

ORIGINAL RESEARCH

Comparison of low-power long-pulse width and high-power short-pulse width holmium laser enucleation of the prostate for benign prostatic hyperplasia: a retrospective study

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Abstract

Background: Holmium laser enucleation of the prostate (HoLEP) is an effective surgical treatment for benign prostatic hyperplasia (BPH), but the optimal laser settings remain unclear. This study compared the efficacy and safety of low-power long-pulse-width HoLEP with high-power short-pulse-width HoLEP. **Methods:** Clinical data from 60 patients with BPH who underwent HoLEP between June and September 2025 were retrospectively analyzed. Patients were divided into a low-power long-pulse-width group (LPL, n = 30; 1.5 J × 30 Hz, 45 W) and a high-power short-pulse-width group (HPS, n = 30; 2.0 J × 40 Hz, 80 W). Baseline characteristics, perioperative outcomes, 6-month postoperative International Prostate Symptom Score (IPSS), quality of life (QoL) score, and maximum urinary flow rate (Qmax) were compared. **Results:** Baseline characteristics were comparable between groups. All procedures were completed successfully, with no perioperative transfusions or severe complications. No significant between-group differences were observed in operative time, surgeon-estimated intraoperative blood loss, catheterization time, or hospital stay. At 6 months, both groups showed significant improvements in IPSS, QoL score, and Qmax compared with preoperative values, with no significant differences between groups. **Conclusions:** Both low-power long-pulse-width and high-power short-pulse-width HoLEP were associated with significant short-term improvements in urinary symptoms, quality of life, and urinary flow, with no statistically significant differences in the perioperative or 6-month functional outcomes analyzed. However, because of the retrospective nonrandomized design and limited sample size, these findings should not be interpreted as evidence of equivalence or noninferiority.

Keywords

Benign prostatic hyperplasia; Holmium laser enucleation of the prostate; Low-power HoLEP; High-power HoLEP; Long-pulse-width laser; Short-pulse-width laser

1. Introduction

Benign prostatic hyperplasia (BPH) is a common condition in older men that can cause bladder outlet obstruction and lower urinary tract symptoms (LUTS), significantly impairing QoL (QoL) [1]. For patients with moderate-to-severe LUTS secondary to benign prostatic obstruction, surgery remains an important treatment option. Holmium laser enucleation of the prostate (HoLEP) is widely used for BPH because it enables complete enucleation, provides effective hemostasis, is suitable for a wide range of prostate sizes, and allows rapid postoperative recovery [2, 3].

The efficacy and safety of HoLEP are related not only on surgeon experience, but also on laser parameter settings. Conventional high-power settings offer high cutting efficiency

and may reduce operative time; however, they may also increase tissue effects and postoperative irritative symptoms. In contrast, low-power settings deliver power gently, require less costly equipment, and may improve operative control while reducing tissue injury. Although research on HoLEP laser power settings has increased, substantial variation remains in equipment models, definitions of power, energy/frequency combinations, surgeon experience, prostate volume, and follow-up duration [4, 5]. Most previous studies have mainly focused on comparisons between low- and high-power settings, whereas few have evaluated both power level and pulse width. Therefore, this study compared the clinical efficacy and safety of low-power, long-pulse-width HoLEP and high-power, short-pulse-width HoLEP for BPH to provide evidence for selecting HoLEP laser parameters.

2. Materials and methods

2.1 Study design and patients

This retrospective study analyzed the clinical data of 60 patients with BPH who underwent HoLEP at our hospital from June 2025 to September 2025. Patients received treatment at one of two hospital campuses. At each campus, the holmium laser system was routinely operated using a different preset parameter configuration. Patients treated at one campus underwent HoLEP using the low-power, long-pulse-width setting (LPL group) of $1.5 \text{ J} \times 30 \text{ Hz}$ (45 W), whereas those treated at the other campus underwent HoLEP using the high-power, short-pulse-width setting (HPS group) of $2.0 \text{ J} \times 40 \text{ Hz}$ (80 W). The laser setting was, therefore, determined by the treatment campus and its preset equipment configuration rather than by individual patient characteristics or intraoperative surgeon preference. At the beginning of the study, the first 30 consecutive patients meeting the eligibility criteria at each campus were included in the corresponding group. All patients were diagnosed preoperatively based on medical history, physical examination, urinary ultrasonography, uroflowmetry, prostate-specific antigen (PSA) testing, and relevant laboratory examinations, and all met the indications for surgical treatment.

