Minimalist Approach for HoLEP with A Low-Power Holmium Source: A Retrospective Study

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Purpose: To assess the efficacy and safety of very low-power Holmium Laser Enucleation of the Prostate (HoLEP) on a 30-W holmium laser source.

Materials and Methods: With the approval of the local ethics committee, we retrospectively analyzed 60 patients treated with HoLEP. There were 30 patients in the low-power (LP) group and 30 patients in the very low-power (VLP) group. For the LP group, we used a 60-W holmium laser machine with laser settings of 2 J and 20 Hz. In the VLP group, we used a 30-W low-power holmium source with laser settings of 2 J and 10 Hz. An experienced surgeon operated on all patients. We evaluated the surgical parameters and practicality of the low-power laser vs. the very low-power laser.

Results: All patients underwent successful HoLEP in the VLP group; it was not necessary to increase the laser output in any case. The mean preoperatively estimated prostate volume was 88.1 mL (range, 30-300 mL). The mean enucleation time and enucleation efficiency were 67.9 min (range, 25-150 min) and 0.99 g/min (range, 0.8-1.8 g/min), respectively. No patient required blood transfusion postoperatively. No stress urinary incontinence was observed at the 3-month postoperative follow-up.

Conclusion: The use of a low-power laser source is encouraging for new surgeons learning HoLEP; it can facilitate the adoption of HoLEP in developing countries, where the initial capital investment may be a major obstacle.

Keywords: benign prostatic hyperplasia; holmium laser; prostatic adenoma; transurethral prostate resection

INTRODUCTION

Medical treatment is initiated in 30% of patients diagnosed with benign prostatic hyperplasia (BPH); approximately 20% of treated individuals do not respond to therapeutic treatment and require surgery.[1] Recent technical developments have minimized problems after BPH surgery while demonstrating outstanding functional outcomes. Hiraoka[2] introduced anatomical endoscopic enucleation of the prostate (AEEP), which has now been recognized as an appropriate method for the surgical treatment of BPH-induced lower urinary tract symptoms.

AEEP can be performed using various energy sources, including high-power ($\geq$ 100 W), low-power holmium ($\leq$ 70 W), diode, green light, and thulium lasers, and monopolar and bipolar diathermy.[3] AEEP provides the same long-term functional outcomes as simple prostatectomy, along with a safety profile similar to successful endoscopic no-enucleation treatments. AEEP is also safe for individuals who are taking anticoagulants.[4] According to both the American Urological Association and the European Urological Association,[5,6] AEEP has been used for approximately 40 years in the treatment of bladder outlet obstruction, regardless of prostate size. Gilling et al.[7] used holmium laser enucleation of the prostate (HoLEP) for the first time in 1998 with an 80-W laser source at 2.0 J and a frequency of 40 Hz. Because of the steep learning curve, HoLEP is regarded as a difficult operation.[8] Furthermore, the high cost of the laser source is a factor that prevents the wide use of HoLEP.[9]

Most of the enucleation phase of the HoLEP process is performed using the holmium yttrium-aluminum-garnet (Ho:YAG) laser's unique ability to create a plasma bubble at the tip of the laser fiber held at a short distance from the tissue. The plasma bubble transfers its energy to the surrounding water by first forming a bubble of hot water vapor that expands rapidly because of coagulant effects, then rapidly collapses and produces pressure waves that can shear tissues.[10] When it is recognized that HoLEP can be performed with a low-power laser source, the cost of HoLEP introduction will be reduced, and it may become a more common operation. Therefore, in this study, we investigated the efficacy and safety of HoLEP using a 30-W holmium laser source at a frequency of 2.0 J and 10 Hz (very low-power HoLEP).

