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Original Article

Comparison of surgical, oncological, and functional outcomes of robot-assisted and laparoscopic radical prostatectomy in patients with prostate cancer

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ABSTRACT

Objective: To compare the oncological and functional outcomes of robot-assisted radical prostatectomy (RARP) and laparoscopic radical prostatectomy (LRP).

Material and methods: We compared patients who underwent the RARP (n=778) and LRP (n=48) techniques for prostate cancer between January 2008 and July 2017 in our clinic. Patient demographics, preoperative and postoperative data, pathologic evaluation, continence, and potency rates were collected and analyzed retrospectively.

Results: The preoperative and demographic data of the patients we included in our study were similar. The mean operation time estimated blood loss, length of hospitalization, and catheterization time were significantly shorter in the RARP group. The statistical analysis was in favor of robotic prostatectomy in the terms of the mean length of hospitalization, catheterization time, and early (<30 days) and intermediate (31-90 days) complications. Positive surgical margins and biochemical recurrence rates, and recovery of continence and erectile function, were similar in both groups.

Conclusion: RARP and LRP in organ-confined prostate cancer are safe and effective methods. Robotic prostatectomy has a shorter operative time, length of hospitalization, catheterization time, and lower early and late complication rates.

Keywords: Laparoscopic radical prostatectomy; oncology; prostate cancer; robot-assisted radical prostatectomy.

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Introduction

Prostate cancer is one of the most significant diseases, and it accounts for approximately 12% of newly diagnosed cancer cases in men.[1] In the United States, prostate cancer comprises approximately 21% (180,090) of newly diagnosed cancers in men.[2] In Turkey, the age-adjusted incidence of prostate cancer in men is 35:100,000 according to 2014 data.[3]

At the time of diagnosis, 78.2% of the patients were in clinical local stage, and the 5-year survival for localized prostate cancer was 100%.[4] Radical prostatectomy is the standard of care in patients with a local disease and a life expectancy >10 years.[5] Radical prostatectomy can be performed in open, laparoscopic (LRP), or robot assisted (RARP) fashion. In the United States, radical prostatectomies are now performed with robotic assistance, with recent estimates as up to 85%.[6] In this study, we aimed to compare the surgical, oncological, and functional efficacy of RARP and LRP techniques for radical prostatectomy in clinically localized prostate cancer.

Material and methods

After the approval of the Umraniye Teaching Hospital ethics committee (Date:08.09.2016, No:2016-99), a total of 826 patients with pros-

tate cancer treated with radical prostatectomy between January 2008 and July A total of 778 patients were treated with RARP, while 48 patients were treated with LRP. The lymph node dissection was decided using the Briganti nomogram (if the estimated risk for positive lymph nodes exceeded 5%) in intermediate-risk disease.[7] An extended lymph node dissection was performed in patients with high-risk disease. We performed the bilateral nerve-sparing surgery in patients with low-risk disease. We also offered nerve-sparing surgery to patients with intermediate-risk disease with a low risk of extracapsular extension.

In the surgical technique for robotic surgery, the Veress needle was used to create a pneumoperitoneum. Five ports were placed: one port for the camera, one port for the assistant, and three ports for robotic arms. In the laparoscopic technique, the Veress needle was also used to create a pneumoperitoneum. Five ports were placed: one port for the camera and four ports for surgical equipment. Both techniques were done via the transperitoneal route. Robotic surgeries were done by three different surgeons, and only one of them had no experience with robotic prostatectomy before, while the laparoscopic surgery was done by a single very experienced surgeon (with over 500 laparoscopic urological surgeries, and over 100 cases were laparoscopic prostatectomies).

Age, body mass index (BMI), the prostate specific antigen (PSA) value, prostate volume obtained in transrectal ultrasound (ml), the percentage of positive biopsy cores, the tumor percentage in each core, biopsy Gleason score and grade group, and D'amico risk groups were collected. Biochemical recurrence (BCR), surgical margin positivity, urinary continence, and sexual health status results were evaluated. Biochemical recurrence was defined as two PSA values over 0.2 ng/mL following the treatment.