The inclusion criteria were as follows: (1) BPH diagnosis; (2) moderate to severe LUTS or poor response to drug therapy; (3) treatment with HoLEP; and (4) complete clinical and follow-up data. The exclusion criteria were as follows: (1) suspected or confirmed urinary malignancies, including prostate or bladder cancer; (2) urethral stricture, neurogenic bladder, or other disorders affecting voiding function; (3) previous prostate-related surgery; (4) severe cardiac, hepatic, or renal dysfunction, or coagulation disorders; and (5) incomplete clinical data or loss to follow-up.

2.2 Surgical procedures

All procedures were performed by the same experienced associate chief physician. Surgery was conducted using a holmium laser generator (Pulse 100H, Lumenis Ltd, Yokneam, Israel) with a $550\text{-}\mu\text{m}$ end-firing fiber (SlimLine 550; Lumenis Ltd.). A 24-channel continuous irrigation resectoscope and a morcellator (Dabaisha, HAWK Inc., Hangzhou, China) were used for all procedures. In the LPL group, the laser was set to $1.5 \text{ J} \times 30 \text{ Hz}$ in the long-pulse-width mode (45 W). In the HPS group, the laser was set at $2 \text{ J} \times 40 \text{ Hz}$ in the short-pulse-width mode (80 W). The enucleation technique was selected according to prostate morphology. A three-lobe technique was used in patients with prominent median-lobe hyperplasia, whereas a two-lobe technique was used in patients without prominent median-lobe hyperplasia. This decision was independent of the laser parameter setting. The hyperplastic adenoma was dissected along the prostatic surgical capsule, and the median and bilateral lobes were sequentially enucleated. Bleeding points were coagulated using the holmium laser. After complete enucleation, the adenoma was pushed into the bladder, morcellated, and removed. At the end of the procedure, a 22-Fr three-way Foley catheter was inserted, and continuous bladder irrigation was performed. Discontinuation of bladder irrigation

and catheter removal were determined according to urine color and patient recovery.

2.3 Outcome measures

The following variables were recorded for all patients: preoperative International Prostate Symptom Score (IPSS), preoperative quality of life (QoL) score, preoperative maximum urinary flow rate (Qmax), operative time, surgeon-estimated intraoperative blood loss, perioperative transfusion, length of hospital stay, and catheterization time. Medical records were retrospectively reviewed for follow-up information documented during routine postoperative care. The 6-month postoperative IPSS, QoL, and Qmax values were extracted for the present analysis. At 6 months postoperatively, IPSS, QoL score, and Qmax were recorded for all patients. The available medical records were retrospectively reviewed for postoperative complications, including stress urinary incontinence, recatheterization, perioperative transfusion, and reoperation. Complications were classified according to the Clavien–Dindo system based on the treatment required for each event.

2.4 Statistical analysis

Statistical analyses were performed using SPSS version 19.0 (IBM Corp., Armonk, NY, USA). The normality of continuous variables was assessed using the Shapiro–Wilk test and inspection of quantile–quantile (Q–Q) plots. The distributions of the analyzed continuous variables and paired differences did not show substantial deviation from normality. Continuous variables are, therefore, presented as mean $\pm$ standard deviation (SD). Between-group comparisons were performed using the independent-samples *t* test, and within-group comparisons between preoperative and 6-month postoperative values were performed using the paired *t* test.

Categorical variables are presented as number. Because the numbers of recorded categorical events were small, categorical variables were compared using the two-sided Fisher's exact test. Between-group mean differences were calculated as LPL minus HPS and are reported with 95% confidence intervals (CIs). All tests were two-sided, and $p < 0.05$ was considered statistically significant. No non-inferiority margin was pre-specified; therefore, nonsignificant results were not interpreted as evidence of equivalence or non-inferiority.

3. Results

3.1 Characteristics of the participants at baseline

A total of 60 patients who underwent HoLEP were included, with 30 patients each in the LPL and HPS groups. No significant between-group differences were observed in age, prostate volume, preoperative IPSS, preoperative QoL score, preoperative Qmax, or preoperative PSA level, indicating comparable baseline characteristics. Details are presented in Table 1. The patient-selection process is shown in Fig. 1.

TABLE 1. Characteristics of the participants at baseline.

