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The Effects of Holmium Laser Enucleation of the Prostate (HoLEP) on Urodynamic Parameters and Bladder Function: A Retrospective Analysis

Holmiyum Lazer Prostat Enükleasyonunun (HoLEP) Ürodinamik Parametreler ve Mesane Fonksiyonu Üzerindeki Etkisi: Retrospektif Bir Analiz

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ABSTRACT

Objective: This study evaluates the impact of Holmium Laser Enucleation of the Prostate (HoLEP) on urodynamic parameters and bladder function in patients with benign prostatic hyperplasia (BPH).

Material And Methods: A retrospective analysis was conducted on 44 patients with urodynamically confirmed BPH who underwent HoLEP in a tertiary care center. Preoperative and 6-month postoperative assessments included the International Prostate Symptom Score (IPSS), uroflowmetry, post-void residual (PVR) volume, and urodynamic studies measuring detrusor pressure, maximum flow rate (Qmax), bladder outlet obstruction index (BOOI), and detrusor overactivity (DO). Statistical comparisons were conducted using paired t-tests, Wilcoxon signed-rank tests, and McNemar's test.

Results: Significant improvements were observed post-HoLEP, including a reduction in IPSS (22.0 ± 7.0 to 6.1 ± 5.0, $p<0.001$), daytime frequency (7.4 ± 1.5 to 5.8 ± 1.2, $p=0.01$), nocturia (3.2 ± 0.8 to 1.1 ± 0.5, $p<0.001$), and PVR (175.0 ± 50.0 to 45.4 ± 15.0 mL, $p<0.001$). Qmax increased from 6.8 ± 2.0 to 19.7 ± 4.5 mL/s ($p<0.001$), maximum bladder capacity from 180.0 ± 45.0 to 375.0 ± 75.0 mL ($p<0.001$), and maximum cystometric capacity from 280.0 ± 56.0 to 415.0 ± 83.0 mL ($p<0.001$). BOOI decreased from 75.9 ± 15.0 to-8.5 ± 5.0 ($p<0.001$). Poor bladder compliance and DO prevalence decreased (13.6% to 6.8%, $p=0.30$; 25.0% to 11.3%, $p=0.10$), though not statistically significant.

Conclusion: HoLEP significantly improves urodynamic parameters and bladder function in BPH patients, particularly in those with complex urodynamic profiles. These findings support HoLEP as an effective treatment for relieving bladder outlet obstruction and improving lower urinary tract symptoms, with potential benefits for detrusor overactivity and bladder compliance.

Keywords: benign prostatic hyperplasia (BPH), holmium laser enucleation of the prostate (HoLEP), lower urinary tract symptoms, urodynamic parameters

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ÖZET

Amaç: Bu çalışma, Holmiyum Lazer Prostat Enükleasyonunun (HoLEP) benign prostat hiperplazisi (BPH) hastalarında ürodinamik parametreler ve mesane fonksiyonu üzerindeki etkisini değerlendirmeyi amaçlamaktadır.

Gereç ve Yöntemler: Üçüncü basamak bir sağlık merkezinde HoLEP uygulanan, ürodinamik olarak doğrulanmış BPH tanısı konmuş 44 hastanın retrospektif analizi yapıldı. Ameliyat öncesi ve 6 ay sonrası değerlendirmeler, Uluslararası Prostat Semptom Skoru (IPSS), üroflowmetri, idrar sonrası rezidüel hacim (PVR) ve detrüsör basıncı, maksimum akış hızı (Qmax), mesane çıkış obstrüksiyon indeksi (BOOI) ve detrüsör aşırı aktivitesini (DO) ölçen ürodinamik çalışmaları içermekteydi. İstatistiksel karşılaştırmalar eşleştirilmiş t-testleri, Wilcoxon işaretli sıralar testi ve McNemar testi ile yapıldı.

