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Contemporaneous comparison of open vs minimally-invasive radical prostatectomy for high-risk prostate cancer

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Abstract

Objectives—• To analyze pathological and short-term oncological outcomes in men undergoing open and minimally-invasive radical prostatectomy (MIRP) for high-risk prostate cancer (HRPC; prostate-specific antigen level [PSA] >20 ng/mL, cT2c, Gleason score 8–10) in a contemporaneous series.

Patients and Methods—• In total, 913 patients with HRPC were identified in the Johns Hopkins Radical Prostatectomy Database subsequent to the inception of MIRP at this institution (2002–2011)

- Of these, 743 (81.4%) underwent open radical retropubic prostatectomy (ORRP), 105 (11.5%) underwent robot-assisted laparoscopic radical prostatectomy (RALRP) and 65 (7.1%) underwent laparoscopic radical prostatectomy (LRP) for HRPC.
- Appropriate comparative tests were used to evaluate patient and prostate cancer characteristics.
- Proportional hazards regression models were used to predict biochemical recurrence.

Results—• Age, race, body mass index, preoperative PSA level, clinical stage, number of positive cores and Gleason score at final pathology were similar between ORRP and MIRP.

- On average, men undergoing MIRP had smaller prostates and more organ-confined (pT2) disease ($P = 0.02$).
- The number of surgeons and surgeon experience were greatest for the ORRP cohort.
- Overall surgical margin rate was 29.4%, 34.3% and 27.7% ($P = 0.52$) and 1.9%, 2.9% and 6.2% ($P = 0.39$) for pT2 disease in men undergoing ORRP, RALRP and LRP, respectively.
- Biochemical recurrence-free survival among ORRP, RALRP and LRP was 56.3%, 67.8% and 41.1%, respectively, at 3 years ($P = 0.6$) and the approach employed did not predict biochemical recurrence in regression models.

Conclusions—• At an experienced centre, MIRP is comparable to open radical prostatectomy for HRPC with respect to surgical margin status and biochemical recurrence.

Keywords

high-risk; minimally-invasive surgery; prostate cancer; radical prostatectomy

Introduction

Minimally-invasive radical prostatectomy (MIRP) has emerged as a widely accepted and utilized modality for the treatment of localized prostate cancer in the USA and worldwide. Laparoscopic radical prostatectomy (LRP) was the initial modality offered but, as a result of technical difficulties and a limited range of motion, was only available at select institutions. Robot-assisted laparoscopic radical prostatectomy (RALRP) has supplanted LRP as the choice technique for MIRP as a result of the advantages of enhanced three-dimensional optics, hinged instrument wrists offering a full range of motion that improves intracorporeal dexterity and ease of use, and patient interest in novel technology. RALRP accounted for 98 000 radical prostatectomy worldwide in 2010 and most of the 85 000 radical prostatectomy performed in the USA alone [1].

The ideal treatment for men with high-risk prostate cancer (HRPC) remains controversial. A growing body of literature argues for equivalent or favourable oncological and functional outcomes for patients with HRPC undergoing radical prostatectomy as monotherapy [2–4] compared to radiation and/or hormone therapy [5,6]. Critics of MIRP comment that the open radical retropubic prostatectomy (ORRP) approach is more suited for patients with HRPC, citing haptic feedback as essential for preventing positive margins and open exposure as necessary for adequate pelvic lymph node (LN) dissection [7,8]. Recently, a number of single-armed analyses have emerged, touting equivalent oncological and functional outcomes of RALRP for HRPC [9–12]. Although a randomized, prospective analysis of ORRP and RALRP would best answer the question of the influence of surgical approach on outcomes after radical prostatectomy, in the present study, we report a large, contemporaneous institutional experience of pathological and short-term oncological outcomes in men undergoing ORRP and MIRP for HRPC.

Patients and Methods

The Johns Hopkins Radical Prostatectomy Database was queried for men with HRPC undergoing radical prostatectomy subsequent to the inception of MIRP at this institution (2002–2011). High-risk criteria included PSA level >20 ng/mL, clinical stage T2c or T3, or Gleason score 8–10 [13]. The present study catalogues the contemporaneous experience as MIRP was adopted into clinical practice. LRP was the initial MIRP offered at our institution and this cohort represents the transition from ORRP and LRP to RALRP. Therefore, a secondary analysis was performed to evaluate the outcomes of LRP and RALRP individually. Surgeon experience was determined using consecutive case numbers for any radical prostatectomy because many surgeons perform both ORRP and MIRP. By institutional policy, all patients undergoing radical prostatectomy receive an extended pelvic LN dissection; all specimens are processed *en bloc*.

