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Switching from Endoscopic Extraperitoneal Radical Prostatectomy to Robot-Assisted Laparoscopic Prostatectomy: Comparing Outcomes and Complications

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Key Words
Prostate cancer · Prostatectomy · Endoscopic extraperitoneal radical prostatectomy · Robot-assisted laparoscopic prostatectomy

Abstract
Objective: Endoscopic extraperitoneal radical prostatectomy (EERPE) and robot-assisted laparoscopic prostatectomy (RALP) are minimally invasive surgical techniques to treat localized prostate cancer. We report the outcome and complications of these two techniques conducted by one individual surgeon. ***Patients and Methods:*** 86 patients underwent EERPE between January 2008 and June 2011, and 100 patients underwent RALP between August 2011 and October 2012. All surgeries were performed by one single surgeon. ***Results:*** The patients of the EERPE and RALP groups had similar clinical characteristics in PSA, prostate volume and D'Amico classification, and were significantly different in their age and BMI as well as in the number of prior surgeries. RALP surgeries were significantly slower (183 vs. 157 min) but also involved lower blood loss (147 vs. 245 ml). Pathological stages and positive surgical margins were similar in both groups. Complications were assessed by the Clavien-Dindo classification. 6 patients in the EERPE group and 3 patients of the RALP group suffered major complications (IIIb–IV). ***Conclusion:*** Altogether our results indicate that the learning curve for RALP was short after experience with EERPE. We hypothesize that this is more a result of the surgical experience of the surgeon with the EERPE than on the robotic technique.
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Introduction

Endoscopic extraperitoneal radical prostatectomy (EERPE) and robot-assisted laparoscopic prostatectomy (RALP) are minimally invasive surgical techniques to treat localized prostatic cancer. Before EERPE was established, laparoscopic radical prostatectomy (LRP), a transperitoneal technique introduced by Schuessler et al. [1] in 1997, had been the primary laparoscopic technique. LRP became more established at the end of the 1990s in some centers in Europe [2–5]. Although LRP led to good oncological and functional results, the technique did not spread widely. The main reasons were long surgery time in addition to a long learning curve. The extraperitoneal technique was extensively used and standardized by Stolzenburg et al. [6, 7]. They reported the advantage of EERPE: minimal invasive surgery combined with an extraperitoneal approach as within open retropubic prostatectomy.

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Table 1. Baseline characteristics

	EERPE	RALP	p
Number of patients	86	100	
Age, years	65.8 (46–78)	63.6 (48–75)	0.017
PSA, ng/ml	7.2 (0.2–50.0)	8.8 (1.4–75)	0.116
Prostate avolume, ml	37.6 (15–120)	41.0 (16–142)	0.103
BMI	27.2 (20.4–42.1)	28.7 (15.7–46.5)	0.003
D'Amico score			
Low	30 (34.9)	33 (33)	0.787
Intermediate	35 (39.5)	38 (38)	0.830
High	21 (25.6)	29 (29)	0.602
Prior surgery (one)	18 (20.9)	25 (25)	0.512
Prior surgeries (two or more)	6 (7.0)	22 (22)	0.004
Inguinal hernia repair (open, TAPP)	9 (10.5)	24 (24)	0.015
Appendectomy (open, laparoscopic)	12 (14.0)	23 (23)	0.116
Cholecystectomy (open, laparoscopic)	3 (3.5)	6 (6)	0.509
Colonresection (open, laparoscopic)	1 (1.2)	1 (1)	>0.999
Transurethral prostate resection	1 (1.2)	6 (6)	0.125
Hormone therapy	9 (10.5)	2 (2)	0.025

Values are presented as n (%) or means (range).

The first RALP was performed in 2000 by Binder and Kramer [8] in Frankfurt, Germany. However, it was first established in the US [9–11]. The advantages of the robotic technique over the standard EERPE are the 3-dimensional view (as in an open surgical technique), tenfold magnification, 7° of movement freedom of the instruments instead of 3° as with standard laparoscopy, motion scaling and a more ergonomic position for the surgeon. As a result of these advantages, the learning curve can be reduced [12] compared to the standard LRP. The aim of this paper is to analyze the results from both surgical techniques – EERPE and RALP – conducted by one individual surgeon who switched from EERPE to the RALP technique in order to provide some evidence on differences in outcome and complications.

