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Holmium Laser Enucleation, Laparoscopic Simple Prostatectomy, or Open Prostatectomy: The Role of the Prostate Volume in terms of Operation Time

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Keywords

Prostate · Benign prostatic hyperplasia · Adenomectomy · Holmium laser enucleation of the prostate · Laparoscopic open prostatectomy

Abstract

Introduction: To compare the prostate removal speeds of 3 enucleation techniques and to evaluate how the operating times change depending on the prostate volume. ***Methods:*** Medical records of patients with 80-g or larger prostates who underwent holmium laser enucleation of the prostate (HoLEP), laparoscopic simple prostatectomy (LSP), or open prostatectomy (OP) due to medical treatment-resistant benign prostatic hyperplasia (BPH) were reviewed retrospectively. Patients were classified into 3 groups according to the surgical procedure. Age, BMI, prostate weights, total operation times, prostate removal speeds, hospitalization and catheterization days, complications, and improvements on functional outcomes in the 3rd month of follow-up were compared between groups. In addition, the association between prostate weight and total operation time was analyzed for each group. ***Results:*** HoLEP, LSP, and OP groups consisted of 60, 61, and 37 patients, respectively. While HoLEP was similar to OP in terms of prostate removal speed and total operation time, LSP was statistically slower and required more operation time than HoLEP and OP. There was a relationship between prostate weight and total operation time only in HoLEP. ***Conclusion:*** LSP, one of the enucleation techniques in the treatment of large prostates, was slower and required more operation time than HoLEP and OP in terms of total operation time and prostate removal speed. HoLEP seems going to be the fastest candidate for the rapid removal of large prostates in the future.

Introduction

Benign prostatic hyperplasia (BPH), which causes lower urinary tract symptoms (LUTS) with ageing, is a common disease that reduces the quality of life. Although the first-choice treatment method is medical, about 30% of older males undergo surgery [1]. One of the crucial parameters in choosing the surgical method is the weight of the prostate, and according to the EAU guidelines, endoscopic enucleation of the prostate or open prostatectomy (OP) is recommended to treat moderate-to-severe LUTS

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in males with prostate sized >80 mL [2]. Although OP was the preferred surgical method in the treatment of large prostates for 100 years, holmium laser enucleation of the prostate (HoLEP) and laparoscopic simple prostatectomy (LSP) are nowadays considered to be alternative methods that replicate the enucleation technique of OP [3].

There are many studies in the literature comparing these minimally invasive procedures with OP and highlighting their superior aspects [4–9]. However, longer duration of the operation is regarded to be the main disadvantage of minimally invasive procedures against OP [10]. Prolonged operative time was associated with an increase in the risk of complications [11]. Therefore, it may be essential to know about the prostate removal speeds of these procedures and prostate volume-related operation time changes, for instance, in patients with comorbidity. In this study, we compared the prostate removal speeds of HoLEP and LSP with OP and evaluated how the operation times change according to the prostate weight in the treatment of large prostates.

Materials and Methods

Outcomes of the patients who underwent HoLEP, LSP, and OP in 2 academic centres between 2010 and 2019 due to medical treatment-resistant BPH were evaluated retrospectively after obtaining approval from the local ethics committee. All open, laparoscopic, and HoLEP operations were performed by 3 experienced surgeons. The characteristics of the patients including age, body mass index (BMI), removed adenoma volumes, operation times, duration of hospitalization and catheterization, and peri-operative and post-operative complications according to Clavien classification were compared. The improvements on International Prostate Symptom Score (IPSS) and maximum urinary flow rate in a flowmetre (Q_{max}) were determined by calculating the difference between the pre-operative and post-operative 3rd month follow-up results and compared.

The total amount of removed prostatic adenomas was obtained from pathology reports for each surgery in gram basis. We excluded the patients with <80-g prostate weight in the pathology specimen from this study. In addition, the patients with morbid obesity, urethral stricture, history of any surgery, and suspicious of prostate cancer, as well as the cases with any complications, were excluded from the study to prevent any adverse effects they may have on the operation time.

Total operation time was defined as the duration between insertion and removal of the resectoscope for HoLEP. Therefore, we included the spent time for haemostasis and morcellation into the operation time. The time spent between skin to skin during the surgery was assessed as total operation time for LSP and OP surgeries. Prostate removal speeds of the procedures were calculated by dividing the total amount of resected adenoma to total operation time in each case. The prostate weights, prostate removal speeds, and total operation times of the groups were compared. In addition, the association between prostate weight and total operation time for each surgical procedure was analyzed.

