# Laparoscopic radical prostatectomy: a single surgeon's experience in 80 cases after 2 years of formal training

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## Abstract

**Background:** To assess the learning curve in laparoscopic radical prostatectomy (LRP) performed by a single surgeon who had a healthcare career as a surgical first assistant for 2 years in high-volume centers treating > 150 cases per year.

**Methods:** The records of 80 LRP cases performed between October 2017 and August 2018 by a single surgeon were consecutively divided into four groups (groups A = first 20 cases, B = second 20 cases, C = third 20 cases, and D = last 20 cases). The groups were compared in terms of surgical and functional outcomes with a minimum follow-up of 6 months.

**Results:** Clinical and surgical stages of the four groups were similar between groups. The operative time ($126.8 \pm 5.48$ min; $P = 0.001$) and time of removal of the drain ($1.65 \pm 0.93$ days; $P = 0.029$) were significantly lower in group D; however, hospitalization, catheterization time, and blood loss were similar between groups. The complication rate was low. No patient had a visceral injury, and there were no procedures needed to open conversion. The positive surgical margin (PSM) rates were similar between groups. In terms of continence and potency, all groups were similar at the 6th-month follow-up after surgery.

**Conclusions:** Our results showed that prior experience in laparoscopic surgery as a surgical first assistant in a high-volume center improves the learning curve and oncological and functional outcomes, and helps to minimize the complication rate

**Keywords:** Learning curve, Laparoscopy, Radical prostatectomy, Prostate cancer

## 1 Background

Radical prostatectomy is the most widely performed surgical treatment for localized and locally advanced prostate cancer. Current techniques include open, laparoscopic, and robot-assisted laparoscopic operations. Although the use of conventional laparoscopy to perform a radical prostatectomy decreased after the invention and widespread use of robot technology, because of the high costs of robotic surgery, it is still used in many regions of the world as an effective alternative to open surgery.

The historical evolution of laparoscopic radical prostatectomy (LRP) started with the transperitoneal technique (TLRP), which was performed in 1997 and later, extraperitoneal laparoscopic radical prostatectomy (ELRP) was successfully applied [1,2]. Bollens et al. presented a series of 50 cases of ELRP in 2001 [3]. Guillonneau et al. found that the outcomes of LRP improved in means of potency and urinary incontinence through the improvements in the visualization of the pelvic anatomy and argued that, this technique required at least 60 cases to obtain proficiency [4]. Secin et al. showed that 250 cases

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were enough to stabilize the rate of decrease in positive surgical margins (PSM) [5]. Mirandolino et al. reported that the percentage of PSM in LRP was similar to the studies using the open technique. The percentage of PSM was from 11 to 26% in a series of 760 cases [6].

LRP was recognized as a technically challenging operation in most of the initial series published. To improve the laparoscopic technique, the surgeon must acquire new anatomical perspectives and good hand-to-eye coordination. Robot-assisted laparoscopic prostatectomy (RALP) is still not cost-effective, and therefore LRP is still widely applicable, as a relatively inexpensive treatment option for prostate cancer patients. Nevertheless, it is well recognized that fellowship programs in LRP shorten this learning curve [7–9]. Furthermore, we think that prior experience in laparoscopic surgery as a surgical first assistant in high-volume centers should affect the rate of the PSM, and the rate of decrease in positive surgical margins would be more rapid in the laparoscopic learning curve. The present study was designed to determine surgical, early and long-term oncological and functional outcomes (potency, continence rate, PSM rate) in the first 80 patients performed by the same surgeon who had a healthcare career as a surgical first assistant for 2 years in high-volume centers treating > 150 cases per year.

