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ARTICLE

Virtual basket mode in HoLEP: reduced early dysuria and faster continence recovery without loss of efficacy

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Objectives: *Holmium laser enucleation of the prostate (HoLEP) is an established treatment for benign prostatic hyperplasia (BPH), but early postoperative dysuria and incontinence remain common concerns. The Virtual Basket (VB) mode has been proposed to reduce tissue trauma. This study evaluated whether VB use improves early postoperative recovery without compromising HoLEP efficacy.*

Methods: *We retrospectively analyzed 168 men who underwent HoLEP between September 2023 and September 2024. Patients were categorized into three groups according to laser settings: 100 W Standard (n = 65), 100 W VB (n = 49), and 80 W VB (n = 54). The primary outcomes were postoperative dysuria and urinary incontinence at 1 and 3 months. Secondary outcomes included catheterization time, hemoglobin drop, surgical and energy efficiency, and perioperative complications. Logistic regression and receiver operating characteristic (ROC) analyses were performed to identify predictors of persistent incontinence.*

Results: *At 1 month, dysuria occurred more frequently in the Standard group (32.3%) than in the VB groups (15.6%) (p = 0.037). This difference was resolved within 3 months. Persistent urinary incontinence at 3 months was significantly lower in the VB groups (2.0% and 1.9%) compared with the Standard group (9.2%) (p = 0.031). Surgical efficiency was higher with Standard HoLEP (2.63 g/min vs. 1.8 g/min, p = 0.035), while energy efficiency was comparable across groups. The 100 W VB group had shorter catheterization times (p < 0.001) and less hemoglobin loss (p = 0.004). Logistic regression identified prostate volume as an independent predictor of incontinence (odds ratio [OR] = 1.018, 95% CI: 1.001–1.034, p = 0.035). ROC analysis demonstrated moderate predictive accuracy (area under curve [AUC] = 0.776).*

Conclusions: *VB-HoLEP significantly reduces early dysuria and accelerates continence recovery while maintaining safety and efficacy. These findings support the routine use of VB mode to improve postoperative recovery and patient satisfaction.*

Key Words: holmium laser enucleation of the prostate (HoLEP), virtual basket, benign prostatic hyperplasia, dysuria, urinary incontinence

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Introduction

Holmium laser enucleation of the prostate (HoLEP) has become a preferred surgical treatment for benign prostatic hyperplasia (BPH), especially in patients with large prostate volumes.[1,2] Compared to traditional techniques such as transurethral resection of the prostate (TURP), HoLEP offers favorable long-term outcomes, with reduced bleeding, shorter

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catheterization time, and a low risk of retreatment.[3–5] However, transient postoperative irritative symptoms—such as dysuria, urgency, and urinary incontinence—remain common and can negatively affect early patient satisfaction.[6,7]

These symptoms are believed to result from mechanical or thermal trauma to the bladder neck, external sphincter, or prostatic urethra during surgery. While they are usually self-limited, occurring in up to 30% of patients in the early postoperative period, they may delay recovery and increase the need for anticholinergic or analgesic medications.[8] Consequently, optimizing laser parameters to reduce postoperative morbidity without compromising the efficacy of enucleation remains a clinical priority.

One recent advancement is the use of modulated laser energy modes, such as the Virtual Basket (VB) setting.[9] This dual-pulse mode was initially developed to reduce stone retropulsion but has since been applied to soft tissue surgery.[10] Theoretically, it improves cutting precision and haemostasias by delivering energy through a preformed vapors bubble channel, thereby reducing collateral tissue damage.[11] Early studies suggest that VB mode may offer technical advantages, including better visibility and reduced bleeding, but its potential to reduce irritative symptoms has not been clearly demonstrated.[11]

This study aimed to compare postoperative dysuria and urinary incontinence among patients undergoing HoLEP using three laser settings: conventional 100 W, 100 W VB, and 80 W VB. We hypothesized that the use of VB mode—particularly at lower power—would reduce the incidence of early irritative symptoms without impairing surgical efficacy.

Materials and Methods

Study design

This retrospective cohort study included male patients who underwent HoLEP between 01 September 2023 and 01 September 2024, at the urology department of Izmir Katip Celebi University. The study was conducted in accordance with the principles of the Declaration of Helsinki. Ethical approval was obtained from Izmir Katip Celebi University Health Research Institutional Review Board (IRB number: 0182, Date: 17 October 2024). Written informed consent was obtained from all patients prior to participation in the study.