Appropriate comparative tests (Students' *t*-test, chi-squared and ANOVA) were used to evaluate patient and prostate cancer characteristics. The Kaplan–Meier method and log-rank test were used to determine biochemical recurrence-free survival (BFS). Proportional hazard regression models were used to determine predictors of BFS, with only significant predictors of BFS in univariate analysis being included in the multivariate model.

Results

Of 10 690 patients undergoing radical prostatectomy subsequent to 2002, 913 (8.5%) patients were identified with HRPC; 743 (81.4%) underwent ORRP, 105 (11.5%) underwent RALRP and 65 (7.1%) underwent LRP. HRPC represented 9.3%, 7.4% and 5.2% of ORRP,

RALRP and LRP cases, respectively ($P < 0.001$). Patient and prostate cancer characteristics are provided in Table 1. Age, race, body mass index, preoperative PSA level, clinical stage, number of positive cores and Gleason score at final pathology were similar between ORRP and MIRP. On average, men undergoing MIRP had smaller prostates and more organ-confined (OC; pT2) disease ($P = 0.02$). However, when evaluating each modality individually, men undergoing LRP included a higher proportion of patients with advanced clinical stage (cT2b), fewer patients with a high Gleason score (9–10) and more patients with OC disease, whereas men undergoing RALRP were statistically similar to men undergoing ORRP with respect to the same variables. In addition, 99%, 91% and 88% of men undergoing RALRP, ORRP and LRP had one high-risk feature, respectively (for a pairwise comparison of RALRP vs ORRP, $P = 0.03$; RALRP vs LRP, $P = 0.015$). Rates of node-positive (N1) disease were highest in the ORRP cohort compared to MIRP, with 10.8%, 3.8% and 3.1% for ORRP, RALRP and LRP, respectively. Accordingly, mean LN count was highest in men undergoing ORRP compared to RALRP and LRP (8 vs 6 vs 5, respectively; for a pairwise comparison of RALRP and LRP, $P < 0.001$; $P > 0.99$). Overall and pT2 positive surgical margin (PSM) rates were similar among ORRP and MIRP. The number of surgeons performing ORRP, RALRP and LRP was 13, 7 and 2, respectively; surgeon experience was greatest for ORRP compared to RALRP and LRP ($P < 0.001$).

BFS at a mean (range) survival of 3 (1–8) years was 56.3%, 67.8% and 41.1% for ORRP, RALRP and LRP, respectively ($P = 0.6$). Surgical modality, when considering ORRP vs MIRP or each modality individually, did not predict BFS in univariate or multivariate regression models controlling for age, PSA level, Gleason score, clinical and pathological stage (Tables 2,3). Rates of adjuvant external beam radiation therapy (EBRT) were 8.1%, 2.9% and 13.8% ($P = 0.035$); rates of any EBRT (adjuvant or salvage) were 13.2%, 3.8% and 15.4% ($P = 0.1$). Rates of early androgen deprivation therapy (<1 year from radical prostatectomy) were 8.1%, 1.0% and 3.1%, respectively; rates of any androgen deprivation therapy were 13.1%, 3.8% and 4.6% ($P = 0.018$). Mean follow-up was 3.2, 1.97 and 1.95 years from ORRP, RALRP and LRP, respectively ($P < 0.001$).

Discussion

Although the ideal treatment for men with HRPc remains controversial, a number of studies show favourable oncological outcomes for radical prostatectomy as monotherapy [2–4] compared to radiation and/or hormone therapy [5,6]. A number of single-arm, retrospective studies tout excellent surgical, oncological and functional outcomes after MIRP in HRPc [9–12]; however, a rigorous comparison of open and minimally-invasive techniques is lacking. Recognizing the inherent selection bias in a retrospective surgical series and in anticipation of the results of prospective, comparative studies [14], we show similar pathological and short-term oncological outcomes among open and minimally-invasive approaches to radical prostatectomy at a large, academic medical institution in which all approaches are performed. Importantly, the present study is a contemporaneous analysis of patients undergoing ORRP and MIRP during the same time period at the same hospital.