Patients and Methods

We investigated a sample of 186 patients that underwent a prostatectomy by one individual surgeon (R.W.). 86 patients underwent EERPE between January 2008 and June 2011. After June 2011, the surgeon switched the surgery method from EERPE to RALP. Afterwards, 100 patients underwent RALP between August 2011 and October 2012. This clear switch of the surgery method over time allows us to identify the effect of the surgical technique on the outcome without having to consider patient inclusion to either method. Table 1 summarizes the baseline characteristics of each group. EERPE patients were significantly older than RALP patients (65.8 vs. 63.6 years). Furthermore, the BMIs were significantly different between both groups: 27.2 in the EERPE versus 28.7 in the RALP group. An important significant difference was the number of previous abdominal surgeries. RALP patients underwent significantly more prior surgeries. Only 24 patients in the EERPE group underwent prior surgeries while 47 RALP patients had one or more of those prior surgeries. The mean PSA was 7.2 ng/ml (0.2–50.0) in the EERPE group versus 8.8 ng/ml (1.4–75) in the RALP group, and the mean prostate volume was 37.6 ml (15–120) versus 41.4 ml (16–142).

EERPE was performed as described by Stolzenburg et al. [13]. RALP was performed with the 4-arm standard S system (Intuitive Surgical®) using the 6-port transperitoneal technique described by Menon et al. [14].

Statistical Analysis

For continuous data, we report means and the smallest, respectively largest value in parentheses. Categorical variables are presented in absolute and relative (in parentheses) occurrences. Continuous variables are compared by Mann-Whitney U test statistics. For categorical variables, χ^2 test statistics are calculated when there are at least five occurrences within a category. When there are less than five occurrences within one category, Fisher's exact test statistics are used. Generally, $p \leq 0.05$ is considered as statistically significant; all p values correspond to 2-sided test statistics. In table 2, the effects of the RALP method on blood loss, continence and surgical margins are denoted in bold. Estimates in column 1 correspond to ordinary least squares coefficients and hence may be interpreted as difference in blood loss during surgery (in ml). Estimates in columns 2 and 3 were obtained from logistic regressions and report odds ratios. All calculations were performed in STATA 12.1 (StataCorp LP, College Station, Tex., USA).

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Table 2. Blood loss, continence and positive surgical margins

	Blood loss (ml), multivariate analysis	Continence (6 months), logistic analysis	Complete resection, logistic analysis
RALP	**–84.13*****	**1.774**	**0.977**
Age (10 years)	29.3**	1.004	1.002
PSA (10 ng/ml)	–2.2	1.008	1.002
Prostate volume (10 ml)	–1.5	0.999	1.001
BMI (10 points)	4.7	0.998	1.000
Prior surgery (one)	–37.23**	0.82	0.587
Prior surgeries (two or more)	–42.11**	0.585	4.713
High D'Amico score	–6.29	1.121	0.163**
Intermediate D'Amico score	21.46	0.910	0.616

This table reports multivariate regression results regarding blood loss (column 1), continence (column 2) and complete resection (column 3) to control for significant baseline characteristics. Numbers in column 1 correspond to marginal effects on blood loss in ml. Numbers in columns 2 and 3 report odds ratios (relative risk ratios). ** $p < 0.05$; *** $p < 0.001$. See text for additional explanations.

Table 3. Perioperative data

	EERPE	RALP	p
Surgery time, min	157 (85–252)	183 (118–360)	<0.001
Blood loss, ml	245 (15–1,000)	147 (20–900)	<0.001
Transfusion	0 (0)	0 (0)	>0.999
Conversion	1 (1.2)	0 (0)	0.462
Lymphadenectomy	82 (95.3)	100 (100)	0.029
Nerve-sparing surgery	17 (19.8)	45 (45)	<0.001
Umbilical hernia repair	0 (0)	4 (4)	0.125
TAPP	0 (0)	6 (6)	0.031
Pathological stage			
pT2a	11 (12.8)	8 (8)	0.282
pT2b	2 (2.3)	3 (3)	>0.999
pT2c	55 (64)	61 (61)	0.334
pT3a	9 (10.5)	22 (22)	0.016
pT3b	9 (10.5)	6 (6)	0.561
Positive surgical margins	11 (12.8)	12 (12)	
pT2R1	4 (5.9)	3 (4.2)	0.706
pT3R1	7 (38.9)	9 (32.1)	0.835
Mean catheter time, days	9.2 (5–50)	7.2 (5–63)	<0.001
Continence after 6 months	75 (87)	91 (91)	0.405

Values are presented as n (%) or means (range).

