

Comparison of Surgical Outcomes Between Holmium Laser Enucleation and Transurethral Resection of the Prostate in Patients With Detrusor Underactivity

Myeong Jin Woo, Yun-Sok Ha, Jun Nyung Lee, Bum Soo Kim, Hyun Tae Kim, Tae-Hwan Kim, Eun Sang Yoo

Department of Urology, Kyungpook National University School of Medicine, Daegu, Korea



Purpose: Currently, holmium laser enucleation of the prostate (HoLEP) and transurethral resection of the prostate (TURP) are the standard surgical procedures used to treat benign prostatic hyperplasia (BPH). Several recent studies have demonstrated that the surgical management of BPH in patients with detrusor underactivity (DU) can effectively improve voiding symptoms, but comparative data on the efficacy of HoLEP and TURP are insufficient. Therefore, we compared the short-term surgical outcomes of HoLEP and TURP in patients with DU.

Methods: From January 2010 to May 2015, 352 patients underwent HoLEP or TURP in procedures performed by a single surgeon. Of these patients, 56 patients with both BPH and DU were enrolled in this study (HoLEP, n=24; TURP, n=32). Surgical outcomes were retrospectively compared between the 2 groups. DU was defined as a detrusor pressure at maximal flow rate of <40 cm H₂O as measured by a pressure flow study.

Results: The preoperative characteristics of patients and the presence of comorbidities were comparable between the 2 groups. The TURP group showed a significantly shorter operative time than the HoLEP group (P=0.033). The weight of the resected prostate was greater in the HoLEP group, and postoperative voiding parameters, including peak flow rate and postvoid residual urine volume were significantly better in the HoLEP group than in the TURP group.

Conclusions: HoLEP can be effectively and safely performed in patients with DU and can be expected to have better surgical outcomes than TURP in terms of the improvement in lower urinary tract symptoms.


Keywords: Prostatic Hyperplasia; Transurethral Resection of Prostate; Lasers; Holmium

- **Research Ethics:** The Institutional Review Board of the Kyungpook National University School of Medicine approved our study protocol (approval number: KNUH 2016-04-004-001).
- **Conflict of Interest:** No potential conflict of interest relevant to this article was reported.

INTRODUCTION

The treatment of benign prostatic hyperplasia (BPH) has undergone enormous alterations in recent years. In 1926, transurethral resection of the prostate (TURP) was presented by McCarthy, leading to a paradigm shift in surgery for BPH. Since that time, TURP has been considered the standard surgical treatment of

small to moderate-size obstructive BPH. The American Urological Association guidelines define TURP as the “gold standard” surgical treatment for BPH [1-3]. Holmium laser enucleation (HoLEP) was developed in the 1990s as a surgical treatment for BPH that is more effective and safer than laser vaporization and traditional resection techniques. HoLEP has become the novel standard for the surgical treatment of BPH because it

Corresponding author: Eun Sang Yoo  <http://orcid.org/0000-0002-7442-6886>
Department of Urology, Kyungpook National University Hospital, Kyungpook National University School of Medicine, 680 Gukchaebosang-ro, Jung-gu, Daegu 41944, Korea

E-mail: uroyoo@knu.ac.kr / Tel: +82-53-420-5851 / Fax: +82-53-421-9618

Submitted: May 17, 2016 / Accepted after revision: June 16, 2016



This is an Open Access article distributed under the terms of the Creative Commons Attribution Non-Commercial License (<http://creativecommons.org/licenses/by-nc/4.0/>) which permits unrestricted non-commercial use, distribution, and reproduction in any medium, provided the original work is properly cited.

is effective while being less invasive and having a low incidence of complications. The effectiveness and safety of HoLEP to treat BPH are well known; recently, this technique has been used on prostates of various sizes [3]. Many studies have compared the effectiveness of HoLEP and TURP in terms of improvement in voiding symptoms, maximal flow rate (Q_{max}), postvoid residual volume (PVR), the International Prostate Symptom Score (IPSS), and complications. Most studies have reported improved postoperative outcomes and the occurrence of fewer complications when HoLEP was used than when TURP was performed.