The most obvious criticism of this analysis is the role of selection bias in the outcomes. Potential sources of bias included, first, that all patients in the present study cohort are selected to do well because they are candidates for surgery rather than non-operative therapies. Accordingly, most patients in this series have one high-risk feature (92%) and a number of studies, including data from our own institution, show that the accumulation of high-risk features portends a poor prognosis [15–18]. Second, because surgeons have a preference for open or minimally-invasive approaches, the outcomes for each modality may reflect referral patterns for individual surgeons, an institutional referral pattern toward one modality for higher-risk patients or other, preoperative characteristics that are not quantified.

However, none of these biases are made inherently clear by examining the data. Patients undergoing ORRP, RALRP and LRP are similar in age, racial/ethnic background, body mass index, PSA level, number of cores positive at biopsy, maximum percentage involved of positive cores and Gleason score at biopsy and pathology. However, men with HRPC represent 9% of the ORRP cohort and 6% of the MIRP patients, indicating that selection certainly bears some influence. More substantively, >50% of patients undergoing LRP had OC (pT2) disease at radical prostatectomy compared to 33% and 34% of ORRP and RALRP, respectively, despite the aforementioned similar preoperative characteristics. This may be a result of random effects given the small size of the MIRP cohorts, although it probably reflects the broader inclusion criteria among the 15 surgeons performing ORRP compared to the two surgeons performing LRP.

Importantly, no differences were noted among open or minimally-invasive approaches for significant short-term oncological endpoints: BFS, positive surgical margin rates and LN counts. The overall BFS rate of 57% at 3 years indicates that these patients are certainly at high-risk for prostate cancer recurrence. Previous studies of MIRP show comparable BFS rates [9–12]. Unfortunately, the follow-up is too short to allow for meaningful analysis of metastases-free or prostate cancer-specific survival. Nevertheless, at this time point, the surgical approach has little impact on BFS, as shown by uni- and multivariate regression models. Additionally, rates of PSM were similar among the approaches and notably low for patients with OC (pT2) disease. Overall PSM rates in previous open and MIRP series are in the range 21–47% and compare favourably with the results of the present study [9–12,19–22]. The very low rate of PSM in OC disease indicates the oncological efficacy of all three approaches and shows that the rates of PSM for MIRP reach the benchmark set by ORRP in the hands of experienced surgeons. Alternatively, low rates of PSM may indicate a more extensive dissection and less precise nerve-sparing. Unilateral and bilateral nerve-sparing is reported in 15–60% and 18–58% of cases in other series [9,11,12]. Although data regarding nerve-sparing on an individual basis are not available, it is our institutional policy to spare nerves bilaterally whenever technically possible based on intra-operative findings. Therefore, a palpable abnormality during ORRP or visualization of adherent periprostatic tissue during MIRP may serve as an indicator for wide resection. Given the similar preoperative characteristics, it may be assumed that intra-operative findings and rates of nerve-sparing are similar among the approaches.

The extent of LN dissection and adequacy of MIRP in sequestering lymphatic tissue is a highly controversial subject. It has been reported that a wider anatomic dissection leads to a greater total LN count and a higher rate of LN metastases [23–25]; however, the role of extended lymph node dissection in improving oncological outcomes is not well established [26,27]. Some studies advocate LN counts in excess of 20 nodes to indicate an adequate dissection [25,28]; however, the total number of nodes is highly variable and dependent on both surgeon and pathologist [29,30]. It is our institutional policy to perform an extended LN dissection in all patients undergoing radical prostatectomy and process our packets *en bloc*. We show a consistent count of five to eight nodes for all three approaches in the presnet study. A comparative study of ORRP and RALRP from Columbia University similarly reported mean LN yields of 7.7 and 6.8 ($P = 0.3$), respectively, for men with intermediate and HRPC [8]. Although some critics may argue that eight LN is an inadequate dissection, we assert that LN counts are highly-subjective and can vary based on surgeon and pathologist processing. We highlight the consistent, institutional approach to LN dissection within our establishment and have established favourable outcomes for men with HR and node-positive prostate cancer [31]. Although the results are statistically significant, the clinical significance between five, six and eight negative nodes is questionable. However, >10% of ORRP patients were N1 at pathological analysis compared to <4% for MIRP. Although this may reflect selection practices, it may also reflect a degree of

inadequate staging for men undergoing MIRP. Nevertheless, very few patients had more than one node-positive, indicating a generally well-selected population with less extensive nodal disease when present.

