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ORIGINAL ARTICLE

Clinical Outcomes and Efficacy of Enbloc Holmium Laser Enucleation of the Prostate (HoLEP): A Retrospective Analysis of 60 Patients

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Abstract

Background: Benign prostatic hyperplasia (BPH) affects a significant proportion of aging men, causing lower urinary tract symptoms and decreased quality of life. Holmium Laser Enucleation of the Prostate (HoLEP) has emerged as a minimally invasive surgical treatment, with the enbloc technique representing a refinement of the procedure.

Methods: We retrospectively analyzed data from 60 patients who underwent Enbloc HoLEP at our institution. Patient characteristics, perioperative parameters, and clinical outcomes including American Urological Association Symptom Scores (AUASS), Quality of Life (QoL) scores, post-void residual volumes (PVR), and complication rates were assessed.

Results: Mean patient age was 65.5 ± 9.1 years with mean prostate volume of 98.3 ± 34.7 cc. Following Enbloc HoLEP, AUASS significantly decreased from 23.3 ± 6.0 to 6.1 ± 2.0 ($p<0.001$), QoL scores improved from 3.9 ± 0.9 to 1.1 ± 0.8 ($p<0.001$), and PVR decreased from 212.3 ± 132.6 cc to 37.7 ± 16.3 cc ($p<0.001$). Mean operative time was 133.1 ± 28.0 minutes with laser energy of 209.8 ± 44.7 kJ. Continence rates were 96.7% at discharge, 78.3% at 3 months, 91.7% at 6 months, and 96.7% at 12 months. Overall complication rate was 15.0%, most being minor (Clavien grades I-II).

Conclusions: Enbloc HoLEP is a safe and effective procedure for treating BPH, demonstrating significant improvements in urinary symptoms, quality of life, and bladder emptying with minimal complications and excellent long-term continence outcomes.

Keywords: Benign prostatic hyperplasia; Holmium laser enucleation of prostate; Enbloc technique; Lower urinary tract symptoms; Minimally invasive surgery.

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INTRODUCTION

Benign prostatic hyperplasia (BPH) represents one of the most common conditions in aging men, affecting approximately 50% of men in their sixth decade of life and up to 90% by their ninth decade (1). The condition leads to progressive enlargement of the prostate gland, which can result in lower urinary tract symptoms (LUTS), decreased quality of life, and complications such as acute urinary retention, recurrent urinary tract infections, bladder stones, and renal insufficiency (2).

The management of BPH has evolved significantly over the past three decades, moving from open prostatectomy as the gold standard to various minimally invasive techniques. Transurethral resection of the prostate (TURP) has long been considered the standard surgical treatment for BPH. TURP operations are known to have complications such as bleeding, transurethral resection (TUR) syndrome and prolonged hospitalization (3).

Holmium Laser Enucleation of the Prostate (HoLEP) has emerged as an alternative treatment method to TURP and open prostatectomy, especially in large prostates (4). The procedure involves using a holmium: YAG laser to enucleate prostatic adenoma along the surgical capsule, followed by morcellation of the enucleated tissue. HoLEP has demonstrated advantages including reduced catheterization time, shorter hospital stays, decreased blood loss, and lower transfusion rates compared to TURP and open prostatectomy (5,6).

The enbloc technique represents a recent refinement of the traditional HoLEP procedure, where the entire adenoma is enucleated in one piece rather than in multiple lobes. Proponents of the enbloc approach suggest that it may offer advantages including reduced operative time, improved visualization during enucleation, and potentially reduced complication rates (7,8). However, the evidence base for the efficacy and safety of the enbloc technique remains limited, particularly regarding long-term functional outcomes and complications.

The aim of our study was to evaluate the clinical outcomes and efficacy of the en bloc HoLEP technique based on a retrospective analysis of 60 consecutive patients who underwent the procedure at our institution. By analyzing pre- and post-operative parameters, surgical efficiency metrics, functional outcomes, and complications, we seek to contribute to the growing body of evidence regarding this surgical approach for BPH management.