Bulgular: HoLEP sonrası IPSS (22,0 ± 7,0'den 6,1 ± 5,0'e, p<0,001), pollaküri (7,4 ± 1,5'ten 5,8 ± 1,2'ye, p=0,01), nokturi (3,2 ± 0,8'den 1,1 ± 0,5'e, p<0,001) ve PVR (175,0 ± 50,0'den 45,4 ± 15,0 mL'ye, p<0,001) anlamlı ölçüde azaldı. Qmax 6,8 ± 2,0'den 19,7 ± 4,5 mL/s'ye (p<0,001), maksimum mesane kapasitesi 180,0 ± 45,0'den 375,0 ± 75,0 mL'ye (p<0,001) ve maksimum sistometrik kapasite 280,0 ± 56,0'dan 415,0 ± 83,0 mL'ye (p<0,001) yükseldi. BOOI 75,9 ± 15,0'den -8,5 ± 5,0'e düştü (p<0,001). Zayıf mesane kompliyansı ve DO prevalansı azaldı (sırasıyla %13,6'dan %6,8'e, p=0,30; %25,0'den %11,3'e, p=0,10), ancak bu değişiklikler istatistiksel olarak anlamlı değildi.

Sonuç: HoLEP, özellikle karmaşık ürodinamik profillere sahip BPH hastalarında ürodinamik parametreleri ve mesane fonksiyonunu anlamlı ölçüde iyileştirir. Bu bulgular, HoLEP'in mesane çıkış obstrüksiyonunu gidermede ve alt üriner sistem semptomlarını iyileştirmede etkili bir tedavi olduğunu desteklerken, detrüsör aşırı aktivitesi ve mesane kompliyansı için potansiyel faydalar sunar.

Anahtar Kelimeler: alt üriner sistem semptomları, BPH, HoLEP, ürodinamik parametre

INTRODUCTION

Benign prostatic hyperplasia (BPH) is one of the most common urological conditions affecting aging men, with a prevalence that increases significantly with age. Epidemiological studies indicate that approximately 50% of men over the age of 50 and up to 80% of men over 80 experience histological evidence of BPH, with a substantial proportion developing bothersome lower urinary tract symptoms (LUTS) (1). These symptoms, broadly categorized into obstructive (e.g., weak urinary stream, hesitancy, and incomplete bladder emptying) and storage-related symptoms (e.g., urgency, frequency, and nocturia), significantly impair quality of life and impose a considerable burden on healthcare systems worldwide (2).

The pathophysiology of BPH involves progressive enlargement of the prostate, leading to bladder outlet obstruction (BOO). Prolonged BOO induces structural and functional changes in the bladder, including detrusor hypertrophy, reduced bladder compliance, and detrusor overactivity or underactivity (3). These alterations may mimic symptoms of other bladder dysfunctions, complicating differential diagnosis and raising concerns about detrusor contractility. To address these diagnostic challenges and to predict postoperative outcomes, urodynamic studies have become a valuable tool in certain clinical scenarios (4). These studies provide objective measures of bladder function, including detrusor pressure, bladder compliance, and the presence of BOO, thereby guiding surgical decision-making and offering insights into the potential reversibility of bladder dysfunction following intervention.

Surgical management of BPH, such as Holmium Laser Enucleation of the Prostate (HoLEP), has been shown to significantly alleviate LUTS by relieving BOO (5). Beyond improving obstructive symptoms, emerging evidence suggests that HoLEP may also ameliorate storage symptoms, potentially by reversing some of the structural and functional bladder changes induced by chronic obstruction (6). However, despite these clinical observations, the objective impact of HoLEP on urodynamic parameters remains a subject of ongoing debate among clinicians. While subjective symptom improvement is well-documented, there is a paucity of studies that comprehensively evaluate the postoperative urodynamic changes to provide objective evidence of the procedure's efficacy in restoring bladder function.

In this retrospective study, we aim to evaluate the effect of HoLEP on urodynamic parameters by analyzing

preoperative and postoperative urodynamic studies in patients with BPH. By assessing objective measures of bladder function, we seek to elucidate the impact of HoLEP on both obstructive and storage-related urodynamic outcomes, thereby contributing to a better understanding of its therapeutic efficacy and guiding clinical decision-making in the management of BPH.