Indicator	LPL group (n = 30)	HPS group (n = 30)	t value	p value
Age (yr)	67.9 ± 7.2	67.7 ± 7.4	0.112	0.911
Prostate volume (mL)	65.6 ± 33.9	56.7 ± 23.3	1.068	0.294
Preoperative IPSS (points)	24.1 ± 3.6	24.8 ± 3.7	0.822	0.417
Preoperative QoL score (points)	5.1 ± 0.5	4.9 ± 0.6	0.205	0.838
Preoperative Qmax (mL/s)	7.7 ± 1.7	7.2 ± 1.9	1.383	0.177
Preoperative PSA (ng/mL)	3.2 ± 1.9	3.6 ± 4.6	0.496	0.623

LPL, low-power long-pulse-width; HPS, high-power short-pulse-width; IPSS, International Prostate Symptom Score; QoL, quality of life; Qmax, maximum urinary flow rate; PSA, prostate-specific antigen.

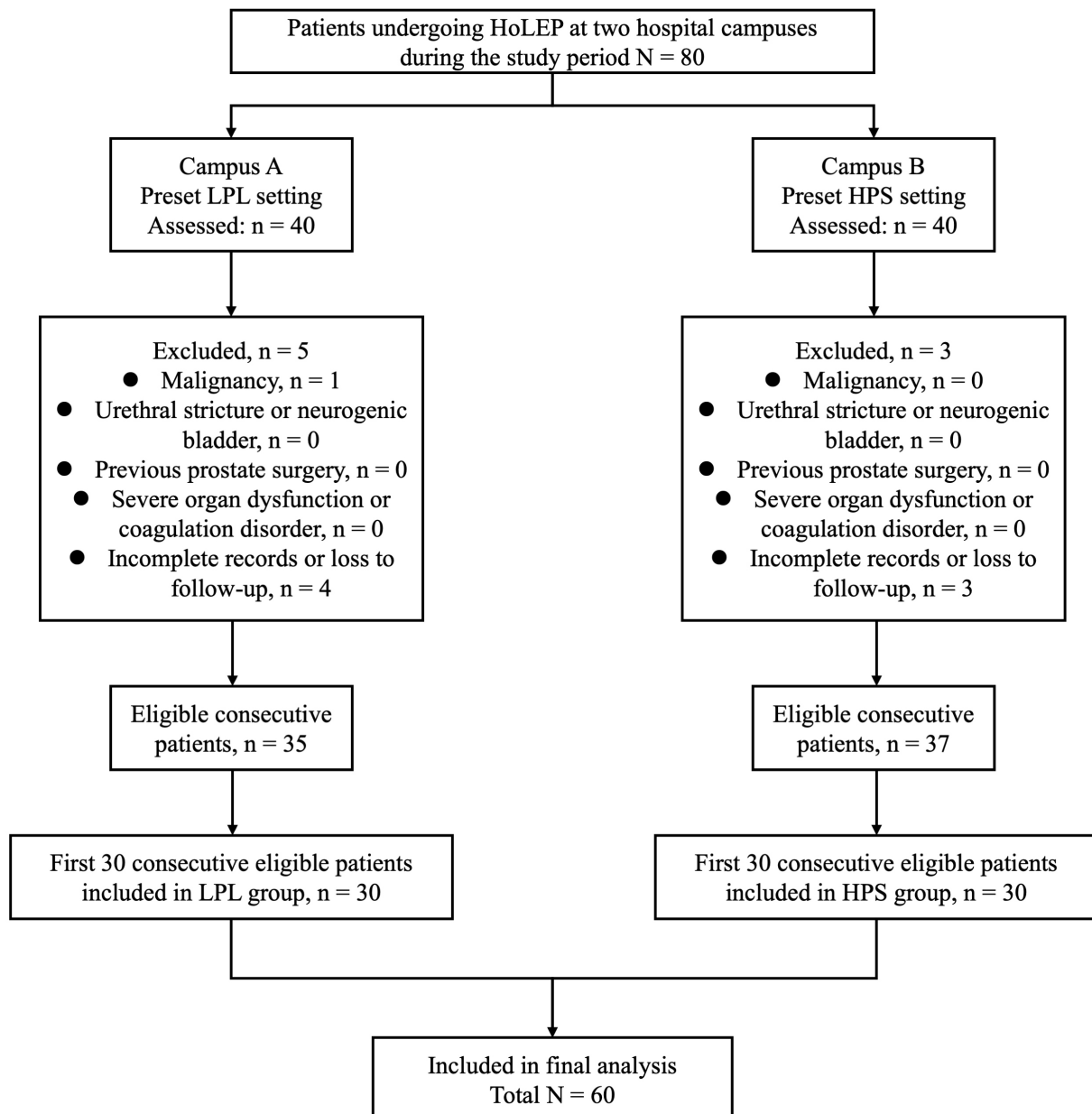


FIGURE 1. Flowchart of patient screening and consecutive inclusion. Patients were screened separately at two hospital campuses, each of which routinely used a different preset laser parameter configuration. At each campus, the first 30 consecutive patients who met all eligibility criteria were included in the corresponding treatment group. LPL, low-power long-pulse-width; HPS, high-power short-pulse-width; HoLEP, holmium laser enucleation of the prostate.

