



## Research Article

# Open simple prostatectomy and robotic simple prostatectomy for large benign prostatic hyperplasia: Comparison of safety and efficacy

Jeong Man Cho, Kyong Tae Moon, Jun Ho Lee, Jae Duck Choi, Jung Yoon Kang, Tag Keun Yoo\*

Department of Urology, Eulji Medical Center, Eulji University School of Medicine, Seoul, South Korea

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## ABSTRACT

**Background:** To compare the safety and efficacy of open simple prostatectomy (OSP) and robotic simple prostatectomy (RSP) for the treatment of large benign prostatic hyperplasia (BPH).

**Materials and methods:** We retrospectively reviewed the medical records of 52 patients who underwent OSP (n = 23) and RSP (n = 29) between January 2005 and March 2019 at a single institution. The preoperative status of the patients, complications related to surgery, and the functional outcomes of the surgery were analyzed.

**Results:** There were no significant differences in the preoperative total prostate volume, transitional volume, prostate-specific antigen value, and age between the two groups. Postoperative improvements in the International Prostate Symptom Score, maximum urinary flow rate, and postvoid residual were significant and similar for both groups. There were no significant differences between the two groups regarding surgery duration and resected prostate volume. The majority of patients in both groups had the urethral Foley catheter removed within the planned 10 day postoperative period, with the exception of two patients in the OSP group who had prolonged indwelling Foley catheter placement because of persistent hematuria. Postoperative hematocrit changes were significantly lower in the RSP group (RSP:  $7.8 \pm 4.1\%$ , OSP:  $14.2 \pm 4.9\%$ ,  $P < 0.001$ ). Seven patients (30.4%) who underwent OSP and two patients (6.9%) who underwent RSP were transfused because of significant intraoperative bleeding. Two patients from the RSP group who received transfusion comprised the first two cases that underwent RSP treatment. During the follow-up period, two patients (one patient in the OSP group and one patient in the RSP group) underwent transurethral incision of the bladder neck for bladder neck contracture.

**Conclusion:** Both OSP and RSP can produce excellent outcomes after surgery. However, complications of bleeding are significantly less prevalent in RSP, suggesting that RSP can replace conventional OSP.

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## 1. Introduction

Benign prostatic hyperplasia (BPH) is one of the most common diseases among men after middle age, which can cause lower urinary tract symptoms that can diminish the quality of life and affect the overall health status of the individual<sup>1–6</sup>. Owing to the advancement of drug therapy, specifically alpha blockers and 5-alpha reductase inhibitors, the need for surgical treatment of BPH has been significantly reduced<sup>7</sup>. However, cases that do not respond to drug therapy require surgical intervention for renal dysfunction

because of bladder outlet obstruction, repetitive bleeding, and acute urinary retention<sup>8,9</sup>. The need for open simple prostatectomy (OSP) has been significantly reduced because of the advancement and availability of various endoscopic surgical techniques, including transurethral resection of prostate (TURP) and Holmium laser enucleation of prostate (HoLEP). However, OSP still plays an important role in the surgical treatment of BPH, and, in particular, it is recommended as the standard surgical treatment for large BPH with volume  $\geq 80$  ml<sup>9,10</sup>. OSP has shown excellent postoperative improvement of urinary symptoms in multiple studies, but it has also been linked to various complications, including infection, increased hospital stay, and blood transfusion<sup>11–16</sup>. As a result, various institutions have attempted to use noninvasive techniques, specifically laparoscopic or robotic techniques, to reduce such complications. Laparoscopic simple prostatectomy (LSP) was first

\* Corresponding author. Department of Urology, Eulji General Hospital, 68 Hangeulbiseong-ro, Nowon-gu, Seoul, 01830, South Korea.  
 E-mail address: [ytk5202@eulji.ac.kr](mailto:ytk5202@eulji.ac.kr) (T.K. Yoo).