MATERIAL AND METHODS

Study Design and Ethical Approval

This study was designed as a retrospective analysis of patients who underwent HoLEP at our institution. After obtaining approval from the Institutional Review Board (IRB) of Başakşehir Çam and Sakura City Hospital under number KAEK/08.11.2023.560, we completed a retrospective review of our prospectively maintained database of men who underwent HoLEP and had preoperative urodynamic testing at our institution. All procedures were conducted in accordance with the ethical standards outlined in the Helsinki Declaration.

Patient Selection

Patients with urodynamically confirmed BPH, based on clinical evaluations and diagnostic tests performed at our urology clinic, and who were deemed eligible for surgical intervention, were included in the study. Patients who underwent preoperative urodynamic studies included those who had the study completed prior to consultation with the primary surgeon, expressed interest in urodynamics to better understand their bladder function and potential postoperative outcomes, had a history of prior bladder outlet surgery, or were considering alternative bladder outlet procedures where urodynamic results could influence the choice of surgery. Exclusion criteria included a history of urethral stricture, previous prostate surgery (except where urodynamic studies were indicated for prior bladder outlet surgery), or incomplete postoperative data that prevented comprehensive analysis.

Preoperative and Postoperative Assessments

All patients underwent a standardized preoperative evaluation, which included completion of the International Prostate Symptom Score (IPSS) questionnaire, frequency-volume charts (Daytime Frequency maximum bladder capacity, nocturia), uroflowmetry, and measurement of post-void residual (PVR) urine volume via ultrasonography (USG). Prostate volume was assessed using transrectal ultrasonography (TRUS). Urodynamic studies were performed using the (MMS, Solar Blue, Netherlands) to evaluate bladder function, including pressure-flow studies to assess detrusor pressure at maximum flow (Pdet) and maximum flow rate (Qmax), in accordance with the International Continence Society (ICS) standards (4).

The Bladder Outlet Obstruction Index (BOOI) was calculated using the formula: Pdet - 2(Qmax). Detrusor overactivity (DO) was defined as spontaneous or provoked involuntary detrusor contractions observed during the bladder filling phase of the urodynamic study (4,7).

Postoperative assessments were conducted at the 6-month follow-up. Patients were re-evaluated using the same diagnostic tools, including IPSS, frequency-volume charts , uroflowmetry, PVR measurement via USG, and urodynamic studies to compare preoperative and postoperative urodynamic parameters.

Surgical Procedure

All HoLEP procedures (150 Watt, Jena MultiPulse HoPLUS, Germany) were performed by two experienced urologists. The surgical technique was selected based on the prostate's anatomical configuration, employing either the trilobar or en-bloc method (8). Following the procedure, a 20 Fr Foley catheter was inserted, and patients were monitored with gentle irrigation for the first 24 hours. The catheter was routinely removed on the third postoperative day.

Data Collection and Analysis

Data were collected from electronic medical records, including preoperative and postoperative clinical assessments, urodynamic parameters, and surgical outcomes. The primary objective was to compare preoperative and postoperative urodynamic parameters, including BOOI and the presence of DO, to evaluate the impact of HoLEP on bladder function.

Statistical Analysis

Data were analyzed using SPSS version 26.0 (IBM Corp., Armonk, NY, USA). Descriptive statistics for continuous variables, including age, body mass index (BMI), prostate-specific antigen (PSA), prostate volume, operation duration, enucleation weight, hospital stay duration, catheterization duration, IPSS, daytime frequency, nocturia, maximum capacity, Qmax, PVR, first desire, maximum cystometric capacity (MCC), and BOOI, were reported as means ± standard deviations (SD). Categorical variables, including diabetes mellitus (DM) rate, biopsy history rate, retention history rate, poor bladder compliance, and DO, were expressed as frequencies and percentages.

Normality of continuous variables was assessed using the Shapiro-Wilk test. For normally distributed variables, differences between preoperative and postoperative measurements were evaluated using paired t-tests. For non-normally distributed variables, the Wilcoxon signed-rank test was applied. Comparisons of categorical variables (poor bladder compliance and DO) were performed using McNemar's test. A p-value of less than 0.05 was considered indicative of statistical significance. All tests were two-tailed.