Patients

Patients were categorized into three groups based on the laser energy mode and power setting used during the procedure: 100 W Standard mode, 100 W VB mode, and 80 W VB mode.

Patients aged 50 years or older who underwent HoLEP and had complete preoperative and postoperative clinical records were included. Patients were required to have a minimum follow-up period of 3 months. Exclusion criteria were pre-existing urinary incontinence, prior prostate surgery, neurogenic bladder, active urinary tract infection, known urethral strictures, or incomplete follow-up data. The collected preoperative characteristics included age, body mass index (BMI), prostate-specific antigen (PSA) level, comorbidities (diabetes, hypertension, anti-coagulant use, ASA score), catheter status, IPSS, and IIEF-5 scores. Patients with a preoperative PSA level $\geq$ 4.0 ng/mL who underwent prostate magnetic resonance imaging (MRI) and were found to have PIRADS $\geq$ 3 lesions were also excluded from the study.

Procedures

All HoLEP procedures in this study were performed by surgeons who had already surpassed the learning curve and achieved a stable level of proficiency. The operations were conducted in a high-volume, tertiary referral urology center with extensive experience in endoscopic prostate surgery. Before the introduction of the VB mode, the surgical team had already accumulated substantial experience with standard HoLEP procedures. Therefore, all operations were carried out by experienced surgeons, minimizing the potential confounding effect of surgical learning. All procedures were performed using the standard three-lobe enucleation technique, without any modification between the standard and VB groups. The same holmium:YAG laser fiber and a 26 Fr continuous-flow resectoscope were used for all cases to ensure procedural uniformity. Laser settings were determined by the surgeon based on intraoperative factors and prostate characteristics. Surgical time was defined as the interval between endoscope insertion and completion of morcellation, including the enucleation and hemostasis phases.

Follow-up

Clinical follow-up was conducted at 1, 3, and 6 months postoperatively. The primary endpoints were the presence of postoperative dysuria and urinary incontinence, assessed based on patient-reported symptoms and medical records. To evaluate postoperative dysuria, each patient was asked if they

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experienced pain or a burning sensation during urination, and their responses were recorded accordingly. To evaluate urinary incontinence, patients were asked if they experienced urine leakage (*yes/no*). Patients who answered 'yes' and used at least one pad per day were classified as incontinent. Secondary outcomes included catheterization time, hemoglobin decrease, anticholinergic drug usage, surgical and energy efficiency metrics, and perioperative complications. Surgical efficiency was defined as the ratio of enucleated tissue weight (g) to enucleation time (min), expressed as g/min. Energy efficiency was defined as the enucleated tissue weight (g) divided by the total laser energy used (kJ), expressed in grams per kilojoule.

Statistical analysis

Continuous variables were reported as medians with interquartile ranges (IQRs), given the non-normal distribution of data. Normality was assessed using the Kolmogorov-Smirnov test. For group comparisons, the Mann–Whitney U test was used for two-group comparisons and the Kruskal-Wallis test for comparisons among more than two groups. Categorical variables were analyzed using the Chi-square test or Fisher's exact test, as appropriate. Significant findings were further analyzed with post hoc pairwise comparisons using Bonferroni correction. Binary logistic regression analysis was performed to identify independent predictors of urinary incontinence at three months. The diagnostic performance of significant variables was evaluated using receiver operating characteristic (ROC) curve analysis. A *p*-value of <0.05 was considered statistically significant. A post-hoc power analysis was conducted for the primary endpoint (dysuria at 1 month). Based on the observed proportions in the Standard group (32.3%; n = 65) versus the combined VB groups (15.6%; n = 103), the effect size was Cohen's h = 0.398. With $\alpha = 0.05$ and the total sample size of 168, the achieved statistical power was 0.79 for a one-sided and 0.69 for a two-sided test, indicating adequate power to detect a clinically meaningful difference. All analyses were performed using SPSS for Windows, Version 29.0 (IBM Corp., Armonk, NY, USA).

