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Comparison of Open and Robotic Radical Prostatectomy: Initial Experience of Robotic Surgery

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1. Abstract

1.1. Purpose

We compared the perioperative, oncological and functional results of initial robot assisted radical prostatectomy (RARP) versus retropubic radical prostatectomy (RRP), in a laparoscopically naive center.

1.2. Methods

Patients with clinical localized prostate cancer who underwent either RRP or RARP between January 2018 and December 2021 were included. We compared the perioperative, oncological, and functional results between initial RARP group and RRP group.

1.3. Results

Among 246 patients, 120 patients underwent RARP and 126 patients underwent RRP. While the operation time was shorter in the RRP group (149.5 vs. 276.4 min, $p<0.001$), the estimated blood loss (1064.3 vs. 678.8 ml, $p<0.001$) and blood transfusion rate (30.9 vs. 7.5 %, $p<0.001$) were superior in the RARP group. In addition, a nerve-sparing procedure was performed more frequently in RARP ($p<0.001$). For urinary continence, RARP provided a significantly better outcome than RRP in terms of return of continence at postoperative 1 year ($p < 0.001$). The rate of erectile function recovery was 17.5% after RRP and 31.7% after RARP at 1 year ($p = 0.010$). The incidence of complications was not significantly different between the RRP and RARP groups ($p = 0.551$).

1.4. Conclusion

Even though it requires a longer op time, RARP provides better perioperative and function outcomes such as erectile function and continence. Based on the findings, we expect the learning curve for experts in RRP to transition to successful RARP to be one year or less.

2. Introduction

Radical prostatectomy (RP) is the main recommended surgical treatment for clinical localized prostate cancer (PCa). The retropubic radical prostatectomy (RRP) was first described by Walsh et al. in the 1980s [1] and is the conventional surgical method, with excellent success rates. However, the complexity of the pelvic anatomy and the prostate location as a deep and hard-to-reach organ motivated surgeons to develop novel techniques [2]. Laparoscopic RP was first reported by Schussler et al. [3] in 1997 as a minimally invasive surgery [3]. However, the steep learning curve and difficult technique of laparoscopic prostatectomy hindered the spread and frequent use of this technique [4]. To overcome these difficulties, robot-assisted radical prostatectomy (RARP) has been used since 2001 [5]. This system provides an enlarged view and advanced articulated robot arms [6,7]. Robot systems help surgeons to control precisely a laparoscopic instrument. With an increasing number of hospitals adopting robotic surgical systems, the number of surgeons performing robotic-assisted radical prostatectomy (RARP) has increased. Many studies have compared RP and RARP in terms of surgery and pathologic and functional outcomes [8-10].

At our center, about 100 prostatectomies each year were performed using the retropubic radical prostatectomy (RRP) technique until a robot system was introduced in 2020, after which the number of cases using the robot-assisted radical prostatectomy (RARP) rapidly increased. However, when transitioning to robot-assisted surgery, surgeons who are accustomed to performing the RRP may experience difficulties with the new surgical methods and equipment, especially in the early years of robotic surgery. The aim of the present study was to compare the perioperative, oncological, and functional results of initial RARP and RRP in a laparoscopically naive center.

3. Materials and Methods

3.1. Patients

This study was approved by the institutional review board of our institution (IRB No. 2022-04-002). Radical prostatectomy cases performed by five surgeons from January 2018 to December 2021 were included in the study. We retrospectively reviewed a database of 126 patients who underwent RRP for clinically localized prostate cancer. Also, we identified 120 patients undergoing RARP for clinically localized Pca between November 2020 and December 2021. Patients who had undergone salvage surgery, surgery for BPH, or received radiotherapy before prostatectomy were excluded, as were patients with incomplete medical records or less than 12 months of follow up.

3.1. Patient Management

The surgical technique of RRP was performed as described by Walsh et al [11]. After the skin, subcutaneous tissue, and muscles were opened through a suprapubic incision, the endopelvic fascia was opened, and the venous plexus was ligated and cut. The urethra was released, suspended, and cut, and the prostate was released from the Denonvilier fascia. Bilateral seminal vesicles and prostate were removed, and the bladder neck was narrowed with vicryl sutures. After a Foley catheter was introduced, urethrovesical anastomosis was created. Finally, fascia, subcutaneous tissue, and skin were closed by layer. RARP was performed as described by Patel et al [12]. The neurovascular bundle (NVB) was preserved in both surgical techniques based on preoperative PSA level, biopsy Gleason score, MRI results, and preoperative erectile function.

