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Comparison of oncological and health related quality of life (HRQOL) outcomes between open (ORP) and robotic-assisted radical prostatectomy (RARP) for localized prostate cancer – findings from the population-based Victorian Prostate Cancer Registry (PCR)

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ABSTRACT

Objective

To compare the short-term oncological and HRQOL outcomes between open (ORP) and robotic-assisted (RARP) radical prostatectomy in the population-based Victorian Prostate Cancer Registry (PCR).

Patients and Methods

This is a prospective cohort of prostate cancer patients who had RP (1117 ORP and 885 RARP) between January 2009 and June 2012. The oncological outcomes of interest were: positive surgical margin (PSM) and biochemical recurrence (BCR) (defined as post-operative PSA >0.2ng/ml). The HRQOL outcomes were: sexual and urinary bother, assessed using the Expanded Prostate Cancer Index Composite (EPIC) at 1- and 2-year post-diagnosis. Student T-test or Mann-Whitney U-test were used for univariate comparison of continuous variables, and Pearson's chi-squared test for categorical variables. Bonferonni correction was applied to account for multiple testing, with threshold for significance of *P*<0.003 for univariate analyses. The inverse probability treatment weighting (*IPTW*)

approach was used to adjust for differences in baseline characteristics between ORP and RARP patients (including age, NCCN risk categories, hospitals, and year of RP) in all multivariate analyses. Logistic regressions were used to analyse for PSM, Cox regressions for BCR, and ordinal logistic regressions for HRQOL outcomes. All multivariate analyses also adjusted for surgeons' average annual caseload, and employed the robust standard errors for clustering by surgeon.

Results:

ORP and RARP patients were followed for a median of 19 months and 17 months respectively. The proportion of patients with NCCN low risk prostate cancer was significantly higher among RARP patients (21% vs. 26%; *P=0.002*). The majority of RP was done in the private sector (77% ORP, and 85% RARP, *P<0.001*). A higher proportion of RARP patients were operated by surgeons with higher annual caseload (65% RARP and 53% ORP operated by surgeons with >20 case/ year (*P*<0.001). In the IPTW-adjusted multivariate analyses, RARP patients had lower risk of PSM (OR=0.56; 95%CI=0.38-0.81), and BCR (HR=0.73; 95%CI=0.55-0.99). In the sensitivity analyses (excluding public hospital patients), the lower PSM risk with RARP remains (OR=0.63; 95%CI=0.38-0.81), but the lower BCR risk with RARP was no longer statistically significant (HR=0.79; 95%CI=0.57-1.12). At 1 year follow-up, 61% ORP and 59% RARP patients reported moderate-big sexual bother (*P=0.2*), while 14% ORP and 11% RARP patients reported moderate-big urinary bother (*P=0.08*). The sexual and urinary bother at 2-year was similar between ORP and RARP. No statistically significant differences in the HRQOL outcomes between ORP and RARP were observed in multivariate analyses.

Conclusion:

We reported a large population-based comparative study on ORP and RARP with better short-term oncological outcomes favouring RARP, but no significant differences in HRQOL outcomes. The results have to be interpreted, taking into account significant surgeon heterogeneity, in a population-based study.

INTRODUCTION

Radical prostatectomy (RP) is the most commonly utilized treatment modalities for prostate cancer, with nearly half of the patients with clinically localized prostate cancer treated with RP (1). Over the past decades, RP approach has evolved with the introduction of minimally invasive RP. Robotic-assisted RP (RARP) using the da Vinci® surgical system (Intuitive Surgical, Sunnyvale, CA, USA) has become increasingly common, now accounting for the majority of RPs done in the US (2), despite the lack of high-quality evidence to substantiate its perceived outcomes benefits over open RP (ORP) (3, 4). This has provoked much debate around the RARP approach, given the high cost involved (5, 6).

Large comparative studies are needed to evaluate the peri-operative, oncological and functional outcomes of different RP approaches. Randomized controlled trials (RCT) would be ideal to assess this issue, but these are notoriously difficult to conduct due to recruitment difficulty and surgeon bias, leading to a lack of adequate equipoise to randomize patients to different RP approaches. Observational studies and systematic reviews therefore form most of the comparative studies in the literature. These studies are often based on single-centre, high-volume, tertiary referral centre case series (7), and have limited generalizability. Important sources for comparative studies, which provide more objective outcomes assessment generalizable to the population-level, are prostate cancer registries (8). However, there are also inherent limitations with registries-based dataset such as the lack of validated patient-reported functional outcomes data. Nevertheless, large systematic reviews have demonstrated better surgical margin (9), urinary function (10), erectile function (11), and complications (12) with RARP compared to ORP.