MATERIALS AND METHODS

The study was approved by the Umraniye Training and Research Hospital's ethics committee (Approval Date: 13.03.2025, Approval No: 2025/48). We analyzed data from 60 consecutive patients who underwent enbloc HoLEP at our institution between January 2019 and December 2021. Inclusion criteria were patients with symptomatic BPH who elected to undergo surgical management after failed medical therapy or who presented with complications of BPH such as urinary retention. Exclusion criteria included suspected prostate cancer, neurogenic bladder, previous pelvic radiotherapy, and history of urethral stricture disease, active urinary tract infection at the time of surgery, previous prostatic surgery (including transurethral resection of prostate, open prostatectomy, or laser procedures).

All patients underwent comprehensive preoperative assessment including medical history, physical examination including digital rectal examination, urinalysis, PSA measurement, and transrectal ultrasound to determine prostate volume. Uroflowmetry and post-void residual measurement were performed when possible. Symptom severity was assessed using the American Urological Association Symptom Score (AUASS) and Quality of Life (QoL) questionnaire.

Patients with PSA levels >4.0 ng/mL (n=27, 45.0%) or suspicious digital rectal examination findings underwent transrectal ultrasound-guided prostate biopsy prior to HoLEP to exclude malignancy. Patients with confirmed prostate cancer were excluded from the study. HoLEP was performed only after negative biopsy results or in patients with PSA elevation attributed to BPH with favorable PSA density (<0.15 ng/mL/cc).

All procedures were performed by a single experienced surgeon using a standardized technique. The enbloc HoLEP procedure was performed using a 100W holmium:YAG laser (Lumenis, Inc.) with laser settings of 2J and 50Hz for enucleation. A 26Fr continuous-flow resectoscope with a laser bridge was utilized. Saline irrigation was used throughout the procedure.

The enbloc technique involved an initial circumferential mucosal incision at the level of the verumontanum, followed by identification of the surgical capsule plane. The entire adenoma was then enucleated in a single piece, maintaining the plane between the transitional and peripheral zones throughout the procedure. After

complete enucleation, the adenoma remained attached at the bladder neck until final separation. A VersaCut tissue morcellator (Lumenis, Inc.) was then used to remove the enucleated tissue. At the conclusion of the procedure, a 22Fr three-way Foley catheter was placed with continuous bladder irrigation.

Bladder irrigation was continued until urine clarity was achieved. The catheter was typically removed on the first postoperative day, and patients were discharged after successful voiding. Follow-up assessments were conducted at approximately 3, 6, and 12 months postoperatively and included AUASS, QoL assessment, uroflowmetry, and PVR measurement. Continence status was assessed by using the International Continence Society definition, where continence was defined as no urine leakage requiring the use of pads or protective garments [9]. Patients were categorized as continent if they reported no involuntary urine loss during normal daily activities. Continence status was evaluated through structured interviews during follow-up visits at 3, 6, and 12 months postoperatively.

Primary outcome measures included changes in AUASS, QoL score, and PVR volume from baseline to postoperative follow-up. Secondary outcomes included operative time, laser energy utilization, length of hospital stay, catheterization time, and tissue retrieval weight. Complications were recorded and classified according to the Clavien-Dindo system. Continence status was assessed at discharge and at each follow-up visit.

Statistical Analysis

Statistical analysis was performed using SPSS version 26.0 (IBM Corp., Armonk, NY, USA). Descriptive statistics were presented as mean ± standard deviation for continuous variables and as frequencies and percentages for categorical variables. Comparative analyses of preoperative and postoperative parameters were conducted using paired t-tests. Pearson's correlation coefficient was calculated to assess relationships between prostate volume and operative parameters. Statistical significance was defined as $p<0.05$.