introduced by Mariano et al. (2002), but according to recently published studies, LSP actually requires increased operation time compared with conventional OSP, without offering many benefits and increasing the probability of complications requiring revision surgery and blood transfusion<sup>17–19</sup>. In recent years, simple prostatectomy using the robotic da Vinci® Surgical System has been attempted to reduce the surgery duration and the risk of surgery-related complications, including blood transfusion. In 2008, Sotelo et al. became the first to report that robotic simple prostatectomy (RSP) demonstrated reduced incidence of complications and excellent postoperative outcomes. Subsequently, several studies also reported that RSP showed excellent surgical safety and efficacy<sup>20–27</sup>. Therefore, we conducted a comparative analysis between OSP and RSP regarding surgical safety and efficacy.

## 2. Patients and methods

### 2.1. Patient inclusion criteria

We retrospectively analyzed 52 patients who could be followed up for at least 6 months from among a sample of patients who underwent OSP or RSP between January 2005 and May 2019 at a single institution. Simple prostatectomy was considered rather than an endoscopic surgery in cases where one or more of the following conditions was present: large BPH with prostate volume (PV)  $\geq 80$  cc, large bladder calculi  $\geq 2$  cm, or cases where endoscopic procedure was not an option due to urethral injury or stenosis. Before surgery, all patients were assessed by the International Prostatic Symptom Score (IPSS), digital rectal examination, transrectal ultrasonography (TRUS), and blood test, including the prostate-specific antigen (PSA) test. Prostatectomy was performed after ruling out prostate cancer by performing uroflowmetry and residual urine measurement on all patients (except those who had a urethral catheter placed before surgery due to urinary retention) and TRUS-biopsy on patients with palpable nodule during digital rectal examination, presence of abnormal echogenicity on TRUS, or PSA level of  $\geq 4$  ng/ml. The PV was measured by TRUS and the prolate ellipsoid formula (PV =  $0.5233 \times \text{transverse length} \times \text{cranial caudal length} \times \text{anteroposterior length}$ ) was used to calculate the total PV (TPV) and transitional zone volume<sup>28</sup>.

## 3. Operative methods

### 3.1. Open simple prostatectomy

OSP was performed by suprapubic subcapsular prostatectomy using a retroperitoneal approach through a central abdominal incision<sup>29</sup>. After general anesthesia or para-anesthesia, the patient was placed in the Trendelenburg position after urethral catheterization, and a lower midline, or Pfannenstiel, incision was made on the abdominal region. Subsequently, the retroperitoneal space was secured, and a vertical incision was made on the bladder, after which left and right ureteral openings were identified, and a circular incision was made on the boundary around the bladder neck and adenoma using an electric scalpel. After using the Metzenbaum scissors to dissect the boundaries of the prostatic adenoma and capsule, digital blunt dissection was performed. Once the prostatic adenoma was completely removed, electrocautery was used for initial hemostasis, and subsequently, hemostasis was completed by a figure-of-eight suture using 3-0 Vicryl in the 5 and 7 o'clock positions on the bladder mucosa and prostatic capsule. When necessary, reconstruction of the bladder neck was also performed. Subsequently, the surgery was completed by placement of a 3-way

urethral catheter, bladder suture, insertion of J-P drain, and abdominal suture.

### 3.2. Robotic simple prostatectomy

RSP was performed using the 4-arm da Vinci® Surgical System, with the patient placed in a steep Trendelenburg position after general anesthesia. The procedure was performed by setting up six ports using the transperitoneal approach (Fig. 1). After dissection of the peritoneum of the entire bladder, the Retzius space was approached to remove all fat tissue covering the prostatic capsule. Subsequently, a horizontal incision was made on the bladder, and the boundary between the bladder and prostatic adenoma was identified. For retraction of the prostatic adenoma, 2-0 Monosyn was used to suture the prostatic adenoma, after which, the third robotic arm was used to retract the prostatic adenoma during the surgery. While checking the left and right ureteral openings, a circular incision was made on the bladder mucosa covering the boundary between the bladder neck and prostatic adenoma, after which, the boundary between the prostatic capsule and adenoma was dissected and the prostatic adenoma was removed. After suturing the prostatic capsule for hemostasis subsequent to the removal of the prostatic adenoma, reconstruction of the bladder neck was performed. Subsequently, the surgery was completed by placement of a 3-way urethral catheter, bladder suture, and insertion of J-P drain (Fig. 2).