3.2. Clinicopathologic, Postoperative, Functional Outcomes

Clinical and pathological characteristics of patients including age at radical prostatectomy, body mass index (BMI), preoperative PSA, prostate volume, biopsy and pathologic Gleason score, clinical T stage, operation time, estimated blood loss (EBL), pathologic T stage, surgical margin status, and NVB preservation were obtained from the medical records. Operation time was defined as skin incision to skin closure in both procedures.

Extent of NVB preservation was classified as full, partial, or non-preservation. The postoperative outcome was assessed as days of hospitalization and of catheterization.

The functional outcomes were postoperative continence and erectile function recovery. Continence, defined as use of no urinary pad, was measured at 12 months postoperatively. Erectile function, defined as the ability to complete sexual intercourse (with or without oral pharmacological therapy), was measured at 12 months after surgery. Complications were stratified according to the Clavien classification system [13]. In addition, biochemical recurrence was evaluated according to PSA level > 0.2 ng/mL in the first year.

4. Statistical Analysis

Continuous variables are presented as mean and standard deviation and categorical variables as percentage. An independent t-test was used to compare continuous variables, and Pearson's chi-square test was used to compare categorical clinicopathologic characteristic. All statistical analyses were performed using SPSS version 21.0 (IBM Corp., Armonk, NY, USA) with a p-value < 0.05 considered statistically significant.

5. Results

5.1. Demographic and Clinical Characteristics

The baseline clinicopathologic characteristics of the first 120 RARP and last 126 RRP cases are summarized in Table 1. In the overall cohort, the mean age at RP was 75.9 years, and preoperative PSA was 9.0 ng/ml. When patients were divided into two groups depending on surgical technique (RRP vs. RARP), age at surgery (76.6 vs. 75.2 years; p = 0.030) and preoperative PSA level (9.9 vs. 8.1 ng/ml; p = 0.039) were significantly higher in the RRP group than in the RARP group. However, there were no significant differences in prostate volume, biopsy GS, and clinical T stage between RRP and RARP groups.

5.2. Perioperative and Pathologic Outcomes

Comparison of perioperative and pathologic outcomes according to surgical type is shown in Table 2. While the operation time was shorter in the RRP group (149.5 vs. 276.4 min, p<0.001), the estimated blood loss (1064.3 vs. 678.8 ml, p<0.001) and blood transfusion rate (30.9 vs. 7.5 %, p<0.001) were superior in the RARP group. In addition, a nerve-sparing procedure was performed more frequently in RARP (p<0.001). However, there were no significant differences in pathologic GS, pathologic T stage, and surgical margin status between RRP and RARP groups.

5.3. Postoperative, Functional Outcomes and Complications

Table 3 shows the comparison of postoperative and functional outcomes and complications of the patients in the first year. While mean length of hospital stay (10.2 vs. 9.5, p=0.034) was shorter in the RARP group, no significant difference was observed between the two groups in catheterization days (10.1 vs. 9.3, p=0.067). For urinary continence, RARP provided a significantly better outcome than RRP in terms of return of continence at postoperative 1 year (p < 0.001). The rate of erectile function recovery was 17.5% after RRP and 31.7% after RARP at 1 year (p = 0.010). The incidence of complications was not significantly different between the RRP and RARP groups (p = 0.551). Need for transfusion was the most common complication after prostatectomy. In addition, one patient after RRP required a wound closure operation under local anesthesia. After RARP, one patient underwent recto-vesical fistula repair operation under general anesthesia, and another patient was admitted to the intensive care unit for pneumonia. During the follow-up period, there were no deaths related to prostate cancer, and the biochemical recurrence rate was not significantly different between the groups (RRP 9.5%, RARP 7.5%; p = 0.570).

Table 1: Baseline clinicopathologic characteristics of 126 patients who had RRP and 120 who had RARP.