A similarly small proportion of patients underwent additional treatment after radical prostatectomy regardless of modality. In a large, comparative study, Hu et al. [32] reported similar rates of additional therapy for MIRP despite a large difference in the proportion of men with OC disease. Although overall rates of EBRT were similar among groups, in the present study, we found the highest rate of adjuvant EBRT in the LRP cohort. Conversely, rates of overall androgen deprivation therapy were highest in the ORRP cohort. This probably reflects the higher proportion of men with advanced pathological disease in the ORRP cohort, individual surgeon preferences regarding the use of adjuvant therapies and differences in the length of follow-up for each modality. Given these shortcomings, additional follow-up may parse out the role of adjuvant therapies in overall prostate-cancer specific outcomes, including metastases and death.

In addition to the previously noted limitations, there are a number of ways of improving future analyses. Only a prospective, randomized study can be free of bias and appropriately answer the question of open vs MIRP. However, individual surgeon skill and experience may drive outcomes in a small series and a large, multi-institutional study is required to best address this issue. As shown in other studies, outcomes after radical prostatectomy are driven by surgeon experience [29,33]. We attempted to control for surgeon experience to the best of our ability by tallying case numbers. Although minimally-invasive surgeons from our institution are experienced, it should be noted that the open surgeons from our institution have significantly more case experience and this undoubtedly affects patient selection, as well as the intra-operative management of high-risk tumours. In addition, functional outcomes would improve the interpretation of the data and, specifically, may augment any conclusions made regarding nerve-sparing and PSM if potency rates were drastically different among modalities. Finally, with time, the acquisition of additional follow-up will better address oncological outcomes and determine the true rates of salvage therapy, metastases and prostate cancer-specific mortality after radical prostatectomy.

In conclusion, given the strengths and weakness of the data reported in the present study, it is our recommendation that both physician and patient undergo a thorough discussion regarding the potential benefits and risks to radical prostatectomy and each approach. In experienced hands, each approach can achieve excellent, short-term oncological outcomes and the surgeon should perform the operation with the highest probability of a favourable outcome. Other studies report favourable outcomes for MIRP with respect to estimated blood loss, length of stay and return to convalescence [32]; the present study reports equivalent rates of PSM and short-term BFS among open and MIRP. Although individual surgeons may prefer an open or minimally-invasive approach for an improved tactile feedback, visualization, nerve-sparing or LN dissection, the decision should be based on surgeon skill and experience, recognizing that either approach can achieve excellent outcomes.

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Abbreviations

BFS	biochemical recurrence-free survival
EBRT	external beam radiation therapy
HRPC	high-risk prostate cancer
LN	lymph node
LRP	laparoscopic radical prostatectomy
MIRP	minimally-invasive radical prostatectomy
OC	organ-confined
ORRP	open radical retropubic prostatectomy
PSM	positive surgical margin
RALRP	robot-assisted laparoscopic radical prostatectomy