### 3.3. Assessment of outcomes

During postoperative follow-up at 3–6 months, all patients were assessed by IPSS to analyze improvement in voiding, storage, and quality of life scores. Uroflowmetry and residual urine measurements were performed again postoperatively at 3–6 months on all patients, and analyses were performed to identify differences between preoperative and postoperative results and differences between surgical methods. Patients with a urethral catheter placed before surgery because of acute urinary retention were excluded from the analyses. We compared and analyzed surgery duration and resected PV and investigated the correlation between preoperative PV and surgery duration was investigated. For RSP,

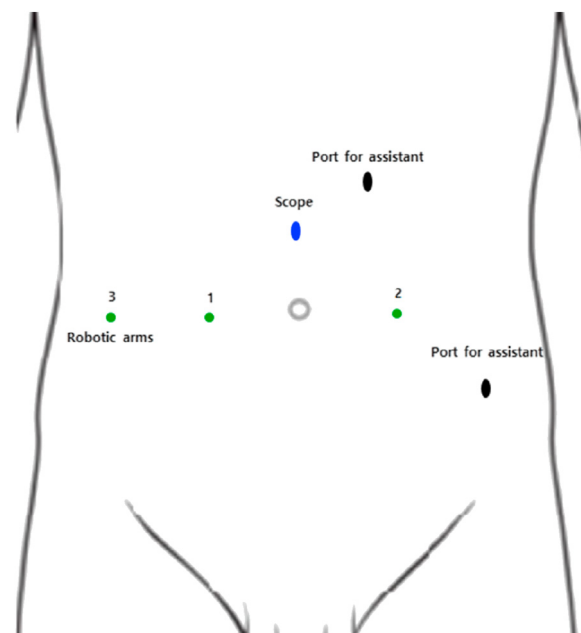
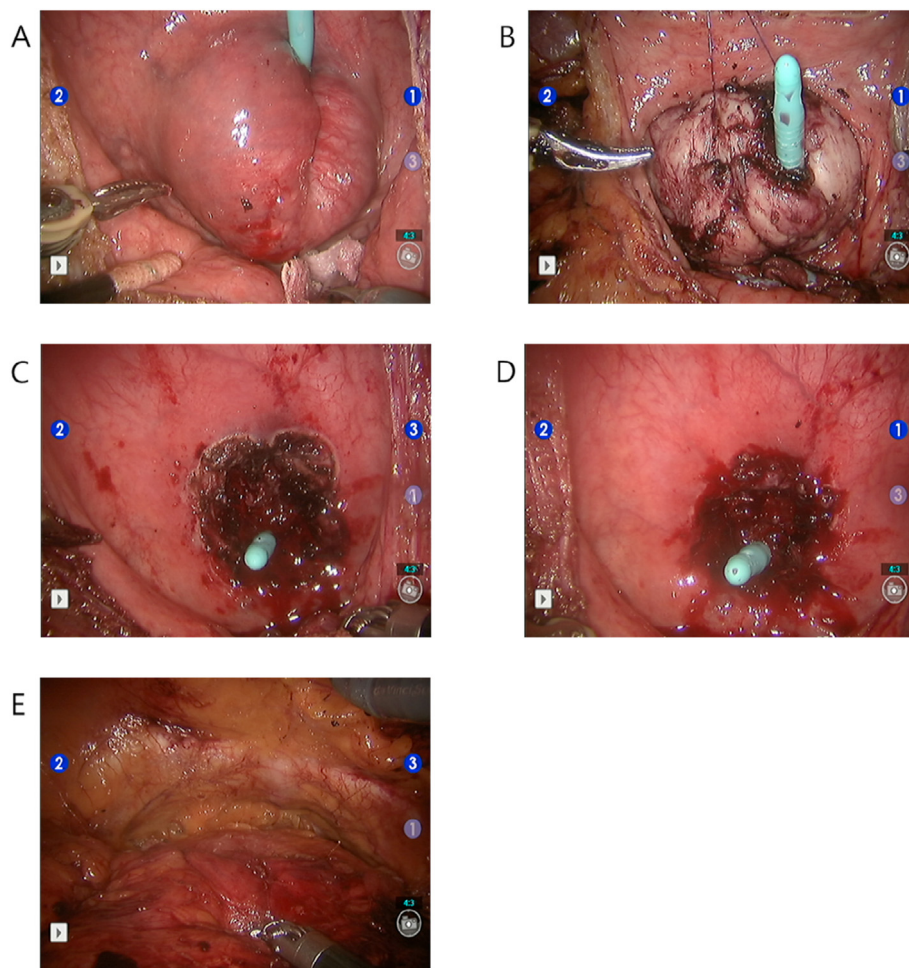


