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ARTICLE

Safety and outcomes of salvage HoLEP after TURP: a comparative study

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Background: *Recurrent prostate surgery may pose additional challenges for achieving an efficient and anatomically precise enucleation. This research investigates how prior transurethral resection of prostate (TURP) affects the perioperative course, functional outcomes, and technical difficulty of Holmium Laser Enucleation of the Prostate (HoLEP) when performed as a primary procedure versus as a salvage treatment.* ***Methods:*** *In this retrospective study, 174 patients who underwent HoLEP between August 2023 and April 2025 were analyzed. Group 1 included 137 patients undergoing primary HoLEP, and group 2 included 37 patients undergoing HoLEP for TURP recurrence. Outcomes assessed included enucleation weight, enucleation and morcellation time and efficiency, blood transfusion, catheter removal, and three-month postoperative International Prostate Symptom Score (IPSS), quality of life (QoL), incontinence, and urethral stricture rates.* ***Results:*** *Mean age was comparable between groups (group 1: 67.84 ± 8.67 vs. group 2: 67.24 ± 8.66 years; p = 0.840). Preoperative prostate volume and enucleation weight were higher in group 2 (81.24 vs. 67.34 mL, p = 0.012; enucleation weight, p = 0.037), while enucleation and morcellation times and efficiencies were similar. At three months, IPSS (8.31 vs. 7.19), QoL (1.56 vs. 1.58), incontinence, and urethral stricture rates did not differ significantly.* ***Conclusion:*** *With meticulous surgical planning, HoLEP represents a safe and effective salvage procedure following TURP, maintaining functional outcomes comparable to primary intervention.*

Key Words: holmium laser enucleation of the prostate, transurethral resection of prostate, enucleation, prostate, re-treatment

Introduction

Laser prostate enucleation is a surgical technique that has emerged and evolved in response to the need for effective management of prostates of varying sizes.[1] Holmium laser enucleation of the prostate (HoLEP) has been extensively evaluated in numerous studies and has been established as a safe and effective alternative to both transurethral resection of the prostate (TURP) and open prostatectomy (OP).[2] The EAU 2024 guidelines recommend HoLEP as an alternative to transurethral resection of the prostate or open prostatectomy for men with moderate-to-severe lower urinary tract symptoms (LUTS) (strength of recommendation: strong).[3]

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With the advent of HoLEP, a size-independent approach for surgical alleviation of LUTS has consistently rated TURP as the surgical benchmark method.[1] The effectiveness of HoLEP is analogous to OP, yet HoLEP is associated with reduced catheterization duration, hospital admission period, and diminished blood loss in addition to peri-operative morbidity.[4] Consequently, HoLEP may represent a feasible therapeutic alternative even in significantly enlarged prostate glands.[4] According to a recent large real-world cohort including more than 33,000 patients, 1886 of 29,790 men who underwent TURP and 98 of 3330 men who underwent HoLEP required a reoperation for BPO within the 3-year follow-up period, corresponding to unadjusted Kaplan–Meier reoperation-free survival rates of 93.5% for TURP and 97.0% for HoLEP; notably, the hazard of reoperation was significantly lower after HoLEP across all prostate-volume categories.[5]

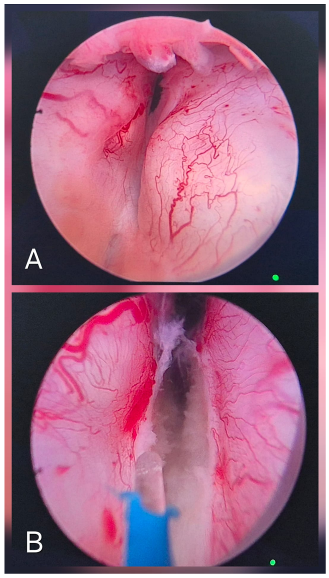

FIGURE 1. Illustrated the endoscopic appearance and initial surgical steps during HoLEP. (A) shows bladder outlet obstruction due to recurrent enlargement of the lateral prostatic lobes, while (B) demonstrates the initial 6 o'clock incision beginning at the bladder neck and extending distally toward the verumontanum