RESULTS

This study evaluated the outcomes of HoLEP in a cohort of 44 patients with BPH. Demographic and clinical characteristics of the cohort are presented in Table 1. The mean age was 65.0 ± 6.5 years, with a mean BMI of 28.4 ± 4.3 kg/m^2. DM was observed in 31% of patients (n=14), while 56.8% (n=25) had a history of prostate biopsy, and 54% (n=24) reported a history of urinary retention. The mean PSA level was 6.1 ± 1.2 ng/mL, and the mean prostate volume was 84.4 ± 16.9 cc. Operative and postoperative characteristics included a mean operation duration of 115.0 ± 17.3 minutes, an enucleation weight of 35.4 ± 7.1 grams, a hospital stay duration of 2.4 ± 0.5 days, and a catheterization duration of 4.2 ± 0.8 days.

Table 2 summarizes the comparison of preoperative and postoperative clinical parameters following HoLEP, along with their statistical significance. Significant improvements were observed across multiple parameters post-surgery. The IPSS decreased from 22.0 ± 7.0 preoperatively to 6.1 ± 5.0 postoperatively (p<0.001). Daytime frequency reduced from 7.4 ± 1.5 to 5.8 ± 1.2 times per day (p=0.01), and nocturia improved from 3.2 ± 0.8 to 1.1 ± 0.5 episodes per night (p<0.001). Maximum bladder capacity increased significantly from 180.0 ± 45.0 mL to 375.0 ± 75.0 mL (p<0.001). The Qmax improved from 6.8 ± 2.0 mL/s to 19.7 ± 4.5 mL/s (p<0.001), and PVR decreased from 175.0 ± 50.0 mL to 45.4 ± 15.0 mL (p<0.001). First desire to void increased from 150.4 ± 30.0 mL to 210.8 ± 42.0 mL (p=0.002). The MCC increased from 280.0 ± 56.0 mL to 415.0 ± 83.0 mL (p<0.001). The BOOI showed a marked reduction from 75.9 ± 15.0 to -8.5 ± 5.0 (p<0.001). The prevalence of poor bladder compliance decreased from 13.6% (n=6) to 6.8% (n=3), though this change was not statistically significant (p=0.30). Similarly, DO prevalence reduced from 25.0% (n=11) to 11.3% (n=5), but the difference was not statistically significant (p=0.10).

Table 1. Clinical and Operative Characteristics of 44 Patients

Parameters	Value/Mean ± SD
Age (years)	65.0 ± 6.5
BMI (kg/m^2)	28.4 ± 4.3
Diabetes Mellitus (DM) Rate	31% (n=14)
Biopsy History Rate	56.8% (n=25)
Retention History Rate	54% (n=24)
PSA (ng/mL)	6.1 ± 1.2
Prostate Volume (cc)	84.4 ± 16.9
Operation Duration (min)	115.0 ± 17.3
Enucleation Weight (g)	35.4 ± 7.1
Hospital Stay Duration (days)	2.4 ± 0.5
Catheterization Duration (days)	4.2 ± 0.8

BMI: Body Mass Index, DM: Diabetes Mellitus, PSA: Prostate-Specific Antigen

Table 2. Comparison of Preoperative and Postoperative Parameters in 44 Patients

Parameters	Preoperative Mean ± SD or Rate	Postoperative Mean ± SD or Rate	p-value
Frequency-Volume Chart		6.1 ± 5.0	0.001
Daytime Frequency	7.4 ± 1.5	5.8 ± 1.2	0.01
Nocturia	3.2 ± 0.8	1.1 ± 0.5	0.001
Maximum Bladder Capacity (mL)	180.0 ± 45.0	375.0 ± 75.0	<0.001
Uroflowmetry			
Qmax (mL/s)	6.8 ± 2.0	19.7 ± 4.5	<0.001
PVR (mL)	175.0 ± 50.0	45.4 ± 15.0	<0.001
Urodynamics Study			
First Desire (mL)	150.4 ± 30.0	210.8 ± 42.0	0.002
Compliance (Poor %)	13.6% (n=6)	6.8% (n=3)	0.30
MCC (mL)	280.0 ± 56.0	415.0 ± 83.0	<0.001
Detrusor Overactivity	25.0% (n=11)	11.3% (n=5)	0.10
BOOI	75.9 ± 15.0	-8.5 ± 5.0	<0.001

IPSS: International Prostate Symptom Score, Qmax: Maximum Flow Rate, PVR: Post-Void Residual Urine, MCC: Maximum Cystometric Capacity ,BOOI: Bladder Outlet Obstruction Index.