Traditionally, surgical treatment was not recommended for patients with BPH combined with detrusor underactivity (DU) due to limited improvement in voiding symptoms and reduced postoperative satisfaction compared to patients with normal detrusor contractility. However, recent studies have shown surgical treatment to be effective in improving voiding symptoms and efficiency in patients diagnosed with BPH and DU [4], but limited comparative data have been published regarding the efficacy and safety of HoLEP and TURP in patients with DU. We therefore retrospectively compared the perioperative and postoperative clinical outcomes of HoLEP and TURP procedures performed by a single surgeon for the surgical treatment of patients who were diagnosed with BPH and DU.

MATERIALS AND METHODS

We retrospectively analyzed the medical charts of patients diagnosed with BPH and DU who underwent surgical treatment (TURP or HoLEP) at Kyungpook National University Hospital between May 2010 and May 2015. A total of 352 patients presenting with voiding symptoms due to BPH were surgically treated by a single surgeon during this period. TURP was performed between May 2010 and April 2012. Since May 2012, when holmium laser instrument equipment was installed, HoLEP has been performed in most patients, except in the event of a technical problem involving the equipment. The inclusion criteria were: (1) detrusor pressure at Q_{max} ($P_{det}Q_{max}$) < 40 cm H_2O as measured by a pressure flow study, and (2) medication with α -receptor blockers or 5α -reductase inhibitors for at least 6 months before surgery. Patients diagnosed with a current urinary tract infection, bladder cancer, or prostate cancer were excluded. After applying these exclusion criteria, 56 patients who underwent surgical management for symptomatic BPH with DU were included in the present study.

DU, or underactive bladder, was defined as late emptying of

the bladder, decreased contractility, and failure to empty the bladder in the normal time span [5]. In this study, we defined DU as a value of $P_{det}Q_{max} < 40$ cm H_2O observed in a preoperative pressure flow study.

Indications for the surgical management of BPH included lower urinary tract symptoms refractory to other medical therapies, or a history of acute urinary retention, bladder stones, gross hematuria, or renal insufficiency secondary to BPH. All patients underwent an initial review of their past medical history, followed by a physical examination, serum prostate-specific antigen measurement, urinalysis, assessment of the IPSS and the quality of life (QoL) score, transrectal ultrasonography to measure the volume of the prostate, uroflowmetry to measure the PVR, and a pressure-flow urodynamic assessment.

The instrumentation for HoLEP included 550-nm end-firing flexible quartz and a continuous-flow resectoscope consisting of a 26-Fr outer sheath and an inner rotating sheath. The device used for HoLEP was the Versapulse Powersuite holmium laser (Lumenis Inc., Tel Aviv, Israel). HoLEP was performed using the standard technique described by Gilling et al. [6]. The procedure was performed with a frequency of 40 Hz and 2.0 J of power. Normal saline was used for irrigation. After a cystoscopic exam, incisions were made at the 5-o'clock and 7-o'clock aspect to enucleate the median lobe of the prostate. Another incision was made at the 12-o'clock aspect to enucleate the lateral lobes of the prostate. A defocused laser beam was used to control points of bleeding. The lobes were then delivered by a VersaCut Morcellator System (Lumenis Inc.) depending upon the size of the enucleated tissue. The specimen retrieved was weighed inside the operating room and sent for histopathologic analysis.

