ORIGINAL RESEARCH

Holmium Laser Enucleation Vs Thulium Laser Enucleation- A Comparative Study (Do We have a Winner)

[1]Dr. Debanga Sarma, [2]Dr. Mandeep Phukan, [3]Dr. Kishlaya Atharwa, [4]Dr. Nabajeet Das, [5]Dr. Puskal Kumar Bagchi, [6]Dr. Sasanka Kumar Barua

[1-6]Department of Urology and Renal Transplant, Gauhati Medical College and Hospital, Guwahati, India

Corresponding author
Dr. Kishlaya Atharwa
Department of Urology and Renal Transplant, Gauhati Medical College and Hospital, Guwahati, India
Email: drkishlayauro@gmail.com

Received: 26 September, 2023 Accepted: 20 October, 2023

ABSTRACT

Purpose: In the last decades, HoLEP has become the most frequent intervention for BPH. In the hands of an experienced surgeon, improvements in urodynamics parameters are similar to those of other techniques of BPH surgery. When matched with Holmium LASER, there are several potential advantages to using Thulium LASER, such as rapid vaporisation, the ability to coagulate, better spatial beam quality, precise tissue incision, etc. When compared with the historical gold standard, transurethral resection of the prostate (TURP), HoLEP and other enucleation techniques such as bipolar enucleation have shown superior efficacy in tissue retrieval . We aimed to compare the outcomes following enucleation using Holmium and Thulium LASER.

Materials and Methods: Our study included patients who satisfied both our inclusion and exclusion criteria. We compared the weight of prostate tissue enucleated, total enucleation time, the improvement in IPSS Score, improvement in Qmax, changes in PVR and other parameters at regular intervals of follow-up . All the surgeries were performed by a single surgeon.

Results: In total, 42 patients underwent HoLEP and 44 patients underwent ThuLEP. On postoperative follow up patients were evaluated for improvement in IPSS score which was comparable in both arms. With HoLEP, the quantity of tissue enucleated postoperatively was greater with p value <0.0001. ThuLEP procedure was faster than HoLEP with p value <0.0001. Immediate postoperatively HoLEP patients experienced less dysuria compared to ThuLEP patients.

Conclusion: Both HoLEP and ThuLEP alleviate lower urinary tract symptoms in a safe and effective manner. HoLEP was statistically superior to ThuLEP in amount of tissue enucleated and less post operative complications.

Keywords: Prostatic Hyperplasia, Holmium LASER Enucleation (HoLEP), Thulium LASER Enucleation (ThuLEP), Post Void Residue, International Prostate Symptom Score, Maximum Flow Rate (Qmax)

INTRODUCTION

Benign prostatic hyperplasia (BPH) is a prevalent condition among elderly males. BPH is a prevalent male health concern, affecting approximately 50% of men in their 5th decade and 80% of men in their 8th decade [1]. Various minimally invasive surgical modalities are available, which include transurethral resection of the prostate (monopolar or bipolar), LASER (Light Amplification by Stimulated Emission of Radiation) enucleation of the prostate (HoLEP, ThuLEP), electrovaporization, Transurethral incision of the prostate (TUIP), etc. [2]. In the past few decades, Ho LEP has been the most common surgical procedure, and the improvements in urodynamic parameters obtained with this technique are comparable to those obtained with other techniques [3]. Krambeck et al. demonstrated that the prognosis and morbidity of Ho LEP are favourable [4]. Theoretically, the thulium laser has several advantages over the holmium laser, such as rapid vaporisation and coagulation, enhanced spatial beam quality, and precise tissue resection [5, 6]. The first article on Thulium: Yttrium Aluminium Garnet (Tm: YAG) LASER prostatectomy utilising vaporesection was published by Bach et al [7]. In an article published by Shao et al., which compared Tm: YAG with Ho: YAG, there was a decreased amount of blood loss in patients who were subjected to Tm: YAG [8]. Holmium LASER is a pulsed LASER, while Thulium LASER, which is a continuous LASER, has more potent coagulation effects[8]. This randomised controlled trial aims to compare intra- and postoperative variables, surgical complications, and outcomes between ThuLEP and HoLEP in patients with benign prostatic hyperplasia over a 12-month period.