Column1	Column2	Column3	Column4	Column5
Variables	Total	RRP	RARP	p-value
Patients, no	246 (100)	126 (51.2)	120 (48.8)	
Age at surgery, yr, mean±SD	75.9±3.2	76.6±2.3	75.2±3.9	0.03
BMI, mean ± SD	24.4 ± 3.2	24.5 ± 3.2	24.3 ± 3.3	0.297
Pre-op PSA level, ng/ml	9.0 ± 7.1	9.9 ± 7.9	8.1 ± 6.0	0.039
Prostate volume, ml	42.7 ± 15.6	43.3 ± 15.1	42.1 ± 16.1	0.556
Biopsy GS, n (%)				0.28
6	63 (25.6)	33 (26.2)	30 (25.0)	
7	129 (52.4)	60 (47.6)	69 (57.5)	
8	51 (20.8)	30 (23.8)	21 (17.5)	
10-Sep	3 (1.2)	3 (2.4)	0 (0)	
Clinical T stage, n (%)				0.057
≤T2	210 (85.4)	111 (88.1)	99 (82.5)	
T3a	30 (12.2)	15 (11.9)	15 (12.5)	
≥T3b	6 (2.4)	0 (0)	6 (5.0)	

RRP, retropubic radical prostatectomy; RARP, robotic-assisted radical prostatectomy; BMI, Body mass index; PSA, prostate specific antigen; GS, Gleason score.

Table 2: Comparison of perioperative and pathologic outcomes according to surgical type.

Column1	Column2	Column3	Column4
Variables	RRP	RARP	p-value
Operation time, minutes	149.5 ± 39.6	276.4 ± 80.5	< 0.001
Estimated blood loss, ml	1064.3 ± 784.3	678.8 ± 526.8	< 0.001
Blood transfusion, n (%)	39 (30.9)	9 (7.5)	< 0.001
Pathologic GS, n (%)			0.157
6	18 (14.3)	21 (17.5)	
7	93 (73.8)	87 (72.5)	
8	3 (2.4)	9 (7.5)	
9-10	12 (9.5)	3 (2.5)	
Pathologic T stage, n (%)			0.809
≤T2	99 (78.6)	102 (85.0)	
T3a	27 (21.4)	12 (10.0)	
≥T3b	0 (0)	6 (5.0)	
Surgical margin, n (%)			0.078
Negative	78 (61.9)	87 (72.5)	
Positive	48 (38.1)	33 (27.5)	
Nerve-sparing procedure, n (%)			< 0.001
No	93 (73.8)	51 (42.5)	
Partial	22 (17.5)	42 (35.0)	
Full	11 (8.7)	27 (22.5)	

RRP, retropubic radical prostatectomy; RARP, robotic-assisted radical prostatectomy; GS, Gleason score.

Table 3: Comparison of postoperative, functional outcomes and complications according to surgical type.

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RRP, retropubic radical prostatectomy; RARP, robotic-assisted radical prostatectomy.

6. Discussion

Although RRP is the conventional surgical treatment for prostate cancer, its use has been declining due to the increasing number of RARP procedures using a robotic surgical system. Despite this new option, many surgeons continue to perform RRP [14]. Several studies have compared the RRP and RARP, with many reporting greater advantages with RARP. However, we wanted to compare RRPs and RARPs performed by surgeons who had experience with RRP but no experience with a robotic system, focusing on the first year of robot system adoption. We also analyzed the amount of time surgeons need to become experienced with RARP.

First, according to EBL, many previous studies have concluded that RARP showed less EBL than RRP. Transfusion rates ranging from 8-30% in RRP have been reported [15,16], as supported by the findings of the present study. We found significant differences in terms of mean EBL, with the RRP group showing a mean EBL greater than 1,000 ml, whereas that of the RARP group was 678 ml. Similarly, the transfusion rate was significantly lower in the RARP group. These findings can be explained by the use of CO_2 gas insufflation in the abdominal cavity, which may restrict bleeding [17]. In addition, the magnified field of view during RARP greatly improves the accuracy of dissection.

Even surgeons experienced in RRP report difficulties in prostatectomy due to the narrow field of view allowed by the pelvic cavity. This limited vision increases the chance of injury to surrounding vessels, causing greater bleeding. Such bleeding itself further obscures the operation field, increasing the likelihood of further bleeding.