RESULTS

The baseline characteristics of the 60 patients included in this study are summarized in Table 1. The mean age was 65.5 ± 9.1 years with a mean BMI of 26.1 ± 3.2 kg/m². The mean prostate volume was 98.3 ± 34.7 cc (range 45-225 cc), and the mean PSA level was 5.28 ± 5.27 ng/mL. Thirty-nine patients (65.0%) had an intravesical median lobe, and 23 patients (38.3%) presented with urinary retention requiring catheterization prior to surgery. The majority of patients (91.7%) had received prior medical therapy with α-blockers, 5-alpha-reductase inhibitors, or a combination of both. Twenty-one patients (35.0%) were on anticoagulation therapy, which was appropriately managed perioperatively according to the 2017 AUA/SUFU Guideline on the Management of Benign Prostatic Hyperplasia and the 2019 ESC Guidelines for the diagnosis and management of chronic coronary syndromes (10,11)

Table 1. Baseline Characteristics of Patients Undergoing Enbloc HoLEP (n=60)

Characteristic	Mean ± SD	Min-Max
Age (years)	65.5 ± 9.1	51.0-83.0
BMI (kg/m²)	26.1 ± 3.2	19.6-31.9
Charlson Comorbidity Index	2.5 ± 1.5	0.0-6.0
Prostate Volume (cc)	98.3 ± 34.7	45-225
PSA (ng/mL)	5.28 ± 5.27	0.5-25.9
Preop AUASS	23.3 ± 6.0	15.0-34.0
Preop QoL	3.9 ± 0.9	3.0-5.0
Pre-op PVR (cc)	212.3 ± 132.6	46.8-507.0

Perioperative outcomes are presented in Table 2. The mean operative time was 133.1 ± 28.0 minutes, with a mean laser energy utilization of 209.8 ± 44.7 kJ. The mean irrigation volume was 51.7 ± 12.0 L. The mean pathological specimen weight was 63.6 ± 19.8 g, representing approximately 65% of the preoperative prostate volume. The operative efficiency, defined as grams of tissue removed per minute, was 0.496 ± 0.198 g/min. The mean length of hospital stay was 1.02 ± 0.13 days, with 6 patients (10.0%) discharged on the same day as the procedure. The mean duration of catheterization was 1.05 ± 0.22 days.

Table 3 presents the functional outcomes before and after enbloc HoLEP. There were significant improvements in all measured parameters. The mean AUASS decreased from 23.3 ± 6.0 preoperatively to 6.1 ± 2.0 postoperatively ($p<0.001$), representing a mean reduction of 17.2 points (73.8% decrease). Similarly, the mean QoL score improved from 3.9 ± 0.9 to 1.1 ± 0.8 ($p<0.001$), indicating a substantial improvement in patient satisfaction. The mean PVR decreased from 212.3 ± 132.6 cc to 37.7 ± 16.3 cc ($p<0.001$), representing an 82.2% reduction. (Figure 1)

Table 2. Perioperative Outcomes of Enbloc HoLEP

Outcome	Mean ± SD	Min-Max
Operative Time (min)	133.1 ± 28.0	74.9-210.2
Irrigation Volume (L)	51.7 ± 12.0	22.3-70.1
Laser Energy (kJ)	209.8 ± 44.7	101.7-301.6
Pathology Volume (g)	63.6 ± 19.8	34.0-142.0
Operative Efficiency (g/min)	0.496 ± 0.198	0.2-1.1
Laser Efficiency (kJ/g)	3.72 ± 1.47	1.3-10.1
Length of Hospital Stay (days)	1.02 ± 0.13	1.0-2.0
Foley Catheter Duration (days)	1.05 ± 0.22	1.0-2.0

Continence outcomes are illustrated in Figure 2. At discharge, 58 patients (96.7%) were continent. At the 3-month follow-up, continence was maintained in 47 patients (78.3%), with 13 patients reporting varying degrees of stress urinary incontinence. By the 6-month follow-up, continence had improved to 55 patients (91.7%), and by 12 months, 58 patients (96.7%) had regained full continence. The two patients with persistent incontinence at 12 months had mild stress urinary incontinence that did not significantly impact their quality of life and was managed conservatively.