MATERIALS AND METHODS

Study Design: The randomised research was conducted between January 2021 and June 2022 after obtaining approval from the institutional ethical review board. As index cases, patients with benign prostatic hyperplasia on USG Scan or with a clinical indication for surgery served as the basis. Patients were distributed into two groups based on the methods by which they underwent holmium or thulium enucleation following randomization. Postoperatively, the weight of the enucleated prostate was determined. Also considered were intraoperative and postoperative variables. The same group was observed postoperatively for improvement in symptoms: IPSS (International Prostatic Symptom Score), Qmax, serum PSA, and PVR values. Patients attending the urology outpatient clinic were eligible for inclusion, as were those with a confirmed diagnosis of benign hyperplasia of the prostate and a surgical indication, an International Prostate Symptom Score ≥12, urodynamic obstruction devoid of detrusor dysfunction, and an absence of pharmacologic response. Excluded from the analysis were patients with a history of prostate surgery, suspicious findings for prostate cancer or urethral stricture, and neurogenic bladders. A total of 88 patients were included in the study. After randomization, each group had 44 patients. Patients were followed up for 12 months, and during follow-up, 2 patients from the HoLEP group didn’t follow up. Thus, we concluded our study with 42 patients in the HoLEP group and 44 patients in the ThuLEP group.

Interventions: HoLEP was accomplished utilising a 100-W Quanta System SpA Pulse Holmium Laser (Samarate (VA)-Italy) with an energy setting of 60 W–70 W (1.5 J X 40–45 Hz). ThuLEP utilised a 50 W thulium: YAG laser system (Samarate (VA)—Italy). A 26-F continuous-flow laser resctoscope was used in both procedures. We used a mechanical tissue morcellator (R. Wolf, PiranhaTM, Germany) for the removal of enucleated tissue. All interventions were conducted by a surgeon with experience in over 200 HoLEP and ThuLEP procedures. The three-lobe technique was commonly used for large prostates. Enucleation was carried out as described by Gilling [9], for HoLEP and Herrmann [7], for Thu LEP. Two incisions were made at 5 and 7 o'clock in the surgical capsule, gradually making a plane in the median lobe. Following the margin of the prostatic capsule towards the verumontanum, the median lobe was then enucleated. The upper and lower planes of two lateral lobes were connected using an incision made at 12 o’clock, and gradual enucleation was done. All enucleations were performed with the surgical capsule in view to avoid any loss in the surgical plane. Following the completion of enucleation, morcellation was performed. As irrigation fluid, a normal saline solution was used throughout the entire procedure. Following surgery, all patients were put on a three-way, 22 Fr. Foley catheter with continuous bladder irrigation with normal saline.

Data collection: The preoperative data included DRE grade, PSA, IPSS, PVR (post-void residue), Qmax (ml/sec), and TRUS prostate volume measurements. The perioperative data included the total operative time, the enucleation time, the morcellation time, and the weight of the resected prostate as measured after morcellation. Post-operative data included a fall in haemoglobin, catheter indwelling time, and duration of hospital admission. IPSS, PSA, PVR, and Qmax were reevaluated in all patients 3, 6, and 12 months after surgery. Perioperative and postoperative complications, including acute urinary retention, post-operative dysuria, long-term strictures, and bladder neck stenosis, were also considered.

Statistical analysis: For statistical analysis, SPSS 23 (IBM Corp., Armonk, New York, United States) was utilised. The t test was used to compare continuous variables expressed in terms of mean standard deviation for independent samples. Continuous nonparametric variables were expressed as the median and standard deviation, and matched pairings were analysed using the Mann-Whitney U or Wilcoxon signed-rank test. The Chi-square test was utilised to compare the categorical variables. A p value less than or equal to 0.05 was regarded as statistically significant for all comparisons.