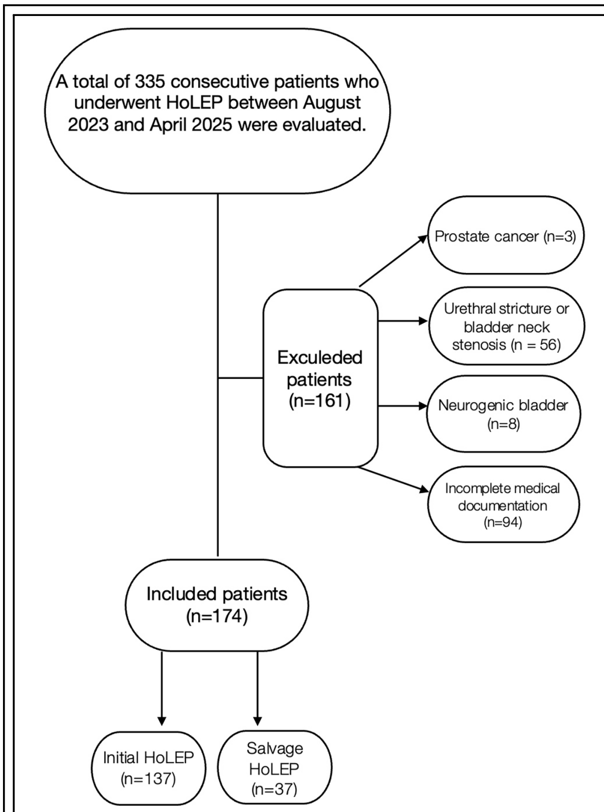

FIGURE 2. Patient selection flowchart. HoLEP, holmium laser enucleation of the prostate

In cases involving very large prostates, the TURP procedure typically begins with resection of the median lobe, followed by resection of the lateral lobes if time permits. This approach is based on the rationale that recurrence of benign prostatic hyperplasia (BPH) predominantly manifests as regrowth of the lateral lobes (Figure 1). Irregular recurrent prostatic lobes obscure the surgical planes, often making subsequent surgical interventions more challenging. The key to performing any HoLEP technique flawlessly lies in accurately identifying the distinct prostatic margins and applying the appropriate surgical strategy. The objective of this study was to rigorously evaluate and compare patient outcomes following primary HoLEP versus HoLEP reintervention, thereby addressing the current knowledge gap regarding efficacy, safety, and functional recovery in the salvage setting.

Materials and Methods

Patient selection

Following approval from the Institutional Review Board of the University of Health Sciences, Kayseri City Hospital, Kayseri, Turkey (Ethics Committee Approval No. 2025/471), data from patients who underwent HoLEP between August 2023 and April 2025 in the Department of Urology at Kayseri City Hospital were retrospectively reviewed. Patients with a diagnosis of prostate carcinoma, urethral stricture, bladder neck stenosis, large bladder diverticula, neurogenic bladder, or incomplete medical records were excluded from the study. A total of 174 patients met the inclusion criteria and were enrolled in the analysis. The study population was divided into two cohorts: primary HoLEP (n = 137) and TURP-secondary HoLEP (n = 37) (Figure 2).

TURP secondary group was formed based on recurrent lower urinary tract symptoms, uroflowmetry results, and adenoma hypertrophy on ultrasound. In cases of early post-TURP recurrence, diagnostic cystoscopy was performed alongside ultrasound and uroflowmetry to directly confirm prostatic regrowth or bladder neck obstruction. However, it is important to acknowledge the inherent heterogeneity in these diagnostic criteria. The lack of a standardized definition for 'post-TURP recurrence' introduces potential diagnostic variability, which may influence the interpretation of surgical outcomes and patient selection within this cohort.