Results

Table 3 lists perioperative data. EERPE surgeries were performed significantly faster relative to RALP. Average surgery time was 157 min (85–252) in the EERPE group versus 183 min (118–360) in the RALP group. However, a significantly lower blood loss occurred during RALP surgeries: 245 ml (15–1,000) in the EERPE versus 147 ml (20–900) in the RALP group. We also conducted a multivariate regression analysis where we controlled for age, PSA, BMI, prostate volume, prior surgeries and D'Amico classification to isolate and quantify the effect of the surgery method on the blood loss during surgery. We find here that the RALP method leads to an approximate 84-ml lower blood

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Table 4. Complications

	Clavien grade	EERPE, n	RALP, n	p
Intraoperative complications				
Rectal injury	IIIb	2	0	0.212
Early complications <1 month postoperatively				
Urinary retention	I	1	1	>0.999
Renal insufficiency (excluding dialysis)	I	0	1	>0.999
Prolonged catheterization >14 days	Id	7	3	0.191
Ureter injury	IIIb	2	0	0.212
Symptomatic hydronephrosis	IIIb	0	1	>0.999
Anuria	IIIb	1	0	0.462
Bowel injury	IIIb	0	1	>0.999
Rectourethral fistula	IIIb	1	0	0.462
Renal insufficiency (including dialysis)	IVa	0	1	>0.999
Late complications >1 month postoperatively				
Symptomatic lymphocele	IIIa	0	3	0.250
Total		14 (16.3%)	11 (11%)	0.293

loss. Because no perioperative blood transfusion was needed in either group, this difference is statistically but not clinically significant. One EERPE patient needed conversion to open surgery. Lymphadenectomy was performed in 95.3% of the EERPE patients and 100% of the RALP patients. Nerve-sparing surgery was indicated in preoperatively potent patients (evaluated with an IIEF-5 questionnaire) with Gleason score ≤7a, PSA <10 ng/ml, <50% tumor in biopsy and no palpable tumor on the ipsilateral side. Nerve-sparing surgery (uni- or bilateral) was performed on 19.8% of the EERPE patients and on 45% of the RALP patients. 4 RALP patients additionally underwent an umbilical hernia repair and 6 RALP patients underwent transabdominal preperitoneal plastic with mesh (TAPP).

The distribution of pathological stages was similar for both groups. 12% of the RALP patients had positive surgical margins. Within these patients, 4.2% had a pathological stage of pT2 and 32.1% of pT3. In the EERPE group, 12.8% of the patients had positive surgical margins, and 5.9% of these had a pathological stage of pT2 and 38.9% of pT3. The odds ratio of 0.977 in logistic regression (table 2, column 3) indicates that there is also no significant difference regarding positive surgical margins between both methods after controlling for the major baseline characteristics.

The mean catheter time was significantly shorter in the RALP group. Average catheter time was 9.2 days in the EERPE group versus 7.2 days in the RALP group. Continence was evaluated with the International Consultation on Incontinence Questionnaire – Urinary Incontinence Short Form (ICIQ-UI Short Form) with an additional question concerning the number of pads. After 6 months, continence was very similar for both groups. 87% of the EERPE patients and 91% of the RALP patients were continent (0 or 1 security pad). Also here, we found no significant difference in the logistic regression (table 2, column 2).

Complications are listed in table 4, and are graded using the Clavien-Dindo classification [15]. The total complication rate was 16.3% in the EERPE group and 11% in the RALP group. Major complications (Clavien grade IIIb–IV) occurred in 6 EERPE patients. Major complications in the RALP group occurred in 3 cases.

Discussion

EERPE and RALP are widely used minimally invasive surgical techniques to treat localized prostatic cancer. To compare these two techniques, we reported perioperative data as well as intraoperative, early and late stage complications of 186 cases, all conducted by one individual surgeon. It must be emphasized that the surgeon switched from the EERPE to RALP over time which allows us to draw two main conclusions. First, our study may be interpreted as a case study that documents the switch of one surgeon from EERPE to RALP. We document that this switch from EERPE to RALP can be carried out without major difficulties. Consequently, we conclude that the RALP learning curve was short in this case. Second, since the switch of technique occurred over time, our study al-

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lows us to identify the effect of the surgery method on outcome and complications without having to worry about patient inclusion to one of both methods. Here, we find that both methods lead to comparable outcomes.

