprostatic anatomy and the ability to more precisely control the instrument in LRPs and RALRPs. The main organ affected by a RP is the rectum, which correlates to advanced tumours, lower surgeries volume, and prior radiation (21).

The advantages of minimally invasive techniques have led to a significant decrease in complications associated with these surgeries. When comparing the length of hospital stay, LRPs and RALRPs were shown to require significantly shorter stays than ORPs (P<0.001 for ORPs *vs.* LRPs and RALRPs and P>0.05 for LRPs *vs.* ORPs), confirming the findings of previous studies (22,23). However, in a study by Wallerstedt *et al.* (23), the lengths of hospital stay in ORPs and RALRPs were 4.1 and 3.3 days, respectively, which is shorter than the present study. This can be contributed to an institute practice that routinely discharged patients after the closed-suction pelvic drain is removed. However, many factors such as socioeconomic status, inexpensive room rates, anxiety, and patient pain tolerance, any of which might affect the length of a hospital stay

Furthermore, the data show that the median operative time was significantly shorter for ORPs (179, 236, and 187 minutes for ORPs, LRPs, and RALRPs, respectively) than it was for minimally invasive surgery (MIS), confirming the findings of previous studies (13). The median difference between the operating times of ORPs and MIS is significantly larger during the early phase of learning curve, but this gap shrinks as surgeons gain experience with the LRP and RALRP methods. This implies that RALRP provides a simpler method that ultimately allows for a shorter operative time compared to LRP.

The oncological control of RP in prostate cancer can be measured by PSM, the biochemical recurrence (BCR) rate, time to biochemical recurrence, local recurrence, and distant metastasis (4). Sachdeva *et al.* (24) and other researchers (25-28) have shown that a PSM in prostate cancer is considered an adverse oncologic outcome, associated with an increased likelihood of BCR. However, the significant predictors of BCR are tumour volume, a high GS, and a high pre-operative PSA. In our study series, there was no statistically significant difference in PSM among the three studied techniques, which is consistent with results of the other literature (11-13). Although the PSM rate in our study was high in comparison with large series data, ranging in a series from 12% (11) to 11% to 50% and, in recent meta-analysis, from 12.1% to 41.3% (12),

Table 2 Perioperative outcomes ORP, LRP and RALRP

Perioperative outcomes	ORP (n=128)	LRP (n=241)	RALRP (n=295)	P value
Operation time (min), median [IQR]	160 [125–225]	210 [170–257.5]†	200 [175–255]†	<0.001**
EBL (mL), median [IQR]	1,600 [1,000–2,500]	500 [300–800]	300 [200–500]	<0.001**
Perioperative complications according to Clavien-Dindo classification, n (%)				
Overall	104 (81.25)	70 (29.05)	26 (8.81)	<0.001***
Grade I	7 (5.47)	10 (4.15)	7 (2.37)	0.228
Grade II	80 (62.50)	47 (19.50)	15 (5.08)	<0.001***
Grade IIIa	4 (3.13)	4 (1.66)	2 (0.68)	0.124
Grade IIIb	11 (8.59)	8 (3.32)	2 (0.68)	<0.001***
Grade IVa	2 (1.59)	1 (0.41)	0 (0.00)	0.046***
Grade IVb	–	–	–	–
Grade V	–	–	–	–
Blood transfusion, n (%)	86 (69.35)	54 (23.48)	15 (5.10)	<0.001***
Adjacent organ injury, n (%)	11 (8.94)	8 (3.46)†	2 (0.68)†	<0.001***
Adjacent organ injury, n (%)				
Bladder	1 (9.09)	2 (33.33)	–	–
Rectum	9 (81.82)	2 (33.33)	–	–
Left ureter	–	1 (16.67)	1 [50]	–
Right ureter	–	1 (16.67)	2 [100]	–
Right external iliac vein	1 (9.09)	–	–	–
Small bowel	1 (9.09)	–	–	–
Hospitalization time (day), median [IQR]	9 [6–11]	6 [5–8]†	6 [5–9]†	<0.001**

EBL, estimated blood loss. †, P>0.05. **, comparison of groups by Kruskal-Wallis test. ***, comparison of groups by Chi-square test.

this can be affected by the multiple surgeons who participated in this study, given the difference in learning curves. For example, in the present study, there were two new instructor surgeons who had just started performing RALRP in 2016. In addition, after the subgroup analysis, the majority of the PSM was in the T3 stage which can result from nature of the cancer that has been extended beyond the prostatic capsule (*Tables S1*,*S2*).