MATERIALS AND METHODS

Patients

With the approval of the local ethics committee, we retrospectively evaluated 60 patients with BPH who had been treated with HoLEP at our institution (Medova Hospital, Konya, Turkey) between January 2022

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Received November 2023 & Accepted November 2024

Table 1. Patients demographic and preoperative parameters

Characteristicsa	Low-Power HoLEP (N = 30)	Very Low-Power HoLEP (N = 30)	*P*-value
Age, years; mean ± SD	69.34 ± 7.89	66.35 ± 9.42	.234
Indication of surgery, N			.36
Retention of urine	8	6	
Failure of medical mgt.	22	24	
Associated medical conditions, N (%)	22 (73%)	21 (70%)	.49[c]
Patient on antiplatelets / anticoagulants, (%)	31%	45%	.31
IPSS; mean ± SD	23 ± 7.87	26.75 ± 6.03	.26[b]
PSA, ug/L; mean ± SD	7.78 ± 7.23	6.63 ± 4.03	.62[b]
Prostate volume, mL; mean ± SD (range)	111.56 ± 66.25 (40-300)	88.09 ± 64.75 (30-300)	.13[b]
Maximum uroflow rate, mL/s; mean ± SD	7.78 ± 6.44	5.26 ± 7.08 .56b	
Postvoid residual urine, ml; mean ± SD	148.85 ± 51.98	178.25 ± 29.24	.87[b]

Abbreviations: IPSS, International Prostate Symptom Score; PSA, Prostate-specific antigen.
[a] The independent samples *t*-test for normally distributed data and the chi-squared test for qualitative data.
[b] Mann-Whitney *U* test
[c] Fisher's exact test

and December 2022, then followed up for >3 months. During 2022, 30 patients for whom low-power sources were used were identified. These patients were compared with the last 30 patients who were operated on in the same period using a 60-W holmium laser. Patients with an associated neurological disorder, urethral stricture, a history of bladder cancer, pelvic radiation, or a preoperative diagnosis of prostate cancer were excluded from the study. Patients with an elevated prostate-specific antigen were counseled regarding preoperative transrectal prostate biopsy. Before surgery, antiplatelet or anticoagulant medications were withheld, following consultation with a patient's primary care provider. All patients underwent a complete history, physical examination, International Prostate Symptom Score (IPSS) evaluation, prostate-specific antigen estimation, urine culture, and transabdominal ultrasound for prostate weight estimation. Furthermore, patients who did not exhibit urinary retention underwent uroflowmetry and sonography to estimate postvoid residual urine volume. All patients provided preoperative written consent for the use of perioperative data in this study.

Intervention

Prior to the start of the trial, a single surgeon (IB) had conducted 300 HoLEP procedures over a 4-year period. The surgeon was blind to which laser device he would use on which patient. When the 60-W holmium laser machine was busy, he used the 30-W holmium source. The en bloc technique was used for the enucleation process.[11] For the low-power (LP) group, we used a 60-W holmium laser machine with a fixed pulse width (Quanta System, CYBER Ho 60, Italy), a 26-Fr continuous-flow resectoscope with a laser bridge (Karl Storz Endoscopy, Tuttlingen, Germany), and a 550-µ end-firing holmium laser fiber. Throughout the en bloc process, we used laser settings of 2 J and 20 Hz in the LP-HoLEP group. We used a 30-W low-power holmium source with a fixed pulse width (Dornier Medilas H Solvo, Germany), a 26-Fr continuous flow resectoscope with a laser bridge (Karl Storz Endoscopy), and a 270-µ end-firing holmium laser fiber in the very low-power (VLP) group. In the VLP-HoLEP group, we used laser settings of 2 J and 10 Hz during the en bloc process. No other coagulation system was used except for trimming. The laser provided the desired coagulation when applied at an appropriate distance (1-3 mm). Transurethral morcellation with a Hawk N5900E (Hawk, Minitech Co., China) introduced through an offset rigid nephroscope with a 26-Fr sheath was used to remove enucleated prostatic tissue (Karl Storz Endoscopy).