Results

Preoperative characteristics

A total of 168 patients were included in the study and stratified into three groups according to laser energy mode and power: 100 W Standard mode (n = 65), 100 W VB mode (n = 49), and 80 W VB mode (n = 54). Preoperative clinical characteristics were generally similar among the three laser energy groups. The mean ages were 66.5 ± 7.1, 67.6 ± 6.6, and 66.6 ± 8.0 years, respectively ($p = 0.7689$). Body mass index also did not differ significantly (25.9 ± 3.2; 26.7 ± 3.8; 27.1 ± 3.9 kg/m^2; $p = 0.2979$). PSA levels tended to be higher in the 100 W Virtual Basket group, although not statistically significant (5.64 ± 6.87 ng/mL; $p = 0.0765$). IPSS and IIEF-5 scores were comparable across groups ($p = 0.8107$ and $p = 0.9667$, respectively). There were also no significant differences in comorbidities or risk factors, including diabetes, hypertension, anticoagulant use, ASA score, and preoperative catheter presence ($p > 0.05$) (Table 1).

Operational findings

There were no significant differences among the three groups in terms of total operative time, morcellation time, or enucleation time ($p > 0.05$). Although the enucleated tissue volume was higher in the 100 W VB group, this difference did not reach statistical significance ($p = 0.0627$). The total laser energy applied was also similar across groups ($p = 0.3070$). Postoperative hospital stay was short and comparable in all groups, averaging approximately 1.1–1.4 days. However, catheterization time differed significantly, being notably shorter in the 100 W VB group ($p < 0.001$) (Table 1).

The mean surgical efficiency (enucleated grams per minute) was 2.63 ± 1.99, 1.84 ± 0.71, and 1.78 ± 1.05 for the 100 W Standard, 100 W VB, and 80 W VB groups, respectively, with a *p*-value at the borderline of statistical significance ($p = 0.051$) (Table 1). Pairwise comparison showed that the Standard energy group had significantly higher surgical efficiency compared to the VB group ($p = 0.035$), confirming that more tissue was removed per operative minute in the Standard group. Energy efficiency (enucleated grams per kJ used) did not differ significantly among the groups (g/kJ; $p = 0.320$) (Figure 1, Table 1).

Functional outcomes

At postoperative month 3, there were no significant differences among the groups in terms of Qmax, IPSS, or IIEF-5 scores ($p > 0.05$). Although there was no significant difference in postvoid residual urine volume between groups, all showed a decrease compared to baseline.

The rates of urinary incontinence at month 1 were similar among groups, recorded as 13.8%, 12.2%, and 9.3%, respectively ($p = 0.742$) (Table 1). By month 3, incontinence rates were 9.2% in the 100 W Standard group, 2.0% in the 100 W VB group, and 1.9% in the

TABLE 1. **Energy type comparison**

Variable	100 W Standard (n = 65)	100 W VB (n = 49)	80 W VB (n = 54)	*p*-value
Age (years), mean ± SD	66.48 ± 7.13	67.55 ± 6.60	66.63 ± 7.99	0.768
BMI (kg/m²), mean ± SD	25.89 ± 3.20	26.68 ± 3.77	27.12 ± 3.91	0.297
Catheterization time (days), mean ± SD	3.55 ± 2.28	2.51 ± 1.79	3.00 ± 0.91	<0.001
Surgical time (min), mean ± SD	71.71 ± 44.32	76.63 ± 47.71	66.81 ± 28.46	0.644
Energy emitted (kJ), mean ± SD	174.77 ± 75.74	184.10 ± 85.49	154.60 ± 51.36	0.307
Lasing time (min), mean ± SD	27.62 ± 12.79	34.30 ± 17.57	27.99 ± 10.17	0.134
Enucleated volume (g), mean ± SD	50.37 ± 28.44	62.33 ± 40.62	45.89 ± 24.78	0.062
Surgical efficiency (g/min), mean ± SD	2.63 ± 1.99	1.84 ± 0.71	1.78 ± 1.05	0.050
Energy efficiency (g/kJ), mean ± SD	3.46 ± 1.64	3.55 ± 1.88	4.09 ± 2.03	0.320
Dysuria at 1st month (%)	32.3%	14.3%	16.7%	0.037
Dysuria at 3rd month (%)	5%	4.1%	3.7%	0.800
Retrograde Ejaculation (%)	83.7%	87.5%	86.7%	0.925
Incontinence at 1st month (%)	13.8%	12.2%	9.3%	0.742
Incontinence at 3rd month (%)	9.2%	2.0%	1.9%	0.098
Incontinence at 6th month (%)	3.1%	0.0%	1.9%	0.472
Hemoglobin drop (g/dL), mean ± SD	1.84 ± 1.07	1.29 ± 0.98	1.62 ± 1.08	0.004

80 W VB group (p = 0.098). Pairwise comparisons revealed that the Virtual Basket groups had significantly lower incontinence rates compared to the Standard energy group ($p = 0.031$) (Figure 2, Table 2).