Note: $p < 0.05$ indicates statistical significance.

DISCUSSION

This study reaffirms the efficacy of HoLEP as a highly effective treatment for BPH, demonstrating significant improvements in both subjective and objective clinical parameters. The detailed evaluation of pre- and postoperative urodynamic parameters, including BOOI, maximum bladder capacity, and MCC, sets this study apart and provides critical insights into HoLEP's impact on bladder function, supporting its role as a first-line surgical option for BPH. Despite our cohort of 44 patients, our study is among the few in the literature to incorporate both pre- and postoperative urodynamic assessments, a methodological distinction that underscores its originality and enhances the understanding of the procedure's therapeutic benefits, particularly in complex patient populations where urodynamics can optimize surgical planning (5,6).

Significant improvements were observed across multiple parameters, including a reduction in IPSS, daytime frequency, nocturia and PVR. Additionally, While the Qmax value increased at a remarkable level ($p<0.001$), a significant increase was observed in the maximum badder capacity from the flow-volume chart and in the MCC from urodynamic studies. ($p<0.001$). The BOOI decreased markedly, confirming HoLEP's ability to relieve BOO. These robust outcomes, driven by the precise enucleation of obstructing prostate tissue, align with prior studies reporting postoperative IPSS scores of 4–8 and Qmax values exceeding 18 mL/s (9). The objective improvements in urodynamic parameters provide compelling evidence for HoLEP's utility in restoring bladder function, particularly in patients with suspected bladder dysfunction.

A notable finding is the reduction in the prevalence of poor bladder compliance from 13.6% (n=6) to 6.8% (n=3), although this change was not statistically significant ($p=0.30$). Despite the modest improvement rate, the observed change suggests that structural bladder changes secondary to BPH-related chronic BOO may be partially reversible following HoLEP. Poor bladder compliance, often resulting from prolonged obstruction, is associated with persistent LUTS and reduced quality of life (10). The partial improvement in these patients highlights HoLEP's potential to mitigate some of the bladder remodeling caused by chronic obstruction, offering hope for improved outcomes in this challenging subgroup. This finding underscores the importance of considering HoLEP for patients with complex urodynamic profiles, as it may address structural bladder changes that contribute to persistent LUTS.

The prevalence of DO decreased from 25.0% (n=11) to 11.3% (n=5), though this reduction was not statistically significant (p=0.10). The relatively high baseline prevalence of DO, likely due to the inclusion of patients undergoing preoperative urodynamic evaluation, exceeds rates typically reported in HoLEP studies (11,12). DO is a hallmark of overactive bladder (OAB) syndrome, characterized by urgency, frequency, and nocturia, which significantly impact patient quality of life (13). The observed reduction, while not statistically significant, indicates that a clinically meaningful number of patients experienced improvement in OAB-related symptoms post-HoLEP. This suggests that HoLEP may alleviate DO in some patients, potentially by relieving BOO and improving bladder compliance, even in those with preoperative urodynamic abnormalities. These findings are particularly relevant for urologists managing BPH patients with OAB symptoms, as they highlight HoLEP's potential to address both obstructive and irritative symptoms, enhancing patient quality of life.

The high proportion of patients with a history of urinary retention (54%, n=24) further distinguishes our cohort. Urinary retention, often an indication for preoperative urodynamic assessment, is associated with worse baseline bladder function and a higher likelihood of urodynamic abnormalities, such as DO or poor compliance. The significant improvements observed across most parameters in this subgroup demonstrate HoLEP's efficacy in a more challenging patient population compared to typical HoLEP cohorts, where urinary retention rates are often lower (14,15). This reinforces HoLEP's versatility and effectiveness in managing BPH-related LUTS, even in patients with a history of urinary retention. The inclusion of preoperative urodynamic assessments in our study enhances the precision of patient selection and outcome evaluation, providing valuable data for clinicians managing complex BPH cases where urinary retention or urodynamic abnormalities are present.