Fig. 1. Ports configuration in robotic simple prostatectomy.



**Fig. 2. Procedure of robotic simple prostatectomy.** (A) After vertical cystostomy, protrusion of prostatic adenoma into the bladder was found. (B) Passed a retraction suture through the adenoma to facilitate the enucleation. (C) After removal of the adenoma, the prostatic fossa was exposed. (D) Capsular plication and bladder neck reconstruction were performed. (E) After closure of vertical cystostomy, surgery was finished.

differences in surgery duration based on surgical experience were also investigated. The difference in preoperative and postoperative hemoglobin levels was compared between the two groups, whereas transfusion rates due to intraoperative bleeding and complications, including fever due to urinary tract infection (UTI), were also investigated. Furthermore, surgery-related complications, specifically postoperative urinary incontinence and bladder neck stenosis, were also investigated. All statistical analyses were performed using SPSS, ver. 20.0 (IBM Co., Armonk, NY). Student *t* test, paired *t* test, correlation analysis, and Chi-square test were performed, with *P* value < 0.05 considered as statistically significant.

#### 4. Results

During the study period, OSP and RSP were performed in 23 and 29 cases, respectively. OSP was performed in 13 and 10 cases before and after 2010, respectively, whereas all 29 cases of RSP were performed after 2010. All patients in both groups had large BPH with  $PV \geq 80$ . There were no differences in age at the time of the surgery, preoperative PSA level, TPV, and transitional zone volume between the OSP and RSP groups (Table 1). In the analysis of IPSS, both surgical methods showed significant improvement in the postoperative total IPSS and quality of life as compared with the preoperative scores, but the two groups did not show differences in the level of

improvement. In the analysis of uroflowmetry and residual urine measurements, both surgical methods achieved significant improvement, but the two groups did not show differences in the level of improvement (Table 2). With respect to the operation time, OSP and RSP groups showed no significant difference, with  $159.6 \pm 29.5$  and  $174.0 \pm 51.9$  minutes, respectively (Table 3). The Pearson's correlation coefficient between TPV and surgery duration for OSP and RSP groups was 0.04 ( $P = 0.86$ ) and  $-0.07$  ( $P = 0.77$ ), respectively, showing no correlation between TPV and surgery duration for both groups. With respect to the surgery duration for RSP, the first two cases required 330 minutes; however, no subsequent case required more than 210 minutes. The mean surgery

**Table 1**  
Baseline patient characteristics.

Parameter	OSP (n = 23)	RSP (n = 29)	<i>P</i> value*
Age (years)	70.7 ± 6.0	70.5 ± 7.9	0.91
PSA (ng/ml)	11.0 ± 8.1	8.4 ± 8.6	0.26
TPV (ml)	118.6 ± 21.7	108.2 ± 25.0	0.12
TZV (ml)	76.6 ± 23.8	67.7 ± 19.5	0.15
Urethral stenosis	1 (4.4%)	1 (3.4%)	

OSP, open simple prostatectomy; PSA, prostate specific antigen; RSP, robotic simple prostatectomy; TPV, total prostate volume; TZV, transitional zone volume.