Parameters

Demographic and clinical data were collected for the study cohort and included chronological age, anticoagulation regimen, American Society of Anesthesiologists (ASA) classification, urinary retention, preoperative prostate volume, preoperative incontinence, total prostate-specific antigen (PSA) level, history of prostate biopsy, and the presence of bladder calculi, as well as the use of α-adrenergic blockers and dutasteride. The International Prostate Symptom Score (IPSS), quality of life (QoL), maximum flow rate (Qmax), and postvoid residual volume (PVR) were assessed prior to surgery and reevaluated during postoperative follow-up.

Perioperative parameters including enucleation weight, enucleation time, enucleation efficiency (enucleated tissue weight/enucleation time; g/min), morcellation time, and morcellation efficiency (morcellated tissue weight/morcellation time; g/min) were recorded and calculated.

Catheterization time, the need for blood transfusion, and complications within the first 30 postoperative days were evaluated according to the Clavien–Dindo classification.[6] Qmax, PVR, urethral stricture, and incontinence were also carefully recorded at the third postoperative month.

Technique and laser settings

The HoLEP procedure was performed using the previously described "omega sign" approach, which is based on the standard three-lobe enucleation technique.[7] If the median lobe was absent, the 2-lobe early apical release method was performed. The two-lobe enucleation technique described by Shvero et al. was utilized.[8] In the standard approach, the posterior incision is initiated at either the 5 o'clock or 7 o'clock position. In our modification, due to the absence of a median lobe, the initial incision was made at the 6 o'clock position to facilitate symmetrical dissection of the lateral lobes. All procedures were performed by the same surgeon.

The laser configuration was 80 W (2 J and 40 Hz) for enucleation and 24 W (0.6 J and 40 Hz) for coagulation. The HoLEP apparatus consisted of a high-output 150-W Ho:YAG laser (Quanta), a 550-μm optical fiber, a modified 26-Fr Storz continuous-flow resectoscope equipped with a working component for stabilizing the laser fiber, an extra-long Storz rigid nephroscope, and a tissue morcellator (Hawk). Bipolar coagulation was applied solely in a limited number of instances post-enucleation to attain optimal hemostasis.

Statistical analysis

Descriptive statistics were conducted to elucidate the baseline and perioperative attributes. Quantitative data were articulated as mean and standard deviation (SD), and categorical data as absolute and relative frequencies. The Shapiro–Wilk examination was applied for normality assessment. The nonparametric Mann–Whitney U and parametric Student's *t*-tests were conducted to explore the variations in continuous clinical and demographic variables between groups. Chi-squared analyses were applied to determine correlations among categorical variables. Multivariate logistic regression analysis was performed to identify independent predictors of postoperative urinary incontinence. Statistical significance was established at the threshold of $p < 0.05$.

Results

Table 1 presents the demographic characteristics and preoperative data of the study groups. In total, 174 patients underwent HoLEP for LUTS secondary to benign prostatic hyperplasia (BPH). A significant difference in prostate volume was observed between the groups, with a mean volume of 67.34 ± 24.90 mL in Group 1 and 81.24 ± 31.30 mL in Group 2 ($p = 0.012$). However, no significant difference was found in preoperative PSA levels. Although the number of accompanying bladder stones was similar, it was statistically higher in Group 2 ($p = 0.012$). Age, anticoagulant use, and the frequencies of α-adre nergic antagonist and dutasteride administration were comparable between the groups. No significant differences were observed in IPSS or QoL scores. Preoperative Qmax was significantly higher in Group 2, whereas preoperative PVR did not differ significantly between the groups ($p = 0.027$ and $p = 0.441$, respectively).