RESULTS

Baseline characteristics: Patients' baseline characteristics are listed in Table 1. There were no statistically significant differences between the HoLEP (n = 42) and ThuLEP (n = 44) groups' baseline characteristics.

Perioperative results: Table 2 displays perioperative data. All of the surgical procedures were conducted satisfactorily. HoLEP required substantially longer enucleation times than ThuLEP ($p < 0.0001$ for both): 58.80(11.67 vs. 41.02(7.19 minutes. The decrease in haemoglobin was substantially greater in the HoLEP group (0.71 (0.23 vs. 0.42 (0.13) compared to the ThuLEP group (both $p < 0.0001$). The percentage of resected weight was significantly greater in the HoLEP group than in the ThuLEP group (67.54 (6.89% vs. 58.35 (7.4%) (both $p <0.001$). In terms of the duration of morcellation and catheter indwelling, there were no significant differences between the two groups.

Follow up results: The variations in IPSS score, Q_{max}, PVR, and PSA three, six, and twelve months, respectively, after the surgery is displayed in Table 3. Regarding follow-up data, there were no statistically significant differences between the two groups ($p > 0.05$).

Complications: Tables 4 and 5 provide comprehensive information on all complications and treatment options. Four (9.52%) patients in the HoLEP group and two (4.54%) patients in the ThuLEP group who experienced postoperative hematuria received prolonged bladder irrigation. One patient in each group required recatheterization due to acute urinary retention after catheter removal, while five (11.9%) patients in the HoLEP group and four (9.09%) ThuLEP group patients developed self-limiting transient incontinence. Two (6.45%) patients in the HoLEP group and nine (24.3%) patients in the ThuLEP group complained of dysuria; however, this resolved with sensitive antibiotics and anticholinergics, which was statistically significant for the ThuLEP group ($p = 0.0497$).Within the 12-month observation periods, urethral stricture and bladder-neck contracture occurred, requiring internal urethrotomies or bladder-neck incisions.

Table 1: Baseline characteristics-

Variable	HoLEP group N= 42	ThuLEP group N=44	P value
Age (years)	64.04 (7.29)	65.68 (7.42)	0.30
Prostate volume(ml)	78.19(17.31)	85.13 (16.61)	0.06
PSA (ng/ml)	3.26 (0.76)	3.25 (0.54)	0.94
IPSS	26.88 (3.06)	27.68 (3.03)	0.22
PVR (ml)	94.14 (26.85)	104.77 (26.52)	0.06
Q max (ml/sec)	9.78 (1.80)	10.09 (1.61)	0.40
Data presented as mean (SD). HoLEP, Holmium laser enucleation of the prostate; ThuLEP, thulium laser enucleation of the prostate			

Table 2: **Perioperative data**

Variables	Ho LEP	Thu LEP	P value
Enucleation time (min)	58.80 (11.67)	41.02 (7.19)	<0.0001
Morcellation time (min)	12.54 (2.84)	12.15(2.50)	0.50
Percentage Resected weight	67.54(6.89)	58.35 (7.4)	<0.0001
Hemoglobin decrease (gm/dl)	0.71 (0.23)	0.42 (0.13)	<0.0001
Catheter indwelling time (days)	2.03(2-3)	2.10(2-3)	--
Data presented as mean (SD). HoLEP, Holmium laser enucleation of the prostate; ThuLEP, thulium laser enucleation of the prostate			

