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Laparoscopic and Robotic Radical Prostatectomy Outcomes in Obese and Extremely Obese Men

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Abstract

Objectives—To evaluate operative and pathologic outcomes of laparoscopic radical prostatectomy (LRP) and robot assisted radical prostatectomy (RARP) in men with progressive changes in BMI category.

Methods—A single-surgeon series of 1,023 LRP and RARP (mostly extraperitoneal) patients was considered, of whom 987 were evaluable. Results were stratified by World Health Organization BMI category. Multivariable linear and logistic regression was used to model operating time (OT), length of stay (LOS), positive surgical margins (PSM), and noncurable cancer.

Results—A total of 57% (563/987) of patients were overweight and 19.6% (193/987) were obese: 152 (15.4%) BMI 30 to <35 (class I obesity), 28 (2.8%) BMI 35 to <40 (class II), and 13 (1.3%) BMI 40 (class III). There were no differences in estimated blood loss, complications, PSM, pathologic stage, or biochemical recurrence across BMI categories (6.0-month median follow-up). However, pelvic lymph node dissection was more commonly omitted and nerve-sparing score was inferior in obese men. On multivariable analysis, higher BMI was a significant predictor of longer OT.

Conclusions—Obese men can safely undergo LRP or RARP, though the ability to perform excellent nerve-sparing appears to decrease with increasing obesity. Nevertheless, obese men may expect perioperative and early oncologic outcomes comparable to those of normal weight men without an increased risk of perioperative complications.

Keywords

prostate cancer; obesity; laparoscopy; robotics

In the United States, the prevalence of obesity, defined as body mass index (BMI) ≥ 30 kg/m², has increased from 12.5% in 1980 to 32.2% in 2008, and continues to rise.¹ Obesity presents a challenge in men with prostate cancer undergoing radical prostatectomy (RP) for a variety of reasons. First, obese patients may present with more aggressive cancers. Several

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large series have shown that higher BMI is associated with higher grade tumors and an increased risk of biochemical recurrence after RP.^{2,3} Second, obesity may render RP more technically challenging, thus compromising oncologic control. Several series have shown an association between BMI and an increased rate of positive surgical margins (PSM) and capsular incision^{4,5,6}. Perhaps because of these surgical challenges, obese men undergo alternative prostate cancer management approaches such as active surveillance, external beam radiation, brachytherapy, and primary androgen deprivation more commonly than their normal-weight counterparts.⁷

In recent years there have been several reports describing the technical feasibility and oncologic efficacy of laparoscopic radical prostatectomy (LRP) and robotic radical prostatectomy (RARP) in obese men. However, many of these studies are limited by small sample size.⁸⁻¹³ In larger series men have been dichotomized as “normal” or “obese”, rather than being stratified by BMI category, a common feature in the smaller series as well.^{14,15}

In concordance with national obesity prevalence trends, there is an increasing percentage of obesity among men undergoing RP at our institution, especially men with World Health Organization (WHO) Class II (BMI ≥ 35) and Class III (BMI ≥ 40) obesity. It is unknown whether their outcomes are comparable to those of thinner men. The current study investigates a large single-surgeon series of men treated with minimally-invasive RP, laparoscopic or robot-assisted, stratified by WHO BMI categories, with attention to peri-operative and oncologic outcomes among BMI groups.

Materials and Methods

We retrospectively reviewed a series of 1023 men who underwent LRP (Aesop™ camera robot-assisted, Computer Motion, Santa Barbara, CA) or RARP (Da Vinci™ robot-assisted, Intuitive Surgical, Sunnyvale, CA) by a single surgeon (CPP) between October 2001 and September 2011. Excluding men without BMI data (26) and those who had undergone neoadjuvant hormonal therapy (10) left 987 men for analysis. Men were grouped into WHO weight classes based on pre-operative BMI (kg/m²): normal weight (<25), overweight (25-29.99), Class I obese (30-34.99), Class II obese (35-39.99), and Class III obese (≥ 40).¹⁶

All prostate biopsy specimens underwent central pathologic review. Operations were performed either transperitoneally (modified Montsouris approach) or extraperitoneally.^{17,18} Due to surgeon preference, RP was increasingly performed extraperitoneally as of 2005, and almost exclusively robotically as of 2009, regardless of patient BMI. Nerve-sparing was graded intra-operatively using a 0-4 scale per side, with 4 reflecting the highest degree of nerve-sparing with generous amounts of periprostatic tissue, and 0 reflecting non-nerve-sparing, creating a bilateral nerve-sparing score (NSS) of 0-8.⁽¹⁹⁻²¹⁾ Prostatectomy specimens were routinely processed and examined by a dedicated genitourinary pathologist as previously described.¹⁹

