



# Learning Curve of Robot-Assisted Laparoscopic Radical Prostatectomy for a Single Experienced Surgeon: Comparison with Simultaneous Laparoscopic Radical Prostatectomy

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**Purpose:** Despite the large number of analytical reports regarding the learning curve in the transition from open to robot-assisted radical prostatectomy (RARP), few comparative results with laparoscopic radical prostatectomy (LRP) have been reported. Thus, we evaluated operative and postoperative outcomes in RARP versus 100 simultaneously performed LRPs.

**Materials and Methods:** A single surgeon had performed more than 1,000 laparoscopic operations, including 415 cases of radical nephrectomy, 85 radical cystectomies, 369 radical prostatectomies, and treatment of 212 other urological tumors, since 2009. We evaluated operative (operation time, intraoperative transfusion, complications, hospital stay, margin status, pathological stage, Gleason score) and postoperative (continence and erectile function) parameters in initial cases of RARP without tutoring compared with 100 recently performed LRPs.

**Results:** Mean operation time and length of hospital stay for RARP and LRP were  $145.5 \pm 43.6$  minutes and  $118.1 \pm 39.1$  minutes, and  $6.4 \pm 0.9$  days and  $6.6 \pm 1.1$  days, respectively ( $p=0.003$  and  $p=0.721$ ). After 17 cases, the mean operation time for RARP was similar to LRP (less than 2 hours). Positive surgical margins in localized cancer were seen in 11.1% and 8.9% of cases in RARP and LRP, respectively ( $p=0.733$ ). At postoperative 3 months, sexual intercourse was reported in 14.0% and 12.0%, and pad-free continence in 96.0% and 81.0% in patients with RARP and LRP, respectively ( $p=0.796$  and  $p=0.012$ ).

**Conclusions:** Previous large-volume experience of LRPs may shorten the learning curve for RARP in terms of oncological outcome. Additionally, previous experience with laparoscopy may improve the functional outcomes of RARP.

**Key Words:** Laparoscopy; Prostatectomy; Prostatic neoplasms; Robotics; Treatment outcome

## INTRODUCTION

Prostate cancer (PCA) is the most common solid carcinoma in Western countries. Although robot-assisted lapa-

roscopic radical prostatectomy (RARP) is now performed in Europe and the US, it is in a relatively early stage in other countries [1]. The number of reports of robotics in the urologic field has increased rapidly. Thus, many urologists

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are faced with uncertainty as to whether they should learn RARP. Moreover, application of this emerging surgical skill in a robotic-naïve hospital may not ensure an acceptable outcome.

Many studies have reported on the learning curve of RARP in institutions with experience of open radical prostatectomies. They have shown that surgeons with experience in open radical prostatectomy can achieve favorable oncological and functional results [1]. However, whether extensive experience with laparoscopy may overcome the learning curve in RARP remains under doubt. The surgeon evaluated in this study (H.K.H.) has performed more than 1,000 urologic laparoscopic operations, including radical prostatectomies, radical or partial nephrectomies, adrenalectomies, radical nephroureterectomies, and radical cystectomies, and recently began to perform RARP. In this study, we evaluated the oncological and functional outcomes of RARP versus 100 recently performed laparoscopic radical prostatectomies (LRPs).

## MATERIALS AND METHODS

### 1. Patient selection

Until November 2013, the primary surgeon's gold standard treatment for localized PCA was LRP. Since December 2013, following installation of a da Vinci robotic system (Intuitive Surgical Inc., Mountain View, CA, USA) in the operating room at our hospital, this surgeon has performed LRP and RARP. Because the national insurance scheme covers the cost of LRP in Korea, but not RARP (which is about four times more expensive than LRP), patients typically select the surgical method according to their economic status. Thus, selection bias can likely be ruled out. We evaluated the oncological and functional outcomes of 50 initial cases of RARP compared with 100 recently performed LRPs.