In the current study, we aim to compare the oncological and health related quality of life (HRQOL) outcomes between ORP and RARP approaches using data from the population-based Victorian Prostate Cancer Registry (PCR).

METHODS AND MATERIALS

Study Cohort: In Victoria, Australia, we established the population-based PCR to investigate systematic variations in cancer presentation and cancer care provided to prostate cancer patients (13). Methods for patients recruitment and data collection in the PCR have previously been described (13). In brief, men with biopsy-confirmed prostate cancer in participating Victorian hospitals were notified to the PCR. An opt-out consent process was used. We included in this study, all patients diagnosed with clinically localized prostate cancer (January 2009 – June 2012) and proceeded to have ORP or RARP as their primary treatment within 12-month of diagnosis (n=2002). The study was approved by the Monash University Heath Research Ethics Committee.

Oncological Outcomes: Positive surgical margin (PSM) was used as a surrogate measures for early oncological outcomes, given the significant association with cancer progression (14, 15). Biochemical recurrence (BCR) was defined as post-operative PSA >0.2ng/ml. Data on PSA was collected in the PCR annually post-diagnosis. Any interval BCR (i.e. PSA >0.2ng/ml between the annual PSA collection) would also be picked up as the PCR routinely collects data on PSA prior to any adjuvant or salvage therapies post-RP. The time to BCR is defined as the interval between the date of RP and the date of BCR. Patients who did not experience BCR were censored on the date of the most recent PSA.

HRQOL Outcomes: All patients were contacted through phone interviews approximately 1-year and 2-year post-diagnosis, during which the HRQOL outcomes were assessed. The urinary and sexual function were assessed using the ‘bother’ items adapted from the Expanded Prostate Cancer Index Composite (EPIC) questionnaires (16). Patients reported the severity of bother for each domain between 1 and 5 (1=“no bother”, 5=“big bother”). Trained data collectors, with medical terminology familiarity, conducted all phone interviews using standardize scripts. Treatment details and accuracy of PSA history were also confirmed during the phone interviews. 1370 patients who completed both the 1-year and 2-year phone interviews were included in the HRQOL outcome analyses.

Control Variables: Pre-operative characteristics included in the analyses were: age at diagnosis, PSA at diagnosis, biopsy Gleason score and clinical stage. The patients were classified into low, intermediate and high-risk using the NCCN risk classification. The hospitals where the RP was performed were classified as public/private and rural/metropolitan. The year of RP was included in the analyses as an indirect way to account for the fact that RARP requires a long learning curve to achieve good PSM (17). Surgeon volume was also included in the analyses, as it is a strong outcome predictor (18-20). The surgeon volume was determined by aggregating the number of ORP and RARP by each surgeon in our study cohort. Because surgeons at different hospitals started contributing their patients for inclusion into the PCR at varying time points after commencement of PCR in 2009, we used the average annual caseload rather than the total caseload for each surgeon.

Statistical Analyses: Univariate comparison of the covariates between ORP and RARP patients were performed using a t-test or Mann-Whitney U-test as appropriate, and a Pearson's chi-square test for categorical variables. Bonferroni correction was applied to account for multiple testing, with threshold for significance defined as $P<0.003$ for all univariate analyses.

The inverse probability of treatment weighting (IPTW) approach was used to adjust for differences patients' pre-operative characteristics in multivariate analyses (21). This method allowed us to control for potential confounding factors that might influence the likelihood of patients having one RP approach over another, and balance the pre-operative characteristics between the two RP approaches, as would occur in a randomized trial. A logistic regression model was used to estimate the propensity score (ps) for RARP (i.e. the predicted probability of patients undergoing RARP based solely on the pre-operative covariates), using the patients' age, NCCN risk classification, hospital type, and year of RP. A probability weighting of 1/ps was the assigned to patients who had RARP, and 1/(1-ps) to patients who had ORP (22, 23). The IPTW was included all subsequent multivariate analyses.