Moreover, patients with PSM are typically given two options: external beam radiation therapy (proton beam radiation) with or without androgen deprivation therapy (ADT) and observation. Unfortunately, data related to the rate of conversion and catheterisation time could not be collected to determine outcomes, as this study was retrospectively conducted. To determine the functional outcomes, such as incontinence and erectile dysfunction, the authors are assembling data and will report on these findings in a following study.

We would like to highlight that our study had some limitations. First, this was a retrospective study that compared different surgical techniques, and these different techniques were performed by different surgeons; as such, bias may exist in the process of evaluating the outcomes of the procedures. Second, this study lacked data about the oncological and functional follow-up. This would be improved by conducting a prospective randomised study with a higher case volume, which would prevent biases and provide much more accurate results.

Conclusions

As minimally invasive techniques, LRP and RALRP are

Table 3 Pathological outcomes of ORP, LRP and RALRP

Pathological outcomes	ORP (n=128)	LRP (n=241)	RALRP (n=295)	P value
Pathological stage, n (%)				0.001***
T2a	10 (7.87)	35 (14.58)	18 (6.16)	
T2b	10 (7.87)	9 (3.75)	3 (1.03)	
T2c	49 (38.58)	98 (40.83)	138 (47.26)	
T3a	24 (18.90)	53 (22.08)	69 (23.63)	
T3b	34 (26.77)	44 (18.33)	64 (21.92)	
T4	0 (0)	1 (0.42)	0 (0)	
Pathologic GS, mean ± SD	7.10±1.03†	7.12±1.00†	7.31±0.93	0.018*
GS ≤6, n (%)	34 (27.20)	56 (23.33)	41 (13.99)	
GS = 3+4, n (%)	38 (30.40)	77 (32.08)	104 (35.49)	
GS = 4+3, n (%)	22 (17.60)	50 (20.83)	64 (21.84)	
GS = 8, n (%)	12 (9.60)	22 (9.17)	35 (11.95)	
GS = 9, 10, n (%)	19 (15.20)	35 (14.58)	49 (16.72)	
Prostate volume (g), median (IQR)	39.3 (29.1–50.0)	38.4 (29.3–50.0)	37.3 (29.2–47.5)	0.669
PSM, n (%)				
Overall	38 (33.04)	91 (40.63)	110 (39.15)	0.383
pT2	17 (44.74)	34 (37.36)	36 (37.73)	0.893
pT3	21 (55.26)	56 (61.58)	74 (67.27)	0.062
pT4	0 (0)	1 (1.10)	0 (0)	–

†, P>0.05. *, comparison of groups by unpaired *t*-test. ***, comparison of groups by Chi-square test. GS, Gleason score; PSM, positive surgical margin.

excellent choices for the treatment of organ-confined prostate cancer and locally advanced prostate cancer as they have superior overall perioperative outcomes and comparable pathological outcomes to those of ORPs. Moreover, the EBL and overall complications are significantly lower in RALRPs. Therefore, further prospective randomised studies with a higher caseloads and long-term oncological and functional follow-up are needed to designate RARP as the standard of care.

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Footnote

Conflicts of Interest: The authors have no conflicts of interest to declare.

Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. The principles of the Helsinki Declaration were followed during the study, and the confidentiality of the patients' data was guaranteed. The Committee for Research of the Faculty of Medicine, Ramathibodi Hospital, Mahidol University approved the study (date of approval: 01 October 2018, ID 07-61-70).