3.2 Comparison of the perioperative parameters between the two groups

All 60 operations were completed successfully. No intraoperative or postoperative transfusions were required, and no severe perioperative complications occurred. The operative time was 74.7 ± 43.3 min in the LPL group and 81.6 ± 36.9 min in the HPS group, and no statistically significant between-group difference was detected ($p = 0.482$). Surgeon-estimated intraoperative blood loss was 29.7 ± 24.3 mL in the LPL group and 41.8 ± 38.8 mL in the HPS group. Although the estimated blood loss was numerically lower in the LPL group, the between-group difference was not statistically significant ($p = 0.167$). The postoperative catheterization time was 3.3 ± 2.1 days in the LPL group and 2.9 ± 1.7 days in the HPS group, with no statistically significant difference ($p > 0.05$). The length of hospital stay was 2.6 ± 1.5 days in the LPL group and 2.1 ± 0.5 days in the HPS group, with no statistically significant difference ($p > 0.05$). The absolute between-group differences and their 95% CIs are presented in Table 2. These nonsignificant findings indicate that no between-group differences were detected in the present sample; they do not establish equivalence or non-inferiority between the two laser settings.

3.3 Changes in preoperative and postoperative parameters

At 6 months postoperatively, both groups showed significant improvements in IPSS, QoL score, and Qmax. In the LPL group, the IPSS decreased from 24.1 ± 3.6 preoperatively to 6.2 ± 1.4 at 6 months postoperatively; the QoL score decreased from 5.1 ± 0.5 to 2.5 ± 0.8 ; and Qmax increased from 7.7 ± 1.7 mL/s to 15.9 ± 1.3 mL/s. All within-group changes were statistically significant (all $p < 0.001$) (Table 3).

In the HPS group, IPSS decreased from 24.8 ± 3.7 preoperatively to 6.5 ± 1.8 at 6 months postoperatively; the QoL score decreased from 4.9 ± 0.6 to 2.2 ± 0.8 ; and Qmax increased from 7.2 ± 1.9 mL/s to 15.3 ± 1.5 mL/s. All within-group changes were statistically significant (all $p < 0.001$) (Table 3).

These within-group findings indicate that both groups experienced significant functional improvement during the 6-month postoperative period. However, within-group statistical significance alone does not establish that the two laser settings produced equivalent treatment effects.

Individual paired observations and the corresponding mean

paired differences with 95% CIs are shown in Fig. 2. The plots demonstrate consistent reductions in IPSS and QoL score and increases in Qmax in both groups. These analyses describe within-group changes and should not be interpreted as demonstrating equivalent changes between the two laser-setting groups.

3.4 Between-group comparison of 6-month functional outcomes

At 6 months postoperatively, the IPSS was 6.2 ± 1.4 in the LPL group and 6.5 ± 1.8 in the HPS group, with no statistically significant difference between the two groups ($p > 0.05$). The postoperative QoL score was 2.5 ± 0.8 in the LPL group and 2.2 ± 0.8 in the HPS group, with no statistically significant difference ($p > 0.05$). Postoperative Qmax was 15.9 ± 1.3 mL/s in the LPL group and 15.3 ± 1.5 mL/s in the HPS group, with no statistically significant difference ($p > 0.05$).

The corresponding between-group effect estimates and 95% CIs are provided in Table 3. Given the limited sample size and the absence of a prespecified non-inferiority margin, these findings should be interpreted as an absence of statistically detected differences rather than evidence of equivalence or non-inferiority.

Postoperative stress urinary incontinence was documented in no patients in the LPL group and in 1 patient (3.3%) in the HPS group. Recatheterization was required in 2 patients (6.7%) in the LPL group and 1 patient (3.3%) in the HPS group. No statistically significant between-group differences were detected in stress urinary incontinence or recatheterization (both $p = 1.000$, two-sided Fisher's exact test). No perioperative transfusions, reoperations, or Clavien–Dindo grade IIIb–V complications were recorded in either group. The recorded complications and their Clavien–Dindo classifications are presented in Table 4.

4. Discussion

BPH is a common condition in middle-aged and older men. BPH can cause bladder outlet obstruction and LUTS, significantly reducing QoL [1]. For patients with inadequate response to medical therapy or have clear surgical indications, surgical remains an important treatment option to relieve obstruction and improve voiding function. HoLEP removes obstructive tissue by completely enucleating the hyperplastic adenoma along the surgical capsule. It offers effective hemostasis, rapid

TABLE 2. Between-group comparisons of perioperative outcomes.