Surgical Technique

HoLEP was performed with 140-W dual pedal holmium laser (Multipulse HoPLUS; JenaSurgical/Asclepion Laser, Jena, Germany), 550-nm bare-ended re-usable laser fibre (JenaSurgical), and a 26-F resectoscope (Karl Storz, Tuttlingen, Germany). Power settings were adjusted separately as 140 W for the left pedal (4-J energy, 35-Hz frequency, and long pulse width combination) and 60 W for the right pedal (2-J energy, 30-Hz frequency, and medium pulse width combination) before every operation. Under general or spinal anaesthesia, the three-lobe technique was performed following a cystoscopic examination. The epithelial incision was initially performed bilaterally to the 5 and 7 o'clock positions that side lobes adjoined the median lobe and then extended to the lateral border of the verumontanum. This incision was then developed up to the prostatic capsule. The created plans were merged at the proximal of the verumontanum, and the median lobe enucleated into the bladder. Before the dissection of lateral lobes, an incision was made at 12 o'clock position starting from the bladder neck to proximal of the verumontanum and lateral lobes were enucleated retrogradely. After haemostasis, the enucleated lobes were morcellated with a multi-cut integrated tissue morcellator (JenaSurgical) and removed using a nephroscope with 5-mm working channel (Karl Storz). The 22-F three-way Foley catheter was inserted at the end of the operation, and irrigation was administered until the day after the surgery.

LSP was performed via the extraperitoneal transvesical approach using 5 ports. A transverse incision was made under the umbilicus for the camera port placement, and a balloon dilatator was used to expose pre-peritoneal space. After removing the adipose tissue on the bladder, a transverse incision was applied to the vesicoprostatic junction of the bladder using the harmonic scalpel. Bilateral ureteral orifices were visualized, and a mucosal incision was made between the surgical capsule and adenoma. Adenoma was enucleated using a harmonic scalpel, an aspiration cannula, and a claw grasper. Capsular haemostasis was performed via a harmonic scalpel or bipolar cautery. Following trigonization with 2-0 polyglactin and placement of a three-way 22-F Foley catheter, the bladder was closed with a running 2-0 polyglactin. The integrity of the bladder was checked with saline irrigation, and a Hemovac drain was placed to the pre-peritoneal space. The operation was finalized after the insertion of the prostatic tissue into the endo catch and the removal of the prostate through sub-umbilical incision.

OP was performed via the transvesical approach. Following the cystoscopy at the time of surgery, the patient was placed in the supine position. The Foley catheter was inserted into the bladder, and a Pfannenstiel incision was made to expose the pre-vesical space. A 3-4 cm longitudinal cystotomy was made, and ureteric orifices were identified. The appropriate plane between the adenoma and the prostate capsule was developed, and the adenoma was gently dissected from the capsule using the index finger. The distal urethra attachments were finally cut using curved scissors. After the adenoma was enucleated, absorbable sutures were used to reconstruct the trigone. A 20–22 F three-way urethral catheter was placed transurethrally after ensuring the haemostasis. In addition, a 20-F Nelaton suprapubic tube was placed into the dome of the bladder from a separate incision by avoiding the peritoneal cavity. The bladder was closed by absorbable sutures. A suction drain was placed in the extravesical space, and the abdominal wound was closed.

Table 1. The comparison of demographic characteristics and operative and functional results of the three groups