Conventional TURP is a monopolar technique using a high-frequency current, with a maximum cutting power of 200 W [7,8]. However, bipolar TURP using saline as the irrigation fluid has been introduced [9]. High-frequency energy, up to 160 W, flows through normal saline, resulting in prostatic adenoma resection at a lower temperature than traditional monopolar TURP, thereby theoretically reducing the thermal tissue damage. At our center, TURP was performed using the standard bipolar technique with saline as the irrigation fluid. The bipolar devices used were a Gyrus 26-Fr resectoscope (Karl Storz GmbH & Co. KG, Tuttlingen, Germany) with a cutting current of 120–160 W and a coagulating power of 60–80 W. Normal saline was used as the intraoperative irrigation fluid. TURP chips were removed using an Ellick evacuator.

The IPSS, Q_{max} , and PVR were investigated to analyze the

postoperative outcomes. Total operation time, the resected volume of the prostate, loss of hemoglobin, catheterization time, length of hospital stay, and postoperative complications were analyzed in both groups. Patients were instructed to stop taking medication at the first follow-up visit 2 weeks after surgery, at which point the decision to prescribe an α -blocker or anticholinergic medication was made according to the patient's symptoms, IPSS, and uroflowmetry results. In addition, postoperative outcomes were assessed 6 months after BPH surgery. The analysis focused on the voiding symptom score, uroflowmetry, and risk of surgical complications. Differences between preoperative and postoperative IPSS, Qmax, and PVR were compared in both groups.

Data are expressed as mean \pm standard deviation. The Student t-test was used to compare differences in baseline patient characteristics, perioperative outcomes, and postoperative outcomes between the 2 groups. Postoperative complications and the medications required after surgery were compared using the chi-square test. Statistical analysis was performed using IBM SPSS ver. 18.0 (IBM Co., Armonk, NY, USA), and P-values < 0.05 were considered to indicate statistical significance.

The Institutional Review Board of the Kyungpook National University School of Medicine approved our study protocol (approval number: KNUH 2016-04-004-001).

Table 1. Comparison of baseline patient characteristics between the HoLEP and TURP groups

Characteristic	HoLEP (n=24)	TURP (n=32)	P-value
Age (yr)	66.9 \pm 7.0	71.4 \pm 5.6	0.274
Prostate volume (mL) ^{a)}	58.0 \pm 17.8	54.2 \pm 13.9	0.386
Preoperative IPSS			
Total	18.7 \pm 6.2	15.7 \pm 7.5	0.120
Voiding subscore	11.1 \pm 4.6	9.0 \pm 4.8	0.104
Storage subscore	7.5 \pm 3.4	6.7 \pm 3.3	0.348
Maximal flow rate (mL/sec)	7.4 \pm 3.0	6.3 \pm 3.9	0.212
Postvoid residual urine volume (mL)	113.0 \pm 128.0	151.0 \pm 118.0	0.258
PdetQmax (cm H ₂ O)	34.4 \pm 6.5	33.1 \pm 10.0	0.575

Values are presented as mean \pm standard deviation. HoLEP, holmium laser enucleation of the prostate; TURP, transurethral resection of the prostate; IPSS, International Prostate Symptom Score; PdetQmax, detrusor pressure at maximal flow rate.

^{a)}Prostate volume was measured by transrectal ultrasonography.

RESULTS

Fifty-six patients were initially included in the analysis: 24 in the HoLEP group and 32 in the TURP group. The mean age of the patients in the HoLEP and TURP groups was 66.9 \pm 7.0 and 71.4 \pm 5.6 years, respectively (P=0.274); the mean prostate volume was 58.0 \pm 17.8 and 54.2 \pm 13.9 mL, respectively (P=0.386); and the PdetQmax was 34.4 \pm 6.5 and 33.1 \pm 10.0 cm H₂O, respectively (P=0.575). No significant differences in the preoperative prostate volume, Qmax, or PdetQmax were observed between the groups (Table 1). The operative time was significantly shorter in the TURP group than in the HoLEP group. The weight of the resected prostate gland was significantly greater in the HoLEP group than in the TURP group. The mean operative time was 90.2 \pm 15.0 and 78.8 \pm 23.9 minutes (P=0.033) in the HoLEP and TURP groups, respectively, and the mean resected volume was 39.0 \pm 17.7 and 25.0 \pm 7.8 g, respectively (P=0.001). Blood loss, catheterization time, and the length of the hospital stay were significantly lower in the HoLEP group. The hemoglobin loss was 1.2 \pm 0.6 and 1.7 \pm 0.9 g/dL (P=0.015) in the HoLEP and TURP groups, respectively (Table 2). After catheter removal, 1 patient in the TURP group (3.1%) required temporary catheter reinsertion due to acute urinary retention. One patient (3.1%) received a blood transfusion due to excessive gross hematuria (Table 3).