Logistic regression was used to estimate the risk of PSM for ORP and RARP patients. Analysis for PSM was also stratified by the pathological stage. The probability of BCR for each RP approach was plotted on the Kaplan Meier curves, and the difference assessed using the log-rank test. Cox proportional hazard regressions were used to estimate the effect of the RP approaches on BCR. The pathological stage and PSM, which are known prognosticators for BCR, were included in the multivariate analyses. There was no evidence of violation of the proportional hazard assumption.

For the 1-year and 2-year HRQOL outcomes, ordinal logistic regressions were used to estimate the OR for sexual and urinary bother between ORP and RARP patients, treating each level of 'bother' as an ordinal category. The interval between RP and HRQOL assessment was included as a covariate in the HRQOL multivariate analyses, given that the HRQOL assessment was performed around 1- and 2-year after prostate cancer diagnosis, whereas the patients had RP at varying times (within 12-months) after prostate cancer diagnosis. There was no evidence of violation of the proportional odds assumptions in the ordinal logistic regressions. All multivariate models also adjusted for surgeons' average annual case load and employed the robust standard errors (24), with the analyses clustered on a surgeon identifier to allow for patient clustering by surgeons (25). Sensitivity analyses were also performed, excluding patients who had RP performed in public hospitals (given that trainee-surgeons are more likely to be involved in RP in public hospitals). All statistical analyses were performed using Stata /IC 12 (StataCorp, College Station, Texas).

RESULTS

Of the 2002 patients included in this study, 1117 (56%) had ORP and 885 (44%) had RARP (Table-1). The average age at diagnosis was 62 years (SD=6.7). Overall, ORP patients have significantly less NCCN low-risk prostate cancer (P<0.001). The average time from diagnosis to RP was 2.3 months (SD=1.8). The majority of RPs was performed in private settings (77% ORP and 85% RARP). All RARP were performed in metropolitan hospitals. Most RARPs (91%) were performed from 2011 onwards, which reflects the progressive growth of health services in the PCR to include large centres performing RARP. The median surgeons' annual caseload was 20 and 21 cases per year respectively for patients who had ORP and RARP (P=0.02).

All patients were followed for a median of 18 months post RP (IQR: 11-22 months). RARP patients had significantly lower proportion of PSM compared to ORP patients (23% vs. 34%; P<0.001) (Table-2). The differences were much more pronounced in patients with organ-confined disease (pT2) – 8% and 24% for RARP and ORP respectively (P<0.001). There was no difference in PSM in patients with non-organ confined disease – 48% and 53% for RARP and ORP respectively (P=0.1). The Kaplan-Meier curves show BCR free survival between ORP and RARP patients, with 18-month BCR free survival of 83% and 89% respectively (P=0.003) (Figure-1). In the IPTW-adjusted multivariate analyses (Table-3), RARP patients had 44% lower risk of PSM (95%CI=0.36-0.81) compared to ORP patients. In the subset analyses by pathological stage, the risk of PSM is significantly lower with RARP among patients with pT2 disease (OR=0.28; 95%=0.19-0.41); however, no statistically significant difference in the PSM was observed between patients with non-organ confined disease (≥pT3) who had RARP vs. ORP (OR=0.78; 95%CI=0.51-1.19). In the sensitivity analyses (excluding public hospital patients), risk of PSM remained lower with RARP in pT2 disease (OR=0.32; 95%CI=0.20-0.53), but not ≥pT3 disease patients (OR=0.82; 95%CI=0.50-1.35). RARP patients had 27% lower risk of BCR (95%CI=0.55-0.99) compared to ORP patients, after adjusting for the IPTW and surgeons' annual caseload, and taking into accounts the pathological stages and PSM. In the sensitivity analyses, there is still a trend towards lower risk of BCR with RARP; however, the association was no longer statistically significant (HR=0.79; 95%CI=0.57-1.12).

Of the 1370 patients included in the HRQOL outcomes analyses, all completed the 1- and 2-year HRQOL assessment at a median of 10.6 (IQR=9.8-11.2) and 22.8 months (IQR=20.8-23.3) post-RP respectively. Overall, at 1-year follow-up, 60% of patients reported moderate-big sexual bother – 19% moderate- and 42% big-bother for ORP, and 21% moderate- and 38% big-bother for RARP (P=0.2). Urinary bother, however, is of less impact, with 13% of patients reported moderate-big urinary bother at 1-year – 9% moderate- and 5% big-bother for ORP, and 9% moderate- and 2% big-bother for RARP (P=0.08). At 2-year, the proportions of patients with moderate-big sexual and urinary bother were similar. In the IPTW-adjusted multivariate analyses, there were no significant differences in the sexual and urinary bother between ORP and RARP patients at both 1-year and 2-year follow-up. Results of sensitivity analyses, excluding public hospital patients, did not differ significantly.