\**P* values were calculated using Student *t* test.

**Table 2**  
Comparison of change in preoperative to postoperative parameters.

Parameter	OSP (n = 23)	RSP (n = 29)	P value*
IPSS (Total)			
Preoperative	15.7 ± 8.3	23.3 ± 7.2	
Postoperative	4.7 ± 3.7	5.0 ± 2.5	
Improvement of IPSS (Δ)	11.1 ± 6.6	18.3 ± 8.2	0.05
QoL score			
Preoperative	3.4 ± 1.5	4.3 ± 1.0	
Postoperative	1.1 ± 1.4	1.2 ± 1.0	
Improvement of QoL (Δ)	2.3 ± 1.3	3.1 ± 1.6	0.22
Qmax (ml/s)			
Preoperative	9.0 ± 5.0	8.1 ± 5.6	
Postoperative	14.1 ± 4.7	18.9 ± 9.8	
Improvement of Qmax (Δ)	5.1 ± 4.8	10.9 ± 7.0	0.06
PVR (ml)			
Preoperative	137.9 ± 97.0	134.3 ± 128.5	
Postoperative	15.0 ± 25.7	23.2 ± 33.8	
Improvement of PVR (Δ)	122.9 ± 100.6	111.1 ± 104.4	0.77

IPSS, International prostatic symptom score; OSP, open simple prostatectomy; PVR, postvoid residual; QoL, quality of life; Qmax, maximal flow rate; RSP, robotic simple prostatectomy.

\*P values were calculated using Student *t* test.

duration for RSP, excluding the first two cases, was 159.3 ± 30.4 minutes. The resected PV in OSP and RSP groups was 72.5 ± 39.2 g and 58.7 ± 27.6 g, respectively, showing no significant difference between the groups (Table 3). JP drain was removed in 4.7 days in the open group and 5.1 days in the RSP group. Cystography was performed on all patients who underwent surgery and the urethral catheter was removed after confirming that the bladder had been sutured. In both groups, the urethral catheter was not removed before 7 days. Before 2010, cystography was performed between postoperative day (POD) 10 and 14. Among 13 cases of OSP performed before 2010, there were no cases in which the urethral catheter could not be removed within POD 10–14 as planned due to complications or nonanastomosis of the bladder. After 2010, cystography was typically planned for POD 7–10. Among 10 cases of OSP performed after 2010, two cases showed persistent hematuria, delaying cystography and subsequent urethral catheter removal to POD 14 in one case and POD 20 in the other case. All RSP procedures were performed after 2010, and in all 29 cases, cystography was performed on POD 7–10, followed by urethral catheter removal. While there were no specific complications that occurred during the postoperative hospital stay, transfusion due to intraoperative bleeding was required in seven (30.4%) and two (6.9%) cases in the OSP and RSP groups, respectively (Table 3). A blood transfusion was performed when the hemoglobin level dropped below 9.0 after surgery. The two cases in the RSP group that required transfusion were the first two cases that were treated, and there was no need for transfusion in subsequent cases. All patients in both groups presented no specific complications, including urinary incontinence,

during the postoperative follow-up period. However, one case in each of the OSP and RSP groups showed bladder neck stenosis during the follow-up period, for which endoscopic resection of the bladder neck was performed (Table 3).