Follow-up

After the operation, all patients received continuous

Table 2. Intraoperative and postoperative outcome

Characteristicsa	Low-Power HoLEP (N = 30)	Very Low-Power HoLEP (N = 30)	*P*-value
Resected prostate weight, gram; mean ± SD (median, range)	89.34 ± 41.00 (100, 40-173)	67.35 ± 40.64 (60, 20-200)	.07
Enucleation time, min; mean ± SD	76.13 ± 33.85	67.90 ± 31.95	.39
Enucleation efficiency, g/min; mean ± SD (median, range)	1.19 ± 0.19 (1.15, 1-1.66)	0.99 ± 0.25 (0.98, 0.75-1.76)	.00[b]
Total energy, kJ; mean ± SD	83.20 ± 39.55	80.62 ± 32.84.81	
Postoperative hospital stay, hours; mean ± SD	29.39 ± 18.84	19.28 ± 14.43	.24[b]
Postoperative duration of catheterization, hours; mean ± SD	26.31 ± 17.09	36.71 ± 8.01	.32[b]
Haemoglobin decrease, g/dL; mean ± SD	0.63 ± 0.56	0.76 ± 0.87	.31[b]
Urinary retention after catheter removal, N (%)	2 (6.7%)	0 (0%)	.50[c]
Erythrocyte replacement due to decreased hemoglobin, N (%)	2 (6.7%)	0 (0%)	.50[c]
Re-cauterization due to bleeding, N (%)	1 (3%)	0 (0%)	.40[c]
3-month Qmax, mL/min; mean ± SD	19.77 ± 4.13	20.51 ± 1.81	.10[b]
Postoperative stress urinary incontinence at 3 months, N (%)	1 (3%)	0 (0%)	.40[c]
Histopathological examination of post-HoLEP prostate specimen (Incidental detection of prostate cancer), N (%)	2 (6.7%)	1 (3%)	.78[c]

Abbreviations: Qmax, Peak flow rate.
[a] The independent samples t-test for normally distributed data and the chi-squared test for qualitative data.
[b] Mann-Whitney U test
[c] Fisher's exact test

bladder irrigation. If the urine was clear, the Foley catheter was withdrawn on postoperative day 1. Patients without clear urine on postoperative day 2 were discharged home with a catheter in situ; they returned 2 or 3 days later for catheter removal. Perioperative complications, catheterization time, hospital stay, enucleation efficiency (EE), and hemoglobin decline were recorded. Before the start of morcellation, the enucleation time was determined from laser fiber insertion to resectoscope removal, including laser use for post-enucleation hemostasis. Postoperative hemoglobin was measured on the first postoperative day. Peak flow rate (Qmax) and postvoid residual urine volume were measured in all patients at 3 months after surgery. The International Consultation on Incontinence Questionnaire-Short Form (ICIQ-SF) score was used to assess stress urinary incontinence before surgery and 3 months after catheter removal. Among the ICIQ-SF items, "leaks when you cough and sneeze" and "leaks when you are physically active or exercising" were regarded as stress urinary incontinence. In November 2023, when the retrospective study was planned, the health records of patients who did not come for a visit after the first 3 weeks were examined, and the missing ones were called for a new control visit.

Statistical Analysis

SPSS software, version 24.0, was used for statistical analysis of demographic, perioperative, and postoperative data. The Kolmogorov-Smirnov test was used to determine data distribution normality. Independent samples *t*-tests (two-tailed) were used to analyze differences in normally distributed data, and the Mann-Whitney U test was used to evaluate non-normally distributed data. The chi-squared test and Fisher's exact test were used to assess differences in qualitative data. *P*-values < .05 were considered statistically significant.

RESULTS

There were 30 patients in the LP-HoLEP group and 30 patients in the VLP-HoLEP group after ≥ 3 months of follow-up. The demographic and preoperative characteristics of both groups were comparable (**Table 1**). In both groups, comorbid diseases such as obstructive lung disease, ischemic heart disease, and diabetes mellitus were similar.

Although the median value of EE was lower in the VLP-HoLEP group, the mean values were similar (0.99 g/min for VLP-HoLEP and 1.19 g/min for LP-HoLEP). The effect of VLP laser use on postoperative hemoglobin drop, catheterization time, and hospital stay was not significant compared to the median value (**Table 2**). There was no difference in postoperative complications such as urinary retention after catheter removal, erythrocyte replacement due to decreased hemoglobin, or re-cauterization due to bleeding ($P > .05$). At the 3-month follow-up, maximum flow rates were satisfactory in both groups (19.77 mL/min for LP and 20.51 g/min for VLP).