Regarding dysuria, a significant difference was observed at month 1, with the 100 W Standard group showing a notably higher rate ($p = 0.037$). However, this difference disappeared by month 3 ($p = 0.800$) (Figure 3, Table 1).

Complications and other findings

Postoperative use of anticholinergic medications was significantly more frequent in the 100 W Standard group ($p = 0.0044$). Rates of retrograde ejaculation were high and similar across all groups ($p = 0.925$). There was no significant difference in the need for re-operation ($p = 0.0920$).

Regarding hemoglobin decrease, a significant difference was observed among groups, with the smallest decrease in the 100 W VB group and the largest in the 100 W Standard group ($p = 0.004$). Major bleeding events occurred only in the 100 W Standard group, with this difference at the borderline of statistical significance ($p = 0.0565$). A total urethral stricture rate of 11.3% was observed. No significant differences were found in the incidence of urethral stricture or bladder neck contracture ($p = 0.1571$ and $p = 0.1132$, respectively).

The detection rate of pathological prostate cancer differed significantly among groups ($p = 0.0007$), being highest in the 100 W VB group (2.0%), followed by the 80 W VB group (1.9%), while no cancer was detected in the 100 W Standard group. No significant

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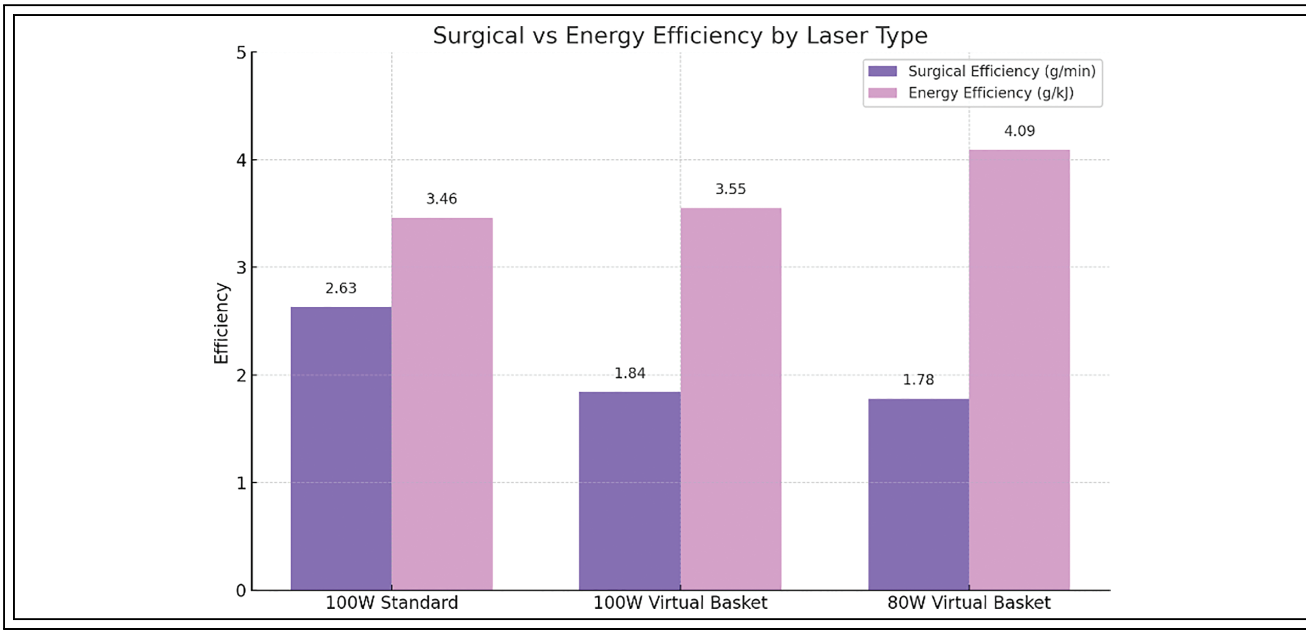