The operative and postoperative characteristics, including a mean operation duration of 115 ± 17.3 minutes, hospital stay of 2.4 ± 0.5 days, and catheterization duration of 4.2 ± 0.8 days, align with established HoLEP protocols (16). The mean prostate volume of 84.4 ± 16.9 cc supports HoLEP's applicability across a range of prostate sizes, consistent with its reported efficacy in both small and large prostates (17). The high prevalence of comorbidities, such as DM (31%) and urinary retention (54%), reflects the complexity of our patient population. Despite these risk factors, which are known to impair bladder function and complicate recovery (15,18), the robust improvements observed across most parameters underscore HoLEP's effectiveness in real-world clinical scenarios. These outcomes support the use of HoLEP in diverse patient populations, including those with comorbidities or complex urodynamic profiles, where precise surgical intervention can yield significant functional improvements.

This study has several limitations. The sample size of 44 patients may limit the generalizability of findings, particularly for non-significant changes in DO and bladder compliance. The lack of statistical significance in these parameters may be due to insufficient power, underscoring the need for larger cohorts. Additionally, the absence of long-term follow-up data restricts insights into the durability of HoLEP's benefits, particularly regarding the reversibility of structural bladder changes and OAB symptoms. The lack of a control group undergoing alternative treatments, such as transurethral resection of the prostate or medical therapy, precludes comparative analyses. Despite these limitations, the inclusion of preoperative urodynamic assessments and the focus on objective parameters strengthen the study's contribution to the literature. Future studies should incorporate larger sample sizes, extended follow-up periods, and comparative arms to validate these findings and explore the long-term impact of HoLEP on DO and bladder compliance.

CONCLUSION

This study reinforces HoLEP as a highly effective treatment for BPH, with significant improvements in LUTS, urodynamic parameters, and quality of life. The detailed assessment of pre- and postoperative urodynamic parameters, including BOOI, maximum bladder capacity, and MCC, provides objective evidence of HoLEP's impact on bladder function, distinguishing this study from much of the existing literature. The partial improvement in poor bladder compliance and DO, particularly in a cohort with a high prevalence of urinary retention and urodynamic abnormalities, suggests that HoLEP may mitigate BPH-related structural bladder changes and OAB symptoms, even in complex cases. Our findings suggest HoLEP's versatility and support its role as a robust treatment option for BPH patients, including those

with challenging clinical profiles. Further research with larger cohorts, longer follow-up, and comparative designs is needed to confirm these outcomes and elucidate HoLEP's long-term effects on bladder function and OAB symptoms.

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Conflict of Interest: The authors declare that they have no conflicts of interest.

Informed Consent: An informed consent was obtained from all the patients.

Ethics Committee Approval: Ethical approval for this study was obtained from the Clinical Research Ethics Committee of Başakşehir Çam and Sakura City Hospital, Istanbul Provincial Health Directorate (Ethics committee approval date and number: 08.11.2023/KAEK/2023.11.560).