### 2. Surgical method

Since 2009, the primary surgeon has performed extraperitoneal-approach intrafascial LRPs using one camera port (umbilicus), two working ports, and one assistance port, as reported previously [2]. The surgeon first identified the bladder neck using a Foley catheter balloon and started the bladder dissection, confirming the prostate

margin, which resulted in a narrow bladder neck. After the bladder neck dissection, the surgeon dissected the radial margin of the prostate using 5 mm clips and cold scissors with no thermal injury so that variable, but consistent, cavernosal nerve branches could be identified along the lateral and ventral aspects of the prostate [3]. The surgeon dissected the intrafascial plane bluntly between the prostatic capsule and the visceral prostatic fascia, which develops deep to the venous sinuses of Santorini's plexus [3]. This maneuver may preserve the detrusor apron and puboprostatic ligaments at the ventral aspect of the prostate. Urethral preservation was maintained so long as this was achievable. During RARP, all patients were operated on extraperitoneally, excepting the first 5 cases. The surgeon used four robotic arms and one assistance port, similar to the approach for LRP. The patient was routinely discharged on day 3 postoperatively and the Foley catheter was removed at the outpatient clinic without cystography.

We compared the oncologic and functional outcomes of RARP with those of 100 recently performed cases of LRP. Since the first LRP was performed in 2009, the patients' characteristics, clinicopathological features of PCA, operative and perioperative data, and oncological and functional results have been collected in a Microsoft Excel (Microsoft, Redmond, WA, USA) spreadsheet.

The functional outcome data of each patient were entered at 6 weeks, and 3, 6, and 12 months postoperatively. Additionally, erectile dysfunction was documented using the 5-item International Index of Erectile Function questionnaire, and continence status was determined by an interview with a urologic nurse, not the surgeon, to reduce bias.

### 3. Statistical analysis

To validate the comparability of the LRP and RARP, we evaluated the characteristics of the patients and the clinicopathological data. We then compared the operative data—including operative time, amount of blood loss, and perioperative complications. Recently, the early continence rate was emphasized because incontinence may cause severe issues in the daily life of the patient. Thus, we evaluated the continence rate at 6 weeks and 3 months postoperatively. The Mann-Whitney U-test was used for continuous variables and Fisher's exact test or the  $\chi^2$  test

for categorical variables. SPSS software ver. 15.0 (SPSS Inc., Chicago, IL, USA) was used to perform the statistical analyses.

## RESULTS

### 1. Patient characteristics in the robot-assisted laparoscopic radical prostatectomy and laparoscopic radical prostatectomy groups

The mean ages and prostate volumes in the RARP and LRP groups were  $64.6 \pm 6.9$  years (57~76 years) and  $66.3 \pm 6.0$  years (54~74 years), and  $34.2 \pm 14.9$  mL (18.8~89.0 mL) and  $32.3 \pm 9.9$  mL (20.4~76.0 mL), respectively ( $p=0.205$  and  $p=0.520$ ). The mean preoperative prostate specific antigen (PSA) was  $10.1 \pm 10.4$  ng/mL and  $12.7 \pm 15.9$  ng/mL in the RARP and LRP groups, respectively ( $p=0.403$ ). The mean Gleason scores and percentages of pathologically localized PCA were 7.0% and 7.1%, and 72.0% and 56.0% in the RARP and LRP

groups, respectively ( $p=0.852$  and  $p=0.075$ ).

The intrafascial, interfascial, and extrafascial nerve sparing procedure was done in 87 (87.0%), 10 (10.0%), and 3 (3.0%) patients in the LRP group, respectively. In the RARP group, each of these procedures was done in 42 (84.0%), 5 (10.0%), and 3 (6.0%) patients, respectively (Table 1).