Means were compared by one-way analysis of variance (ANOVA) for continuous variables and chi-square or Fisher's exact test for proportions. Proportional hazards models were used to analyze biochemical recurrence among BMI categories in univariate fashion only, due to limited follow-up and a low number of PSA failures, particularly among men in the highest BMI categories. The changing incidence of WHO class II and class III obesity in our series was analyzed by chi-square test.

Linear and logistic regressions were used to analyze operating time (OT), post-operative length of stay (LOS), PSM, and “noncurable” cancer, the latter defined as a 10-year likelihood of biochemical recurrence ≥ 25% based on pathologic features at surgery (pT2 with Gleason pattern 4+3 or worse, or pT3 with Gleason >6, or pT3 with PSM).²⁰ All

candidate predictors that were statistically significantly associated with the outcome on univariate analyses were included in the multivariable models using a stepwise forward approach. Because surgery in men with higher BMI has become more frequent in recent years, we included an interaction between BMI category and year of surgery and tested model fit before and after incorporating the interaction term.

The level of statistical significance was pre-defined as a p-value ≤ 0.05 . All statistical analyses were performed using STATA™ 10.0 (StataCorp, College Station, Texas).

Results

Baseline characteristics of the 987 men, stratified by BMI group, are shown in Table 1. The mean BMI for the entire cohort was 27.5 kg/m² (interquartile range 25.1, 29.4). There were no differences in pre-operative demographic parameters or in disease characteristics between BMI groups, with the exception of pre-operative International Prostate Symptom Score (IPSS), which was higher in increasingly obese patients ($p=0.032$). Obese men were increasingly likely to have undergone surgery in more recent years in the series ($p<0.001$).

Table 2 demonstrates surgical and oncologic outcomes stratified by increasing BMI. There was a significant trend towards a higher utilization of robotics in higher BMI categories ($p=0.004$). An extraperitoneal approach was used in 64% of all cases, and was used more frequently in men with BMI ≥ 35 compared to thinner men (78% versus 63%, $p=0.054$). Surgeon-assessed NSS was lower in higher BMI categories ($p<0.001$). Pathologic outcomes, including Gleason score, pathologic stage, and PSM, did not differ among obesity categories. Complications were rare and similar overall among BMI categories. The significant Mantel-Haenszel chi-squared p-value of 0.039 for deep vein thrombosis (DVT) was related to a single DVT in the class II obesity category. Of 26 recorded complications, 23 were Clavien grade I-II. Three Clavien grade IV complications were all pulmonary embolism (PE) events requiring ICU admission.

The likelihood of PLND decreased with increasing obesity, although the association was marginally non-significant ($p=0.068$). When dichotomizing the cohort at the BMI 35 cut-point, men with BMI ≥ 35 underwent PLND less often than men with BMI <35 (65.7% vs 48.8%, $p=0.026$). We investigated this finding further by analyzing the subgroup of men in whom PLND was indicated per current National Comprehensive Cancer Network (NCCN) guidelines predicted probability of lymph node metastases $\geq 2\%$ per Partin nomogram).^{21,22} Of 41 morbidly obese men (BMI ≥ 35), PLND was omitted in 2 of the 14 (14.3%) men in whom it was indicated, a higher rate of omitted PLND than for men with BMI <35 (2.2%) (Fisher's exact $p=0.052$, Table 3).

Univariate and multivariable regression analyses were performed to assess BMI category as a predictor of OT and LOS (linear models) and PSM and noncurable cancer (logistic models). The results are shown in Table 4. Higher BMI was an independent predictor of longer OT. BMI category was not independently associated with LOS, PSM, or noncurable prostate cancer. In all four regression models, the term for the interaction between BMI category and year of surgery was not statistically significant (data not shown). In other words, the increasing prevalence of higher BMI over time had no independent predictive effects. Therefore the interaction term was omitted from the final multivariable models.