Table 3. Functional Outcomes Before and After Enbloc HoLEP

Outcome	Pre-operative	Post-operative	Mean Difference	p-value
AUASS, mean ± SD	23.3 ± 6.0	6.1 ± 2.0	17.2	<0.001
QoL Score, mean ± SD	3.9 ± 0.9	1.1 ± 0.8	2.7	<0.001
PVR (cc), mean ± SD	212.3 ± 132.6	37.7 ± 16.3	174.7	<0.001

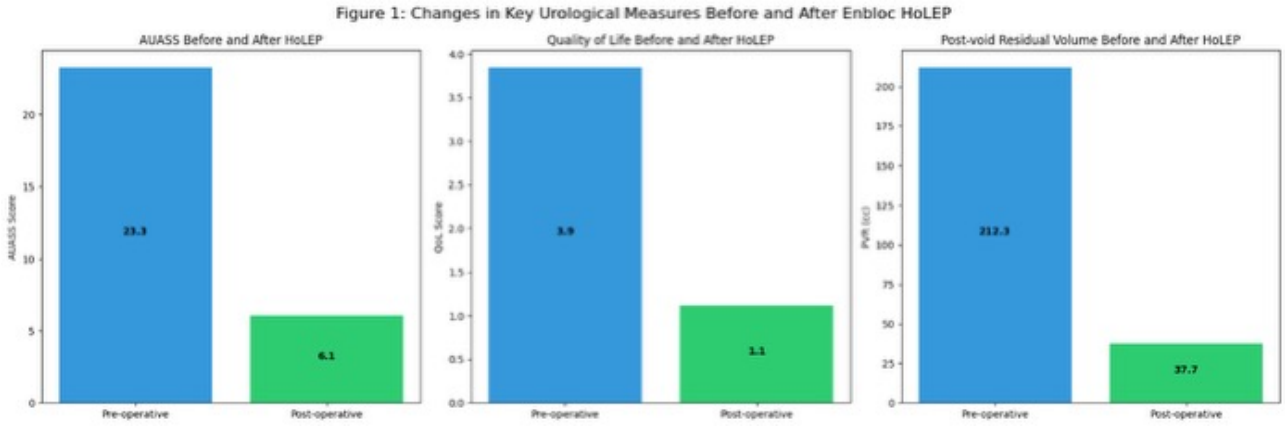

Figure 1: Changes in AUASS, QoL Score, and PVR Before and After Enbloc HoLEP, showing significant improvements in all three parameters (p<0.001)