### 2. Operative and postoperative outcomes in the robot-assisted laparoscopic radical prostatectomy and laparoscopic radical prostatectomy groups

Mean operation time and mean hospital stay in the RARP and LRP groups were  $145.5 \pm 43.6$  minutes (90~240 minutes) and  $118.1 \pm 39.1$  minutes (80~220 minutes), and  $6.4 \pm 0.9$  days (5~9 days) and  $6.6 \pm 1.1$  days (5~11 days), respectively ( $p=0.003$  and  $p=0.721$ ). The mean operation time for RARP in the 1st to the 10th RARP, the 11th to the 20th, the 21st to the 30th, the 31st to the 40th, and beyond the 40th were 170, 144, 123, 121, and

**Table 1.** Patients' characteristics

Characteristic	RARP	LRP	p value
Mean age (yr)	$64.6 \pm 6.9$	$66.3 \pm 6.0$	0.205
Mean prostate volume (mL)	$34.2 \pm 14.9$	$32.3 \pm 9.9$	0.520
Mean preoperative PSA (ng/mL)	$10.1 \pm 10.4$	$12.7 \pm 15.9$	0.403
Mean Gleason score	7.0	7.1	0.852
Pathological T2 or less	36 (72.0)	56 (56.0)	0.075

Values are presented as mean  $\pm$  standard deviation or number (%).

RARP: robot assisted laparoscopic radical prostatectomy, LRP: laparoscopic radical prostatectomy, PSA: prostate specific antigen.

**Table 2.** Intraoperative and postoperative outcomes

Variable	RARP	LRP	p value
Mean operative time (min)	$145.5 \pm 43.6$	$118.1 \pm 39.1$	0.003
Mean hospital stay (d)	$6.4 \pm 0.9$	$6.6 \pm 1.1$	0.721
Positive margin rate	14 (28.0)	34 (34.0)	0.578
In pathologically T2 or lower	4 (11.1)	5 (8.9)	0.733
In pathologically T3 or higher	10 (71.4)	29 (65.9)	1.000
Recovery of potency			
At postoperative 6 weeks	6 (12.0)	8 (8.0)	0.552
At postoperative 3 months	7 (14.0)	12 (12.0)	0.796
Recovery of continence			
At postoperative 6 weeks	34 (68.0)	33 (33.0)	<0.001
At postoperative 3 months	48 (96.0)	81 (81.0)	0.012

Values are presented as mean  $\pm$  standard deviation or number (%).

RARP: robot assisted laparoscopic radical prostatectomy, LRP: laparoscopic radical prostatectomy.

127 minutes, respectively. After 20 cases, the mean operation time for RARP was similar to that for LRP (less than 2 hours). There were no intraoperative transfusions or open conversions due to any complications in either approach. Positive surgical margins in localized PCA were seen in 11.1% (4/36) and 8.9% (5/56) of the RARP and LRP groups, respectively ( $p=0.733$ ). At 6 weeks postoperatively, sexual intercourse was reported in 12.0% and 8.0%, and pad-free continence in 68.0% and 33.0%, of patients in the RARP and LRP groups, respectively ( $p=0.552$  and  $p<0.001$ ). At 3 months postoperatively, sexual intercourse was reported in 14.0% and 12.0%, and pad-free continence in 96.0% and 81.0%, of patients in the RARP and LRP groups, respectively ( $p=0.796$  and  $p=0.012$ ) (Table 2).

## DISCUSSION

LRP is associated with a relative reduction in the range of motion, counterintuitive movements, 2 dimensional (D) vision, and reduced haptic sense [4]. These limitations of LRP may be obstacles to its wider use. Schuessler et al [5] first reported nine cases of LRP in 1997 and concluded that there was no advantage to LRP regarding oncological or functional outcomes compared with open surgery. However, 3 years later, Guillonnet and Vallancien [6] reported that LRP was not only feasible but, more importantly, reproducible and that this procedure may replace open surgery.

RARP was first reported in 2001 [7], and it has recently gained popularity rapidly. The da Vinci system offers 10× magnification, binocular vision, tremor filtration, 3D vision, and articulated instruments, which together enable more precise tissue dissection and preservation of anatomical structures around the prostate during the surgery. The more precise dissection of the prostate produces more favorable outcomes in recovery of incontinence and erectile dysfunction. The main obstacle to RARP remains its cost. The initial cost of the system is 3 million US dollars, and maintenance costs are approximately 200,000 US dollars per year. Menon and colleagues reported that 75 robotic surgeries per year were required to cover the cost of the system [8]. At our institution, the cost of RARP is about fivefold that of LRP.