FIGURE 1. Surgical and energy efficiency according to laser types (100 W Standard, 100 W VB, 80 W VB)

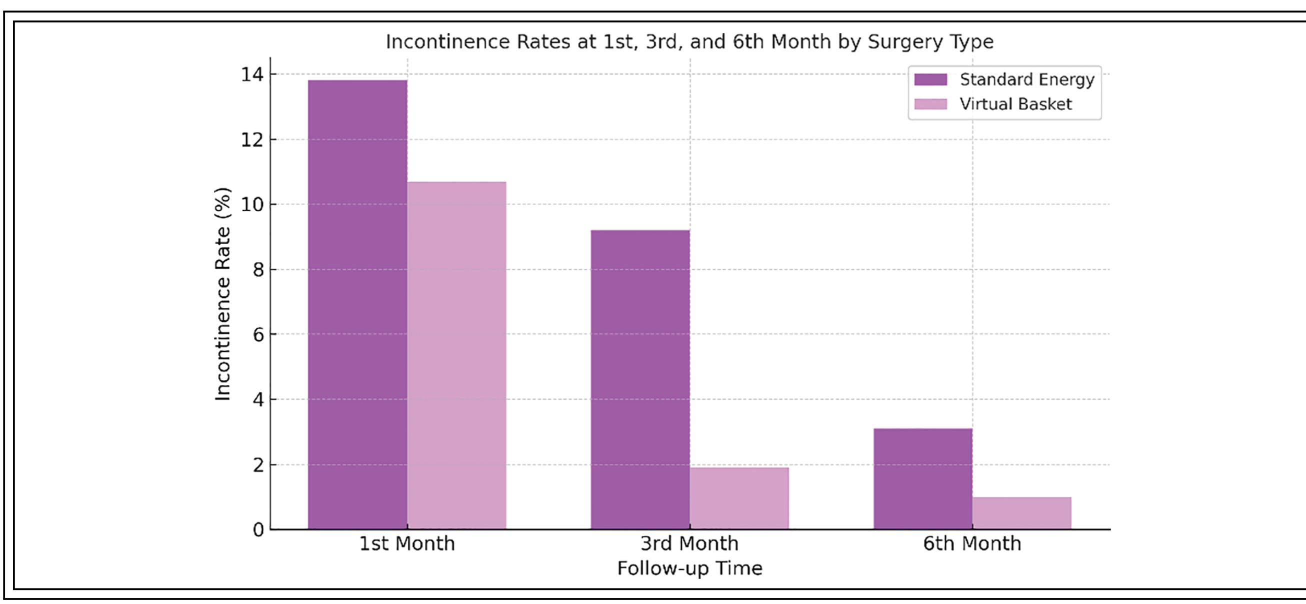


FIGURE 2. Urinary incontinence rates at 1st, 3rd, and 6th months by energy modality (Standard vs. Virtual Basket)

differences were observed for non-prostatic pathologies ($p = 0.1336$).

Logistic regression and ROC analysis

A binary logistic regression model was developed to predict urinary incontinence at 3 months postoperatively. The model was statistically significant ($p = 0.006$; Nagelkerke $R^2 = 0.226$). Among the variables included, prostate volume was found to be a significant independent predictor (odds ratio [OR] = 1.018, 95% CI: 1.001–1.034; $p = 0.035$), while the type of surgery (100 W Standard vs. VB modes) showed a trend toward significance (OR = 7.03, 95% CI: 0.81–60.73; $p = 0.083$). Receiver operating characteristic

TABLE 2. **Comparison of surgical efficiency and urinary incontinence rates between standard energy and VB groups**

Variable	Standard energy (n = 65)	Virtual basket (n = 103)	*p*-value
Surgical efficiency (g/min), mean ± SD	2.63 ± 1.98	1.80 ± 0.90	0.035
Incontinence at 1st month (%)	13.8%	10.7%	0.538
Incontinence at 3rd month (%)	9.2%	1.9%	0.031
Incontinence at 6th month (%)	3.1%	1.0%	0.317