References

1. Intuitive Surgical Inc.. [December 1, 2012] Annual Report. Sunnyvale, California. Available at: <http://investor.intuitivesurgical.com/phoenix.zhtml?c=122359&p=irol-reportsAnnual>.
2. Berglund RK, Jones JS, Ulchaker JC, et al. Radical prostatectomy as primary treatment modality for locally advanced prostate cancer: a prospective analysis. *Urology*. 2006; 67:1253–6. [PubMed: 16678888]
3. Pierorazio PM, Guzzo TJ, Han M, et al. Long-term survival after radical prostatectomy for men with high Gleason sum in pathologic specimen. *Urology*. 2010; 76:715–21. [PubMed: 20350749]
4. Van Poppel H, Joniau S. An analysis of radical prostatectomy in advanced stage and high-grade prostate cancer. *Eur Urol*. 2008; 53:253–9. [PubMed: 17949893]
5. Zelefsky MJ, Eastham JA, Cronin AM, et al. Metastasis after radical prostatectomy or external beam radiotherapy for patients with clinically localized prostate cancer: a comparison of clinical cohorts adjusted for case mix. *J Clin Oncol*. 2010; 28:1508–13. [PubMed: 20159826]
6. Kupelian PA, Buchsbaum JC, Elshaikh M, Reddy CA, Zippe C, Klein EA. Factors affecting recurrence rates after prostatectomy or radiotherapy in localized prostate carcinoma patients with biopsy Gleason score 8 or above. *Cancer*. 2002; 95:2302–7. [PubMed: 12436435]
7. Blute ML. No proof of inferiority: open radical retropubic prostatectomy remains state-of-the-art surgical technique for localized prostate cancer. *J Urol*. 2009; 181:2421–3. [PubMed: 19371882]
8. Truesdale MD, Lee DJ, Cheetham PJ, Hruby GW, Turk AT, Badani KK. Assessment of lymph node yield after pelvic lymph node dissection in men with prostate cancer: a comparison between robot-assisted radical prostatectomy and open radical prostatectomy in the modern era. *J Endourol*. 2010; 24:1055–60. [PubMed: 20575697]
9. Jayram G, Decastro GJ, Large MC, et al. Robotic radical prostatectomy in patients with high-risk disease: a review of short-term outcomes from a high-volume center. *J Endourol*. 2011; 25:455–7. [PubMed: 21235415]
10. Engel JD, Kao WW, Williams SB, Hong YM. Oncologic outcome of robot-assisted laparoscopic prostatectomy in the high-risk setting. *J Endourol*. 2010; 24:1963–6. [PubMed: 21087128]
11. Lavery HJ, Nabizada-Pace F, Carlucci JR, Brajtford JS, Samadi DB. Nerve-sparing robotic prostatectomy in preoperatively high-risk patients is safe and efficacious. *Urol Oncol*. 2010; 30:26–32. [PubMed: 20189844]
12. Shikanov SA, Thong A, Gofrit ON, et al. Robotic laparoscopic radical prostatectomy for biopsy Gleason 8 to 10: prediction of favorable pathologic outcome with preoperative parameters. *J Endourol*. 2008; 22:1477–81. [PubMed: 18613786]
13. D'Amico AV, Whittington R, Malkowicz SB, et al. Biochemical outcome after radical prostatectomy, external beam radiation therapy, or interstitial radiation therapy for clinically localized prostate cancer. *JAMA*. 1998; 280:969–74. [PubMed: 9749478]