The operative time, postoperative drainage, length of hospitalization, catheterization time, and perioperative and postoperative complications (Clavien-Dindo Classification), postoperative pain, estimated blood loss, and blood transfusion rates were also evaluated in both groups in the perioperative period.

The incontinence status was evaluated at 1, 3, 6, and 12 months. Continence was defined as the absence of urinary incontinence with no security pad. Potency after radical prostatectomy was defined as the achievement of erections strong enough for penetration. The preoperative and postoperative erection was evaluated with an IIEF-5 questionnaire at 0, 1, 3, 6 and 12 months, and the status of reaching the preoperative erection level was recorded.

All procedures were performed in accordance with the ethical standards of the 1964 Helsinki declaration and its later amendments. Informed consent was obtained from all individual participants included in the study.

Statistical analysis

The chi-squared test was used to compare qualitative data. The Mann-Whitney U test was used to compare differences between the two independent groups when the dependent variable was not normally distributed. A p-value <0.05 was considered statistically significant. The present study protocol was reviewed and approved by the institutional review board of our hospital (Reg. No. 13767). Informed consent was submitted by all subjects when they were enrolled.

Results

Patients demographics

The mean age was 62.3 (42-77) years in the robotic group and 63.8 (50-76) years in the laparoscopy group. Patients demographics is presented in Table 1. The mean age, BMI, PSA level, biopsy grade group, clinical stage, ASA score, and prostate volume were similar between groups. The mean IIEF score was statistically different, and it was lower in the laparoscopy group. The comorbidities of the two groups were as-

Table 1. Patient characteristics

	RARP	LRP	p
Age, years	62.3 (6.5)	63.8 (5.8)	0.23
BMI (kg/m^2)	27.2 (2.7)	26.9 (1.6)	0.80
PSA (ng/mL)	8.6 (8.9)	9.2 (4.9)	0.17
Biopsy Grade Group (%)			
Grade group 1	492 (63.3)	27 (56)	0.75
Grade group 2	189 (24.3)	12 (25)	0.87
Grade group 3	67 (8.6)	5 (11)	0.75
Grade group 4	25 (3.3)	3 (6)	0.69
Grade group 5	5 (0.6)	1 (0.5)	-
EAU Clinic Stage (D'Amico)			
Low risk (%)	609 (78.2)	40 (83)	0.17
Intermediate risk (%)	159 (20.4)	5 (10)	0.23
High risk (%)	10 (1.28)	3 (6)	-
ASA Score	1.8 (0.6)	1.9 (0.7)	0.072
Preoperative prostate volume (cc)	48 (0.9)	44.7 (3.8)	0.653
IIEF-5 Score	16 (7.6)	13.7 (4.3)	0.049

BMI: body mass index; PSA: prostate specific antigen; EUA: European Association of Urology; IIEF-5: International Index of Erectile Function-5 score

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Table 2. Perioperative results of patients

	RARP	LRP	p
Operation time, min	206 (2.2)	248 (24)	0.01
Trocar placement + position, min	19 (1.8)	18 (3.4)	0.462
Dissection of seminal vesicles, min	18.0 (0.37)	41 (3.8)	0.02
Retzius access, min	10.8 (0.19)	14 (0.68)	0.01
Opening the endopelvic fascia, min	12.6 (0.25)	25.4 (2.6)	0.02
Division of DVC, min	13.2 (0.22)	28.6 (2.47)	0.01
Bladder-neck dissection, min	14.4 (2.47)	22.6 (1.22)	0.01
Control of prostate vascular pedicles, min	30.5 (0.67)	41.2 (2.87)	0.01
Apical and urethral dissection, min)	10.3 (1.2)	14.8 (1.6)	0.121
Posterior reconstruction and urethrovesical anastomosis, min	22 (0.5)	38 (2.87)	0.001
Closure, min	26 (0.52)	16.8 (1.19)	0.001
Estimated blood loss, ml	172 (5.8)	183 (23)	0.108
Transfusion rate (%)	7/635 (1.1)	2/48 (4.1)	0.05