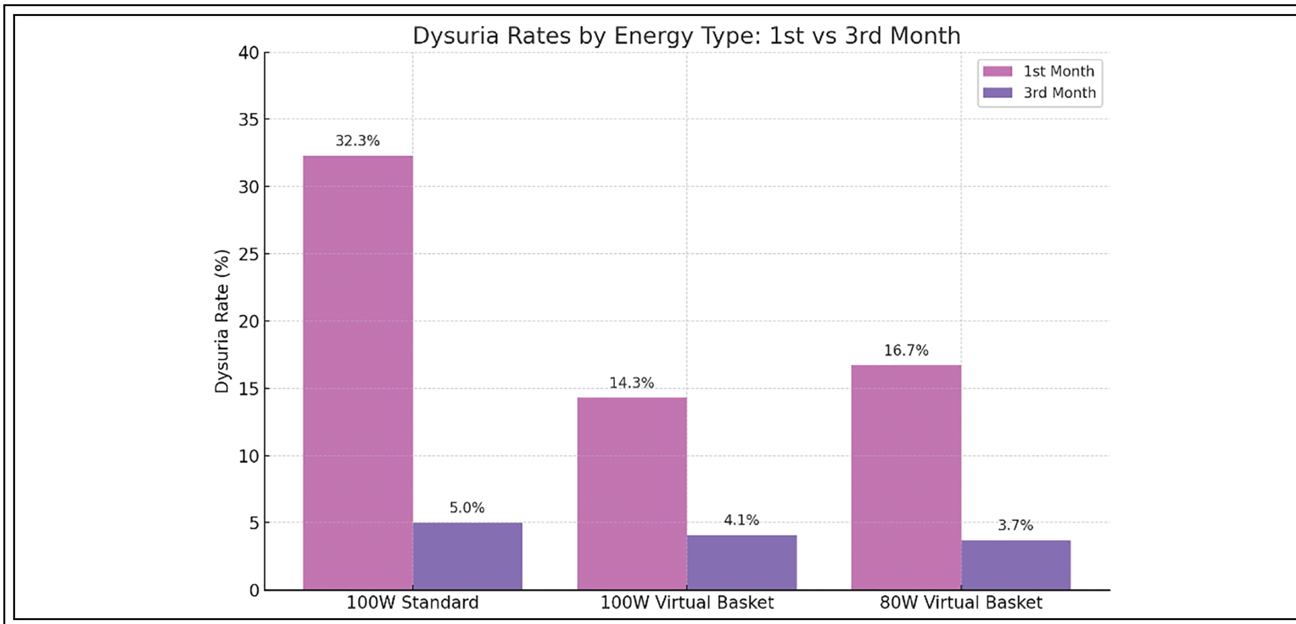


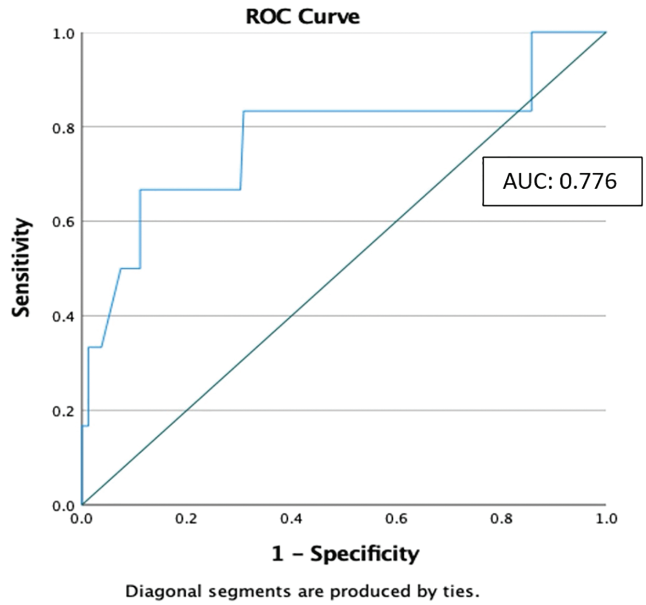
FIGURE 3. Dysuria rates at 1st and 3rd months according to energy type

(ROC) analysis demonstrated good discriminative ability, with an area under the curve (AUC) of 0.776 (95% CI: 0.503–0.968). At the optimal cut-off point, the model achieved a sensitivity of 66.7% and specificity of 82.7%, indicating that it is moderately effective in identifying patients at risk of postoperative urinary incontinence (Figure 4).