14. Paserotti, C.; Antunes, A.; Okano, M., et al. Early Results on A Prospective Randomized Trial: Robotic-Assisted Laparoscopic Prostatectomy (RALP) Versus Retropubic Radical Prostatectomy (RRP) Study. American Urological Association; Washington, DC: 2011.
15. Bastian PJ, Boorjian SA, Bossi A, et al. High-risk prostate cancer: from definition to contemporary management. *Eur Urol.* 2012; 61:1096–106. [PubMed: 22386839]
16. Briganti A, Joniau S, Gontero P, et al. Identifying the best candidate for radical prostatectomy among patients with high-risk prostate cancer. *Eur Urol.* 2012; 61:584–92. [PubMed: 22153925]
17. Pierorazio PM, Ross AE, Lin BM, et al. Preoperative characteristics of high-Gleason disease predictive of favourable pathological and clinical outcomes at radical prostatectomy. *BJU Int.* 2012; 110:1122–8. [PubMed: 22373045]
18. Loeb S, Schaeffer EM, Trock BJ, Epstein JI, Humphreys EB, Walsh PC. What are the outcomes of radical prostatectomy for high-risk prostate cancer? *Urology.* 2010; 76:710–4. [PubMed: 19931898]
19. Bastian PJ, Gonzalgo ML, Aronson WJ, et al. Clinical and pathologic outcome after radical prostatectomy for prostate cancer patients with a preoperative Gleason sum of 8 to 10. *Cancer.* 2006; 107:1265–72. [PubMed: 16900523]
20. Lau WK, Bergstralh EJ, Blute ML, Slezak JM, Zincke H. Radical prostatectomy for pathological Gleason 8 or greater prostate cancer: influence of concomitant pathological variables. *J Urol.* 2002; 167:117–22. [PubMed: 11743287]
21. Donohue JF, Bianco FJ Jr, Kuroiwa K, et al. Poorly differentiated prostate cancer treated with radical prostatectomy: long-term outcome and incidence of pathological downgrading. *J Urol.* 2006; 176:991–5. [PubMed: 16890678]
22. Manoharan M, Bird VG, Kim SS, Civantos F, Soloway MS. Outcome after radical prostatectomy with a pretreatment prostate biopsy Gleason score of ≥ 8 . *BJU Int.* 2003; 92:539–44. [PubMed: 14511029]
23. Bader P, Burkhard FC, Markwalder R, Studer UE. Is a limited lymph node dissection an adequate staging procedure for prostate cancer? *J Urol.* 2002; 168:514–8. [PubMed: 12131300]
24. Heidenreich A, Varga Z, Von Knobloch R. Extended pelvic lymphadenectomy in patients undergoing radical prostatectomy: high incidence of lymph node metastasis. *J Urol.* 2002; 167:1681–6. [PubMed: 11912387]
25. Briganti A, Chun FK, Salonia A, et al. Critical assessment of ideal nodal yield at pelvic lymphadenectomy to accurately diagnose prostate cancer nodal metastasis in patients undergoing radical retropubic prostatectomy. *Urology.* 2007; 69:147–51. [PubMed: 17270638]
26. Masterson TA, Bianco FJ Jr, Vickers AJ, et al. The association between total and positive lymph node counts, and disease progression in clinically localized prostate cancer. *J Urol.* 2006; 175:1320–4. [PubMed: 16515989]
27. Briganti A, Blute ML, Eastham JH, et al. Pelvic lymph node dissection in prostate cancer. *Eur Urol.* 2009; 55:1251–65. [PubMed: 19297079]
28. Joniau S.; Van Baelen, A.; Spahn, M., et al. In High-Risk Prostate Cancer, A Pelvic Lymph Node Dissection with >20 Lymph Nodes Removed at Radical Prostatectomy Significantly Improves Overall Survival. American Urological Association (AUA); Washington, DC: 2011.
29. Briganti A, Capitanio U, Chun FK, et al. Impact of surgical volume on the rate of lymph node metastases in patients undergoing radical prostatectomy and extended pelvic lymph node dissection for clinically localized prostate cancer. *Eur Urol.* 2008; 54:794–802. [PubMed: 18514383]
30. Bochner BH, Herr HW, Reuter VE. Impact of separate versus en bloc pelvic lymph node dissection on the number of lymph nodes retrieved in cystectomy specimens. *J Urol.* 2001; 166:2295–6. [PubMed: 11696756]
31. Allaf ME, Palapattu GS, Trock BJ, Carter HB, Walsh PC. Anatomical extent of lymph node dissection: impact on men with clinically localized prostate cancer. *J Urol.* 2004; 172:1840–4. [PubMed: 15540734]
32. Hu JC, Gu X, Lipsitz SR, et al. Comparative effectiveness of minimally invasive vs open radical prostatectomy. *JAMA.* 2009; 302:1557–64. [PubMed: 19826025]

33. Vickers A, Bianco F, Cronin A, et al. The learning curve for surgical margins after open radical prostatectomy: implications for margin status as an oncological end point. *J Urol*. 2010; 183:1360–5. [PubMed: 20171687]

What's known on the subject? and What does the study add?

- The ideal treatment for men with high-risk prostate cancer is controversial, although most physicians agree that a multimodal approach, including radiation and hormone therapy with or without surgery, offers the best chance of cancer control. Minimally-invasive radical prostatectomy has emerged as a treatment option for clinically localized cancer; however, critics argue that the open approach may afford advantages of tactile feedback and a better lymph node dissection.
- The present study demonstrates that open and minimally-invasive radical prostatectomy offer equivalent short-term outcomes for men with high-risk prostate cancer at a highly experienced centre.

Table 1

Patient and prostate cancer characteristics for 913 men with high-risk prostate cancer undergoing open radical retropubic prostatectomy (ORRP) and minimally-invasive radical prostatectomy (MIRP) from 2002 to 2011.