For all patients median and mean PSA follow-up after surgery was 6.0 and 17.4 months, respectively (range 0-108 months). In the 55 men who experienced biochemical recurrence, median and mean times to recurrence were 24.0 and 27.0 months, respectively (range 1-90 months). In a univariate Cox proportional hazards model, BMI category was not associated

with disease recurrence ($p=0.565$), though this result is limited due to a lack of long-term follow-up.

Comment

Reflecting the obesity epidemic in the United States, an increasing percentage of men in contemporary RP series are obese.¹² Here we show that although the rates and severity of obesity increased over time, obese men with prostate cancer can undergo LRP or RARP with similar cancer control and without excessive morbidity, compared to their counterparts with lower BMI. Men in the highest extremes of obesity had pathological tumor grade, stage, and PSM rates that did not differ significantly compared to normal-weight and overweight individuals. With regard to the safety of LRP and RARP, class II and III obese men fared no worse in terms of estimated blood loss, LOS, and overall complications. Across obesity categories, there were no significant differences in short-term biochemical recurrence. Because follow-up was limited, particularly for men in the highest BMI categories, we evaluated a surrogate for long-term recurrence risk--noncurable cancer based on adverse pathologic features. BMI category was not associated with noncurable cancer.

However, men in extreme BMI categories still bore certain disadvantages. Despite no significant differences among BMI categories in pre-operative PSA, tumor grade, or clinical stage, men in higher BMI categories underwent PLND less often. Furthermore, for men in higher BMI categories, NSS was worse. Subjective NSS takes into account both nerve-sparing quantity and quality, and is in use by various groups in the United States.²³⁻²⁵ The relation between BMI and nerve-sparing *quality* has not previously been assessed to our knowledge, though prior studies have demonstrated mixed results with respect to BMI and nerve-sparing *frequency*.^{13,26,27} In addition, on multivariable analysis, higher BMI category was found to be an independent predictor of longer OT, suggesting added surgical difficulty inherent in operating on the obese patient, even with a minimally-invasive approach.

Multiple prior studies have performed similar analyses comparing peri-operative and oncologic outcomes between normal weight and obese men undergoing minimally-invasive radical prostatectomy.⁸⁻¹⁴ Similar to our findings, the majority of these reports found no significant associations between obesity and EBL, rates of PSM, complication rates, or pathologic stage and grade.^{8,13,14} Our series was consistent with other studies that have shown longer operative times in obese men.^{8-11,14,15} The published literature is nevertheless somewhat limited by the small sample size of the majority of these series. To our knowledge, there has been only one publication looking at BMI in over 1000 men treated with LRP/RARP.¹⁴ The 242 patients with BMI ≥ 30 kg/m² in that large study were analyzed as a single group, whereas in the present study we examined outcomes by increasing severity of obesity. Other series stratifying men by WHO obesity class I, II, and III, report on much smaller numbers of patients, limiting the interpretation of their findings.⁸

It is noteworthy that within our near 1000-patient series there was no significant association found between obesity and adverse pathologic outcomes after surgery: pathologic grade, stage, positive margins, and noncurable cancer. This differs from the findings of many large open RP series that have concluded that obesity increases the risk of capsular incision⁶, PSM, and pathologic grade.^{2,3} These findings suggest that open RP may be more technically difficult in obese men, whereas laparoscopic and particularly robotic technology may enable surgeons to achieve equivalent oncologic outcomes in obese and normal weight individuals. The extraperitoneal approach also appears to be well-suited for overweight and obese men given that it allows for access to the prostate avoiding abdominal fat, which can be copious in men with central obesity. However, one series of extraperitoneal laparoscopic radical prostatectomy has reported higher positive margin rates for obese men.¹⁵ In the current

study, in which most obese men received an extraperitoneal approach and in which robotic technology was increasingly utilized, PSM did not differ among obesity categories, and after adjusting for biopsy Gleason and PSA, increasing BMI category was not an independent risk factor for PSM.