At the 6-month postoperative follow-up, patients in the HoLEP group demonstrated higher Qmax and lower PVR values than those in the TURP group. The Qmax and PVR were 18.5 \pm 7.1 and 13.2 \pm 6.5 mL/sec, respectively (P=0.005), and 13.75 \pm 41.7 and 45.0 \pm 57.6 mL, respectively (P=0.022) in the HoLEP and TURP groups. Patients showed overall improvements in

Table 2. Comparison of perioperative surgical outcomes between the HoLEP and TURP groups

Variable	HoLEP (n=24)	TURP (n=32)	P-value
Resected volume (g)	39.0 \pm 17.7	25.0 \pm 7.8	0.001
Operative time (min)	90.2 \pm 15.0	78.8 \pm 23.9	0.033
Hemoglobin loss (g/dL)	1.2 \pm 0.6	1.7 \pm 0.9	0.015
Postoperative catheterization (day)	3.3 \pm 0.6	4.5 \pm 1.0	< 0.001
Hospital stay (day)	4.3 \pm 0.6	5.5 \pm 1.0	< 0.001

Values are presented as mean \pm standard deviation. HoLEP, holmium laser enucleation of the prostate; TURP, transurethral resection of the prostate; IPSS, International prostate symptom score.

the IPSS. The HoLEP group showed significantly greater improvement in the total IPSS, the IPSS voiding symptom score,

Table 3. Postoperative complications at 6 months

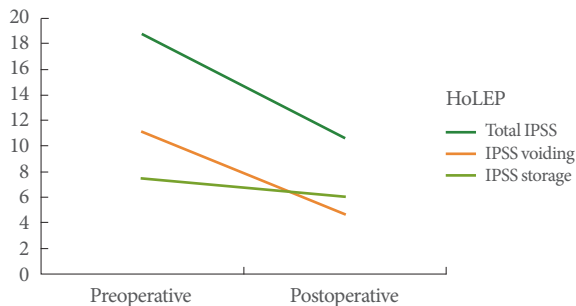
Adverse event	HoLEP (n=24)	TURP (n=32)	P-value
Blood transfusion	0 (0)	1 (3.1)	0.382
Recatheterization	0 (0)	1 (3.1)	0.382
Urethral stricture	0 (0)	2 (6.3)	0.212
Stress urinary incontinence	1 (4.2)	0 (0)	0.244
Total	1 (4.2)	4 (12.5)	0.279

Values are presented as number (%).
HoLEP, holmium laser enucleation of the prostate; TURP, transurethral resection of the prostate.

Table 4. Comparison of postoperative voiding status between the HoLEP and TURP groups

Variable	HoLEP (n=24)	TURP (n=32)	P-value
Postoperative IPSS			
Total	10.7 ± 5.4	12.5 ± 7.6	0.307
Voiding subscore	4.7 ± 3.7	6.8 ± 4.7	0.078
Storage subscore	6.1 ± 3.5	5.8 ± 3.2	0.709
Maximal flow rate (mL/sec)	18.5 ± 7.1	13.2 ± 6.5	0.005
Postvoid residual urine volume (mL)	13.75 ± 41.7	45.0 ± 57.6	0.022
ΔTotal IPSS	8.0 ± 7.4	3.2 ± 1.8	0.005
ΔIPSS Voiding subscore	6.5 ± 5.8	2.3 ± 1.4	0.002
ΔIPSS Storage subscore	1.5 ± 3.1	0.9 ± 1.2	0.445