	HoLEP	LSP	OP	*p* value
Pre-operative characteristics				
Age	70.1±7.5 71 (46–83)	70.2±7.7 69.5 (51–88)	73.5±8.2 71 (46–90)	0.066[a]
BMI	25.3±2 25.3 (20–29.5)	25.4±3.6 25 (18–35)	26.6±4.8 26.8 (17–35)	0.214[b]
Adenoma volume, g	99.5±21.3 92 (80–150)	103.5±23.3 96.5 (80–190)	100.4±28 89 (80–186)	0.194[b]
Operative characteristics				
Operation time, min	89.6±24.7* 86 (55–170)	124.8±40.2 120 (60–210)	95.9±25.1* 90 (60–150)	0.000[b]
Resection speed, g/min	1.14±0.22* 1.11 (0.58–1.76)	0.90±0.32 0.88 (0.38–2.09)	1.10±0.37* 1.00 (0.53–1.95)	0.000[b]
Early post-operative characteristics				
Hospitalization, day	1±0.1** 1 (1–2)	6.1±3.4 5 (2–20)	7.5±3.6*** 7 (3–19)	0.000[b]
Catheterization, day	3±0.3** 3 (2–5)	6.4±0.8 6 (6–11)	8.8±2.7*** 9 (4–20)	0.000[b]
Pre-operative complications, *n* (%)	1 (1.7)	1 (1.6)	0	0.720[c]
Post-operative complications, *n* (%)	2 (3.3)	2 (3.1)	3 (7.5)	0.508[c]
Improvements in functional outcomes at the 3rd month of follow-up				
Change in Q_{max}, mL/s	19.6±6 19.9 (6.7–35)	18.6±5.2 18 (7.2–30.9)	16.7±4.8 16.1 (8.7–29.9)	0.052[a]
Change in IPSS	18.3±5 19 (8–27)	16.7±4.8 16 (10–28)	16.3±4 17 (7–26)	0.067[b]

HoLEP, holmium laser enucleation of the prostate; LSP, laparoscopic simple prostatectomy; OP, open prostatectomy; BMI, body mass index; Q_{max}, maximum flow rate; IPSS, International Prostate Symptom Score. [a] One-way ANOVA test. [b] Kruskal-Wallis test. [c] χ^2 test. * Difference with the LSP group, $p < 0.05$. ** Difference with LSP and OP groups, $p < 0.05$. *** Difference with HoLEP and LSP groups, $p < 0.05$.

Statistical Analyses

Data were analyzed using SPSS v 22 software program for Windows (SPSS, Inc., Chicago, IL, USA). Distribution of the variables was assessed using the Kolmogorov-Smirnov test. While the statistical analyses of continuous variables were performed with the one-way ANOVA test, the statistical analyses of non-homogenous distributed variables were performed via the Kruskal-Wallis test. The Mann-Whitney U test was used for conducting pairwise comparisons after obtaining a significance in the Kruskal-Wallis test. Categorical variables were analyzed using χ^2 tests. The relationship between operation time and prostate volume in each group was analyzed using the Spearman correlation test. A probability level of $p < 0.05$ was considered significant.

Results

A total of 158 patients were included in the study. The surgical groups of HoLEP, LSP, and OP consisted of 60, 61, and 37 patients, respectively. Comparison findings of the surgical procedures are shown in Table 1. No statistical differences were established in terms of pre-operative parameters including age, BMI, and removed prostate volumes between groups ($p > 0.05$).

While the mean operation time of HoLEP was shorter than that of LSP (89.6 ± 27.4 min vs. 124.8 ± 40.2 min, respectively, $p = 0.000$), the mean prostate removal speed was higher (1.08 ± 0.23 g/min vs. 0.90 ± 0.32 g/min, respectively, $p = 0.000$). However, there was no statistical difference between HoLEP and OP in terms of operation time and prostate removal speed (shown in Table 1).

LSP had longer operation time than OP (124.8 ± 40.2 min vs. 95.9 ± 25.1 min, respectively, $p = 0.000$). Also, the mean prostate removal speed of LSP was slower than OP (0.90 ± 0.32 g/min vs. 1.08 ± 0.38 g/min, respectively, $p = 0.027$) (shown in Table 1).

The correlation analysis findings between prostate weight and operation time for each surgery are shown in Table 2. There was a relationship between prostate weight and operation time ($p = 0.000$ $R = 0.743$) only in the HoLEP group. Furthermore, we noticed the correlation

Table 2. The correlation analysis results between prostate weight and operation time for each group

	HoLEP	LSP	OP
p value	0.000	0.065	0.784
R	0.743	0.238	–0.047

HoLEP, holmium laser enucleation of the prostate; LSP, laparoscopic simple prostatectomy; OP, open prostatectomy.