REFERENCES

1. Roehrborn CG. Benign prostatic hyperplasia: an overview. Rev Urol. 2005;7 Suppl 9(Suppl 9):S3-S14. PMID: 16985902.
2. Gratzke C, Bachmann A, Descazeaud A, Drake MJ, Madersbacher S, et al. EAU guidelines on the assessment of non-neurogenic male lower urinary tract symptoms including benign prostatic obstruction. Eur Urol. 2015;67(6):1099-1109. https://doi.org/10.1016/j.eururo.2014.12.038
3. Mirone V, Imbimbo C, Longo N, Fusco F. The detrusor muscle: an innocent bystander in benign prostatic hyperplasia. Eur Urol. 2006;50(5):872-874. https://doi.org/10.1016/j.eururo.2006.07.014
4. Abrams P, Cardozo L, Fall M, Griffiths D, Rosier P, et al. The standardisation of terminology in lower urinary tract function: report from the standardisation sub-committee of the International Continence Society. Urology. 2003;61(1):37-49. https://doi.org/10.1016/s0090-4295(02)02243-4
5. Gilling PJ, Wilson LC, King CJ, Westenberg AM, Frampton CM. 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(3):408-411. https://doi.org/10.1111/j.1464-410X.2011.10359.x
6. Ahyai SA, Gilling P, Kaplan SA, Kuntz RM, Madersbacher S, 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(3):384-397. https://doi.org/10.1016/j.eururo.2010.06.005
7. Griffiths D, Höfner K, van Mastrigt R, Rollema HJ, Spångberg A, et al. Standardization of terminology of lower urinary tract function: pressure-flow studies of voiding, urethral resistance, and urethral obstruction. Neurourol Urodyn. 1997;16(1):1-18. https://doi.org/10.1002/(SICI)1520-6777(1997)16:1<1::AID-NAU1>3.0.CO;2-I
8. Gilling PJ, Aho TF, Frampton CM, King CJ, Fraundorfer MR. Holmium laser enucleation of the prostate: results at 6 years. Eur Urol. 2008;53(4):744-749. https://doi.org/10.1016/j.eururo.2007.04.052
9. 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(3):1012-1016. https://doi.org/10.1097/01.ju.0000136218.11998.9e
10. Madersbacher S, Lackner J, Brössner C, Röhlich M, Stancik I, et al. Interrelationships of bladder compliance with age, detrusor instability, and obstruction in elderly men with lower urinary tract symptoms. Neurourol Urodyn. 1999;18(1):3-13. https://doi.org/10.1002/(SICI)1520-6777(1999)18:1<3::AID-NAU2>3.0.CO;2-4
11. Kim SK, Kim KH, Kim SH, Yoo SJ, Jeong YW. Health-related quality of life in adult males with lower urinary tract symptoms. Qual Life Res. 2019;28(9):2419-2428. https://doi.org/10.1007/s11136-019-02205-w
12. Naspro R, Bachmann A, Gilling P, Kuntz R, Madersbacher S, et al. A review of the recent evidence (2006-2008) for 532-

nm photoselective laser vaporisation and holmium laser enucleation of the prostate. Eur Urol. 2009;55(6):1345-1357. https://doi.org/10.1016/j.eururo.2009.03.070

13. Coyne KS, Sexton CC, Irwin DE, Kopp ZS, Kelleher CJ, et al. The impact of overactive bladder, incontinence and other lower urinary tract symptoms on quality of life, work productivity, sexuality and emotional well-being in men and women: results from the EPIC study. BJU Int. 2008;101(11):1388-1395. https://doi.org/10.1111/j.1464-410X.2008.07601.x
14. Law YXT, Castellani D, Dell'Atti L, Aho T, Teoh JY, et al. Differences in surgical and functional outcomes in benign prostate hyperplasia patients with only lower urinary tract symptoms versus those in retention: a systematic review and meta-analysis. Neurourol Urodyn. 2021;40(6):1389-1401. https://doi.org/10.1002/nau.24708
15. Yuk HD, Oh SJ. Effect of urinary retention on the surgical outcome of holmium laser enucleation of the benign prostatic hyperplasia. Investig Clin Urol. 2023;64(1):31-40. https://doi.org/10.4111/icu.20220232
16. Elmansy HM, Kotb A, Elhilali MM. Holmium laser enucleation of the prostate: long-term durability of clinical outcomes and complication rates during 10 years of followup. J Urol. 2011;186(5):1972-1976. https://doi.org/10.1016/j.juro.2011.06.065
17. Krambeck AE, Handa SE, Lingeman JE. Holmium laser enucleation of the prostate for prostates larger than 175 grams. J Endourol. 2010;24(3):433-437. https://doi.org/10.1089/end.2009.0147
18. Xin C, Fan H, Xie J, Hu J, Sun X, et al. Impact of diabetes mellitus on lower urinary tract symptoms in benign prostatic hyperplasia patients: a meta-analysis. Front Endocrinol (Lausanne). 2022;12:741748. https://doi.org/10.3389/fendo.2021.741748