## 2 Methods
Ethics approval for the study was given by the local human subjects ethics committee of our institution. Between October 2017 and August 2018, a total of 80 radical prostatectomy procedures were performed with the extraperitoneal approach using the Heilbronn technique [10]. Patients were prospectively followed up, and the demographic and clinical characteristics were collected for the entire 180-day postoperative period. Total operating room time was calculated from the first insufflation on to the last trocar extraction, and the estimated blood loss (EBL) was assessed with the measurement of sucker bottle volumes. No urine leakage or only one pad/day used was accepted as urinary continence. The ability to achieve an erection sufficient for penetration was described as postoperative potency. Functional outcomes were recorded during 6-month follow-up. Serum PSA level of $\geq 0.2$ ng/ml was accepted to define biochemical recurrence of prostate cancer. There were no exclusion criteria or no patients who were referred to for open or robot-assisted RP. Bilateral pelvic lymphadenectomy was performed in all patients with D'Amico intermediate or high-risk prostate cancer. 3/0 mono-absorbable sutures were used to perform the urethrovesical anastomosis. The interfascial technique was performed to preserve the neurovascular bundle (NVB). To assess the overall learning curve, 80 patients were divided into four groups

(Group A = first 20 cases, Group B = second 20 cases, Group C = third 20 cases, and Group D = last 20 cases).

All statistical analysis was performed using IBM SPSS software Version 22. The difference between patient groups was determined using the Mann–Whitney U test and Fisher's exact test, when necessary. Variables with normal distribution were shown by mean and standard deviation (mean ± SD). Independent samples t test and ANOVA were used to compare continuous values and the Tukey test was applied to explore differences between groups. A *P* value of < 0.05 was significant. The independent samples t test and one-way ANOVA were used to analyze the differences between means.

### 2.1 Training and post-training surgical experience
The surgeon worked as a primary-hand assistant in the last 2 years of his residency in the institution where he worked as a cancer center where more than 150 LRPs were performed annually. In the same center, other cancer operations such as nephrectomy, partial nephrectomy, and cystectomy were performed by laparoscopic approach. The surgeon was first involved in 50 laparoscopic nephrectomy and laparoscopic partial nephrectomy cases as the first-hand assistant to the experienced surgeon. Afterward, he was assisted by an experienced surgeon in 15 patients during laparoscopic nephrectomy. He helped the experienced surgeon as a first-hand assistant in the first 50 LRP cases, and then he was assisted by the experienced surgeon in 20 patients. After the residency, the surgeon performed a total of 186 laparoscopic surgeries, including 80 cases of LRP, 37 cases of laparoscopic partial nephrectomy, 12 cases of laparoscopic pyeloplasty, and other laparoscopic cases in the first 2 years.

## 3 Results
The mean age of all patients was 65.6 (46–82). The mean preoperative prostate-specific antigen (PSA) value was 10.5 (2–37) ng/ml. There were no significant differences among the groups in age, body mass index, PSA, and ASA scores (Table 1). Table 2 shows the intraoperative and postoperative variables in each patient group. The mean amount of intraoperative bleeding was 175 ml (between 20 and 500 ml). The median catheter removal time was 9 days (between 7 and 17 days), and the median surgical drain removal time was 2 days (between 1 and 7 days). There was no statistical difference between the groups in terms of protection rate of neurovascular bundles, length of hospital stay, rate of estimated blood loss, and catheterization time. The mean operation time was 156 (103–270) minutes, and there was a significant difference in surgical time and drainage time reduction in favor of Group D. Table 3 analyzes final pathological evaluation. The extracapsular extension of the tumor was

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**Table 1** Patient characteristics and the preoperative data

| | Group A | Group B | Group C | Group D | P |
|---|---|---|---|---|---|
| Age (years) (mean ± SD) | 67.2 ± 7.4 | 63 ± 8.19 | 66 ± 5.63 | 65.4 ± 9.01 | 0.3 |
| BMI (mean ± SD) | 28.23 ± 5.77 | 27.91 ± 5.40 | 28.61 ± 3.37 | 28.11 ± 3.96 | 0.971 |
| ASA (mean ± SD) | 2.2 ± 0.52 | 2.05 ± 0.61 | 2 ± 0.65 | 1.8 ± 0.77 | 0.273 |
| Pre-op PSA (mean ± SD) ng/mL | 10.33 ± 7.44 | 10.06 ± 6.97 | 12.43 ± 7.47 | 9.21 ± 8.64 | 0.593 |