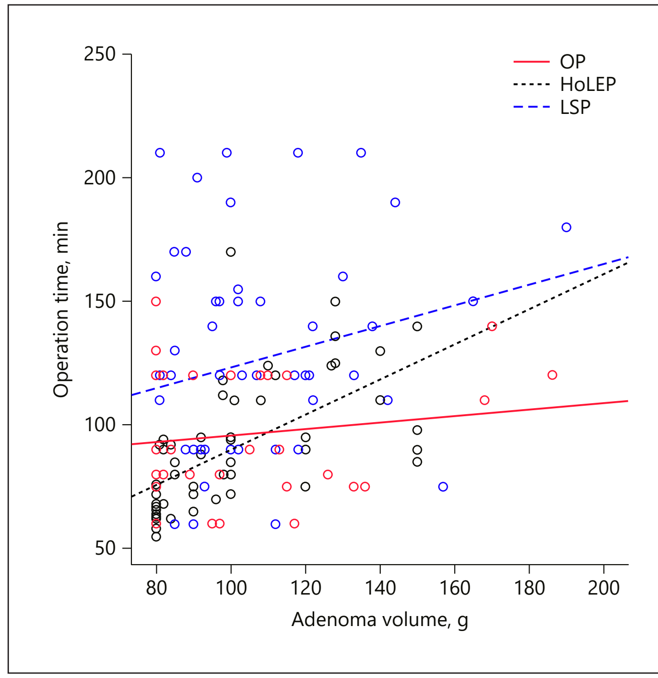

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Fig. 1. The correlation analyses between HoLEP, LSP, and OP groups. HoLEP, holmium laser enucleation of the prostate; LSP, laparoscopic simple prostatectomy; OP, open prostatectomy.

lines of HoLEP and OP groups to intersect approximately at 110-g prostate weight (shown in Fig. 1).

The length of hospitalization and catheterization was statistically different between each of the groups, as shown in Table 1 ($p = 0.000$). While the length of hospitalization and catheterization of the HoLEP group was the shortest (1 ± 0.1 and 3 ± 0.3 days, respectively), it was the longest in the OP group (7.5 ± 3.6 and 6.4 ± 0.8 days, respectively). Duration of hospitalization and catheterization was found as 6.1 ± 3.4 and 6.4 ± 0.8 days for the LSP group, respectively, and these findings were statistically different from the HoLEP and OP groups, as shown in Table 1 ($p = 0.000$).

The ratio of complications in the peri-operative and post-operative periods was similar between groups ($p > 0.05$). In the HoLEP group, blood transfusion was established to 1 patient (Clavien grade 1) peri-operatively and fever was detected in 2 patients post-operatively. In the LSP group, blood transfusion was established to 2 patients in the peri-operative and post-operative periods (Clavien grade 1) and urinary leakage was determined in 1 patient (Clavien grade 1) post-operatively. In the OP group, epididymo-orchitis requiring antibiotherapy occurred in 1 patient (Clavien grade 2), urinary leakage was determined in 1 patient (Clavien grade 1), and blood transfusion was established to 1 patient (Clavien grade 2). The improvements on Q_{max} and IPSS results in the 3rd month of follow-up were similar between groups, as shown in Table 1 ($p = 0.052$ and $p = 0.067$, respectively).

Discussion

The role of OP, which has been the preferred surgical method in the treatment of large prostates for over 100 years, is fading away in urologist's armamentarium due to the advances in minimally invasive methods [12]. Nowadays, HoLEP and LSP are preferred as alternative enucleation procedures [3]. Minimally invasive approaches have several advantages including lower blood loss, lower transfusion rates, and shorter hospital stays. However, they usually have longer duration of operation compared to OP, especially in the treatment of large prostates [4, 10]. Prolonged operation time is associated with an increase in the risk of complications such as bleeding, surgical site infection, venous thromboembolism, or cardiac, neurologic, and respiratory problems, and this might be important especially in the treatment of comorbid patients [11]. The optimal surgical method should provide the maximum removal of the prostate with fewer complications [13]. Therefore, knowing the amount of prostate that can be removed in a particular time by a procedure and how the total duration of this procedure changes depending on prostate volume might be important in terms of deciding the patient's anaesthesia method and even the type of surgery.

The present study found no statistical difference between the 3 surgical methods in terms of age, BMI, and resected adenoma weights. In addition, all adenomas were over 80 g. Since the factors that may affect the operation time such as BMI or adenoma weight were similar between the groups, we accurately analyzed and evaluated the prostate removal speeds of these surgical techniques and changes in the operation time according to prostate volumes.