Indicator	LPL group (n = 30)	HPS group (n = 30)	t value	p value	Mean difference, LPL–HPS (95% CI)
Operative time (min)	74.7 ± 43.3	81.6 ± 36.9	0.711	0.482	-6.90 (-27.62 to 13.82)
Surgeon-estimated intraoperative blood loss (mL)	29.7 ± 24.3	41.8 ± 38.8	1.416	0.167	-12.13 (-28.97 to 4.70)
Catheterization time (d)	3.3 ± 2.1	2.9 ± 1.7	1.075	0.292	0.43 (-0.53 to 1.40)
Length of hospital stay (d)	2.6 ± 1.5	2.1 ± 0.5	1.721	0.096	0.50 (-0.08 to 1.08)

LPL, low-power long-pulse-width; HPS, high-power short-pulse-width; CI, confidence interval.

TABLE 3. Comparison of preoperative and 6-month postoperative follow-up parameters between the two groups.

Indicator	Group	Preoperative	6 months postoperative	<i>t</i> value	<i>p</i> value
IPSS (points)					
	LPL group (n = 30)	24.1 ± 3.6	6.2 ± 1.4	25.75	<0.001
	HPS group (n = 30)	24.8 ± 3.7	6.5 ± 1.8	24.07	<0.001
	<i>t</i> value	0.822	0.769		
	<i>p</i> value	0.417	0.447		
QoL score (points)					
	LPL group (n = 30)	5.1 ± 0.5	2.5 ± 0.8	14.19	<0.001
	HPS group (n = 30)	4.9 ± 0.6	2.2 ± 0.8	18.81	<0.001
	<i>t</i> value	0.205	1.355		
	<i>p</i> value	0.838	0.185		
Qmax (mL/s)					
	LPL group (n = 30)	7.7 ± 1.7	15.9 ± 1.3	20.24	<0.001
	HPS group (n = 30)	7.2 ± 1.9	15.3 ± 1.5	17.04	<0.001
	<i>t</i> value	1.383	1.585		
	<i>p</i> value	0.177	0.123		

IPSS, International Prostate Symptom Score; LPL, low-power long-pulse-width; HPS, high-power short-pulse-width; QoL, quality of life; Qmax, maximum urinary flow rate.