In this study, the mean operating time was 157 min in the EERPE group and 183 min in the RALP group. The longer mean operating time of our RALP group could be explained by a significantly higher number of nerve-sparing surgeries. 4 RALP patients additionally underwent an umbilical hernia repair and 6 RALP patients underwent a TAPP.

The mean blood loss was 245 versus 147 ml. There was no need for perioperative blood transfusions. Stolzenburg et al. [13] had after 300 EERPEs (178 patients undergoing lymphadenectomy) a mean operating time of 140 min, and 4 patients (1.3%) needed a blood transfusion. Rocco et al. [16] showed after 120 RALPs a mean operating time of 215 min (165–450) and a mean blood loss about 200 ml (50–2,000).

The critical criterion to evaluate an oncosurgical technique is local cancer control. The positive margin is a risk factor for disease recurrence. In this study the R1 rates correspond with the numbers published in other centers. Stolzenburg et al. [17] published after 1,300 EERPEs a R1 rate of 9.8% for stage pT2 and 34.3% for stage pT3. Patel et al. [18] showed after 500 RALPs a total R1 rate of 9.4%; in the first 100 RALPs it was 13%. Padavano et al. [19] published after 153 RALPs, R1 rates of 30% at stage pT2 and 67% at stage pT3.

The total complication rate in our study was 16.3% in the EERPE group and 11% in the RALP group. This is in accordance with analyses of other centers. In the multianalysis review from Coelho et al. [20] containing only studies with more than 250 patients, the complication rate for RALP was about 10.3% (4.3–15.7). Hu et al. [21] published in a serial of 358 LRPs and 322 RALPs 9 rectal injuries (Clavien grade IIIb), and in 5 patients a rectourethral fistula occurred. All rectal injuries happened in the LRP group. A ureter injury occurred (Clavien grade IIIb) in 1 patient in the LRP group and in 1 patient in the RALP group. Murphy et al. [22] described a total complication rate of 15.75% after 400 RALPs; 21 patients had a Clavien III complication. Among these were 5 patients with a rectal injury. Bhandari et al. [23] assessed after the analysis of two subsequent groups (n = 200) undergoing RALP that the complication rate did not decrease according to the experience of the surgeon. He even had 2 bowel injuries in the second group. We conclude that our outcomes are comparable to the elite center outcomes presented in the literature.

In our study, the surgeon was experienced in laparoscopy before learning the robotic technique. Our results indicate that in this case, the learning curve for RALP was very short. The parameters to rate the learning curve include operating time, blood loss, need for transfusions, occurrence of perioperative complications, and oncological and functional results. A major advantage of RALP should be a short learning curve for an inexperienced surgeon in laparoscopy. Patel et al. [10] published that after 200 initial surgeries there was a mean operating time of 141 min and the learning curve involved 20–25 surgeries. Ahlering et al. [12] postulated that an inexperienced surgeon in laparoscopy with good open surgery skills can gain after 8–12 RALPs very similar results as an experienced laparoscopy surgeon after more than 100 LRPs. However, Doumerc et al. [24] shows with a higher number of patients that there is a much longer learning curve for RALP. In their analysis, a very skilled open surgeon (>2,000 retropubic radical prostatectomies) who was inexperienced in laparoscopy needed 110 surgeries to get to a mean operating time of 3 h. The number of positive margins was stable after 120 RALPs. There is a controversial discussion of the role of laparoscopic experience needed for RALP. Experience in laparoscopy is definitely not coactively needed, but it facilitates the change to the robotic techniques enormously. In the authors' opinion, it is not possible to draw a general conclusion how many surgeries are necessary to reach the end of the learning curve. In general, the learning curve is influenced by the surgical skills of the surgeon, patient characteristics, surgery frequency and experience of the center with the described surgical technique.

Conclusions

The outcomes, measured by positive surgical margins, severe complications and continence, were generally similar under both techniques. We also find significant difference in average surgery time and mean catheter time. The blood loss was statistically, but not clinically, significant. Our results indicate that switching from EERPE allowed good results by RALP to be achieved in very short time.

Disclosure Statement

The authors report no conflicts of interest.

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