Perioperative evaluations and postoperative outcomes are presented in Table 2. A significantly higher enucleation weight was observed in group 2 ($p = 0.037$). However, no significant differences were found in enucleation time, morcellation time, or enucleation and morcellation efficiencies. Similar rates of postoperative blood transfusion and comparable catheter removal times were also noted ($p = 0.944$ and $p = 0.206$, respectively). A total of 40 adverse events were recorded, the majority of which were pera (Clavien–Dindo grades I and II), with no severe complications (Clavien–Dindo grades IV

TABLE 1. **Demographic and preoperative parameters between groups**

Parameter	All patients (n = 174)	Primary HoLEP (n = 137)	Secondary HoLEP (n = 37)	*p* value
Age (years)	67.68 ± 8.65	67.84 ± 8.67	67.24 ± 8.66	0.840°
ASA score (I/II/III/IV)	81/48/41/4	73/39/30/3	8/9/11/1	—
Anticoagulation (n)	51	36	15	0.910^
Urinary catheter (n)	52	45	7	0.232^
Alpha-blocker (n)	153	123	30	0.149^
Dutasteride (n)	53	43	10	0.609^
Incontinence (n)	46	33	13	0.176^
Bladder stone (n)	15	8	7	0.012♦
Prostate biopsy (n)	9	8	1	0.445^
Prostate volume (mL)	70.30 ± 26.91	67.34 ± 24.90	81.24 ± 31.30	0.012♦
IPSS	21.86 ± 5.71	21.75 ± 5.70	22.31 ± 5.88	0.654°
QoL score	4.15 ± 0.99	4.17 ± 0.99	4.08 ± 1.01	0.533°
Qmax (mL/s)	6.29 ± 5.32	5.82 ± 5.12	8.06 ± 5.77	0.027♦
PVR (mL)	120.12 ± 117.88	120.61 ± 126.24	118.32 ± 81.72	0.441♦
PSA (ng/mL)	3.55 ± 2.88	3.56 ± 2.90	3.48 ± 2.82	0.880♦

Note. All values represent mean ± SD or frequency (n.); °Student's *t*-test; ^Chi-square test; ♦Mann–Whitney U test; ASA, American Society of Anesthesiologists; IPSS, International Prostate Symptom Score; QoL, Quality of Life; Qmax, Maximum flow rate; PVR, Post-void residual volume; PSA, Prostate-specific antigen; HoLEP, Holmium Laser Enucleation of the Prostate; —, Not applicable. Preoperative demographic characteristics for the entire cohort and for each group separately are reported.

and V). Grade 1 complications primarily included catheter-related severe pain and urinary retention. These events were observed in 13 patients in group 1 and seven patients in group 2. Grade 2 complications consisted of urinary tract infection and hemorrhage requiring blood transfusion. A total of 13 patients experienced grade 2 complications, of whom 10 were in group 1 and three in group 2. Endoscopic evacuation for clot retention was performed in three patients who presented with grade 3a complications. Four patients required anesthesia for coagulation due to significant hemorrhage and were classified as having grade 3b complications (group 1: 3 patients; group 2: 1 patient).

According to the postoperative third-month functional outcomes presented in Table 3, Qmax in cohort 2 (25.37 ± 7.17) was significantly higher than in cohort 1 (21.10 ± 8.78; $p = 0.009$). Although a reduction in PVR was observed in cohort 2, the difference between the groups was not statistically significant ($p = 0.291$). At three months postoperatively, no significant differences were detected in IPSS or QoL scores. Thirteen patients presented with severe obstructive voiding symptoms and were diagnosed with urethral stricture ($p = 0.868$). Internal urethrotomy was conducted in these cases. Overall, persistent incontinence was observed in 29 patients (16%). Furthermore, the frequencies of urinary incontinence enduring at three months did not vary between the cohorts ($p = 0.679$). Multivariate logistic regression analysis revealed that preoperative urinary incontinence was the only independent predictor of postoperative urinary incontinence (OR: 6.053; 95% CI: 2.376–15.420; $p < 0.001$). No other variables were found to be statistically significant (Table 4).