Furthermore, the current analysis did not detect significant associations between biochemical recurrence and increasing degrees of obesity, although follow-up was limited, particularly in the highest BMI categories. Previously reported data on biochemical recurrence and obesity have been mixed. Series of men undergoing RP (open or lap/robot) from the Veterans' Affairs SEARCH database have found that higher BMI, especially BMI $\geq 35 \text{ kg/m}^2$, is a significant risk factor for biochemical recurrence.^{2,28} However, in multiple large series of open RP, BMI was not found to be an independent predictor of biochemical recurrence, nor was it found to be able to modify the ability of PSA to predict biochemical recurrence.^{5,29,30} Although, literature on biochemical recurrence and LRP and RARP is more limited, three published series have shown no association between BMI and biochemical recurrence risk.^{10,14,15}

Obesity can present anesthesia- and positioning-related challenges as well. During LRP or RARP, the potential for steep Trendelenburg positioning and consequent restrictive ventilatory difficulty is compounded in the setting of abdominal obesity. In our experience the extraperitoneal approach is advantageous in this respect, as significantly less Trendelenburg is required. In all patients we take care to ensure all pressure points are generously-padded, and for select patients with very large lower limbs we also employ plus-sized lithotomy stirrups as used in bariatric surgery. In this series, we did not observe any neuromuscular positioning-related morbidities, regardless of BMI.

Nonetheless, our results did identify some disadvantages for obese individuals relative to their normal weight counterparts, as mentioned above. Heavier men were shown to have worse cavernous nerve-sparing as subjectively graded intra-operatively, a finding that has been correlated with recovery of erectile function.²³ Furthermore, we found that obese men underwent PLND less frequently, a finding that is not explained by differences in pre-operative tumor characteristics. As LRP/RARP are technically feasible, even in extremes of obesity, obesity should not contraindicate PLND when it is otherwise indicated. However, the amount of fat covering the pelvic lymph nodes in morbidly obese men makes PLND more difficult and more risky in these men. A tendency to want to play it safe and avoid obturator injury and vascular complications likely explains why obese men received fewer PLNDs than were indicated by current guidelines (though the guidelines were not in effect throughout the duration of the study).

Our study was retrospective and reports the experience of a single high-volume surgeon at a single center, and hence is subject to the limitations of such series. Factors determining choice of extraperitoneal versus transperitoneal approach, degree of cavernous nerve-sparing, and performance of PLND were not recorded and were sometimes subject to intra-operative decisions. Although this is a 10-year experience, the median and mean PSA follow-up after surgery were short, at 6.0 and 17.4 months. Therefore, actuarial biochemical failure risks are difficult to estimate. For this reason, we studied rates of noncurable cancer found at RP, which predicts a 25% 10-year risk of biochemical recurrence, as a proxy in this cohort. Rates of noncurable cancer did not differ significantly across all BMI categories.

Conclusions

In this retrospective series of approximately 1,000 men undergoing LRP and RARP increasing BMI was found to be an independent predictor of longer operating time, though

there were no significant disadvantages in complication rates, pathologic outcomes, percentage of ‘noncurable’ cancer, or biochemical recurrence rates with progressive changes in BMI category. These findings suggest that obese men with prostate cancer can undergo minimally-invasive radical prostatectomy safely and with similar oncologic outcomes to their normal weight counterparts. Nevertheless, obese men receive slightly worse intra-operative nerve-sparing and receive PLND less often than they should, likely due to technical surgical challenges.

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Baseline characteristics, single-surgeon series of men undergoing laparoscopic or robotic radical prostatectomy stratified by BMI, 2001-2011

Table 1

	BMI < 25 Normal wt.	BMI 25, <30 Overweight	BMI 30, <35 Class I obese	BMI 35, <40 Class II obese	BMI 40 Class III obese	p
N (%)	231 (23.4%)	563 (57.0%)	152 (15.4%)	28 (2.8%)	13 (1.3%)	
Age	58.3	58.3	57.7	57.3	56.2	0.574
Race						0.647
White	192 (83.1%)	463 (82.4%)	122 (80.3%)	19 (67.9%)	11 (84.6%)	
Black	30 (13.0%)	77 (13.7%)	23 (15.1%)	8 (28.6%)	2 (15.4%)	
Other	9 (3.9%)	22 (3.9%)	7 (4.6%)	1 (3.6%)	0 (0.0%)	
Mean PSA (ng/ml)	5.9	6.0	6.2	5.3	6.9	0.636
Clinical Stage						0.531
cT1	165 (71.4%)	412 (73.4%)	101 (66.4%)	22 (78.6%)	11 (84.6%)	
cT2	49 (21.2%)	116 (20.7%)	35 (23.0%)	4 (14.3%)	1 (7.7%)	
cT3	17 (7.4%)	33 (5.9%)	16 (10.5%)	2 (7.1%)	1 (7.7%)	
Biopsy Gleason						0.479
2-6	165 (71.4%)	401 (71.2%)	111 (73.0%)	21 (75.0%)	6 (46.2%)	
7 (3+4)	49 (21.2%)	103 (18.3%)	24 (15.8%)	5 (17.9%)	5 (38.5%)	
7 (4+3)	10 (4.3%)	37 (6.6%)	9 (5.9%)	2 (7.1%)	2 (15.4%)	
8-10	7 (3.0%)	22 (3.9%)	8 (5.3%)	0 (0.0%)	0 (0.0%)	
IPSS (mean)	6.7	6.4	8.1	9.4	9.1	0.032
SHIM (mean)	19.6	18.9	16.5	18.8	17.0	0.182