Values are presented as mean ± standard deviation.
HoLEP, holmium laser enucleation of the prostate; TURP, transurethral resection of the prostate; IPSS, International prostate symptom score; Δ, Difference between preoperative score and postoperative score.



and the IPSS storage symptom score than the TURP group. The changes in the total IPSS and IPSS voiding symptom score were 8.0 ± 7.4 and 3.2 ± 1.8 , respectively ($P = 0.005$), and 6.5 ± 5.8 and 2.3 ± 1.4 , respectively ($P = 0.002$), in the HoLEP and TURP groups. The change in the IPSS storage symptom score was also greater in the HoLEP group than in the TURP group, but this difference was not statistically significant (Table 4) (Fig. 1). Two patients in the TURP group developed urethral stricture (6.3%), and 1 patient in the HoLEP group showed persistent stress urinary incontinence (4.2%) (Table 3).

Postoperatively, 56.6% of patients in the TURP group required α -blocker medications and 28.1% required anticholinergic medications. However, in the HoLEP group, 12.5% of patients required α -blocker medications and 16.7% of patients required anticholinergic medications (Fig. 2).

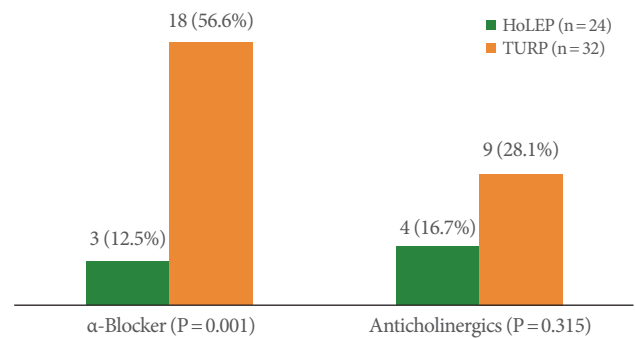


Fig. 2. Number of patients who required medications after surgery. Postoperatively, α -blocker medications were required by 56.6% and 12.5% ($P = 0.001$) of the patients in the TURP and HoLEP groups, respectively. Anticholinergics were required by 28.1% and 16.7% ($P = 0.315$) of the patients in the TURP and HoLEP groups, respectively. HoLEP, holmium laser enucleation of the prostate; TURP, transurethral resection of the prostate.

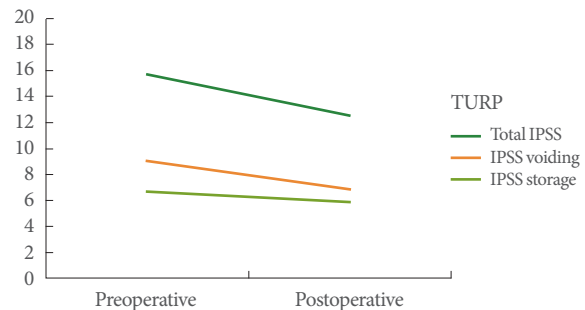


Fig. 1. Variation in the total IPSS, the voiding subscore, and the storage subscore. IPSS, International Prostate Symptom Score. HoLEP, holmium laser enucleation of the prostate; TURP, transurethral resection of the prostate.