Variable	Entire cohort	ORRP	MIRP	P
Patients, <i>n</i>	913	743	170	
Year of radical prostatectomy, median (range)	2007 (2002–2011)	2006 (2002–2011)	2008 (2002–2011)	0.002
Age (years), median (range)	60 (38–76)	60 (38–74)	61 (41–76)	0.61
Body mass index (kg/m ²), median (range)	27.1 (16–41.8)	27.1 (16.0–41.8)	26.9 (18.5–38.5)	0.65
Race, <i>n</i> (%)				0.68
African-American	108 (11.8)	84 (11.5)	24 (14.1)	
Caucasian	744 (81.5)	609 (83.5)	135 (79.4)	
Other	61 (6.7)	50 (6.9)	11 (6.5)	
High-risk features, <i>n</i> (%)				0.23
1	805 (91.7)	659 (91.0)	146 (94.8)	
2	69 (7.9)	62 (8.6)	7 (4.5)	
3	4 (0.5)	3 (0.4)	1 (0.6)	
PSA level (ng/mL), median (range)	6.6 (0.2–97.2)	6.65 (0.2–97)	6.48 (1.6–49.9)	0.23
Clinical stage, <i>n</i> (%)				0.26
cT1c or cT2a	660 (72.3)	547 (75.0)	113 (66.5)	
cT2b	127 (13.9)	105 (14.4)	22 (12.9)	
cT2c or cT3a	101 (11.1)	77 (10.6)	24 (14.1)	
Positive cores, median (range)	3 (1–16)	3 (1–16)	3 (1–11)	0.21
Percent positive cores, median (range)	70 (1–100)	70 (5–100)	60 (1–100)	0.016
Biopsy Gleason score, <i>n</i> (%)				0.016
5–6	192 (21.0)	141 (19.1)	51 (30.0)	
7	363 (39.8)	301 (40.7)	62 (36.5)	
8	228 (25.0)	191 (25.8)	37 (21.8)	
9–10	130 (14.2)	107 (14.5)	19 (11.2)	
Pathological Gleason score, <i>n</i> (%)				0.52
5–6	53 (5.8)	39 (5.2)	14 (8.2)	
7	127 (13.9)	104 (14.0)	23 (13.5)	
8	396 (43.4)	324 (43.6)	72 (42.4)	
9–10	337 (36.9)	276 (37.1)	61 (35.9)	
Pathological stage, <i>n</i> (%)				0.02
Organ-confined (pT2)	318 (34.8)	247 (33.3)	69 (40.6)	
Extraprostatic extension (pT3a)	367 (40.2)	299 (40.4)	68 (40.0)	
Seminal vesicle invasion (pT3b)	142 (15.6)	115 (15.5)	27 (15.9)	
Lymph node metastases (N1)	86 (9.4)	80 (10.8)	6 (3.5)	
Lymph node count, median (range)	8 (0–39)	8 (0–37)	6 (0–39)	<0.001
Positive nodes, median (range)	1 (1–12)	1 (1–8)	1 (1–12)	0.26
Lymph node dissection omitted, <i>n</i> (%)	13 (1.4)	6 (0.8)	7 (4.1)	0.049
Prostate volume (mL), median (range)	49.8 (8.5–224)	50 (8.5–224)	47.05 (24.7–94.5)	0.002

Variable	Entire cohort	ORRP	MIRP	P
Surgical margin, <i>n</i> (%)	272 (29.8)	218 (29.4)	54 (31.8)	0.53
Positive surgical margin pT2, <i>n</i> (%)	19 (2.1)	14 (1.9)	5 (2.9)	0.6
Surgeons, <i>n</i>	16	15	9	
Surgeon experience, median case number (range)	1123 (20–4540)	1428 (20–4540)	353 (22–977)	<0.001

Table 2

Data regarding patients undergoing robot-assisted laparoscopic (RALRP) and laparoscopic radical prostatectomy (LRP) compared to open radical retropubic prostatectomy (ORRP).