Discussion

This study demonstrated that the 100 W Standard mode resulted in a significantly higher incidence of dysuria at 1 month (32.3%) compared to the VB modes (14.3% for 100 W VB and 16.7% for 80 W VB). This difference in irritative symptomatology suggests that VB pulse modulation confers a protective effect against early postoperative dysuria, likely through reduction of collateral thermal and mechanical damage to the urethral mucosa and sphincter region. Notably, by 3 months, the dysuria rates equalized to low levels across all groups (~4%–5%),[12] indicating that dysuria is largely a transient issue. This temporary nature should be emphasized during preoperative counseling to reassure patients about the expected course of postoperative symptoms.

Regarding early postoperative urinary incontinence (UI), while overall rates at 1 month were not significantly different between groups (~10%–14%), by the 3-month follow-up, the combined VB groups



Sensitivity	Specificity	Area	95% Confidence Interval
66.7%	82.7%	0.776	0.503-0.968

FIGURE 4. Receiver operating characteristic (ROC) curve for predicting urinary incontinence at 3 months

had a significantly lower incidence of persistent incontinence (~2%) compared to the Standard 100 W group (~9%).[11] This implies that patients treated with VB-HoLEP tend to recover continence faster in the early months after surgery. By 3–6 months, most cases of HoLEP-related incontinence in all groups were transient and had resolved, consistent with prior observations that post-HoLEP urinary leakage is usually temporary and disappears within the first few months.[7,13–17] Even transient incontinence can negatively impact patient satisfaction and quality of life in the recovery phase.[11,18]

Mechanistically, the VB mode's dual-pulse energy delivery might reduce inadvertent trauma to continence structures (external sphincter and bladder neck) by allowing more controlled enucleation and hemostasis, thereby lessening the risk of sphincteric injury or edema that contributes to stress incontinence in the immediate postoperative period. Similar findings were reported by Heidenberg et al., who demonstrated that techniques minimizing apical and peri-sphincteric traction such as early apical release significantly improved early continence recovery after HoLEP.[19] Interestingly, Bozzini et al.[11] previously noted that shorter operative time in HoLEP correlates with reduced postoperative incontinence risk.[20] In their randomized comparison, the VB mode significantly shortened enucleation time, supporting the postulate that VB-HoLEP might lower transient UI incidence.[21] Although our overall operative times were comparable between groups, the enucleation phase was shorter with VB mode. However, this time-saving benefit may have been offset by longer morcellation times or larger prostate sizes in the VB groups. In the Standard mode, slightly lower enucleation efficiency might have resulted in prolonged instrument time near the sphincter, potentially contributing to higher incontinence rates.

In terms of enucleation efficacy, our study found that the 100 W Standard HoLEP achieved a higher enucleation rate (2.63 g/min) than either 100 W VB or 80 W VB settings (1.8 g/min).[22] However, this did not translate into shorter total operative time, likely because the VB groups had, on average, larger prostates, or other factors such as morcellation time contributed.[23,24] The small difference in enucleation speed may be of limited clinical significance, especially since energy efficiency (tissue removed per unit energy) was statistically equivalent among the three groups. Notably, the 80 W VB arm showed the highest mean energy efficiency (4.09 g/kJ) despite its lower power, suggesting that VB mode's benefits do not come at the cost of increased energy expenditure.

Importantly, VB mode showed perioperative advantages linked to improved recovery. The 100 W VB group had significantly shorter postoperative catheterization time compared to Standard mode, and both VB groups exhibited smaller hemoglobin drops, particularly the 100 W VB arm ($p = 0.004$).[11,25,26] All major bleeding complications occurred only in the Standard group, although numbers were low (trend $p = 0.056$).[27] These findings mirror those of Bozzini et al.,[11] who reported nearly half the hemoglobin loss with VB-HoLEP compared to conventional mode. Reduced bleeding likely contributed to quicker catheter removal and lower dysuria and urgency symptoms.[28] Additionally, the need for postoperative anticholinergic medications was significantly higher in the Standard 100 W group (43%) compared to VB groups (~20%),[29] supporting fewer storage symptoms in VB patients.