DISCUSSION

We evaluated the short-term oncological and HRQOL outcomes among prostate cancer patients who had ORP and RARP using the Victorian PCR database. The major strength of our study is the use of population-based data. For the findings of comparative study on RP approaches to be reflective of the current practice patterns and to be generalizable, it needs to capture most, if not all, RPs in the population, given that RPs are not infrequently being performed outside of high-volume tertiary institutions. To our knowledge, most population-based comparative studies on RP approaches were from the US Surveillance, Epidemiology, and End Results (SEER)-Medicare database (26, 27). However, these studies were restricted to the US Medicare-aged men (i.e. aged >65), while our population-based registry data captured patients of all age groups.

There are several important findings in our study. Firstly, we observed significant differences in the pre-operative characteristics between ORP and RARP patients. The differences may reflect disparity in access to care and possibly discriminatory selection of patients for ORP and RARP by the surgeons, based on patients' pre-operative characteristics. We attempted to balance all the measured covariates by including them in the derivation of the propensity score for the IPTW adjustment. These are common covariates, which are matched on, in prostate cancer randomized trials. However, the use of IPTW-approach does not redress the potential imbalance conferred by other unmeasured confounders, not included in the IPTW derivation.

Secondly, we reported better short-term oncological outcomes with RARP compared to ORP. A meta-analysis of 13 comparative studies by Novara et al reported no significant difference in PSM between ORP and RARP patients – 20% in RARP and 21% in ORP (9). The proportion of PSM is lower in pT2 disease – 11% in RARP and 12% in ORP (9). In our study, we observed a similar proportion of PSM with RARP (23% overall, and 8% in pT2 disease), however, there is significantly higher proportion of PSM with ORP (34% overall, and 24% in pT2 disease). We also reported a 27% lower risk of early BCR with RARP compared to ORP, after adjustment for the surgical specimens histopathology. To date, no studies have shown significant differences in BCR between RARP and ORP (28-31). A possible explanation is that earlier studies reported a lower proportion of BCR compared to our population-based study; hence probably lack the statistical power to detect a difference, if one exists. Different definitions of BCR might explain part of this, but there is no differential ascertainment of BCR in our cohort treated with the two RP approaches, suggesting the difference we observe is real. It is also important to highlight that early BCR often reflects micro-metastatic disease, whereas local recurrence often show up as late BCR. Given the higher proportion of PSM with ORP, it is likely that we will observe more significant differences in BCR with longer follow-up.

The findings of higher proportion of PSM and BCR observed in our study need to be interpreted, taking into account the significant surgeon heterogeneity at a population-level; and this may reflect the “average” effect of treatment in the population. However, when compared to other population-based study, the PSM with ORP in our study is still significantly higher. In a recent SEER-Medicare study, Hu et al reported an overall 18% PSM with ORP, with 14.6% in pT2 disease (32) (compared to 34% overall, and 24% in pT2 disease with ORP in our study. One could postulate that, experienced surgeons are more likely to adopt RARP, and hence the higher PSM in ORP are attributable to less experienced surgeons. In fact, in our cohort of patients, we did observe slightly higher proportion of ORP patients operated by surgeons with lower annual caseload, compared to RARP patients.

In addition, surgeon heterogeneity was only accounted for by including surgeons' average annual caseload as covariate in all multivariate analyses. This may not reflect the true differences in individual surgeons' experience. It is also important to highlight that the PCR has yet to capture *all* RPs performed in the state of Victoria, and there are a small number of institutions in Victoria, which have not contributed clinical data to the PCR to date. There are surgeons who perform RPs at multiple institutions, and any RPs performed in non-PCR participating institutions will have not been captured in our database. Hence, we could not discount the possibility of misclassification of each surgeon's annual caseload.