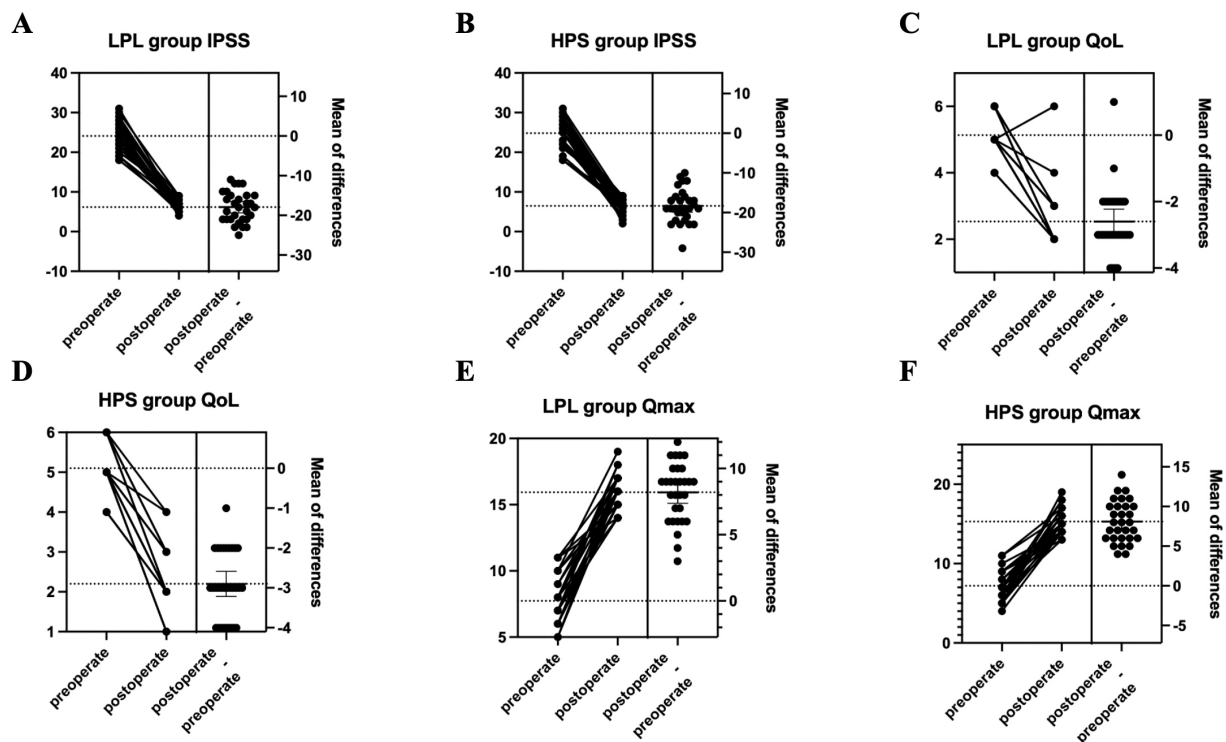


FIGURE 2. Paired estimation plots showing changes in functional outcomes from preoperative assessment to 6 months after surgery. (A) IPSS in the LPL group; (B) IPSS in the HPS group; (C) QoL score in the LPL group; (D) QoL score in the HPS group; (E) Qmax in the LPL group; and (F) Qmax in the HPS group. In each panel, the left axis shows individual paired preoperative and postoperative observations, with values from the same patient connected by a line. The right axis shows the distribution of the paired differences, calculated as the 6-month postoperative value minus the preoperative value. The central horizontal line and error bars represent the mean paired difference and its 95% confidence interval, respectively. IPSS, International Prostate Symptom Score; QoL, quality of life; Qmax, maximum urinary flow rate; LPL, low-power long-pulse-width; HPS, high-power short-pulse-width.

TABLE 4. Recorded perioperative and postoperative complications.

Complication	Clavien-Dindo grade	LPL group (n = 30)	HPS group (n = 30)	p value
Perioperative transfusion	II	0	0	-
Postoperative urinary incontinence	I	0	1	>0.9999 [†]
Recatheterization	I	2	1	>0.9999 [†]
Reoperation	III	0	0	-
Clavien–Dindo grade IIIb–V complications	-	0	0	-

[†]Fisher's exact test. LPL, low-power long-pulse-width; HPS, high-power short-pulse-width.

postoperative recovery, and applicability across a wide range of prostate volumes, and is recommended by national and international guidelines as well as numerous studies for the surgical treatment of BPH/LUTS [2–4].

Previous studies have shown that, compared with conventional transurethral resection of the prostate, HoLEP provides reliable improvements in IPSS, Qmax, and postvoid residual urine volume while reducing catheterization time and hospital stay, and the risk of perioperative transfusion and other complications [4–6]. In patients with large prostates, HoLEP can achieve long-term outcomes comparable to those of open prostatectomy, while offering lower invasiveness and faster recovery [7]. Consequently, HoLEP has become an important surgical option for BPH. However, its efficacy and safety depend not only on the procedure itself, but also on factors such as surgeon experience, prostate volume, gland morphology, tissue morcellation efficiency, and laser parameter settings [8]. Among these, power and pulse width are key determinants of the laser-tissue interaction.

Recently, comparisons between low-power and high-power HoLEP have received increasing attention. In a randomized controlled trial, Elshal *et al.* [9] found that low-power HoLEP was noninferior to high-power HoLEP in terms of enucleation efficiency. Becker *et al.* [10] reported favorable 12-month outcomes with low-power HoLEP and demonstrated its safety and feasibility. In a systematic review, Scoffone *et al.* [11] concluded that low-power HoLEP was generally comparable to conventional high-power HoLEP in terms of feasibility, efficacy, and safety. Similarly, Gkolezakis *et al.* [12] and Suh *et al.* [13] showed that low-power HoLEP achieved functional outcomes similar to those of high-power HoLEP and may reduce total energy delivery and postoperative irritative symptoms. Gao *et al.* [14] compared low-power and high-power HoLEP in patients with small-volume prostates and found similar efficacy between the two approaches, while the low-power setting offered advantages in energy consumption and postoperative pain. Furthermore, the systematic review and meta-analysis by Chen *et al.* [15] found no significant differences between low-power and high-power HoLEP in postoperative IPSS, QoL, Qmax, or complications.