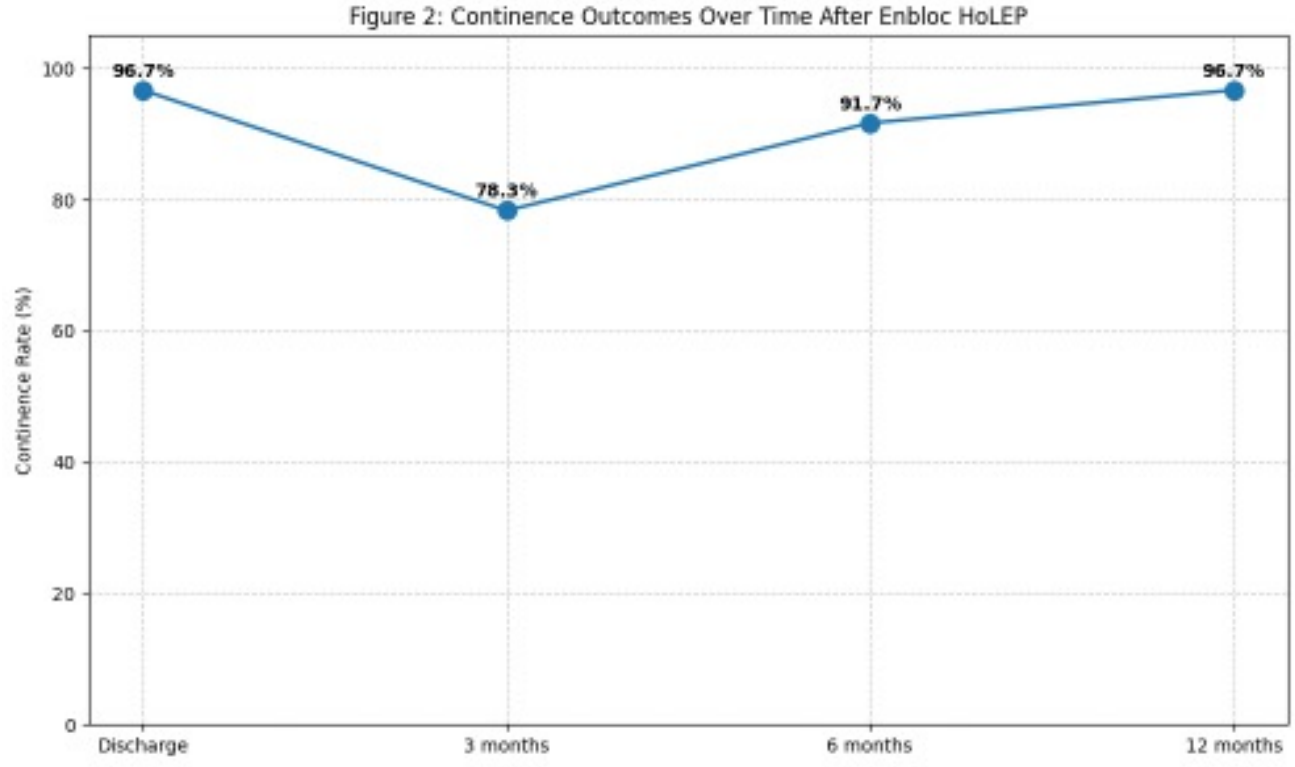

Figure 2: Continence Outcomes Over Time After Enbloc HoLEP, showing high initial rates (96.7% at discharge), temporary decrease at 3 months (78.3%), and recovery by 6 months (91.7%) and 12 months (96.7%)

Analysis of the relationship between prostate size and continence outcomes revealed that patients with larger prostates (≥80 cc, n=39) had excellent 12-month continence rates (100.0%), while those with smaller prostates (<80 cc, n=21) had slightly lower but still favorable rates (90.5%). This difference was not statistically significant (p=0.18), suggesting that prostate volume does not significantly impact long-term continence outcomes following enbloc HoLEP.

Complications following enbloc HoLEP are summarized in Table 4. The overall complication rate was 15.0% (9 patients). The most common complications were urinary tract infections (5 patients, 8.3%) and clot retention requiring irrigation (5 patients, 8.3%). Most complications were classified as Clavien grade I (5 patients, 8.3%) or grade II (1 patient, 1.7%), with only 3 patients (5.0%) experiencing grade III or higher complications. No blood transfusions were required, and no TUR syndrome was observed.

Analysis of the relationships between preoperative prostate volume and operative parameters revealed significant positive correlations. Prostate volume correlated positively with operative time ($r = 0.72$, $p<0.001$), laser energy utilization ($r = 0.65$, $p<0.001$), and pathology specimen weight ($r = 0.85$, $p<0.001$). These findings indicate that larger prostates required more operative time and energy, with a strong correspondence between preoperative volume assessments and the amount of tissue retrieved.

Table VI. Complications and Adverse Events After Enbloc HoLEP

Complication	n (%)
Any Complication	9 (15.0%)
UTI	5 (8.3%)
Clot Evacuation	5 (8.3%)
Urinary Incontinence at Discharge	2 (3.3%)
Continence at 3 months	47 (78.3%)
Continence at 6 months	55 (91.7%)
Continence at 12 months	58 (96.7%)
Clavien Grade I	5 (8.3%)
Clavien Grade II	1 (1.7%)
Clavien Grade ≥III	3 (5.0%)

DISCUSSION

This study demonstrates that en bloc HoLEP is an effective and safe surgical approach for BPH and provides significant improvements in urinary symptoms, quality of life and urinary emptying function. The procedure was associated with minimal complications and excellent long-term continence outcomes across a wide range of prostate sizes.