SD = standard deviation; ASA: American Society of Anaesthesiologists, BMI: body mass index, PSA: prostate-specific antigen

**Table 2** Intraoperative and postoperative variables

| | Group A | Group B | Group C | Group D | P |
|---|---|---|---|---|---|
| Estimated bleeding (ml) (mean ± SD) (min–max) | 182 ± 53.89 (100–285) | 192 ± 122.77 (100–500) | 192.5 ± 111.54 (50–500) | 134 ± 82.99 (20–450) | 0.180 |
| Drainage time (days) (mean ± SD) (min–max) | 2.25 ± 0.44 (2–3) | 2.4 ± 0.5 (2–3) | 2.35 ± 1.31 (1–7) | 1.65 ± 0.93 (1–5) | 0.029** |
| Urinary catheter time (days) (mean ± SD) (min–max) | 9.25 ± 1.07 (7–11) | 9.9 ± 1.74 (7–14) | 9.3 ± 2.18 (7–17) | 8.55 ± 1.61 (7–14) | 0.105 |
| Hospitalization time (days) (mean ± SD) (min–max) | 5.2 ± 1.28 (4–9) | 5.15 ± 1.23 (3–9) | 4.7 ± 2.9 (3–15) | 4.65 ± 1.76 (2–10) | 0.711 |
| Surgical time (Mean ± SD) (min–max) | 177.8 ± 47.13 (112–250) | 161.55 ± 46.9 (103–253) | 160.65 ± 43.93 (105–270) | 126.8 ± 5.48 (120–136) | 0.001* |
| Nerve sparing (%) | | | | | |
| None | 14 (70%) | 10 (50%) | 14 (70%) | 11 (55%) | 0.429 |
| Unilateral | 1 (5%) | 1 (5%) | 3 (15%) | 2 (10%) | |
| Bilateral | 5 (25%) | 9 (45%) | 3 (15%) | 7 (35%) | |
| Clinic stage: n (%) | | | | | |
| T2 | 10 (50%) | 7 (35%) | 11 (55%) | 12 (60%) | 0.423 |
| T3 | 10 (50%) | 13 (65%) | 9 (45%) | 8 (40%) | |
| Gleason score (%) | | | | | |
| ≤ 6 (%) | 10 ( 50%) | 14 (70%) | 16 (80%) | 13 (65%) | 0.523 |
| 7 (%) | 7 (35%) | 3 (15%) | 3 (15%) | 4 (20%) | |
| > 7 (%) | 3 (15%) | 3 (15%) | 1 (5%) | 3 (15%) | |

SD = standard deviation; CV: coefficient of variation

**Table 3** Postoperative pathological evaluation

| | Group A | Group B | Group C | Group D | P |
|---|---|---|---|---|---|
| Positive surgical margin: n (%) | 7 (35%) | 2- (10%) | 4- (20%) | 6 (30%) | 0.254 |
| In pathologically T2 or lower | 2 (10%) | 0- (0%) | 3- (15%) | 1 (5%) | 0.308 |
| In pathologically T3 or higher | 5 (25%) | 2- (10%) | 1- (5%) | 5 (25%) | 0.196 |
| Lymph node | | | | | |
| NX | 10 (50%) | 13 (65%) | 11 (55%) | 9 (45%) | 0.624 |
| N0 | 10 (50%) | 7 (35%) | 9 (45%) | 11 (55%) | |
| ECE (%) | 9 (45%) | 12 (60%) | 10 (50%) | 7 (35%) | 0.456 |
| SVI (%) | 4 (20%) | 2 (10%) | 3 (15%) | 3 (15%) | 0.853 |