A group-based comparison of postoperative functional outcomes demonstrated no significant difference between primary and secondary HoLEP in terms of Δqmax, ΔIPSS, or ΔqoL (Table 5). However, the reduction in PVR was significantly greater in the secondary HoLEP group ($p = 0.035$). Overall, both groups showed comparable improvements across functional parameters.

TABLE 2. **Intraoperative and postoperative parameters between groups**

Parameter	All patients	Primary HoLEP	Secondary HoLEP	*p* value
Enucleation time (min)	53.77 ± 17.84	52.95 ± 16.52	56.42 ± 18.19	0.447♦
Morcellation time (min)	13.61 ± 6.46	13.12 ± 5.79	15.46 ± 8.32	0.218♦
Enucleation efficiency (g/min)	0.73 ± 0.27	0.70 ± 0.22	0.84 ± 0.38	0.054♦
Morcellation efficiency (g/min)	1.89 ± 0.73	1.87 ± 0.75	1.96 ± 0.67	0.338♦
Enucleated tissue weight (g)	38.79 ± 17.75	37.12 ± 16.31	44.95 ± 21.44	0.037♦
Blood transfusion (n)	5	4	1	0.944^
Catheter removal time (h)	38.96 ± 7.86	38.54 ± 7.74	40.51 ± 8.21	0.206♦
Clavien–Dindo grade (0/I/II/IIIa/IIIb)	134/20/13/3/4	110/13/10/1/3	24/7/3/2/1	0.141^

Note. All values represent mean ± SD or frequency (n.); ^Chi-square test; ♦Mann–Whitney U test; HoLEP, Holmium Laser Enucleation of the Prostate.

TABLE 3. **Postoperative outcomes at 3 months between groups**

Parameter	All patients	Primary HoLEP	Secondary HoLEP	*p* value
Qmax (mL/s)	22.00 ± 8.62	21.10 ± 8.78	25.37 ± 7.17	0.009♦
PVR (mL)	27.47 ± 40.40	29.22 ± 43.12	21.08 ± 27.92	0.291♦
IPSS	7.95 ± 2.27	8.31 ± 2.83	7.19 ± 2.11	0.079°
QoL score	1.57 ± 1.02	1.56 ± 0.98	1.58 ± 1.17	0.942°
Incontinence (n)	29	22	7	0.679^
Urethral stricture (n)	13	10	3	0.868^

Note. All values represent mean ± SD or frequency (n.); °Student's *t*-test; ^Chi-square test; ♦Mann–Whitney U test; Qmax, Maximum flow rate; PVR, Post-void residual volume; IPSS, International Prostate Symptom Score; QoL, Quality of Life; HoLEP, Holmium Laser Enucleation of the Prostate.

Discussion

Some evidence suggests that prior surgical interventions may complicate anatomical dissection by altering tissue planes, which could potentially affect operative efficiency and postoperative recovery.[9] Conversely, other reports emphasize the feasibility and safety of salvage HoLEP, highlighting its anatomical precision and low morbidity even in complex cases.[10] The absence of consensus and the scarcity of high-quality comparative data have resulted in a knowledge gap that impedes optimal patient counseling and surgical decision-making.[11]

A total of 119 studies comprising 130,106 patients were included in the meta-analysis. The reoperation rates after TURP were 4.0% at 1 year, 5.0% at 2 years, 6.0% at 3 years, and 7.7% at 5 years. For open prostatectomy, the reoperation rates were 1.3% at 1 year and 4.4% at 5 years.[2] We were able to obtain data on the interval between two surgeries in 14 of the 37 patients with recurrence. Among these, one patient experienced recurrence as early as 2 years and another at 4 years post-TURP; in both cases, the diagnosis was confirmed by cystoscopy. In the remaining patients, the recurrence interval ranged from 6 to 17 years. The reported frequency of reoperation following TURP is consistent with several large-scale studies. Although the initial prostate volume was not specified in most of these studies, it can be inferred that the likelihood of subsequent intervention increases with larger prostate sizes. The primary reason for reintervention is insufficient tissue removal. In a large cohort study comparing TURP and HoLEP outcomes, the reoperation rate was significantly higher in the TURP group (4.50%) than in the HoLEP group (1.27%) over a six-year follow-up period.[12]