Table 3. Postoperative characteristics

	RARP	LRP	p
Length of hospitalization, day (sd)	3.02 (0.6)	3.68 (0.29)	0.001
Catheterization time, day (sd)	9.2 (0.11)	11.6 (0.97)	0.001
Early complications (Clavien score >2) (%)	14/778 (1.77)	2/48 (4.16)	0.005
Late complications (Clavien score >2) (%)	5/778 (0.6)	2/48 (4.16)	0.001

Clavien Score: The Clavien-Dindo Classification

sessed according to the Charlson comorbidity index, and they were also similar between the two groups.

Intraoperative data

The intraoperative data of the robotic and laparoscopic radical prostatectomy techniques are presented in Table 2. The mean operation time was 206 min in the robotic group and 248 min in the laparoscopic group, and the difference was statistically significant (p=0.01). The mean estimated blood loss was 172 ml in the robotic group and 183 ml in the laparoscopic group (p=0.108).

Postoperative data and complications

The mean length of hospitalization, catheterization time, and early and late complications of the robotic and laparoscopic radical prostatectomy techniques are shown in Table 3. Robotic prostatectomy has favorable results in terms of the mean length of hospitalization, catheterization time, and early (<30 days) and intermediate (31-90 days) complication rate. The incidence of Grade <3 complications (prolonged drainage, transfusion, urinary tract infection, etc.) was 2.1% in the robotic group and 4.16% in the laparoscopic group (p=0.005). The incidence of the early-period and Grade≥3 complications (death, ureteral trauma requiring catheterization, bowel injury, etc.) was 1.77% in the robotic group and 4.16% in the laparoscopic group (p=0.005). Late-period Grade≥3 complications (such as anastomotic stricture, lymphocele, severe urinary incontinence, etc.) were found to be 0.6% in the robotic group and 4.16% in the laparoscopy group, and the difference was statistically significant (p=0.001).

Oncological outcomes

The oncologic data of the robotic and laparoscopic radical prostatectomy techniques are presented in Table 4. The mean prostate volume, tumor volume, and tumor percentage were statistically similar. The rate of pathological pT2 disease was 58%, and the rate of pathological T3 disease was 41.3% in the robotic group, whereas the rate of pathological T2 disease was 62% and pathological pT3 disease was 38% in the laparoscopic group. A positive surgical margin rate was 17% in the robotic group and 12.5% in the laparoscopic group (p=0.42). A positive surgical margin rate was 10.4% in pT2 and 26% in pT3 disease in the robotic group and 6.6% in pT2 disease and 22.6% in pT3 disease in the laparoscopic group (p=0.36 for pT2 and p=0.54 for pT3).

Table 4. Pathologic results

	RARP	LRP	p
Specimen prostate volume (cc)	55.83 (1.09)	53.26 (4.2)	0.974
Tumor volume	3.2 (5.2)	2.79 (4.3)	0.340
Tumor volume/prostate volume (%)	7.04	5.2	0.419
Pathologic stage			**0.713**
pT2	456 (58.7%)	29 (60.4%)	
pT3	322 (41.3%)	17 (39.6%)	
Pathologic Grade Group			**0.646**
Grade Group 1 (Gleason score <7)	323 (41.6%)	13 (27%)	
Grade Group 2 (Gleason score 3+4:7)	299 (38.5%)	21 (43%)	
Grade Group 3 (Gleason score 4+3:7)	98 (12.6%)	10 (20%)	
Grade Group 4 (Gleason score 8)	32 (4.1%)	3 (6%)	
Grade Group 5 (Gleason score 9-10)	25 (3.2%)	2 (4%)	
Overall PSMs, no (%)	**128/778 (17)**	**6/48 (12.5)**	**0.43**
pT2 PSM	46/456 (10.1)	2/30 (6.6)	0.36
pT3 PSM	84/322 (26)	4/18 (22.2)	0.549
Lymph node positivity, no (%)			
Positivity in LND+ patients	20/75 (26.6)	2/8 (25)	0.48
Positivity in total patients	20/778 (2.6)	2/48 (4.1)	0,08
Biochemical recurrence, overall (%)	**83/684 (12.1)**	**6/48 (12.5)**	**0.79**
pT2 (%)	28/361 (7.7)	2/30 (6.6)	0.61
pT3 (%)	60/323 (18.5)	4/18 (22)	0.85