The overall stricture rate in our series may appear higher than in some reports, mainly because we included all urethral, meatal, and bladder neck narrowing identified during follow-up. Most were mild cases managed conservatively with short-term catheterization or a single dilatation, and the rate of clinically significant strictures requiring surgical intervention was consistent with previous studies. The inclusion of minor or transient cases likely contributed to the higher overall percentage observed.

The relatively low incidence of incidental prostate cancer observed in our cohort was likely related to preoperative patient selection. Patients with PSA ≥ 4 ng/mL and PIRADS ≥ 3 lesions on MRI were excluded from the study, whereas those with PIRADS 1–2 findings were included. Therefore, the low detection rate reflects the benign HoLEP population studied rather than incomplete tissue resection.

Overall, VB-HoLEP offers a smoother recovery: earlier catheter removal, less blood loss, and reduced irritative symptoms, without compromising obstruction relief efficacy. Although hospital stay durations were uniformly short (~1.1–1.4 days) with no statistical difference, studies suggest that improved perioperative outcomes with VB could facilitate same-day or next-day discharge in appropriate clinical settings.[8]

However, this study has limitations. Its retrospective, non-randomized design introduces potential selection bias; surgeons may have preferred VB for larger or more vascular prostates, potentially confounding outcomes. All procedures were performed by surgeons beyond the HoLEP learning curve in a high-volume tertiary centre; therefore, potential bias related to operator experience was considered minimal.

Although the post-hoc analysis suggested approximately 79% (one-sided) power for detecting the observed difference in 1-month dysuria, the study was not prospectively powered; therefore, these findings should be interpreted with caution. While multivariable analysis identified prostate size as an independent risk factor for incontinence, the use of VB showed only a trend toward significance.[29,30] Moreover, follow-up was limited to 6 months, precluding conclusions about long-term durability. Our definitions of dysuria and incontinence were based on patient self-report rather than standardized quantitative measures. Future studies should incorporate validated quality-of-life questionnaires, objective assessments (e.g., Visual Analogue Scale [VAS] for dysuria, pad weight tests for incontinence severity), and standardized outcome measures to ensure consistency and comparability across trials.

Another limitation of this study is the absence of preoperative prostate volume and membranous urethral length data. Although ultrasound measurements were available for most patients, they were excluded due to concerns about measurement variability caused by different radiologists and inconsistent bladder-filling conditions. Prostate MRI was not routinely performed before HoLEP; it was obtained only in patients with a PSA level ≥ 4.0 ng/mL. Among these, those with PIRADS ≥ 3 lesions were excluded from the study, whereas patients with PIRADS 1–2 findings were included. However, since MRI data were not available for all participants, it was not incorporated into the statistical analysis to avoid potential selection bias. These factors limited our ability to evaluate preoperative gland size and anatomic variations. In addition, as most patients in our cohort had moderate-sized prostates, the present findings may not be fully generalizable to very large gland volumes.

Finally, surgical technique modifications remain important. For example, Cochetti et al.[8] described a "Cap HoLEP" technique preserving a small anterior adenoma portion near the apex to shield the sphincter, significantly improving immediate continence rates. Combining such techniques with VB or other pulse modulation may optimize continence outcomes further.

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Conclusions

Virtual Basket (VB) laser energy during HoLEP significantly reduces early dysuria and facilitates faster recovery of continence without compromising efficacy or safety. By enabling shorter catheterization, less bleeding, and fewer irritative symptoms, VB-HoLEP offers a smoother postoperative course while maintaining equivalent functional outcomes at 3–6 months. These findings support the routine adoption of VB mode in HoLEP to improve early recovery and patient satisfaction, although prospective randomized studies are warranted to confirm its benefits.

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Author Contributions

Conceptualization: Serkan Özcan, Mertcan Dama, Yiğit Akın; Methodology: Sacit Nuri Görgel, Osman Köse; Writing—original draft: Serkan Özcan, Mertcan Dama, Enis Mert Yorulmaz; Writing—review & editing: Enis Mert Yorulmaz, Mertcan Dama, Yiğit Akın. All authors reviewed the results and approved the final version of the manuscript.

Availability of Data and Materials

Data available on request from the corresponding author.

Ethics Approval

Ethical approval was obtained from Izmir Katip Celebi University Health Research Institutional Review Board (IRB number: 0182, Date: 17 October 2024). Written informed consent was obtained from all patients prior to participation in the study.

Conflicts of Interests

The authors declare no conflicts of interest to report regarding the present study.

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