Table 2

Peri-operative and pathologic outcomes of men undergoing laparoscopic or robotic radical prostatectomy stratified by BMI

	BMI < 25 Normal wt.	BMI 25, <30 Overweight	BMI 30, <35 obese	BMI 35, <40 Class I obese	BMI 40 Class II obese	P
N (%)	231 (23.4)	563 (57.0)	152 (15.4)	28 (2.8)	13 (1.3)	
Approach						<i><0.001</i>
Laparoscopic	211 (91.3%)	486 (86.3%)	122 (80.3%)	20 (71.4%)	10 (76.9%)	
Robotic	20 (8.7%)	77 (13.4%)	30 (19.7%)	8 (28.6%)	3 (23.1%)	
Extraperitoneal	140 (60.5%)	355 (62.7%)	104 (68.7%)	22 (79.3%)	10 (76.9%)	<i>0.019</i>
PLND	231 (70.0%)	360 (63.8%)	100 (66.4%)	12 (41.4%)	8 (61.5%)	<i>0.054</i>
Mean OR time (h)	3.09	3.27	3.31	3.06	2.82	<i>0.008</i>
EBL (ml)	213	225	232	201	227	<i>0.582</i>
Nerve-Sparing Score (NSS) (0-8) * (mean)	6.0	5.6	5.2	5.3	4.5	<i><0.001</i>
Mean Length of Stay (d)	1.6	1.7	1.8	1.5	1.3	<i>0.099</i>
Complications						
Infection	2 (0.9%)	5 (0.9%)	6 (3.9%)	0 (0.0%)	0 (0.0%)	<i>0.179</i>
DVT	0 (0.0%)	5 (0.9%)	3 (2.0%)	1 (3.6%)	0 (0.0%)	<i>0.039</i>
PE	1 (0.4%)	0 (0.0%)	2 (1.3%)	1 (3.6%)	0 (0.0%)	<i>0.062</i>
Pathologic Gleason sum						<i>0.304</i>
2-6	150 (64.9%)	365 (64.8%)	92 (60.5%)	15 (53.6%)	7 (53.8%)	
7 (3+4)	54 (23.4%)	120 (21.3%)	37 (24.3%)	7 (25.0%)	5 (38.5%)	
7 (4+3)	22 (9.5%)	48 (8.5%)	16 (10.5%)	6 (21.4%)	1 (7.7%)	
8-10	5 (2.2%)	30 (5.3%)	7 (4.6%)	0 (0.0%)	0 (0.0%)	
Pathologic Stage						<i>0.175</i>
pT0-pT2 N0	191 (81.4%)	472 (82.2%)	127 (82.2%)	22 (75.0%)	9 (69.2%)	
pT3a N0	35 (15.2%)	69 (12.3%)	23 (15.1%)	5 (17.9%)	2 (15.4%)	
pT3b or pN1	5 (2.2%)	22 (3.9%)	2 (1.3%)	1 (3.6%)	2 (15.4%)	

	BMI < 25 Normal wt.	BMI 25, <30 Overweight	BMI 30, <35 obese	BMI 35, <40 Class I obese	BMI 40 Class II obese	P
Positive Surgical Margin	36 (15.6%)	100 (17.8%)	34 (22.4%)	5 (17.9%)	3 (23.1%)	0.138
Biochemical Failures**	17 (7.3%)	27 (4.7%)	9 (5.9%)	2 (6.9%)	0 (0%)	0.561
Noncurable cancer found at RP***	44 (19.0%)	119 (21.1%)	35 (23.0%)	9 (32.1%)	4 (30.8%)	0.083
Months f/u						
Mean	20.5	18.4	12.9	5.7	5.5	<0.001
Median	9.0	9.0	3.0	0.0	0.0	
IQR	0-36.0	2.0-24.0	0-12.0	0-9.0	0-2.0	