PSM: positive surgical margin; LND: lymph node dissection

Lymph node dissection (LND) was performed in 9.6% of the robotic group, and a positive lymph node rate was 26.6%. In the laparoscopic group, the LND ratio was 16.6%, while the lymph node positivity was 25%. The cumulative lymph node positivity was 2.57% in the robotic group and 4.1% in the laparoscopic group. All patients with the lymph node positivity were received as early hormonotherapy except two patients with micrometastatic disease due to a pathologic review of the single positive lymph node.

The biochemical recurrence (BCR) rates of both groups are shown in Table 4. The BCR rate was 7.74% in pT2 and 18.5% in the pT3 group, and overall 12.1% in the robotic surgery group. In the laparoscopic group, the BCR was seen in in the pT2 disease in 6.6% of the patients and with the pT3 disease in 22% and overall 12.5%.

Functional outcomes

1) Continence: Our continence rates at 1, 3, 6, and 12 months after RARP and LRP are presented in Table 5. In terms of continence, the two groups were similar at the 1st, 3rd, 6th, and 12th month follow-up after surgery.

Table 5. Continence and potency rates after surgery

	RARP	LRP	p
Continence (%)			
First month	591/778(75)	32/48 (66)	0.31
Third month	629/778 (80)	38/48 (79)	0.81
Sixth month	704/778 (90.5)	42/48 (87)	0.40
Twelfth month	739/778 (95)	44/48 (91)	0.41
Potency (%)			
First month	198/660 (33)	12/48 (25)	0.52
Third month	288/660 (44)	16/48 (33)	0.34
Sixth month	345/660 (52)	20/48 (41)	0.37
Twelfth month	429/660 (65)	26/48 (54)	0.2

2) Potency: We performed nerve-sparing surgery in 40 patients with a laparoscopic group (83%) and in 620 patients

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with a robotic group (79.6%). The potency rates at 1, 3, 6, and 12 months after the robotic and laparoscopic radical prostatectomy are presented in Table 5. The status of reaching the preoperative erection level rates was similar in both groups, and no statistically significant differences were observed.

Discussion

Prostate cancer is the second most common cause of cancer-related mortality in the United States and the fifth leading cause of cancer mortality among men worldwide.[8] With the ease of access to health care, screening schedules and the widespread use of PSA, patients are diagnosed with prostate cancer at an earlier age and earlier stage. Radical prostatectomy is the standard of care for clinically localized prostate cancer with at least 10 years of life expectancy.

Radical prostatectomy can be performed with open RRP, laparoscopic, and robotic techniques. Despite the advances in the technique, the procedure still has serious complications, such as bleeding, pain, incontinence, anastomosis stricture, and erectile dysfunction. While the learning curve for RRP is between 250 and 1000 cases and for LRP 200 and 750 cases, RARP has been reported to be 40 procedures.[9]

In our institution, we have performed radical prostatectomies for prostate cancer in open fashion in 4%, in laparoscopic fashion in 4%, and in robotic fashion in 92% in the past 10 years. In a study conducted in the United States, Bijlani et al.[10] found that robotic surgery had become more frequent in recent years, and approximately 80% of the radical prostatectomies are currently performed by the robotic methods.