One of the two patients requiring blood transfusion in the LP-HoLEP group had a history of splenectomy and received one unit of erythrocyte suspension replacement to manage prolonged hematuria. Another patient with a history of chronic lymphocytic leukemia was also administered one unit of erythrocyte suspension replacement. Two patients who developed urinary retention in the LP-HoLEP group were able to void normally after 3 days of re-catheterization. One patient in the LP-HoLEP group had incontinence during follow-up and an ICIQ-SF score of 13; that patient had undergone re-catheterization to manage prolonged bleeding in the postoperative period.

DISCUSSION

To our knowledge, this is the first study to evaluate the results of using a low-power holmium source in the endoscopic treatment of symptomatic BPH. In this study, we showed that HoLEP can be conducted without any problems or limitations using a low-power laser source. In 1998, Gilling et al. announced the first HoLEP procedure, in which morcellation and enucleation procedures were combined.[7] Over the past two decades, comparative studies regarding the potential benefits of HoLEP over endoscopic no-enucleation therapies have utilized power settings of 80-100 W.[12] Thus, HoLEP has often been used at 80-100 W.[13]

Rassweiler et al. were the first to demonstrate the viability of transurethral laser enucleation of the prostate at low power settings in 2008.[14] Although power settings of 24 W and 40 W allowed safe enucleation, the authors observed respective blood transfusion rates of 10% and 8%. When the power level was adjusted from 24 W to 40 W, the operation time was lowered by 27%. These findings suggest that lower power settings increase the operation time and the frequency of blood transfusions required. In the previous decade, Scoffone et al.[15] revealed that, at 40-W power levels, the laser photothermic effect on the capsule is lowered without reducing EE or enucleation effectiveness. Multiple authors verified this, demonstrating that the effectiveness of LP-HoLEP was similar to the effectiveness of high-power HoLEP.[9,16,17]

In the literature, the EE was reported as 0.45 g/min at 24 W by Rassweiler et al.[14] and 1.14 g/min at 30 W by Minagawa et al.[9] Although the median EE of the 60-W holmium laser source was higher than that of the 30-W low-power holmium source in our study, it is our contention that the VLP EE is acceptable in comparison to the EE observed in other studies (0.99 g/min). When we evaluated EE separately in each group, we found mean values in the literature range.[18]

The single-series retrospective study by Minagawa et al.[9] provided the most evidence regarding LP-HoLEP efficacy. Despite the LP setting, HoLEP was successfully completed in all cases, with no need for increased laser output and no patient requiring blood transfusion. These results support the notion that high power is unnecessary for efficient enucleation with excellent hemostasis. Another meta-analysis showed no difference in postoperative transfusion rates between the LP and high-power groups.[13] In the present study, the hemorrhagic complications and postoperative hemoglobin decline in the VLP group were comparable with findings recorded using low-power laser settings,[9] although approximately 45% of the patients in our VLP group used antiplatelet or anticoagulants. Considering that there were fewer hemorrhagic complications in the VLP group in our study and the same experienced surgeon performed the HoLEP procedure in both groups, we believe that surgical experience is more important than laser adjustment for safe surgery. With respect to mean postoperative catheterization time and hospitalization, no significant difference was observed between the LP and VLP groups. Given that the surgeon (IB)

in our study did not utilize any additional coagulation methods other than trimming in both patient groups, we think that optimal coagulation can also be achieved with VLP.

In terms of functionality, which is an essential consideration in the setting of benign disorders such as BPH, short-term postoperative Qmax was examined. VLP-HoLEP was non-inferior to LP-HoLEP, with comparable results in terms of postoperative Qmax improvement. Shah et al.[18] reported that uroflow and symptom score in the LP group were similar to those parameters in the high-power laser group at early and long-term follow-up (up to 5 years). Similarly, in prospective studies of LP-HoLEP, Gilling et al. found no differences between groups in postoperative Qmax or IPSS score within 12 months after surgery.[13] On the date of our study, patients who did not come to follow-up after 3 weeks of follow-up were called for a new control visit, and long-term voiding parameters, including at least the 3rd month, were evaluated. We found that approximately 50% of the patients came to the repeated follow-up visit after being called. Considering that the repeated controls of the patients are directly financed by the patient in line with the health payment system in our country, we think that patients do not attend repeated follow-up visits for economic reasons unless they have serious voiding problems.