HoLEP is a highly suitable technique for both primary and secondary prostate surgeries due to its minimally invasive nature and proven efficacy in achieving complete excision of prostatic tissue. A critical aspect that should not be overlooked is that accurate identification of the prostatic capsule and maintenance of the correct surgical plane constitute the cornerstone of the HoLEP procedure. However,

TABLE 4. **Multivariate logistic regression analysis for postoperative urinary incontinence after HoLEP**

Variables	B	S.E.	Wald	df	*p*-value	Exp(B)	95% CI for Exp(B)
Bladder stone (yes)	−0.142	0.740	0.037	1	0.848	0.868	0.204–3.700
Preoperative PSA	−0.069	0.094	0.532	1	0.466	0.934	0.777–1.123
Prior TURP (yes)	0.056	0.551	0.010	1	0.919	1.057	0.359–3.116
Prostate volume(mL)	−0.021	0.020	1.084	1	0.298	0.980	0.942–1.018
Enucleated tissue weight (g)	0.056	0.034	2.758	1	0.097	1.058	0.990–1.130
Enucleation time (min)	−0.015	0.019	0.622	1	0.430	0.985	0.950–1.022
Alpha-blocker use (yes)	−0.027	0.673	0.002	1	0.968	0.973	0.260–3.642
Preoperative incontinence (yes)	1.800	0.477	14.240	1	<0.001	6.053	2.376–15.420
Catheter removal time (hr)	−0.024	0.040	0.344	1	0.557	0.977	0.903–1.057
Constant	1.763	1.267	1.936	1	0.164	5.831	–

Note. HoLEP, Holmium Laser Enucleation of the Prostate; PSA, Prostate specific Antigene; TURP, Transurethral Resection of the Prostate; B, Coefficient; S.E., Standard Error; df, Degrees of Freedom; CI, Confidence Interval; –, Not applicable. In the multivariate logistic regression analysis, preoperative urinary incontinence was the only independent predictor of postoperative urinary incontinence after HoLEP.

TABLE 5. **Group-based comparison of postoperative functional outcomes using Δ-changes**

Parameter	Primary HoLEP (95% CI)	Secondary HoLEP (95% CI)	*p* value°
ΔQmax (mL/s)	13.74 ± 11.56 (−5.66 to 2.64)	15.25 ± 10.57 (−5.50 to 2.48)	0.240
ΔPVR (mL)	−90.05 ± 128.63 (−37.22 to 51.59)	−97.24 ± 89.23 (−29.28 to 43.65)	0.035
ΔIPSS	−10.73 ± 7.51 (−2.93 to 2.70)	−10.62 ± 8.41 (−3.17 to 2.94)	0.231
ΔQoL	−2.05 ± 1.65 (−0.91 to 0.32)	−1.75 ± 1.84 (−0.96 to 0.37)	0.259

Note. All values represent mean ± SD. °: Independent-samples *t* test; Qmax, Maximum flow rate; PVR, Post-void residual volume; IPSS, International Prostate Symptom Score; QoL, Quality of Life; Δ = postoperative value − preoperative value.

repeat BPH surgeries raise concerns regarding the surgeon's ability to consistently maintain dissection within the appropriate anatomical plane. Consequently, the duration of the procedure may serve as an indirect indicator of intraoperative complexity. The enucleation and morcellation times of primary and secondary HoLEP procedures in the present study did not show any significant differences compared with those reported in previous studies.[13] However, prostate size was markedly larger in the post-TURP cohort compared with the other group, and the enucleated tissue weight was also greater in this cohort, in contrast to the findings of a previous study.[14] Regrettably, the data pertaining to prostate volume preceding the commencement of initial BPH treatment were not accessible for examination. It is likely that TURP was performed in patients with large prostates, where only median lobe resection could be achieved within the limited operative time. Consequently, the residual prostate tissue continued to grow.