Table 3: **Changes in PSA and IPSS**

	3 Months	6 Months	12 Months
IPSS			
HoLEP	7.04 (0.73)	7.14 (0.65)	8.06 (0.72)
Thu LEP	6.77 (1.09)	6.84 (0.84)	7.85 (0.64)
P value	0.182	0.068	0.156
PSA (ng/ml)			
Ho LEP	0.63 (0.14)	0.72 (0. 11)	0.73 (0.14)
Thu LEP	0.65 (0.13)	0.68 (0.12)	0.74 (0.15)
P value	0.846	0.111	0.75
Qmax (ml/sec)			
Ho LEP	18.76 (1.98)	18.46 (1.65)	17.76 (0.44)
Thu LEP	18.97 (1.57)	18.84 (1.85)	17.64 (1.36)
P value	0.586	0.318	0.58
PVR(ml)			
Ho LEP	25.16 (6.58)	28.24 (4.68)	28.88 (5.82)
Thu LEP	23.20 (5.45)	26.16 (5.65)	26. 64 (5.46)
P value	0.135	0.067	0.691
Data presented as mean (SD). Ho LEP, Holmium laser enucleation of the prostate; Thu LEP, thulium laser enucleation of the prostate; Qmax, Maximum Flow Rate; PVR, post void residue; IPSS, International Prostatic Symptom Score; PSA, prostate specific antigen			

Table 4: **Early post op Complications**

Complications	Treatment required	Ho LEP	Thu LEP	P value
Post op hematuria	Bladder irrigation	4 (9.52)	2 (4.54)	0.42
Acute urinary retention	recatheterisation	1(2.38)	1(2.38)	1.0
Dysuria	Antibiotics and anticholinergic	2 (4.76)	9 (20.45)	0.0496
Transient Incontienence	Functional training	5(11.9)	4 (9.09)	0.735
Data presented as n (%). HoLEP, Holmium laser enucleation of the prostate; ThuLEP, thulium laser enucleation of the prostate				

Table 5: Long term complications (12 months follow up)

Complications	Treatment required	Ho LEP	Thu LEP	P value
Urethral stricture	Directly visualised internal urethrotomy	1(3.2)	2 (5.4)	1.0
Bladder neck stenosis	Bladder neck incision	1(3.2)	1 (2.7)	1.0
Data presented as n (%). Ho LEP, Holmium laser enucleation of the prostate; Thu LEP, thulium laser enucleation of the prostate				

DISCUSSION

Transurethral prostate resection (TURP) represents a paradigm shift in urology due to its development, refinement, and prevalent use [10,11]. When compared to the traditional electrical coagulation used in monopolar or bipolar TURP, laser features make it possible to coagulate tissue more accurately and thoroughly. The development of the holmium laser was a turning point in the field of minimally invasive BPH laser therapy [12]. Historically, open prostatectomy was the only therapeutic option for males with prostates greater than 80–100 cc. Two studies compared HoLEP and open prostatectomy in patients with prostate volumes of >70 ml and >100 ml six months, two years, and five years after the procedures. Compared to the open procedure, catheterization time and hospital stay were considerably shorter, as were blood loss and the need for blood transfusions; however, operative time was longer for HoLEP, and postoperative dysuria was reported more frequently after HoLEP [13,14]. HoLEP and ThuLEP offer complete adenoma removal, resulting in outstanding long-term functional outcomes and a low recurrence rate [15,16]. We present the 12-month results of a randomised, controlled trial comparing ThuLEP and HoLEP in men with prostate enlargement. Our research found a significant difference in operation time, favouring the ThuLEP approach. On the one hand, the wavelength of the