The breakdown of molecular bonds by the heat energy released from plasma bubbles is secondary to the holmium laser ablation of soft tissue. Coagulation is caused by a heated water-vapor bubble that forms on the edge of the plasma bubble.[10] Frequency reduction leads to lower pressure in the plasma bubble, thereby increasing the photomechanical effect. However, at higher frequencies, the Ho:YAG laser may behave as a continuous-wave laser, resulting in a stronger photothermal impact.[15] Use of the photomechanical effect to enucleate the prostate at a lower frequency may result in less heat injury to adjacent tissues. This hypothesis was empirically confirmed because LP-HoLEP has been linked with fewer postoperative irritative symptoms, compared with typical high-power HoLEP.[19] Evaluation of our study in the context of these data indicated that the use of a low-power laser source (Dornier Medilas H Solvo, 30 W) provided good efficacy and safe surgical results at a total energy of 20 W (laser settings of 2 J and 10 Hz), thereby decreasing the initial capital investment for the laser machine. The use of a low-power laser source reduces the requirement for high-power sockets and multi-phase connectors, which are not standard in operating rooms.[9] The use of a low-power laser source is encouraging for the learning curve of new surgeons who will begin HoLEP surgery; it can facilitate the adoption of HoLEP in developing and developed countries, where the initial capital investment may be a major obstacle.

Although postoperative stress urinary incontinence has decreased in recent years, it remains a complication of HoLEP. It has been reported that 0-3.3% of patients do not totally recover their continence at 12 months.[13] Laser-induced heat dissipation to the sphincter muscle is reduced when the laser output is reduced to 2.0 J and 20 Hz or 1.5 J and 30 Hz during dissection around the prostate apex. Therefore, low-power HoLEP is assumed to reduce sphincter damage.[9] In our study, one patient in the LP-HoLEP group had incontinence during follow-up and an ICIQ-SF score of 13; that patient had undergone re-catheterization to manage prolonged bleeding in the postoperative period, and we suspect that sphincter damage was caused by re-catheterization. Although our results were not particularly supportive, the exceptional incontinence we encountered in both the low-power and very low-power patient groups suggests robust sphincter protection.

Our study had some limitations. The surgeries were all conducted by a single experienced surgeon, and the mean prostate size was 100 g. Thus, the results may not be applicable to HoLEP procedures performed by inexperienced surgeons or to patients with larger prostates. Furthermore, the surgeon was not blinded to the laser settings. Sexual function was not recorded in this study. One of the important limitations of our study was the reluctance of the patients to come for repeated postoperative follow-up visits. We think that VLP data should be supported by long-term follow-up prospective studies with a larger number of patients. When the results were comparable in both groups in the long term, starting in the 3rd month, we saw that the use of VLP-HoLEP did not have a negative impact on outcome durability. Finally, the 30-W laser source group was limited to 30 patients due to the retrospective cross-sectional analysis. We compared it to the previous 30 standard 60-W HoLEP patients conducted in the same time period, consistent with the surgeon's equivalent experience parity. This comparison allowed us to see the same surgeon's professional skill in both the LP-HoLEP and VLP-HoLEP groups, demonstrating that success in both groups is dependent on the correct technical approach.

CONCLUSIONS

Using a low-power holmium laser source at 2 J and a frequency of 10 Hz, HoLEP can be performed safely and without any technical difficulties. When the cost analysis is reduced to a basic level, we think that HoLEP with a 30-W holmium source instead of a 60-W holmium source reduces the costs by up to one-third. The use of a low-power laser source is encouraging for the learning curve of new surgeons who will begin HoLEP surgery; it can facilitate the adoption of HoLEP in developing and developed countries, where the initial capital investment may be a major obstacle.

SUMMARY

A new study shows that a prostate surgery called HoLEP can be done safely with a much lower-power, and thus cheaper, laser. This makes the procedure more accessible for hospitals, especially in developing countries, and may be safer for new surgeons to learn.

ACKNOWLEDGEMENTS

This study was approved by the Necmettin Erbakan University Research Ethics Committee (2023/4636) as a retrospective archive project.

CONFLICT OF INTEREST

The authors report no conflict of interest.

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