Pulse duration and proprietary pulse-modulation technologies represent related but distinct aspects of holmium laser energy delivery. Pulse duration refers to the length of an individual laser pulse, whereas pulse-modulation technologies modify the pattern of energy delivery and the resulting vapor-

bubble dynamics. This study compared manufacturer-defined long- and short-pulse-width modes used with different power settings. Neither group received treatment using Moses or any other proprietary pulse-modulation technology. Therefore, these findings should not be extrapolated to comparisons involving such technologies. Previous studies suggest that in HoLEP performed by experienced surgeons, pulse modulation may have a limited effect on clinically relevant procedural efficiency. Surgeon experience, accurate identification and maintenance of the capsular plane, traction direction, prostate morphology, and morcellation efficiency may have a greater influence on overall operative performance.

In this single-center retrospective study, we compared a low-power long-pulse-width setting of 1.5 J × 30 Hz (45 W) with a high-power short-pulse-width setting of 2.0 J × 40 Hz (80 W). Both groups showed significant improvements in IPSS, QoL score, and Qmax at 6 months postoperatively, and no statistically significant between-group differences were observed in the perioperative or 6-month functional outcomes. However, given the small sample size, nonrandomized design, and absence of a prespecified noninferiority margin, the lack of statistically significant differences should not be interpreted as evidence of equivalence or noninferiority. Accordingly, the findings should be considered exploratory and hypothesis-generating.

Previous studies comparing low-power and high-power HoLEP have generally demonstrated substantial postoperative improvements in urinary symptoms, QoL, and urinary flow parameters with both approaches. The present findings are consistent with these reports. In both study groups, IPSS and QoL scores decreased significantly and Qmax increased significantly at 6 months postoperatively.

However, significant within-group improvements from preoperative to postoperative assessments do not indicate that the magnitude of improvement was identical between groups. Evaluation of between-group differences is more appropriately based on direct comparisons of change scores or a baseline-adjusted analyses. The relatively narrow numerical differences in the observed 6-month mean values should also be interpreted in the context of statistical uncertainty. Reporting CIs is, therefore, important because the intervals indicate the range of group differences that remains compatible with the available data.

In terms of perioperative safety, no perioperative transfusions or severe complications occurred in either group. How-

ever, the absence of transfusion or severe complications in a cohort of 60 patients does not establish equivalent perioperative safety. Rare adverse events cannot be assessed reliably in a sample of this size, and postoperative complications were not originally recorded using a standardized classification system. Accordingly, the present findings should be limited to stating that no transfusions or severe complications were recorded in the analyzed cohort. The low-power mode of the holmium laser delivers less energy, which may reduce local instantaneous explosive effects and tissue injury. Surgeon-estimated intraoperative blood loss was numerically lower in the LPL group than in the HPS group, but the difference was not statistically significant. This observation should be interpreted cautiously because blood loss during transurethral surgery was estimated by the operating surgeon and was not supported by standardized perioperative changes in hemoglobin or hematocrit. Irrigation fluid and urine output further limit the precision of visual blood-loss estimation in endoscopic prostate surgery. Consequently, the present data do not provide sufficient evidence that the LPL setting improves hemostasis.

Regarding surgical efficiency, the HPS mode is generally believed to provide superior cutting and tissue-separation performance and may theoretically reduce enucleation time, particularly in large prostates. However, operative time did not differ significantly between groups in this study, averaging 74.7 ± 43.3 min in the LPL group and 81.6 ± 36.9 min in the HPS group. The authors suggest that the comparable outcomes may be attributable to the enhanced hemostatic effect of the LPL mode during enucleation, which reduces intraoperative bleeding and improves visualization, thereby decreasing the time required for hemostasis. Furthermore, the core of HoLEP depends on accurate identification and maintenance of the surgical capsule plane. Although the laser facilitates incision, dissection, and coagulation, operative time is more likely influenced by surgeon experience, recognition of anatomical landmarks, traction technique, prostate morphology, and morcellation efficiency than by laser power alone [8].

In terms of postoperative recovery, catheterization duration and length of hospital stay were comparable between groups, with no significant differences observed. These outcomes are influenced by various factors, including postoperative hematuria, bladder irrigation requirements, patient comorbidities, perioperative care protocols, and physician discretion regarding catheter removal. Consequently, laser settings alone may not be the primary determinant. In the present cohort, the LPL setting was not associated with prolonged catheterization time or hospitalization. Nevertheless, the limited statistical power and wide CIs warrant cautious interpretation of these results.

The potential clinical value of the LPL setting lies primarily in demonstrating that technically successful HoLEP and significant short-term functional improvement were observed using this parameter combination. Whether it offers advantages in energy consumption, tissue interaction, postoperative irritative symptoms, or economic outcomes requires further investigation using prospectively defined and objectively measured endpoints.