The main aim of the radical prostatectomy procedure is to eradicate the disease, but also to maintain continence and potency.[11] Risks of incontinence and mortality due to prostate cancer independent comorbidities increase with age in patients undergoing radical prostatectomy.[12]

Radical prostatectomy can be performed with using the RARP technique with similar oncologic results and favorable functional results and low complication rates as the LPR. The robotic technique provides a three-dimensional view of the surgical field, better illumination, higher magnification, greater and more intuitive movement capability of the robotic arms, minimization of tremor, and venous tamponade of pneumoperitoneum.[13]

In the largest systematic review in the literature, the mean duration of procedure for LRP was 236.54 (144-400) min, whereas for RARP, the mean duration of 187.91 (137-330) min was reported.[8] In a randomized controlled trial in which Porpiglia et al.[14] compared LRP with RARP, the mean duration of LRP operation was 138.1 min, and RARP was 147.6 min (p=0.068). In our study, the operative time of the RARP group was significantly shorter than the LRP group. The mean estimated blood loss and transfusion rates are similar in our study. In a study by Novara et al.[15], the mean estimated blood loss in RARP was 166 mL, and the transfusion rate was reported as 2%. Asimakopoulos et al.[16] reported that the estimated blood loss and transfusion rates were similar in RARP and LRP. Ploussard et al.[17] compared the estimated blood loss in the RARP and LRP, and it was significantly lower in RARP, whereas the transfusion rates were similar.

In the largest systematic review in the literature, the mean length of hospitalization for LRP was 6.09 days and 3.85 days for RARP. De Carlo et al.[18] also showed that the mean of catheterization time was 6.96 days in the RARP group and 10.32 days in the LRP group. Porpiglia et al.[14] reported the mean hospital length-of-stay was 4.6 days for RARP and 4.8 days for LRP. In this study, the mean length of hospitalization and mean catheterization time were significantly shorter in the RARP group. Early and late complication rates were significantly lower in the robotic group in this cohort. In a recent review, which compared open vs laparoscopic vs robotic prostatectomy, Basiri et al.[19] showed that the major complication rate was significantly different between ORP and RARP. They also revealed that the estimated blood loss, transfusions, and length of hospitalization were lower for RARP, moderate for LRP, and high for ORP.

In our study, pathologic prostate size, tumor volume, and tumor percentage were similar. De Carlo et al.[18] showed that the surgical margin positivity in pT2 was 10.53% in RARP and 17.44% in LRP, whereas in pT3, it was 53% in RARP and 49.1% in LRP. Asimakopoulos et al.[16] reported that a positive surgical margin rate was 15.4% in RARP and a 10% in LRP. The surgical margin positivity rates in our study were similar in the pT2 stage to the literature, while in the pT3 stage it was lower. Previous studies showed that there was no significant difference between BCR ratios among these two techniques.[17,18] In a recent review, Lee et al.[20] showed that RARP is superior in the terms of biochemical recurrence-free survival, whereas positive surgical margins were similar between RARP an LRP.

The pelvic lymph nodes are the most common sites of metastases in prostate cancer. In this study, the lymph node positivity was 2.57% in the robotic group and 4.1% in the laparoscopic group, and it seems similar to the recent literature. In a recent review, the risk of lymph node invasion (LNI) at

radical prostatectomy (RP) ranged between 3% and 24%.[21] In another meta-analysis of the long-term outcomes for the robot-assisted radical prostatectomy showed that the lymph node invasion positivity ranged between 0.5% and 11.3%.[22] Preisser et al.[23] hypothesized and also showed that LNI rates may actually be on the rise in contemporary patients who underwent RP. The lymph node invasion increased during their study period from 2.5% (2004) to 6.6% (2014). The authors also found that clinical tumor characteristics (clinical tumor stage, baseline serum PSA value, and biopsy Gleason grade group), pathological tumor characteristics (pathological tumor stage and pathologic Gleason grade group) are independent predictors of LNI. Cross-sectional imaging with computed tomography (CT) and magnetic resonance imaging (MRI) are noninvasive techniques that show morphologic characteristics, but they are not enough to evaluate the lymph node positivity before the operation. However, functional MRI by using diffusion-weighted imaging, MR lymphography (MRL) with ultra-small paramagnetic iron oxide particles, and hybrid PET/MRI imaging, PET tracers including fluoro-D-glucose, sodium fluoride, choline, prostate specific membrane antigen-binding ligands, acetate, and fluciclovine are promising in improving the initial lymph node staging.[24,25]