Thulium Laser is closer to the water absorption peak, and water is the primary absorbing substance, compromising approximately two-thirds of the prostate, resulting in a high energy absorption rate and tissue vaporisation during enucleation [15,17]. The thulium Laser’s physical properties may also play a crucial role. Unlike the pulsed mode of the Holmium Laser, the continuous wave mode of the Thulium laser may result in faster enucleation [18]. During enucleation, Thulium Possesses an intrinsic vaporisation effect, resulting in a further reduction in time. Less haemoglobin was lost in the ThuLEP group, possibly as a result of the laser's continuous wave emission and shorter wavelength, which cause simultaneous coagulation and vaporisation. This result is consistent with the findings of other studies [19,20]. Several studies [21,22] indicate that the overall PSA reduction may be an indicator of complete adenoma excision. In our study, the PSA reduction percentage at 12 months following Ho LEP and Thu LEP was 80.51% and 80%, respectively. Intraoperatively and postoperatively, we encountered complications of Clavin grades 1, 2, and 3a. In both groups, we observed transient incontinence. Five (11.9%) of the HoLEP patients and four (9.09%) of the Thu LEP patients both experienced temporary incontinences. The cumulative duration of the procedure was the most crucial element in determining transient incontinence. The incidence of postoperative transient incontinence and rehabilitation delays associated with this complication appeared to increase with the duration of the operation [23]. The thulium laser's continuous wave output allows for a more accurate and clean incision, decreasing mechanical stress, whereas the holmium laser's pulsed output splits the tissue and requires more traction with the resectoscope to separate the adenoma from the capsule. During follow-up, no statistically significant differences in Qmax, IPSS, or PVR were found, indicating that both techniques were equivalent in improving urinary flow and resolution of LUTS. In this study, HoLEP required significantly longer operating periods than Thu LEP ($p<0.05$). After surgery, one patient in each group developed acute urinary retention, which was treated with Foley's catheterization. Seven days later, catheter-free trials were successful in both patients. Following Thu LEP, nine patients (20.45%) in the Thu LEP group and two patients (4.76%) in the Ho LEP group developed dsyuria. In this study, neither prostate cancer nor histopathological evidence of prostatic carcinoma were detected. This article has some restrictions. The sample size was relatively small, and the study was conducted at a single centre; therefore, multicenter and large-scale studies are required to further confirm the superiority of Ho LEP over Thu LEP. To determine the precise role of Thu LEP in the surgical management of large prostates, extended follow-up outcomes are required. Finally, it is necessary to compare erectile and sexual functions following these two interventions. This issue must be resolved in future research.