DISCUSSION

Ahyai et al. [10] performed a meta-analysis of 23 randomized controlled trials comparing TURP, HoLEP, open prostatectomy (OP), and photoselective vaporization of the prostate in 2,245 patients. The authors found that HoLEP was superior to TURP in terms of IPSS and postoperative Qmax; moreover, HoLEP was the only surgical treatment for which reoperation was not required for the resection of a prostate adenoma within 5 years. Some researchers have argued that HoLEP has a significantly longer operative time compared to TURP. However, Ahyai et al. [10] reported that the mean resection rate of prostate tissue (g/min) for HoLEP and TURP was not significantly different (0.52 g/min vs. 0.57 g/min). According to that study, both surgical procedures were equally time-efficient. HoLEP was associated with fewer postoperative complications than TURP, and post-transurethral resection syndrome has never been reported with HoLEP, even for large prostates weighing hundreds of grams [10]. Yin et al. [11] published a meta-analysis comparing 6 randomized controlled trials comparing HoLEP to TURP. HoLEP was significantly superior to TURP in terms of both Qmax and IPSS at 1-year postoperative follow-up visits. Furthermore, HoLEP patients benefited from less intraoperative bleeding, a shorter catheterization time, shorter hospital stays, and lower transfusion rates. Gilling et al. [12] reported postoperative outcomes from prospective cohorts followed for 92 months. They reported that HoLEP, on average, resulted in greater resected volume of the prostate, shorter catheterization times, and shorter hospital stays. Furthermore, patients who underwent HoLEP exhibited greater reductions in voiding symptoms and greater improvements in postoperative Qmax when compared to preoperative values. No patient in the HoLEP group required reoperation for the resection of prostate adenoma, compared to an 18% reoperation rate in the TURP group [12]. Naspro et al. [13] found that patients who underwent HoLEP had almost equivalent functional outcomes, but a lower transfusion rate, shorter catheterization times, and shorter hospital stays than those who underwent OP. Many other studies have also shown shorter hospital stays and urethral catheterization times with HoLEP. The preoperative and postoperative outcomes of these studies have demonstrated that HoLEP is more effective than TURP. Those findings are similar to the findings of our study. The results concerning the necessity of reoperation provide clear evidence that HoLEP is an appropriate alternative to TURP and OP.

DU is a common cause of urinary bladder dysfunction, al-

though it is under-researched and poorly understood. The clinical features of unsuitable bladder emptying may arise because of DU but may also be due to bladder outflow obstruction (BOO). It is often difficult to differentiate DU from BOO without invasive pressure flow studies. Clinical evaluation is further limited by the subjective interpretation of the effects of diminished strength, decreased length of contraction, and prolonged emptying time. Nevertheless, the distinction between DU and BOO provides a useful conceptual framework within which to define the functional abnormality underlying the clinical presentation of patients who may have variable symptoms, because it is recognized that the “bladder is an unreliable witness.” [14].

Most studies of TURP have not evaluated its durability or efficacy, although morbidity has often been reported to improve. In men with enlarged prostates, treatment alternatives are even more limited. The characteristics of the holmium laser wave length determine its versatility and provide an endoscopic alternative to both TURP and OP when used for enucleation [15,16]. Several studies have found that BPH patients with DU had less favorable symptomatic and clinical outcomes after transurethral prostate surgery. Thomas et al. [17] reported that no advantages in terms of long-term symptomatic improvement or urodynamic findings were found to have arisen from TURP in BPH patients with DU. TURP in BPH patients with DU is associated with a smaller long-term decrease in BOO, showing a reduction in voiding pressure with no significant change in voiding flow rate. It was not associated with changes in detrusor contractility. Subjective and objective changes in symptoms were not found. Additionally, patients without urodynamic obstructions showed no statistically significant postoperative differences compared to the preoperative data [18]. However, other recent studies have reported that transurethral BPH surgery in patients with DU resulted in significantly improved QoL and voiding symptoms. Thus, the effects of transurethral prostate surgery in patients with DU are still poorly understood. Despite the many controversies, few studies have compared the surgical outcomes of TURP versus HoLEP for the treatment of BPH with DU. In the present study, we showed that HoLEP was superior to TURP with regard to postoperative Qmax, PVR, symptomatic improvement, and QoL. It seems that when patients with DU underwent transurethral surgery, the most significant effect was related to the removal of prostatic obstruction. With the resolution of outflow obstruction, voiding is possible with low bladder detrusor muscle contractility, resulting in postoperative benefits in urinary symptoms and reduced PVR. Both