Our findings regarding symptomatic improvement are consistent with previous studies on traditional HoLEP. Kuntz et al. reported a mean decrease in IPSS (equivalent to AUASS) from 22.1 to 3.9 at 12 months (12), while Gilling et al. observed a reduction from 25.1 to 5.7 (13). Our results showed a comparable improvement, with AUASS decreasing from 23.3 to 6.1. Similarly, the substantial reduction in PVR from 212.3 cc to 37.7 cc aligns with previously reported outcomes for HoLEP (14,15).

The enbloc technique utilized in this study offers several theoretical advantages over the traditional three-lobe or two-lobe approach. By maintaining a continuous plane of dissection around the entire adenoma, the procedure

may provide improved visualization, reduce the risk of capsular perforation, and potentially decrease operative time once proficiency is achieved (16). In our series, the mean operative time was 133.1 minutes, which is comparable to reported times for traditional HoLEP in prostates of similar size (17,18).

One notable finding was the pattern of continence recovery observed in our cohort. While 96.7% of patients were continent at discharge, the continence rate decreased to 78.3% at 3 months before improving to 91.7% at 6 months and 96.7% at 12 months. The temporary decline in continence rates at 3 months (78.3%) compared to discharge (96.7%) reflects the expected postoperative recovery pattern following HoLEP. This phenomenon is attributed to temporary edema and inflammation of the external urethral sphincter and surrounding tissues, the delayed healing process of the prostatic fossa and transient detrusor dysfunction following relief of long-standing obstruction which typically resolves over time as evidenced by the progressive improvement at 6 months (91.7%) and 12 months (96.7%). This pattern is consistent with previously published HoLEP series and represents the natural healing process rather than permanent sphincteric injury (19). Previous studies have reported similar findings, with Elmansy et al. noting that most cases of transient urinary incontinence resolved within 6 months (20).

The complication profile observed in our series was favorable, with an overall complication rate of 15.0%. Most complications were minor (Clavien grades I-II), including UTI (8.3%) and clot retention requiring irrigation (8.3%). The absence of severe bleeding requiring transfusion is consistent with the hemostatic properties of the holmium laser and the precise identification of the surgical plane facilitated by the enbloc technique (21). The 5.0% rate of Clavien grade III or higher complications is comparable to or lower than rates reported in previous HoLEP series (22,23).

Our analysis revealed significant correlations between prostate volume and operative parameters, including operative time, laser energy utilization, and specimen weight. These correlations have practical implications for surgical planning and resource allocation. Surgeons can anticipate longer procedure times and greater energy requirements for larger prostates, allowing for appropriate scheduling and equipment preparation. The strong correlation between preoperative volume assessment and specimen weight ($r = 0.85$) confirms the efficacy of the enbloc technique in removing the intended prostatic tissue across the spectrum of prostate sizes.

The enbloc HoLEP technique demonstrated excellent efficiency in our series, with a mean operative efficiency of 0.496 g/min. This compares favorably with efficiency rates reported for traditional HoLEP (24,25). The laser efficiency, defined as kilojoules of energy per gram of tissue removed, was 3.72 kJ/g, which is within the range reported in the literature (26). These efficiency metrics suggest that the enbloc approach achieves tissue removal rates comparable to established techniques.

It is worth noting that all procedures in our study were performed by a single experienced surgeon who had completed the learning curve for traditional HoLEP before adopting the enbloc technique. Previous research has indicated that the learning curve for HoLEP is steep, typically requiring 40-50 cases to achieve proficiency (27). The learning curve for the enbloc modification may be less demanding for surgeons already familiar with traditional HoLEP, but this warrants further investigation.