Another potential unaccounted surgeon heterogeneity is the fact that trainee-surgeons are more likely to be involved in RPs in public hospitals as part of their training. Due to the nature of administrative data collection in the PCR, the RPs were often documented as being performed by the supervising consultant-surgeon, and not capturing the actual ‘surgeon’ who in a public hospital is more likely to be a trainee-surgeon. An inherent limitation of our study is the attribution of the surgery – and hence the outcomes – to the documented consultant-surgeons on the record, and not the variably supervised trainee-surgeons. However, in our sensitivity analyses excluding patients who had RP in public hospitals, the lower risk of PSM with RARP remained. There was sill a trend towards lower risk of BCR with RARP, but the association was no longer statistically significant. This could be due to the reduced sample size in the sensitivity analyses, and hence reduced power to detect a statistically significant association.

Thirdly, we did not observe significant differences in the HRQOL outcomes between patients treated with either RP approach. In the SEER-Medicare study, Hu et al reported worse urinary and sexual functions with minimally invasive RP (26); however, the contentious findings were criticized for the use of diagnosis billing codes to define erectile dysfunction and incontinence (33, 34). Another major strength of our study is the use of patient-administered questionnaires for HRQOL assessment. At the same time, we acknowledge some weaknesses in our HRQOL assessment. Firstly, there was a lack of information on the baseline HRQOL status due to the impracticality of interviewing patients – identified through a state cancer registry – pre-treatment. Since there is always a delay between diagnosis and notification to PCR, patients would often have proceeded to RP prior to PCR recruitment. Secondly, in order to minimize respondent burden, we only used the 'bother' items adapted from the EPIC questionnaires. Thirdly, similar to other population-based studies, we do not have information on RP nerve-sparing status, which is an important predictor for HRQOL outcomes.

CONCLUSION

We reported a large population-based comparative study on ORP and RARP, with high and unbiased ascertainment of cases. We observed better short-term oncological outcomes favouring RARP, but no significant differences in the HRQOL outcomes up to two years post-diagnosis. The results have to be interpreted taking into account the surgeon heterogeneity in a population-based setting, which is likely incompletely accounted for, despite our robust statistical approaches. We recognized that these are early oncological and HRQOL outcomes, at variance to most published literature, and long-term follow-up is definitely warranted.

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CONFLICT OF INTEREST

The authors indicated no conflicts of interest

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TABLE – 1 I Demographic and Pre-operative Characteristics of Patients Undergoing Open (ORP) and Robotic Assisted (RARP) Radical Prostatectomy			
	ORP	**RARP**	**P-value***
Patient, n	1117 (56%)	885 (44%)	
Time from diagnosis to RP (month), mean (SD)	2.2 (1.5)	2.5 (2.0)	
Age of diagnosis (years)			
Mean (sd)	62.3 (6.7)	62.1 (6.7)	0.4
<60	389 (35%)	316 (36%)	0.3
60-70	593 (53%)	482 (54%)	
>70	135 (12%)	87 (10%)	
Serum PSA at diagnosis (ng/mL)			
Median (IQR)	6.1 (4.6-8.5)	5.5 (4.3-7.8)	<0.001
<4	155 (14%)	166 (19%)	0.02
4-10	766 (69%)	584 (66%)	
>10	181 (16%)	124 (14%)	
(Missing)	15 (1%)	11 (1%)	
Clinical Stage			
<cT2b	621 (56%)	484 (55%)	0.02
cT2b/cT2c	138 (12%)	134 (15%)	
>cT2c	55 (5%)	23 (3%)	
(Missing)	303 (27%)	244 (28%)	
Pathological Stage			
pT2 (organ-confined)	735 (66%)	557 (63%)	0.2
pT3/4 (non-organ-confined)	382 (34%)	328 (37%)	
Biopsy Gleason score			
<7	289 (26%)	279 (32%)	0.02

7	632 (56%)	477 (54%)	
>7	192 (17%)	128 (14%)	
(Missing)	4 (0.4%)	1 (0.1%)	
NCCN risk categories			
Low risk	238 (21%)	232 (26%)	0.002
Intermediate risk	624 (56%)	501 (57%)	
High Risk	255 (23%)	152 (17%)	
Hospital Type			
Public	258 (23%)	130 (15%)	<0.001
Private	859 (77%)	755 (85%)	
Hospital Location			
Regional	121 (11%)	0 (0%)	<0.001
Metropolitan	996 (89%)	885 (100%)	
Year of surgery			
2009	256 (23%)	27 (3%)	<0.001
2010	299 (27%)	59 (7%)	
2011	354 (31%)	445 (50%)	
2012	208 (19%)	354 (40%)	
Surgeon volume (Annual case load)			
Median (IQR)	20 (11-26)	21 (17-25)	0.02
<10/ year	193 (17%)	89 (10%)	<0.001
11-20/ year	329 (30%)	224 (25%)	
21-30/ year	327 (29%)	385 (44%)	
>30/ year	268 (24%)	187 (21%)	
*Threshold for significance was defined as P<0.003 following Bonferonni correction for multiple testing			