the TURP and HoLEP groups showed improvements in voiding symptoms and in other postoperative data, including QoL, IPSS, Qmax, and PVR. Therefore, both TURP and HoLEP can be effective in patients with BPH and DU. However, our data demonstrated that patients in the HoLEP group showed significantly greater improvements than patients in the TURP group in the other parameters, with the exception of operative time. Possible reasons for the longer operative time in the HoLEP group could be the slow vaporization by holmium laser energy or the additional time required for adenoma morcellation. Similar findings have been previously reported by Kuntz et al. [19]. In this study, although the overall operative time was longer with HoLEP than TURP, statistical significance was not observed when dividing the weight of resected prostate tissue by time in an analysis of tissue removal efficiency. Additionally, the hemostatic nature of the holmium laser provides many perioperative and postoperative advantages compared to TURP, including a lower rate of complications, less blood loss, reduced catheterization time, and shorter hospitalization.

One of the major and most common complications of TURP is the risk of bleeding. A recent review by Rassweiler et al. [8] evaluating TURP complications reported that hemorrhage was the most common complication, despite recent advances in resection techniques and technology. Decreased postoperative bleeding has been one of the main advantages of HoLEP.

In our analysis, all patients stopped taking 5 α -reductase inhibitors postoperatively, but some patients in both groups required α -blocker or anticholinergic medications. It was more common for patients to require medication in the TURP group than in the HoLEP group, which was ascribable to the improved efficiency of obstruction removal using HoLEP. In this study, all procedures were performed by a highly experienced single surgeon. Consequently, the adenomas were resected sufficiently in all procedures. However, we found that greater quantities of adenoma were resected in the HoLEP procedures. This is thought to be due to differences in the surgical technique of HoLEP, which enables anatomically based resection. More effective removal of adenomas is expected to lead to better outcomes after HoLEP.

Certain limitations of this study should be considered. This study lacked long-term follow-up, and was retrospective in design. The analysis was limited to a small number of patients because of the rarity of patients with both BPH and DU undergoing surgical treatment. Future prospective studies are needed to obtain a more detailed analysis of this patient population, including outcomes related to prostate size and sexual function. In ad-

dition, a study including BPH patients without DU will be necessary. The findings of this study warrant further validation in a randomized controlled study with a larger number of patients and longer follow-up in order to evaluate HoLEP as the new standard procedure for the surgical treatment of BPH with DU.

In conclusion, over the course of short-term follow-up, HoLEP and TURP were found to effectively improve postoperative symptom-related outcomes in BPH patients with DU. HoLEP showed better efficacy than TURP in improving voiding symptoms, Qmax, PVR, medication requirements, and in minimizing postoperative complications.