SD = standard deviation; ECE: *Extracapsular* extension of tumor; SVI: seminal vesicle invasion; CV: coefficient of variation

observed in 47.5% of cases, and seminal vesicle invasion was observed in 18.75%. PSM rate was 23.7%, and no difference was observed across all groups. We observed that the PSM rate was positive in 15% of the patients with pT2 stage, and 32.5% of the patients with pT3. Table 4 shows functional outcomes at 6 months after surgery. Overall continence and potency rates were 87.5% and 21.3%, respectively, and no difference was observed across

**Table 4** Functional outcomes

|                                                  | Group A        | Group B        | Group C       | Group D       | P     |
|--------------------------------------------------|----------------|----------------|---------------|---------------|-------|
| Continence at 6 months (%)                       | 16 (80%)       | 19 (95%)       | 17 (85%)      | 18 (90%)      | 0.515 |
| Potency at postoperative 6 months (%)*           | 3 (15%)        | 5 (25%)        | 3 (15%)       | 6 (30%)       | 0.569 |
| Potency at postoperative 6 months (%)†           | 2 (40%)        | 4 (44%)        | 1 (33%)       | 3 (43%)       | 0.989 |
| Follow-up time (mean ± SD)                       | 15.30 ± 1.92   | 10.9 ± 1.12    | 7.7 ± 1.38    | 5.7 ± 1.34    | 0.001 |

SD = standard deviation

*Overall

†Bilateral nerve sparing technique

groups. Table 5 shows complications, and there were only three patients who had urinary infection, two patients with urinary extravasation, and one patient had bladder neck stenosis, postoperatively.

## 4 Discussion

LRP has been well established with functional and oncological outcomes similar to open radical prostatectomy for nearly 20 years, with reduced blood loss, reduced analgesic requirements, and the advantages of hospital discharge and recovery [11–13]. It is necessary to understand the learning curve of a surgical procedure and to shorten the learning curve in order to avoid possible complications. Factors investigated in this study are crucial for surgical training as well as interventions to shorten the learning curve. Controversy continues on the number of cases required to become proficient in LRP. There has been no consistent definition of how many patients per surgeon should be operated for favorable outcomes. The findings of our study have important clinical implications. Our study showed that there was a plateau from the beginning, in PSM, the rate of potency, the rate of continence, *urinary catheter time,* and hospital stay, unlike the majority of the previously published reports [14, 15]. These results may reflect the benefits of a modular mentored fellowship in LRP at a high-volume center.

In this study, we analyzed the 6 months' outcomes of 80 cases of ELRP, performed by a single surgeon who completed a 2-year modular mentored training on laparoscopy. We think that previous training in high-volume centers for 2 years, treating > 150 cases per year, should influence the result of the PSM, and this rate decreases faster during the learning curve (LC) in LRP. However, we know that the duration of training is different between surgeons, even within the same institution, and trained by the same mentors [16].

LRP is an advanced surgical procedure that requires significant laparoscopic expertise and has a prolonged *operative duration* that *would* be associated with a greater risk of developing complications [17]. Recently, researchers *have shown* that about 50–60 cases are enough for surgeons who had a previous laparoscopic experience, in learning curve [18, 19]. A 2012 study found that previous experience of trainees in laparoscopic surgery could improve laparoscopic surgical skills in terms of short-term outcomes [20]. Fabrizio et al. demonstrated that trainee operating with a mentor had shorter operation time compared to the operations that were performed alone. [21]. Moreover, it is not known how long training is needed to achieve excellent results in laparoscopy. In this study, we have demonstrated that after adequate formal training in a high-volume center, LRP can be performed as the primary operating surgeon

**Table 5** Complications

|                      | Group A (n = 20) | Group B (n = 20) | Group C (n = 20) | Group D (n = 20) |
|----------------------|------------------|------------------|------------------|------------------|
| Urinary infection    | 1                | 1                | 1                | 1                |
| Urinary extravasation| 0                | 1                | 1                | 0                |
| Bladder neck stenosis| 1                | 0                | 0                | 0                |
| Rectal injury        | 0                | 0                | 0                | 0                |
| Pulmonary embolism   | 0                | 0                | 0                | 0                |
| Urinary retention    | 0                | 0                | 0                | 0                |
| Wound infection      | 0                | 0                | 0                | 0                |
| Clavien 1–2          | 3 (15%)          | 4 (20%)          | 4 (20%)          | 3 (15%)          |
| Clavien 3            | 1 (5%)           | 1 (5%)           | 1 (5%)           | 0                |

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safely with favorable outcomes. We used the PSM rate as a marker of oncological safety and continence rate as a marker of functional outcome.