The present study focused on IPSS, QoL score, and Qmax at 6 months after surgery. Other clinically relevant postoperative outcomes, including postvoid residual urine volume, transient

urinary incontinence, urgency, recatheterization, urinary retention, urinary tract infection, readmission, and reintervention, were not systematically included in the original analysis.

Other minimally invasive and laser-based techniques have also demonstrated favorable outcomes for the treatment of BPH. Rezūm water vapor thermal therapy provides durable improvement in lower urinary tract symptoms and urinary flow, with a low surgical retreatment rate at 5 years, and may represent an effective minimally invasive option in appropriately selected patients [16]. Thulium laser enucleation of the prostate (ThuLEP) has likewise shown high efficacy and safety. Importantly, prospective randomized studies directly comparing ThuLEP with HoLEP have demonstrated comparable improvements in IPSS, QoL, Qmax, and other functional outcomes, while ThuLEP may be associated with less perioperative hemoglobin reduction [17, 18]. A systematic review and meta-analysis of randomized trials similarly found broadly comparable functional efficacy and safety between HoLEP and ThuLEP, although the evidence for potential advantages of ThuLEP in blood loss and transient urinary incontinence was of low certainty [19]. These findings suggest that effective anatomical enucleation can be achieved using different laser platforms, with the choice of technique also depending on surgeon experience, equipment availability, and local practice.

This study has several limitations. First, it was a single-center retrospective study with a relatively small sample size and no a priori sample-size calculation. With 30 patients in each group, the study had limited power to detect small or moderate between-group differences, and nonsignificant findings may, therefore, reflect type II error. Second, all procedures were performed by the same experienced surgeon. Although this reduced the influence of inter-surgeon variability, it may limit the generalizability of the findings to surgeons with different levels of experience. Third, the study was not designed as an equivalence or non-inferiority trial, and no non-inferiority margin was prespecified. Therefore, the absence of statistically significant between-group differences cannot demonstrate equivalence or non-inferiority. Fourth, the laser setting was determined by the treatment campus because the two campuses routinely used different preset parameter configurations. Although this reduced the likelihood that the surgeon selected the laser setting according to individual prostate characteristics, treatment allocation was not randomized. Differences in patient referral patterns, perioperative management, equipment-related factors, or other unmeasured characteristics between the two campuses may, therefore, have introduced center-related confounding. In addition, although patients were consecutively included at each campus, selecting a predefined number of 30 patients per group does not eliminate potential selection bias. Therefore, future prospective, adequately powered, multicenter studies should use standardized setting-allocation criteria or randomization, prespecified primary outcomes, objective hemostatic measures, comprehensive energy and efficiency parameters, standardized complication reporting, and longer follow-up. If equivalence or non-inferiority is the intended research question, an appropriate margin should be prespecified and the sample size should be calculated accordingly.

5. Conclusions

Both low-power long-pulse-width HoLEP and high-power short-pulse-width HoLEP were associated with significant improvements in lower urinary tract symptoms, quality of life, and maximum urinary flow rate at 6 months after surgery. No statistically significant between-group differences were detected in the perioperative and short-term functional outcomes analyzed. Although low-power long-pulse-width HoLEP may represent a technically feasible parameter setting, the present retrospective study was not designed to establish equivalence or non-inferiority. Larger prospective studies with adequate statistical power and objective measures of hemostasis and surgical efficiency are required.

AVAILABILITY OF DATA AND MATERIALS

The authors declare that all data supporting the findings of this study are available within the paper and any raw data can be obtained from the corresponding author upon request.

AUTHOR CONTRIBUTIONS

MCW and GHL—designed the research study. MCW—performed the research. YMD and CHY—analyzed the data. YMD and MCW—wrote the manuscript. All authors contributed to editorial changes in the manuscript. All authors read and approved the final manuscript.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

This study has obtained ethical approval from the Medical Ethics Committee of Sir Run Run Shaw Hospital (approval no. 20260227-009), and informed consent has been obtained from all patients.

ACKNOWLEDGMENT

The authors would like to thank the medical and nursing teams involved in the perioperative care of the patients for their dedication and support.

FUNDING

This research was supported by Zhejiang Provincial Natural Science Foundation of China under Grant No. LTGD23H050001.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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How to cite this article: Mingchao Wang, Yiming Ding, Chenhao Yu, Gonghui Li. Comparison of low-power long-pulse width and high-power short-pulse width holmium laser enucleation of the prostate for benign prostatic hyperplasia: a retrospective study. *Journal of Men's Health*. 2026; 22(9): 28-36. doi: 10.22514/jomh.2026.073.