Continence is one of the major secondary outcomes of radical prostatectomy, which directly affects the quality of life. In this study, we found no difference between RARP and LRP in terms of incontinence. In a recent systematic review, Ficarra et al.[26] showed that the mean 12-month continence rates were 89%-100% in RARP and 80%-97% in LRP. In cumulative analyses, the 12-month urinary continence recovery rate was superior in RARP compared to RRP and LRP. In a systematic review, De Carlo et al.[18] also showed that the mean rate of continent patients was similar to this study; 89.12% at thec 6th and 92.78% at the 12th month in patients who underwent RARP. The continence rate of patients receiving LRP was reported to be 63.8% at the 6th and 73.8% at the 12th month, and it was found to be lower than the LRP continence rates in our study. Asimakopoulos et al.[16] also revealed that the continence rate of patients receiving RARP at 12 months was reported as 94%, and LRP as 83%. In another review, Lim et al.[27] compared the continence rate between RARP an LRP, and they included five comparative studies and found no difference.

Potency is another issue after radical prostatectomy, which is crucial in patients with a higher IIEF-5 score. In our study, there was no difference between the two groups in terms of the status of reaching the preoperative erection level. De Carlo et al.[18] showed that the average potency ratios in the RARP group were reported as 32.53% in the 3rd month and 60.93% in the 12th month. Potency rates in the LRP group were reported as 35% in the 3rd month and 56% in the 12th month. Asimakopoulos et al.[16] reported a mean potency of 77% in patients who underwent nerve-sparing RARP at 12 months, and the potency rate in LRP was 32%. In another study, Haglind et al.[28] compared robotic vs open prostatectomy, and they reported that the 12-month potency rate for the robotic group was 29%. In a recent systematic review, the rate of erectile dysfunction and incontinence were found to be significantly lower after RARP than LRP.[19] Factors that may affect the rate of potency are the preoperative erectile function status, the age of the patient, nerve-sparing technique, comorbidities of patients, the experience of the surgeon, limitation of thermal energy dissection, and penile rehabilitation.[29]

The cost of robotic surgery is still another important issue when comparing these techniques. At the cost of near US$2 million per robot, a yearly maintenance fee close to US$135,000, and US$1500-$2000 per patient cost in disposable robotic instruments per operation is very high compared with a laparoscopic surgery. However recent cost analyses showed that RARP can be equivalent in terms of costs to standard open radical prostatectomy in high-volume prostatectomy centers (RARP is performed on the order of 10 cases per week).[30] The cost analysis was planned for this study, but it cannot be done due to our hospital billing-system changes over years. In a recent cost analysis by our institution, it has been found that the robotic surgery is close to $2600 per operation (including maintenance fee), and laparoscopic surgery is close to $700 per operation.

The main limitation of this study is the lack of prospective randomization. Another limitation is a low number of patients in the LRP group. Despite the fact that LRP was administered by a single very experienced surgeon (with over a 500 laparoscopic urological surgeries; with over 100 laparoscopic prostatectomies) in our study, we think that the application of RARP by three different surgeons and the learning curve of one surgeon may have an effect on the results. To verify the results of the two techniques, there is a need for prospective randomized controlled trials with a higher number of patients.

In conclusion, robotic and laparoscopic radical prostatectomy in organ-confined prostate cancer are safe and effective methods. Robotic prostatectomy has a shorter duration, the length of hospitalization, catheterization time, and lower early and late complication rates.

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Ethics Committee Approval: Ethics committee approval was received for this study from the ethics committee of Ümraniye Teaching Hospital (Date: 08.09.2016, No:2016-99).

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