* Intra-operative grading of nerve-sparing using a 0-4 scale per side with 4 reflecting the highest degree of nerve-sparing and 0 reflecting non-nerve-sparing, creating a bilateral nerve-sparing score (NSS) of 0-8 for each patient, with 0 meaning no nerves were spared and 8 meaning both were spared with generous amounts of periprostatic tissue

** defined as two post-operative consecutive PSA measurements 0.2, a single post-operative PSA measurement >0.2, or receipt of salvage radiation, androgen deprivation, or chemotherapy; p-value reflects Chi-squared test; logrank p-value of BMI category univariate Cox proportional hazards model is p=0.565

*** defined as having 25% chance of biochemical recurrence at 10 years after surgery based on pathologic findings

Table 3

Rates of receiving pelvic lymph node dissection (PLND) in patients for whom PLND was indicated, single-surgeon series of laparoscopic and robotic radical prostatectomy, stratified by BMI

	BMI < 25 Normal wt.	BMI 25, <30 Overweight	BMI 30, <35 Class I obese	BMI 35, <40 Class II obese	BMI 40 Class III obese	P
N (%)	231 (23.4)	563 (57.0)	152 (15.4)	28 (2.8)	13 (1.3)	
Mean nodal yield (IQR)	6.0 (2-9)	5.9 (3-8)	6.9 (2.5-10)	7.7 (5-9)	6.8 (4.5-8.5)	0.327
No. in whom PLND indicated *	69	164	41	7	7	0.836
No. in whom PLND omitted	4	2	0	1	1	
Inappropriately omitted PLND (%) **	5.8%	1.2%	0.0%	14.3%	14.3%	0.017 **

* based on Partin nomogram-predicted probability of lymph node metastasis 2%

** proportion reflects number in whom PLND omitted divided by number in whom PLND indicated

*** Fisher's exact test

Table 4

Effects of increasing BMI in univariate and multivariable linear models of operating time and length of stay and logistic models of positive surgical margins and noncurable prostate cancer; single-surgeon series of laparoscopic and robotic radical prostatectomy, 2001-2011

	BMI	Univariate	Multivariable
Operating Time β (95% C.I.) p	Linear	0.00 (-0.01, 0.01) p=0.886	0.02 (0.01, 0.03) p<0.001 *
Length of Stay β (95% C.I.) p	Linear	0.00 (-0.01, 0.01) p=0.883	0.01 (-0.01, 0.02) p=0.350 **
Positive Margin O.R. (95% C.I.) p	<25	Referent	Referent ^
	25-30	1.17 (0.78, 1.78) p=0.448	1.16 (0.71, 1.88) p=0.554
	30-35	1.56 (0.93, 2.63) p=0.094	1.55 (0.84, 2.83) p=0.158
	35-40	1.18 (0.42, 3.30) p=0.756	1.27 (0.39, 4.13) p=0.691
	40	1.63 (0.42, 6.20) p=0.477	1.70 (0.38, 7.67) p=0.487
Noncurable Ca. $\times$ O.R. (95% C.I.) p	<25	Referent	Referent ^^
	25-30	1.14 (0.77, 1.68) p=0.508	1.10 (0.73, 1.67) p=0.640
	30-35	1.27 (0.77, 2.10) p=0.347	1.25 (0.73, 2.13) p=0.411
	35-40	2.01 (0.85, 4.75) p=0.110	1.97 (0.77, 5.05) p=0.158
	40	1.89 (0.56, 6.42) p=0.308	1.78 (0.45, 7.05) p=0.413

* adjusting for year of surgery, nerve-sparing score, surgical technique (extraperitoneal vs transperitoneal), and whether pelvic lymph node dissection was performed)

** adjusting for year of surgery, nerve-sparing score, surgical technique (extraperitoneal vs transperitoneal and laparoscopic vs robotic), and presence of post-operative complication

$\times$ defined as having 25% chance of biochemical recurrence at 10 years after surgery based on pathologic findings

^ adjusting for year of surgery, nerve-sparing score, surgical technique (laparoscopic vs robotic), pre-operative PSA, biopsy Gleason sum, gland weight, and presence of post-operative complication

^^ adjusting for year of surgery, surgical technique (extraperitoneal vs transperitoneal and laparoscopic vs robotic), and pre-operative PSA, and gland weight