REFERENCES

1. McVary KT, Roehrborn CG, Avins AL, Barry MJ, Bruskewitz RC, Donnell RF, et al. Update on AUA guideline on the management of benign prostatic hyperplasia. *J Urol* 2011;185:1793-803.
2. Li S, Zeng XT, Ruan XL, Weng H, Liu TZ, Wang X, et al. Holmium laser enucleation versus transurethral resection in patients with benign prostate hyperplasia: an updated systematic review with meta-analysis and trial sequential analysis. *PLoS One* 2014;9:e101615.
3. Aho TF. Holmium laser enucleation of the prostate: a paradigm shift in benign prostatic hyperplasia surgery. *Ther Adv Urol* 2013;5:245-53.
4. Cho MC, Ha SB, Park J, Son H, Oh SJ, Kim SW, et al. Impact of detrusor underactivity on surgical outcomes of laser prostatectomy: comparison in serial 12-month follow-up outcomes between potassium-titanyl-phosphate photoselective vaporization of the prostate (PVP) and holmium laser enucleation of the prostate (HoLEP). *Urology* 2016;91:158-66.
5. Abrams P, Cardozo L, Fall M, Griffiths D, Rosier P, Ulmsten U, et al. The standardisation of terminology of lower urinary tract function: report from the Standardisation Sub-committee of the International Continence Society. *Neurourol Urodyn* 2002;21:167-78.
6. Gilling PJ, Cass CB, Cresswell MD, Fraundorfer MR. Holmium laser resection of the prostate: preliminary results of a new method for the treatment of benign prostatic hyperplasia. *Urology* 1996;47:48-51.
7. Marszalek M, Ponholzer A, Pusman M, Berger I, Madersbacher S. Transurethral resection of the prostate. *Eur Urol Suppl.* 2009;8:504-12.
8. Rassweiler J, Teber D, Kuntz R, Hofmann R. Complications of transurethral resection of the prostate (TURP): incidence, management, and prevention. *Eur Urol* 2006;50:969-79.
9. Ho HS, Cheng CW. Bipolar transurethral resection of prostate: a

- new reference standard? *Curr Opin Urol* 2008;18:50-5.
10. Ahyai SA, Gilling PJ, Kaplan SA, Kuntz RM, Madersbacher S, Montorsi F, et al. Meta-analysis of functional outcomes and complications following transurethral procedures for lower urinary tract symptoms resulting from benign prostatic enlargement. *Eur Urol* 2010;58:384-97.
 11. Yin L, Teng J, Huang CJ, Zhang X, Xu D. Holmium laser enucleation of the prostate versus transurethral resection of the prostate: a systematic review and meta-analysis of randomized controlled trials. *J Endourol* 2013;27:604-11.
 12. Gilling PJ, Wilson LC, King CJ, Westenberg AM, Frampton CM, Fraundorfer MR. Long-term results of a randomized trial comparing holmium laser enucleation of the prostate and transurethral resection of the prostate: results at 7 years. *BJU Int* 2012;109:408-11.
 13. Naspro R, Suardi N, Salonia A, Scattoni V, Guazzoni G, Colombo R, et al. Holmium laser enucleation of the prostate versus open prostatectomy for prostates >70 g: 24-month follow-up. *Eur Urol* 2006;50:563-8.
 14. Turner-Warwick R, Whiteside CG, Worth PH, Milroy EJ, Bates CP. A urodynamic view of the clinical problems associated with bladder neck dysfunction and its treatment by endoscopic incision and trans-trigonal posterior prostatectomy. *Br J Urol* 1973;45:44-59.
 15. Wilson LC, Gilling PJ, Williams A, Kennett KM, Frampton CM, Westenberg AM, et al. A randomised trial comparing holmium laser enucleation versus transurethral resection in the treatment of prostates larger than 40 grams: results at 2 years. *Eur Urol* 2006;50:569-73.
 16. Gilling PJ, Kennett K, Das AK, Thompson D, Fraundorfer MR. Holmium laser enucleation of the prostate (HoLEP) combined with transurethral tissue morcellation: an update on the early clinical experience. *J Endourol* 1998;12:457-9.
 17. Thomas AW, Cannon A, Bartlett E, Ellis-Jones J, Abrams P. The natural history of lower urinary tract dysfunction in men: the influence of detrusor underactivity on the outcome after transurethral resection of the prostate with a minimum 10-year urodynamic follow-up. *BJU Int* 2004;93:745-50.
 18. Rodrigues P, Lucon AM, Freire GC, Arap S. Urodynamic pressure flow studies can predict the clinical outcome after transurethral prostatic resection. *J Urol* 2001;165:499-502.
 19. Kuntz RM, Ahyai S, Lehrich K, Fayad A. Transurethral holmium laser enucleation of the prostate versus transurethral electrocautery resection of the prostate: a randomized prospective trial in 200 patients. *J Urol* 2004;172:1012-6.