In RARP, surgeons are provided a magnified field of view through which vessel injury can be avoided, resulting in less bleeding and more accurate dissection. However, despite this benefit of bleeding control, RARP may involve a longer operation time (op time) due to the attention required. Our study supports this, with a significantly longer op time of RARP. Another important factor that contributes to the longer op time for RARP is the time required for docking the robot, especially for surgeons with little or no previous experience. Previous studies have reported op times from 110 minutes to 540 minutes depending on surgical experience [18-20]. The mean op time in the 120 RARP cases analyzed in this study was 276.4 minutes. The mean op time for the first 60 cases was 295.6 minutes, whereas the mean op time for the latter 60 cases was 257.2 minutes. The significant difference is likely due to increased experience with the robot system. As the use of RARP continues to increase, the related op time is expected to decrease further, negating the difference with RRP. In this study, the positive surgical margin (PSM) rates in RRP and RARP were 38.1% and 27.5%, respectively. However, no significant difference was observed between the two groups. This agrees with previous studies [17, 19, 21-23]. That also did not find significant difference between the two groups in PSM rate. The higher PSM rate in RRP is attributable to the magnified field of view of RARP, allowing more precise dissection and lower EBL. The lack of significant difference can be explained by greater attention to nerve sparing in the RARP group, which is associated with higher likelihood of margin positivity. However, considering several previous studies reporting significantly lower PSM in RARP, it is possible that this difference in our surgeons also will become significant as surgeons gain experience. The relationship between surgical margin status and nerve sparing should be considered during early surgical experience with RARP. The percentage of patients who maintained continence was significantly higher in the RARP group at postoperative one year in this study, consistent with many previous results. This is likely due to more precise apical dissection and few traumatic procedures on the urethral sphincter complex because of the increased view with RARP. The recovery of erectile function is a crucial concern in radical prostatectomy (RP). The present study reported significantly higher erectile function at postoperative one year (17.5 % vs. 31.7%, p=0.010) in patients in the RARP group, again in agreement with many previous studies [21,23]. There are several reasons for this result. First, the mean age in the RARP group was slightly lower than in the RRP group (76.6 vs. 75.2, p=0.030), and such younger patients may achieve better recovery of erectile function. In addition, the larger field of view with RARP allows more accurate dissection and fewer complications. Most importantly, after the introduction of robotic surgery, nerve sparing increased in use compared to that during RRP. RARP offers many technical advantages over RRP and is expected to result in fewer complications. Some previous studies have shown significant differences in complications between the two groups, while other studies reported no difference. Wallerstedt et al. reported no significant difference in re-hospitalization and number of Clavien-Dindo 3b complications between two groups in their prospective, comparative study [24]. Pompe et al [25]. Reported slightly better complication rates for RARP than RRP in their single-center retrospective analysis [25]. In the present study, we found no significant differences between the two groups. In both groups, most complications were minor, Clavien II or lower, with transfusions accounting for the majority of cases. Major complications of Clavien III or higher were more common in the RARP group (2 cases) than the RRP group (1 case), but the difference was not significant. In the RRP group, there was no critical complication and one case of wound dehiscence that required closure under local anesthesia. In the RARP group, one complication was recto-vesical fistula that was repaired surgically under general anesthesia. This complication occurred early after the introduction of RARP in our center, when the surgeons had little RARP experience. In the learning curve of RARP, mistakes during dissection near the rectum can lead to critical complications, and close attention is required.

Despite the potential clinical implications of our study, this study has limitations. First, this was a retrospective, non-randomized study for which the likelihood of a selection bias cannot be excluded. Second, evaluation of erectile function and continence was performed using validated questionnaires (IIEF-5; International Index of Erectile Function, ICIQ; International Consultation on Incontinence Questionnaire) in some patients and simple interviews in others, possibly resulting in inaccurate assessment in some patients. However, we believed that the key outcomes were adequately assessed. Third, due to the short follow-up period, we could not evaluate long-term oncological outcomes such as recurrence-free survival, cancer-specific survival, and overall survival rates. Even though we identified PSM rate and biochemical recurrence (BCR) rates, the follow-up period was too short to assess the BCR accurately, and more data are needed to evaluate long-term oncological outcomes properly.

Despite these limitations, this study offers information about outcomes between a highly skilled RRP group (many years of experience) and an early experience with RARP group (initial year after adoption of the robot system). Also, this study provides information on focuses of attention for surgeons in the early years of RARP experience.

7. Conclusion

In conclusion, the results of this study suggest that RARP can performed with limited difficulties even in a laparoscopy-naïve center. Even though it requires a longer op time, RARP provides better perioperative and function outcomes such as erectile function and continence. Based on the findings, we expect the learning curve for experts in RRP to transition to successful RARP to be one year or less. Therefore, RARP is our technique of choice in patients with localized prostate cancer.

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