Although RARP may offer more convenient movements of the instruments and other advantages, as mentioned above, there has been no consensus as to the superiority of RARP over LRP. Pure laparoscopy has a long learning curve, which is a disadvantage in starting with laparoscopy. Thus, a greater number of surgeons have become familiar with robotic systems recently than ever performed pure laparoscopy, which makes it difficult to compare the outcomes of the two approaches. Hakimi et al [9] demonstrated similar functional outcomes of both approaches by a single surgeon. Another study reported outcomes of RARP compared with LRP [10] and concluded that the oncological and functional outcomes of LRP were similar to those of RARP for a surgeon with large-volume experience of LRP. Gosseine et al [11] reported no statistically significant difference in the recovery of continence between the groups, although incontinence appeared to be less severe and less frequent in the RARP group.

While the learning curve from radical retropubic prostatectomy to RARP has been reported, the learning curve for LRP to RARP has not been well documented [12]. This study evaluated the learning curve for RARP for a single surgeon with experience of more than 1,000 laparoscopic urologic operations. The current report reviewed the characteristics of patients in the LRP and RARP groups retrospectively. All LRPs were performed extraperitoneally. Although the surgeon used an intraperitoneal approach in the first five cases of RARP, since the sixth patient, all RARP procedures have been performed using an extraperitoneal approach. The mean operative time of 100 recently performed LRP cases was 118 minutes. Jaffe et al [13] reported an operative time of 134 minutes after 189 RARP cases. In his study, the operation duration fell to less than 2 hours after 210 cases. The mean operation time was more than 4 hours in the initial 12 cases of RARP. Bhandari et al [14] reported that the mean operative time decreased to 180 minutes after 250 cases of RARP. Although the mean operative time was significantly longer in the RARP group compared with LRPs (145 minutes vs. 118 minutes), it fell to less than 2 hours after patient 17, which was similar to that following the performance of over 200 RARP procedures, as reported by Jaffe et al [13].

In the LRP group, the positive surgical margin rate of pathologically localized PCA was 8.9%. Although the

positive surgical margin rate for RARP in patients with pathologically localized PCA was 11.1%, which was higher than that of LRP, this oncological result was comparable to other studies involving participants with large-volume experience of RARP. Atug et al [15] demonstrated that the positive surgical margin rate was 45.1% in their initial series of 33 RARP cases, which decreased to 21.2% for the following 33 patients. Other studies also reported positive surgical margin rates of 50.0% to 59.0% in their initial experience of RARP [13,16,17]. Weizer et al [18] suggested that 80 cases of RARP were needed to overcome the learning curve of a positive surgical margin.

The continence recovery rates at postoperative 6 weeks and 3 and 6 months were 33.0%, 81.0%, and 95.0%, respectively. These operative and postoperative functional outcomes were more favorable than those in other previous LRP studies [6,8,9,11]. The RARP patients included in this study showed similar ages, prostate volumes, preoperative PSAs, and percentages of localized PCA compared with the LRP group. Erectile function and continence recovery rates were more favorable with RARP at 6 weeks and 3 months postoperatively. No postoperative complications or conversions to open surgery occurred in either group.

The current study had several limitations. First, this report concerns relatively short-term follow-up results for functional outcomes. However, today, many urologic oncologists emphasize early functional outcomes after radical prostatectomies, especially in the first 3 months. Second, the surgeon of the present study recommended RARP in patients with large prostate volumes (>70 mL) because of the limited potential for movement of instruments in LRP, which may act as a selection bias.

## CONCLUSIONS

This study demonstrated that experience with LRP shortened the learning curve for RARP because the LRP procedure is somewhat similar to that of RARP. The results showed that the learning curve for the operative time and positive surgical margin rate of RARP could be overcome by accumulation of considerable experience with LRP. The current work also demonstrated functional outcomes comparable to other large-volume studies of RARP.

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## CONFLICT OF INTEREST

No potential conflict of interest relevant to this article was reported.

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