In our study, almost all recurrence cases demonstrated marked enlargement of the lateral lobes, whereas the median lobe was nearly absent. This observation prompted us to modify our surgical approach. Initially, we employed the conventional tri-lobe enucleation technique; however, in subsequent cases, we adopted a bi-lobe enucleation approach.

The bi-lobe technique allowed for a more focused dissection of the enlarged lateral lobes while minimizing unnecessary manipulation in the median lobe region, which was often minimal or absent in these patients. This adjustment reduced operative time and provided better control of the surgical plane, particularly in prostates with asymmetric regrowth after previous TURP. Moreover, despite deviating from the standard tri-lobe approach, we did not encounter significant intraoperative difficulties or an increased rate of complications.

Overall, our findings suggest that the bi-lobe technique may offer a practical and efficient alternative in selected post-TURP cases with predominant lateral lobe hypertrophy.

Patients in the contemporary cohort who underwent secondary HoLEP demonstrated excellent functional outcomes, comparable to those observed in the primary HoLEP group and in other large series. Regarding voiding parameters, both PVR and Qmax improved significantly in each group, consistent with findings reported in extensive case analyses.[15,16] Furthermore, comparison of IPSS and QoL scores between groups 1 and 2 revealed a subjective improvement in symptoms following HoLEP. These results are in line with the findings of Enikeev et al. And Jiang et al., who similarly reported significant improvements in PVR, IPSS, and QoL parameters among patients with BPH following HoLEP.[17,18]

A previous study comparing the outcomes of salvage HoLEP after different prior surgical procedures reported longer total operative time, morcellation time, and catheterization time in the salvage group, despite similar preoperative prostate volumes.[19] In contrast, our findings showed no significant differences in these parameters. This discrepancy may be explained by the inclusion criteria of Durant et al., who grouped various prior interventions, such as transurethral microwave thermotherapy and photoselective vaporization, together with TURP. These techniques tend to leave more residual tissue and cause more pronounced anatomical alterations than TURP alone.

These findings suggest that the nature of the previous surgical intervention plays a critical role in determining the complexity of salvage HoLEP. Therefore, when evaluating operative efficiency and outcomes, it is essential to distinguish between patients with prior TURP and those who have undergone other minimally invasive procedures.

Urinary incontinence is a common postoperative complication following HoLEP.[20] Recently introduced HoLEP techniques have demonstrated variable rates of postoperative urinary incontinence. Kim et al. Reported a 2% incidence with the 'Inverted Omega En-bloc' technique,[21] whereas Demirtas et al. Observed a 33% rate using the 'Reverse S-J incision' technique.[22] In the current investigation, no instances of urinary incontinence attributable to sphincteric damage were documented. Within the three-month post-operative period, 29 (16%) patients exhibited ongoing urinary incontinence.

It should be noted that longer follow-up durations may lead to improved continence outcomes. Several studies have reported a significant reduction in urinary incontinence rates and an improvement in symptom scores within 6 months after HoLEP, suggesting that early postoperative results may underestimate long-term functional recovery.[23]

The primary outcome of concern was urethral stricture, as repeated procedures are known to increase the risk of its occurrence. However, in the present study, no significant difference in stricture rates was observed between the two groups. Although no cases of bladder neck contracture were identified, the incidence of urethral strictures was consistent with previously reported data in the literature.[24] In a long-term follow-up study spanning 6 months to 10 years, the incidence of urethral stricture was found to be comparable to that in our cohort.[25] This finding indicates that the majority of strictures likely develop within the early postoperative period, particularly during the first 3 months.