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Supplementary

Table S1 Time analysis of PSM

PSM by years	ORP (n=128), n (%)	LRP (n=241), n (%)	RALRP (n=295), n (%)	P value
Overall	38 (33.04)	91 (40.63)	110 (39.15)	0.383
2008	6/38 (16.20)	15/91 (16.48)	0 (0)	0.873
pT2	4/6 (66.67)	4/15 (26.67)	0 (0)	0.070
pT3	2/6 (33.33)	10/15 (66.67)	0 (0)	0.074
pT4	0 (0)	1/15 (6.67)	0 (0)	–
2009	8/38 (21.05)	8/91 (8.79)	0 (0)	0.746
pT2	4/8 (50.00)	4/8 (50.00)	0 (0)	0.746
pT3	4/8 (50.00)	4/8 (50.00)	0 (0)	1.000
pT4	0 (0)	0 (0)	0 (0)	–
2010	1/38 (2.63)	8/91 (8.79)	0 (0)	0.326
pT2	1/1 (100.00)	1/8 (12.50)	0 (0)	0.383
pT3	0 (0)	7/8 (87.50)	0 (0)	0.039***
pT4	0 (0)	0 (0)	0 (0)	–
2011	1/38 (2.63)	5/91 (5.49)	0 (0)	0.629
pT2	0 (0)	2/5 (40.00)	0 (0)	0.551
pT3	1/1 (100.00)	3/5 (60.00)	0 (0)	0.294
pT4	0 (0)	0 (0)	0 (0)	–
2012	5/38 (13.16)	14/91 (15.38)	0 (0)	0.294
pT2	2/5 (40.00)	7/14 (50.00)	0 (0)	0.432
pT3	3/5 (60.00)	7/14 (50.00)	0 (0)	0.387
pT4	0 (0)	0 (0)	0 (0)	–
2013	4/38 (10.53)	9/91 (9.89)	12/110 (10.91)	0.520
pT2	2/4 (50.00)	6/9 (66.67)	9/12 (75.00)	0.404
pT3	2/4 (50.00)	3/9 (33.33)	3/12 (25.00)	0.894
pT4	0 (0)	0 (0)	0 (0)	–
2014	1/38 (2.63)	12/91 (13.19)	22/110 (20.00)	0.071
pT2	0 (0)	3/12 (25.00)	12/22 (54.55)	0.027***
pT3	1/1 (100.00)	9/12 (75.00)	10/22 (45.45)	0.623
pT4	0 (0)	0 (0)	0 (0)	–
2015	7/38 (18.42)	7/91 (7.69)	21/110 (19.10)	0.891
pT2	3/7 (42.86)	3/7 (42.86)	4/21 (19.05)	0.262
pT3	4/7 (57.14)	4 /7(57.14)	17/21 (80.95)	0.276
pT4	0 (0)	0 (0)	0 (0)	–
2016	4/38 (10.53)	10/91 (10.99)	33/110 (30.00)	0.949
pT2	1/4 (25.00)	4/10 (40.00)	4/33 (12.12)	0.208
pT3	3/4 (75.00)	6/10 (60.00)	29/33 (87.88)	0.811
pT4	0 (0)	0 (0)	0 (0)	–
2017	1/38 (2.63)	3/91 (3.30)	22/110 (20.00)	0.478
pT2	0 (0)	0 (0)	7/22 (31.82)	0.397
pT3	1/1 (100.00)	3/3 (100.00)	15/22 (68.18)	0.163
pT4	0 (0)	0 (0)	0 (0)	–

***, comparison of groups by the Chi-s(quare test. Data are presented as number (percent, %). PSM, positive surgical margin; ORP, open radical prostatectomy; LRP, laparoscopic radical prostatectomy; RALRP, robotic-assisted laparoscopic radical prostatectomy.