## 5. Discussion

Severe lower urinary tract symptoms and large PV before treatment are known to increase the likelihood of failure of the efficacy of drug therapy<sup>30–32</sup>. Choi et al. administered drug therapy to 667 patients with BPH, and the results showed that the type of drug therapy, age of the patient, and PV were risk factors for failed drug therapy<sup>32</sup>. As reported by various studies, PV is one of a group of key risk factors for failed drug therapy. This is especially true for patients with large BPH and with PV ≥ 80 ml, who comprised our study population and who demonstrate an increased risk of failure with drug therapy, and thus, surgical intervention must be considered for these patients. The need for OSP has been significantly reduced because of the advancement and availability of various endoscopic surgical techniques, including bipolar TURP and HoLEP. Meanwhile, Ou et al. conducted a randomized controlled study comparing TURP and OSP in patients with large BPH with PV ≥ 80 ml. The results indicated that OSP showed greater improvement in symptoms, maximal urinary flow rate, and residual urine after voiding than TURP during postoperative follow-up for 1 year. Moreover, OSP showed a decreased operation time and less postoperative complications than TURP. Based on these findings, they reported that OSP was superior to TURP for patients with large BPH with PV ≥ 80<sup>33</sup>. Ahyai et al. analyzed the amount of time required to complete TURP, HoLEP, and OSP for treating BPH and reported that HoLEP and OSP offered greater benefits than TURP with respect to operation time. However, HoLEP required a longer operation time with increased prostate size, whereas OSP did not show a correlation between prostate size and operation time; meanwhile, OSP also demonstrated reduced operation time in cases involving prostate size ≥ 80 g<sup>34</sup>. Based on these study results, OSP still plays an important role in the surgical treatment of large BPH with PV ≥ 80 ml and is recommended as the standard surgical modality for large BPH in various treatment guidelines<sup>9,10</sup>. Moreover, in cases with difficult endoscopic approach due to urethral injury or stenosis or cases that involve large bladder calculi, OSP should be considered before endoscopic approach. However, numerous studies have reported that OSP showed excellent outcomes with respect to improvement in urinary symptoms; however, it is associated with a relatively high prevalence of complications, including bleeding and infection<sup>11–16</sup>. In a multicenter study by Gratzke et al. on the outcomes of 902 OSP cases, 5.1% of the patients experienced UTI, 7.5% of the patients required blood transfusion, and 3.7% of the patients required revision

**Table 3**  
Perioperative and postoperative assessment and complications.

Parameter	OSP (n = 23)	RSP (n = 29)	P value*
Time of surgery (minutes)	159.6 ± 29.5	174.0 ± 51.9	0.24
Adenoma weight (g)	72.5 ± 39.2	58.7 ± 27.6	0.18
Postoperative hematocrit drop (%)	14.2 ± 4.9	7.8 ± 4.1	<0.01
Blood transfusion	7 (30.4%)	2 (6.9%)	0.03
Foley cath. indwelling time (day)	10.7 ± 2.5	7.9 ± 0.9	0.07
Postoperative CBI time (day)	4.2 ± 0.8	3.9 ± 0.5	0.69
Postoperative UTI	3 (14.3%)	4 (13.8%)	0.54
Postoperative PSA (ng/ml)	1.1 ± 1.3	1.5 ± 2.4	0.49
Postoperative incontinence	0	0	
Late complication (Bladder neck contracture)	1 (4.4%)	1 (3.4%)	

CBI, continuous bladder irrigation; OSP, open simple prostatectomy; PSA, prostate specific antigen; RSP, robotic simple prostatectomy; UTI, urinary tract infection.

\*P values were calculated using Student *t* test and Chi-square test.