TABLE-2 I Unadjusted Oncological and Functional Outcomes by RP approaches			
	ORP	**RARP**	**P-value***
Oncological Outcomes			
Follow up (month), median (IQR)	19 (12-22)	17 (11-20)	
Positive Surgical Margin– n (%)			
All patients			<0.001
No	739 (66%)	683 (77%)	
Yes	378 (34%)	202 (23%)	
pT2 disease (organ-confined)			<0.001
No	561 (76%)	511 (92%)	
Yes	174 (24%)	46 (8%)	
>pT2 disease (non-organ-confined)			0.1
No	178 (47%)	172 (52%)	
Yes	204 (53%)	156 (48%)	
Biochemical Recurrence – n (%)			
No	894 (80%)	777 (88%)	<0.001
Yes	223 (20%)	108 (12%)	
HRQOL Outcomes			
Time from RP to 12-month HRQOL assessment (month), median (IQR)	10.6 (9.8-11.2)	10.6 (9.8-11.2)	
12-Month Sexual Bother – n (%)			
No Bother	162 (22%)	124 (19%)	0.2
Very small Bother	38 (5%)	43 (7%)	
Small Bother	89 (12%)	92 (14%)	
Moderate Bother	138 (19%)	136 (21%)	
Big Bother	304 (42%)	244 (38%)	
12-Month Urinary Bother –n (%)			

No Bother	351 (48%)	321 (50%)	0.08
Very small Bother	162 (22%)	145 (23%)	
Small Bother	115 (16%)	103 (16%)	
Moderate Bother	69 (9%)	58 (9%)	
Big Bother	34 (5%)	12 (2%)	
Time from RP to 24-month HRQOL assessment (month), median (IQR)	22.7 (21.9-23.3)	22.8 (21.9-23.4)	
24-Month Sexual Bother – n (%)			
No Bother	176 (24%)	142 (23%)	0.03
Very small Bother	49 (7%)	55 (9%)	
Small Bother	114 (16%)	95 (15%)	
Moderate Bother	119 (16%)	139 (22%)	
Big Bother	273 (37%)	202 (32%)	
24-Month Urinary Bother –n (%)			
No Bother	375 (51%)	356 (56%)	0.06
Very small Bother	172 (24%)	148 (23%)	
Small Bother	100 (14%)	78 (12%)	
Moderate Bother	53 (7%)	46 (7%)	
Big Bother	31 (4%)	11 (2%)	
*Threshold for significance was defined as P<0.003 following Bonferonni correction for multiple testing			

TABLE–3 | Oncological and health related quality of life outcomes for RARP (compared to ORP), adjusted for inverse probability of treatment weighting (IPTW)*, clustering by surgeon

	OR	**95% CI**	**P-value**
HRQOL Outcomes			
12-Month Sexual Bother [X§]	1.05	0.85-1.30	0.7
12-Month Urinary Bother [X§]	1.14	0.91-1.44	0.3
24-Month Sexual Bother [X§]	1.07	0.88-1.32	0.5
24-Month Urinary Bother [X§]	1.21	0.95-1.54	0.1
Oncological Outcomes			
Positive surgical margin[X]			
All patients	0.56	0.38-0.81	<0.01
pT2 disease (organ-confined)	0.28	0.19-0.41	<0.01
>pT2 disease (non-organ-confined)	0.78	0.51-1.19	0.20
	HR	**95% CI**	**P-value**
Biochemical Recurrence[X#]	0.73	0.55-0.99	0.04

*All analyses adjusted for inverse probability of treatment weight (IPTW) (including age at diagnosis, PSA, clinical stage, Gleason score, hospital type, and year of RP)

[§] Adjusted for interval between RP and HRQOL outcomes assessment

[X] Adjusted for surgeons average annual caseload

[#] Adjusted for surgical margin status and pathological stage

Figure–1 | Biochemical Recurrence Free Survival
Between ORP and RARP Patients