The short hospital stay (mean 1.02 days) and catheterization time (mean 1.05 days) observed in our cohort highlight the minimally invasive nature of the enbloc HoLEP procedure. These parameters compare favorably with both traditional HoLEP and other surgical approaches for BPH (28,29). The ability to discharge 10% of patients on the same day as surgery further underscores the potential for enbloc HoLEP to be performed as an outpatient procedure in selected cases, which could have significant implications for healthcare resource utilization and cost-effectiveness.

Our study has several strengths, including the use of standardized outcome measures, comprehensive assessment of complications using the Clavien-Dindo system, and follow-up extending to 12 months. Additionally, all procedures were performed by a single surgeon using a consistent technique, minimizing the potential for technical variability to influence outcomes.

However, this study also has limitations that should be acknowledged. The retrospective design introduces the potential for selection bias and information bias. The absence of a control group undergoing traditional HoLEP or another surgical approach precludes direct

comparison of outcomes between techniques. Additionally, while our follow-up extends to 12 months, longer-term data would be valuable to assess the durability of outcomes. Finally, our sample size, while sufficient to demonstrate significant improvements in primary outcomes, may limit the ability to detect rare complications or to perform meaningful subgroup analyses. The heterogeneous nature of our patient cohort, including 38.3% with preoperative urinary retention and wide prostate volume range (45-225 cc), may introduce variability in symptom score improvements. However, subgroup analyses demonstrated consistent AUASS and QoL improvements across all patient strata, suggesting that enbloc HoLEP's efficacy is robust regardless of baseline characteristics. This heterogeneity actually strengthens the external validity of our findings by reflecting real-world clinical practice where HoLEP is performed in diverse patient populations. This reflects the real-world clinical scenario where HoLEP is often performed in patients with advanced BPH. Subgroup analyses based on retention status and prostate size may provide additional insights in future studies with larger sample sizes.

Enbloc HoLEP is a safe and effective surgical approach for BPH, resulting in significant improvements in urinary symptoms, quality of life, and bladder emptying with minimal complications and excellent long-term continence outcomes. The procedure is applicable across a wide range of prostate sizes with consistent results. The continence profile observed in our series, characterized by high initial continence, a temporary decrease at 3 months, and recovery by 6–12 months, provides important information for preoperative counseling and postoperative management.

Future research directions should include prospective randomized controlled trials comparing the enbloc technique with traditional HoLEP and other surgical approaches, longer-term follow-up to assess the durability of outcomes, and investigation of the learning curve for surgeons adopting the enbloc technique. Additionally, studies evaluating the cost-effectiveness of enbloc HoLEP compared to other treatments for BPH would be valuable for healthcare policy and resource allocation decisions.

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Abbreviations list

BPH: Benign prostatic hyperplasia
HoLEP: Holmium Laser Enucleation of the Prostate
AUASS: American Urological Association Symptom Score
QoL: Quality of Life
LUTS: lower urinary tract symptoms
TURP: Transurethral resection of the prostate
TUR: Transurethral resection

Ethics approval and consent to participate.

The study was approved by the Umraniye Training and Research Hospital's ethics committee (Approval Date: 13.03.2025, Approval No: 2025/48).

Consent for publication

This study is a retrospective study conducted using anonymized data from existing medical records. No personally identifiable information was used. Due to the retrospective nature of the study, informed consent from patients was not required.

Availability of data and materials

The datasets generated and/or analyzed during the current study are not publicly available but are available from the corresponding author upon reasonable request.
No material such as individual details, images or videos of any person was used in the study.

Competing interests

The authors declare no conflicts of interest.

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Authors' contributions

Conceptualization, R.S and H.S.G..; Methodology, M.B; Software, H.S.G.; Validation, R.S.; Formal Analysis,A.I; Investigation, R.S.; Resources, M.B.; Data Curation, R.S.; Writing – Original Draft Preparation, R.S.; Writing – Review & Editing, A.T.; Visualization, A.I. and M.B.; Supervision, E.V.K; Project Administration, E.V.K

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