Table S2 Time analysis of GS grade group

Year	ORP (N=128), n (%)	LRP (N=241), n (%)	RALRP (N=295), n (%)
2008			
G1 (GS ≤ 6)	7 (53.85)	19 (59.38)	0 (0)
G2 (GS = 3+4)	2 (15.38)	4 (12.50)	0 (0)
G3 (GS = 4+3)	2 (15.38)	5 (15.63)	0 (0)
G4 (GS = 8)	1 (7.69)	4 (12.50)	0 (0)
G5 (GS = 9, 10)	1 (7.69)	0 (0)	0 (0)
2009			
G1 (GS ≤ 6)	12 (66.67)	10 (50.00)	0 (0)
G2 (GS = 3+4)	2 (11.11)	3 (15.00)	0 (0)
G3 (GS = 4+3)	2 (11.11)	4 (20.00)	0 (0)
G4 (GS = 8)	1 (5.56)	2 (10.00)	0 (0)
G5 (GS = 9, 10)	1 (5.56)	1 (5.00)	0 (0)
2010			
G1 (GS ≤ 6)	2 (33.33)	12 (44.44)	0 (0)
G2 (GS = 3+4)	1 (16.67)	4 (14.81)	0 (0)
G3 (GS = 4+3)	3 (50.00)	7 (25.93)	0 (0)
G4 (GS = 8)	0 (0)	4 (14.81)	0 (0)
G5 (GS = 9, 10)	0 (0)	0 (0)	0 (0)
2011			
G1 (GS ≤ 6)	3 [60]	9 (52.94)	0 (0)
G2 (GS = 3+4)	1 [20]	2 (11.76)	0 (0)
G3 (GS = 4+3)	0 (0)	2 (11.76)	0 (0)
G4 (GS = 8)	1 [20]	3 (17.65)	0 (0)
G5 (GS = 9, 10)	0 (0)	1 (5.88)	0 (0)
2012			
G1 (GS ≤ 6)	6 (37.50)	12 (41.38)	0 (0)
G2 (GS = 3+4)	2 (12.50)	7 (24.14)	0 (0)
G3 (GS = 4+3)	4 (25.00)	6 (20.69)	0 (0)
G4 (GS = 8)	1 (6.25)	2 (6.90)	0 (0)
G5 (GS = 9, 10)	3 (18.75)	2 (6.90)	0 (0)
2013			
G1 (GS ≤ 6)	6 (37.50)	9 (39.13)	14 (46.67)
G2 (GS = 3+4)	5 (31.25)	4 (17.39)	7 (23.33)
G3 (GS = 4+3)	1 (6.25)	5 (21.74)	6 [20]
G4 (GS = 8)	0 (0)	2 (8.70)	3 [10]
G5 (GS = 9, 10)	4 [25]	3 (13.04)	0 (0)
2014			
G1 (GS ≤ 6)	6 (54.55)	12 (41.38)	17 [34]
G2 (GS = 3+4)	1 (9.09)	6 (20.69)	13 [26]
G3 (GS = 4+3)	3 (27.27)	6 (20.69)	10 [20]
G4 (GS = 8)	1 (9.09)	1 (12.50)	6 [12]
G5 (GS = 9, 10)	0 (0)	4 (13.79)	4 [8]
2015			
G1 (GS ≤ 6)	4 (22.22)	5 (23.81)	16 (26.67)
G2 (GS = 3+4)	5 (27.78)	7 (33.33)	21 (35.00)
G3 (GS = 4+3)	0 (0)	3 (14.29)	9 (15.00)
G4 (GS = 8)	5 (27.78)	4 (19.05)	5 (8.33)
G5 (GS = 9, 10)	4 (22.22)	2 (9.52)	9 (15.00)
2016			
G1 (GS ≤ 6)	3 (27.27)	13 (50.00)	24 (26.09)
G2 (GS = 3+4)	3 (27.27)	9 (34.62)	20 (21.74)
G3 (GS = 4+3)	1 (9.09)	3 (11.54)	17 (18.48)
G4 (GS = 8)	2 (18.18)	0 (0)	18 (19.57)
G5 (GS = 9, 10)	2 (18.18)	1 (3.85)	13 (14.13)
2017			
G1 (GS ≤ 6)	2 (28.57)	3 (30.00)	15 (26.32)
G2 (GS = 3+4)	2 (28.57)	5 (50.00)	14 (24.56)
G3 (GS = 4+3)	1 (14.29)	0 (0)	12 (21.05)
G4 (GS = 8)	2 (28.57)	1 (10.00)	11 (19.30)
G5 (GS = 9, 10)	0 (0)	1 (10.00)	5 (8.77)

GS, Gleason score; G, grade group; ORP, open radical prostatectomy; LRP, laparoscopic radical prostatectomy; RALRP, robotic-assisted laparoscopic radical prostatectomy.