surgery because of bleeding<sup>12</sup>. Various institutions have attempted to use simple prostatectomy as a minimally invasive surgery to reduce surgery-related complications and shorten the postoperative recovery time. The LSP has been performed in various institutions since its introduction by Mariano et al.<sup>19</sup>. However, according to McCullough et al., LSP offers greater benefits than OSP with respect to duration of postoperative urethral catheter indwelling, length of hospital stay, and UTI<sup>17</sup>. According to a recent meta-analysis study, LSP and OSP showed similar effects on increasing maximal urinary flow rate and improved symptoms, but LSP was superior with respect to length of hospital stay, duration of urethral catheter indwelling, and estimated blood loss. Yet, there were no significant differences between LSP and OSP in total complication and blood transfusion rate, as well as number of revision surgeries required; however, LSP did, in fact, require an increased operation time<sup>18</sup>. The reason for this may be because of increased difficulty that is associated with laparoscopic techniques. Open prostatectomy using the da Vinci® Surgical System is more convenient for the surgeon, because the prostatic adenoma could be dissected while retracting it with the third arm and, therefore, should have a shorter learning curve than laparoscopic techniques and enable more precise dissection. Indeed, Sotelo et al. were the first to report on the outcomes of RSP using the da Vinci® Surgical System on seven patients, in which excellent postoperative outcomes were obtained for all patients with no resulting complications, with the exception of a single case that required a blood transfusion<sup>20</sup>. Autorino et al. analyzed the outcomes from LSP and RSP performed on patients with large BPH and reported that RSP was superior to LSP with respect to operation time and estimated blood loss<sup>35</sup>. Meanwhile, several other institutions performed RSP, with most studies reporting a low incidence of blood transfusion, and an absence of differences were noted regarding postoperative outcomes as compared to conventional OSP<sup>22–28</sup>. In the present study, the number of cases that required blood transfusion was seven (30.4%) and two (6.9%) in OSP and RSP, respectively, revealing a significantly lower transfusion rate in the RSP group. Moreover, the two cases that required transfusion in the RSP group were the first two cases in which RSP was performed. At the time, implementation of the da Vinci® Surgical System was relatively new, but as the surgeons gained proficiency with the technique, there were no additional cases that needed a blood transfusion. The RSP requires a significantly smaller skin incision than conventional OSP, whereas RSP also enables precise adenoma dissection under direct field-of-view rather than blunt dissection. Moreover, intraoperative venous bleeding due to compression caused by carbon dioxide fluctuation is less frequent, and hemostasis using electrocautery is possible by accurately identifying the site of bleeding. Furthermore, it also offers the advantage of enabling suturing of the exact location of the site of bleeding when suturing the prostatic capsule for hemostasis. Indeed, significantly less blood loss is expected for RSP compared with OSP, and in the present study, the rate of bleeding-related complications was considerably lower. In the present study, both OSP and RSP showed significant improvement in IPSS, maximal urinary flow rate, and residual urine after voiding, but there were no differences in the level of improvement between the two groups. Therefore, RSP was found to offer surgical effectiveness comparable to conventional OSP. The results also showed that there was no difference in the weight of resected PV and surgery duration between the two groups. After the first two cases of RSP were performed, proficiency in the use of the robotic technique increased, and the surgery duration did not exceed 210 minutes in any of the cases after the third case. The mean operation time for RSP, excluding the first two cases, was  $159.3 \pm 30.4$  minutes. There was an absence of specific complications, including urinary incontinence, in all patients in both groups during the postoperative

follow-up period. However, one case in each of the OSP and RSP groups showed bladder neck stenosis during the follow-up period, in which endoscopic resection of the bladder neck was performed. In the two cases that involved bladder neck stenosis, there were no identifiable issues with the condition of the patient or any intraoperative complications or technical issues; hence, additional large-scale studies may be needed in the future to analyze the cause. In the present study, which is the first in Korea to report on RSP, we encountered considerably less bleeding-related complications than conventional OSP, while demonstrating comparable surgery duration, resected PV, and surgical effect compared with OSP. The limitations in the present study included the retrospective study design; also, the registration period was relatively long, and the size of the study population was small. Moreover, additional comparisons should be made with HoLEP, which has been reported to be used widely for BPH, with favorable outcomes.

## 6. Conclusions

Owing to the advancement of various endoscopic instruments and techniques, the need for invasive procedures to treat BPH is gradually decreasing. However, invasive prostatectomy is still needed for cases involving large BPH with PV  $\geq 80$  ml, large bladder calculi, existing urethral injury, or urethral stenosis, and both OSP and RSP can offer excellent postoperative outcomes. However, bleeding-related complications are much less frequent with RSP, and thus, this technique could be a safe alternative for conventional OSP.

## Conflicts of interest

No conflicts of interest to declare.

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