The selection of the enucleation technique should be guided by the prostate's anatomical configuration and volume. From a clinical standpoint, the bi-lobe technique seems to facilitate better exposure and tissue handling, making it a more practical option in Salvage HoLEP cases.

While our comparison between primary and salvage HoLEP remains robust, it should be interpreted within the context of evolving guideline recommendations that continue to broaden the spectrum of acceptable surgical options for BPH. Current EAU guidance increasingly acknowledges multiple enucleation and non-laser modalities as viable alternatives in selected patients, particularly those with specific anatomical features or concerns regarding preservation of sexual function.

Although retreatment procedures are not distinctly addressed as a separate category in existing EAU algorithms, our findings provide meaningful real-world data supporting salvage HoLEP as an effective and reliable intervention. These outcomes, achieved in the hands of an experienced surgeon, reinforce the role of HoLEP as a durable option even in the retreatment setting.

Given that all procedures were performed by a single surgeon who had already surpassed the HoLEP learning curve, the technical consistency across cases reduces surgeon-related variability and strengthens the internal validity of our findings. However, this also limits external generalizability, as outcomes achieved by an experienced high-volume surgeon may not fully reflect results in lower-volume or early-learning settings. Therefore, surgeon experience should be considered when interpreting the comparative outcomes between primary and secondary HoLEP.

This study demonstrates that HoLEP is a safe and effective option for both primary and salvage procedures, providing comparable functional outcomes and low complication rates. However, several limitations should be considered. The retrospective design prevented a priori power calculation, and the sample size of the salvage group (n = 37) limits the statistical power for detecting differences in functional outcomes and complication rates, introducing a potential risk of type II error. These constraints should be considered when interpreting the results. The interval between the index TURP and salvage HoLEP was only available for 14 out of 37 patients, ranging from 2 to 17 years. The largely missing data regarding this surgical interval represents a major methodological limitation. The duration between procedures is a critical factor that potentially dictates the degree of peri-prostatic fibrosis, alteration of anatomical planes, and overall surgical complexity. Consequently, the absence of this information limits our ability to fully characterize the technical challenges encountered during salvage HoLEP and may confound the generalizability of our perioperative results. Sexual and ejaculatory functions were not evaluated, and the short and variable follow-up restricted analysis of long-term efficacy, durability, and complication rates. Because multiple statistical comparisons were performed without formal correction, the risk of type I error is increased; therefore, the results should be interpreted as exploratory.

Conclusion

Within the constraints of its retrospective design and short-term follow-up, this study suggests that HoLEP is a feasible option in the salvage setting. However, due to the exploratory framework of this analysis and the aforementioned methodological caveats, definitive conclusions regarding the long-term clinical equivalence of primary and salvage HoLEP cannot be drawn. Further high-powered, prospective studies with extended follow-up are essential to validate these preliminary findings and to more accurately assess late complications such as stricture formation and continence durability.

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Author Contributions

Volkan Sabur conceived and designed the study, and wrote the draft. Abdullah Gölbaşı collected data, reviewed the literature, performed the analyses, and prepared the manuscript. All authors provided critical feedback to each other and contributed to the final manuscript after discussing the results and commenting on the manuscript. There are no other persons who met the authorship criteria but are not listed. All authors reviewed and approved the final version of the manuscript.

Availability of Data and Materials

The datasets supporting the findings of the current study are openly available in https://doi.org/10.5281/zenodo.16995112.

Ethics Approval

All procedures performed in the studies involving human participants followed the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards. Ethics committee approval was obtained from the University of Health Sciences Medical Faculty of Kayseri.

The approval was formally documented at the meeting held on 17 June 2025, and the document was assigned the reference number 2025/471. Informed consent was obtained from the patient at every treatment step throughout the entire treatment process in which a healthcare professional educated the patient about the risks, benefits, and alternatives of a given procedure or intervention.

Conflicts of Interest

The authors declare no conflicts of interest.

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