PSM status is a parameter that cannot be misevaluated and can, therefore, be used as an objective parameter in the follow-up of the learning curve [22]. Secin et al. showed that the learning curve for PSM was overcome after approximately 200–250 cases in a multicenter study that included 1862 patients [5]. Rassweiler et al. and Jacob et al. found that positive margin rates after LRP range from 15 to 44% and 18.9%, respectively [23, 24]. In a comprehensive review that included 14 studies on LRP, PSM was between 6.1% and 21.9% in patients with pT2 stage and between 17.2% and 54.4% in patients with pT3 stage [25]. Also, the reduction of PSM rates of the apex and the posterolateral margins of the prostate was associated with experience and the learning curve [26, 27]. Rodrigeuz et al. also showed a plateauing of PSM rates in their series after 200 cases [28]. In our study, there was no difference in means of PSM between groups. Although T3 prostate cancers are a very heterogeneous group and, therefore, PSM is not dependent on the surgeon, PSM in patients who have a final pathological stage of pT2 is mostly dependent on the surgeon. In our study, both in the patients with pathological stages of pT2 and pT3, PSM was not significantly different among the study groups.

Although the PSM rate can be reduced by performing wide tumor dissection, potency and continency rates decrease due to sacrificing the neurovascular bundle and the necessary anatomical structures that would maintain continence. Therefore, a low PSM ratio should not be the criterion of the learning curve alone. Additionally, functional and long-term oncological outcomes should also be considered. Continence rates following LRP vary between 73 and 90% at postoperative 6 months and 71.6% and 97.7% at postoperative 12 months [25]. Our overall continence rate at 6th month was 87.5%, which was consistent with the previous reports. In the same review, potency rates in 15 studies varied between 46 and 72% at postoperative 12 months. The potency rate in the patients in whom the bilateral nerve sparing technique was performed, was close to the lower limit in our study however these were the outcomes at postoperative 6 months, which might further improve during the follow-up. Our study showed that no significant difference in functional outcomes was observed between the groups.

In a recent review, including 13 studies and 1674 patients having LRP, intraoperative complications occurred in 33 (2.0%) cases and postoperative complications occurred in 204 (12.2%) cases [29]. Good et al. reported the pentafecta outcomes in a retrospective

study, including 550 patients, and reported the overall complication rate as 8.9% which fell below the mean level for the series after 50 cases [14]. They showed that the complications learning curve showed a continual decline throughout the series, starting to plateau after 150 cases. Consistent with the previous reports, the overall complication rate was 8.8% in our series, and the majority of those were minor complications.

There are several limitations to our study. The most critical issues were the limited number of patients and the short follow-up time. Although we could compare the groups sufficiently to demonstrate the effects of the learning curve of a single surgeon, further analysis of oncological and functional outcomes such as biochemical recurrence and long-term continence and potency rates would be possible with a longer follow-up time. Also, due to the low overall complication rate, the effects of the learning curve on the complication rate could not be determined.

## 5 Conclusions

LRP is a technically challenging procedure and cannot be learned within a short training phase. Our results showed that prior experience in laparoscopic surgery as a surgical first assistant in a high-volume center improves the learning curve and oncological and functional outcomes, and helps to minimize the complication rates. And also, in centers where laparoscopic surgery is used intensively, the learning curve duration is significantly shortened after receiving training under an experienced surgeon's guidance.

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## Declarations

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