CONCLUSION

Both Thu LEP and Ho LEP improved the IPSS, Q_{max}, PVR, and PSA similarly, with sustained results after a year. Both techniques resulted in comparable excision of prostatic tissue with a low incidence of complications. Overall, the Ho LEP cohort had more tissue removed. There were no differences in catheterization duration, irrigation volume, or hospitalisation time. Thu LEP had reduced blood loss, demonstrating the thulium laser's superior hemostatic capacity. In addition, early postoperative complications like dysuria were more prevalent in Thu LEP. Temporary incontinence was more prevalent in the Ho LEP group.

REFERENCES

1. Becher EF, McVary KT. Surgical Procedures for BPH/ LUTS: Impact on Male Sexual Health. Sex Med Rev 2014;2:47-55.
2. Hoekstra RJ, Van Melick HH, Kok ET, Ruud Bosch JL. A 10-year follow-up after transurethral resection of the prostate, contact laser prostatectomy, and electrovaporization in men with benign prostatic hyperplasia; long-term results of a randomized controlled trial. BJU Int. 2010;106:822–6.
3. Gilling PJ, Mackey M, Cresswell M, Kennett K, Kabalin JN, Fraundorfer MR. Holmium laser versus transurethral resection of the prostate: a randomized prospective trial with 1-year follow-up. J Urol. 1999;162:1640–4
4. Krambeck AE, Handa SE, Lingeman JE. Experience with more than 1,000 holmium laser prostate enucleations for benign prostatic hyperplasia. J Urol.2010;183:1105–9.
5. Fried NM, Murray KE. High-power thulium fiber laser ablation of urinary tissues at 1.94 microns. J Endourol. 2005;19:25–31.
6. Fried NM. High-power laser vaporization of the canine prostate using a 110 w thulium fiber laser at 1.91 microns. Lasers Surg Med. 2005;36:52–6.
7. Bach T, Herrmann TR, Ganzer R, Burchardt M, Gross AJ. RevoLixvaporesection of the prostate: initial results of 54 patients with a 1-year follow-up. World J Urol. 2007;25:257–62.
8. Shao Q, Zhang FB, Shang DH, Tian Y. Comparison of holmium and thulium laser in transurethral enucleation of the prostate]. Zhonghua Nan Ke Xue.2009;15:346–9.
9. Gravas S, Bachmann A, Reich O, Roehrborn CG, Gilling PJ, De La Rosette J (2011) Critical review of lasers in benign prostatic hyperplasia (BPH). BJU Int 107(7):1030–43.
10. Hartung, R., Mauermayer, W., Beck, F. &Karcher, G. The controlled TUR: a new method for the measurement of intraoperative blood-loss during TUR (author's transl.) [German]. Urologe A 15, 254–57.
11. Mauermayer, W. Indications for surgical treatment of prostatic adenoma [German]. Med. Klin. 73, 1363–70.
12. Elkoushy MA, Elhilali MM (2016) Management of benign prostatic hyperplasia larger than 100 ml: simple open enucleation versus transurethral laser prostatectomy. CurrUrol Rep 17(6):44.
13. Kuntz, R. M., Lehrich, K. &Ahyai, S. A. Holmium laser enucleation of the prostate versus open prostatectomy for prostates greater than 100 grams: 5-year follow-up results of a randomised clinical trial. Eur. Urol. 53, 160–66.
14. Kuntz, R. M. &Lehrich, K. Transurethral holmium laser enucleation versus transvesical open enucleation for prostate adenoma greater than 100 gm: a randomized prospective trial of 120 patients. J. Urol. 168, 1465–9.
15. Herrmann TR, Bach T, Imkamp F, Georgiou A, Burchardt M, Oelke M, et al. Thulium laser enucleation of the prostate (ThuLEP): transurethral anatomical prostatectomy with laser support Introduction of a novel technique for the treatment of benign prostatic obstruction. World J Urol 28(1):45–51.
16. Jones P, Alzweri L, Rai BP, Somani BK, Bates C, Aboumarzouk OM. Holmium laser enucleation versus simple prostatectomy for treating large prostates: Results of a systematic review and meta-analysis. Arab J Urol. 2016;14(1):50-8.
17. Kyriazis I, Swiniarski PP, Jutzi S, Wolters M, Netsch C, Burchardt M, et al. Transurethral anatomical enucleation of the prostate with Tm:YAG support (ThuLEP): review of the literature on a novel surgical approach in the management of benign prostatic enlargement. World J Urol 33(4):525–30.
18. Netsch C, Becker B, Tiburtius C, Moritz C, Becci AV, Herrmann TRW, et al. A prospective, randomized trial comparing thulium vapoenucleation with holmium laser enucleation of the prostate for the treatment of symptomatic benign prostatic obstruction: perioperative safety and efficacy. World J Urol 35(12):1913–21.
19. Sun F, Sun X, Shi Q, Zhai Y. Transurethral procedures in the treatment of benign prostatic hyperplasia: a systematic review and meta-analysis of effectiveness and complications. Medicine 97(51):e13360.
20. Bach T, Wendt-Nordahl G, Michel MS, Herrmann TR, Gross AJ. Feasibility and efficacy of Thulium:YAG laser enucleation (VapoEnucleation) of the prostate. World J Urol 27(4):541–45.
21. Zhang F, Shao Q, Herrmann TR, Tian Y, Zhang Y. Thulium laser versus holmium laser transurethral enucleation of the prostate: 18-month follow-up data of a single center. Urology 79(4):869–74.
22. Tinmouth WW, Habib E, Kim SC, Kuo RL, Paterson RF, Terry CL,et al., Change in serum prostate specific antigen concentration after holmium laser enucleation of the prostate: a marker for completeness of adenoma resection? J Endourol 19(5):550–54.
23. Nam JK, Kim HW, Lee DH, Han JY, Lee JZ, Park SW. Risk factors for transient urinary incontinence after holmium laser enucleation of the prostate. World J Men's Health 33(2):88–94.