Studies that specifically investigate the amount of prostate that can be removed in a certain period with any surgical procedure are limited in the literature. Ahyai et al. [14] reported HoLEP and OP to be able to remove 0.92 and 1.01 g of prostates per minute, respectively, and there was no statistical difference in comparison. However, in that study, the mean prostate weight was 88 g and it was ranging between 45 and 150 g [14]. The present study found that HoLEP and OP removed 1.14 ± 0.22 and 1.10 ± 0.37 g of prostates per minute, respectively, and no statistical difference was found in this comparison (p = 0.431). In addition, to the best of our knowledge, there is no study investigating the tissue removal speed of LSP in the literature. We found LSP to be able to remove 0.88 ± 0.24-g prostate per minute, and this value was lower than the tissue removal speeds of HoLEP and OP. These results show that LSP is 1 step behind HoLEP as a minimally invasive procedure in terms of removing large prostates quickly.

Evaluating only the tissue removal speeds of these procedures is not enough for urological practice. In this context, operation times of the procedures and how these times change depending on prostate volumes should also be considered.

According to the literature, the duration of the operation is a disadvantage of HoLEP against OP [4–6, 15, 16]. However, Ahyai et al. [14] reported similar operation times for these 2 procedures. We also found the mean operation times of HoLEP and OP to be statistically similar in our study. In addition, our correlation analysis demonstrated a relationship between prostate volume and operation time of HOLEP. As it is known, HoLEP consists of 2 steps: enucleation and morcellation, and the volume of the prostate does not affect the enucleated tissue weight per minute [13]. In addition, it was reported that the surgical experience not to affect the duration of morcellation, but to shorten the enucleation and total operation time [17]. Although all the procedures of this study were performed by experienced surgeons, our findings of the relationship between prostate volume and operation time demonstrate the increase in the duration of HoLEP with prostate weight regardless of the surgical experience, and the prolongation of the morcellation process might be considered to be the primary reason for this increase. In addition, the correlation lines of HoLEP and OP intersected approximately at 110-g prostate levels and the operation times of HoLEP were longer than OP over this value (shown in Fig. 1). The future innovations in morcellation devices may enable HoLEP to remove bigger prostates in shorter durations.

In the present study, the operation time of LSP was in line with the literature and was longer compared to HoLEP and OP [7, 18, 19]. In addition, although there is no statistical correlation between operation time of LSP and removed prostate weight (p = 0.065), the correlation line demonstrated an increase in the operation time with prostate weight. During LSP, the length of bladder incision can be extended 1-2 cm according to the prostate size for enucleation. The correlation line demonstrated that closing of this extended bladder incision leads to a partial increase in the operation time even in the hands of those experienced with laparoscopy. In addition, it is expected that the correlation lines of HoLEP and LSP will intersect in prostates that weigh over 200 g and the duration of HoLEP will be longer than LSP over this value; consequently, the operation time-related advantage of HoLEP against LSP might disappear in huge prostates (shown in Fig. 1).

To the best of our knowledge, studies comparing these 3 procedures in the same paper in terms of effectiveness and complications are limited. However, various studies have indicated that the IPSS and Q_{max} results of these methods and also the complication rates are similar [3, 4, 7, 15, 20]. We found the functional results and complication rates of all 3 surgical procedures to be similar in accordance with the literature. In addition, duration of hospitalization and catheterization was shortest in HoLEP and longest in OP groups in the present study, in accordance with the literature [3, 15].

Furthermore, today's world is dominated by financial issues and the economic burden of surgical procedures is getting more and more critical; thus, the distribution of financial resources is an important issue [21]. Regarding this, estimating the operation time of a procedure as well as the duration of hospitalization and catheterization may be useful in many issues, such as operating room scheduling or managing the employment of the staff.

Absence of separate information about the duration of morcellation and enucleation stages of HoLEP was one of the limitations of the present study. Other limitations were the retrospective design and the limited number of patients in groups.

Conclusions

LSP, an enucleation technique in the treatment of large prostates, is slower than HoLEP and OP in terms of total operation time and prostate removal speed. The operation times of HoLEP are longer than those of OP in prostates that weigh over 110 g. Technologic advances in the future may make HoLEP the most advantageous method in terms of operation time in the treatment of huge prostates.

Statement of Ethics

All the patients have given their written informed consent for the surgical intervention in this study. The data presented in this study were obtained ethically in accordance with the World Health Association Declaration of Helsinki. The study was approved by the Ethics Committee of Uludağ University Faculty of Medicine (Reference No. 2020-9/12).

Conflict of Interest Statement

The authors have no conflicts of interest to declare.

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Author Contributions

Gunseren designed and wrote the present research study. Çiçek and Yıldız acquired the data. Gunseren and Akdemir analyzed the data. Vuruskan, Yavaşçaoğlu, and Arslan critically revised the manuscript.

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