Variable	RALRP	LRP	P
Patients, <i>n</i>	105	65	
Year of radical prostatectomy, median (range)	2008 (2005–2011)	2006 (2002–2011)	<0.001
Age (years), median (range)	62 (41–76)	60 (43–74)	0.6
Body mass index, median (range)	27.3 (21.8–38.5)	26.9 (18.5–34.0)	0.8
Race, <i>n</i> (%)			0.7
African-American	12 (12.4)	12 (19.4)	
Caucasian	86 (88.7)	49 (79.0)	
Other	7 (7.2)	4 (6.5)	
High-risk features, <i>n</i> (%)			0.053 ***
1	93 (98.9)	53 (88.3)	
2	1 (1.1)	6 (10.0)	
3	0 (0.0)	1 (1.7)	
PSA level (ng/mL), median (range)	6.4 (2.4–45)	6.7 (1.6–50)	0.011
Clinical stage, <i>n</i> (%)			0.022 **
cT1c or cT2a	75 (77.3)	38 (61.3)	
cT2b	13 (13.4)	9 (14.5)	
cT2c or cT3a	9 (9.3)	15 (24.2)	
Positive cores, median (range)	3 (1–11)	3 (1–10)	0.4
Percent positive cores, median (range)	60 (5–100)	60 (1–100)	0.1
Biopsy Gleason score, <i>n</i> (%)			0.23
5–6	31 (29.8)	20 (30.8)	
7	37 (35.6)	25 (38.5)	
8	23 (22.1)	14 (21.5)	
9–10	13 (12.5)	6 (9.2)	
Pathological Gleason score, <i>n</i> (%)			0.06 **
5–6	5 (4.8)	9 (13.8)	
7	13 (12.4)	10 (15.4)	
8	45 (42.9)	27 (41.5)	
9–10	42 (40.0)	19 (29.2)	
Pathological stage, <i>n</i> (%)			0.02 **
Organ-confined (pT2)	36 (34.3)	33 (50.8)	
Extraprostatic extension (pT3a)	46 (43.8)	22 (33.8)	
Seminal vesicle invasion (pT3b)	19 (18.1)	8 (12.3)	
Lymph node metastases (N1)	4 (3.8)	2 (3.1)	
Lymph node count, median (range)	6 (1–22)	5 (0–39)	<0.001 *
Positive nodes, median (range)	1 (1–1)	1.5 (1–12)	<0.001 **

Variable	RALRP	LRP	P
Lymph node dissection omitted, <i>n</i> (%)	3 (2.9)	4 (6.2)	<0.049 *
Prostate volume (mL), median (range)	46.5 (24.7–94.5)	48.4 (28–87)	<0.001
Surgical margin, <i>n</i> (%)	36 (34.3)	18 (27.7)	0.52
Positive surgical margin pT2, <i>n</i> (%)	3 (2.9)	2 (3.1)	0.8
Surgeons, <i>n</i>	7	2	
Surgeon experience, median case number (range)	297 (32–945)	440 (22–977)	<0.001 *

* $P > 0.05$ for pairwise comparison of LRP and RALRP.

** $P > 0.05$ for pairwise comparison of ORRP and RALRP.

*** $P > 0.05$ for pairwise comparison of ORRP and LRP.

Table 3

Multivariable regression predicting biochemical recurrence free survival in 913 men with high-risk prostate cancer undergoing open radical retropubic prostatectomy (ORRP), robot-assisted laparoscopic (RALRP) or laparoscopic radical prostatectomy (LRP).

Variable	Hazard ratio (95% CI)	P
Age (years)	0.99 (0.97–1.02)	0.605
PSA level (ng/mL)	1.01 (1.00–1.03)	0.060
cT1c or cT2a (referent)		
cT2b	1.20 (0.82–1.75)	0.343
cT2c or cT3	1.36 (0.77–2.42)	0.293
Gleason 6–7 (referent)		
Gleason 8	2.41 (1.30–4.48)	0.005
Gleason 9–10	2.60 (1.42–4.76)	0.002
Organ-confined (referent)		
Extraprostatic extension	3.67 (2.22–6.07)	<0.001
Seminal vesicle involvement	6.28 (3.68–10.74)	<0.001
Lymph node involvement	8.21 (4.57–14.74)	<0.001
Positive surgical margin	1.21 (0.88–1.66)	0.249
ORRP (referent)		
RALRP	0.70 (0.32–1.51)	0.359
LRP	1.17 (0.62–2.20)	0.624
Surgeon experience (per 100 cases)	0.99 (0.97–1.00)	0.042

Minimally-invasive radical prostatectomy was not a significant predictor of biochemical recurrence if substituted for RALRP and LRP (hazard ratio, 0.93, 95% CI, 0.56–1.54; P = 0.77).