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En bloc enucleation of the prostate with early apical release using a high-power (200 W) thulium device: studying a learning curve

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SUMMARY

OBJECTIVE: The aim of this study was to reveal the learning curve of early apical release en bloc laser prostatectomy using a high-power thulium (200 W) laser device.

METHODS: We obtained data on the initial 60 patients who had thulium laser enucleation of the prostate by a single surgeon between October 2021 and August 2022 to treat the signs and symptoms of benign prostatic hyperplasia at our clinic. The cases were split into three groups, each consisting of 20 patients. Prostate volumes, prostate-specific antigen and hemoglobin levels, the International Prostate Symptom Score, Quality of Life scores, the International Index of Erectile Function-5 scores, and uroflowmetry parameters were documented preoperatively. The enucleation weight, the enucleation and morcellation times, as well as the efficiency, hospitalization, and catheterization durations were calculated. The patients were re-evaluated at 6 months postoperatively, examined for functional results, and compared to baseline conditions.

RESULTS: Enucleation times, morcellation times, enucleation weight, and enucleation efficiency were significantly different among the groups. However, there was no statistically significant difference in total operative time and morcellation efficiency. In terms of postoperative statistics, the reduction in hemoglobin was significantly greater in Group 1 compared to Group 2. Six months after surgery, all groups had comparable validated ratings (International Prostate Symptom Score, Quality of Life, and the International Index of Erectile Function-5) on postoperative examinations. There were no long-term complications in either group throughout the perioperative period.

CONCLUSION: Completing 40 first cases would be sufficient for managing the learning curve for early apical release en bloc thulium laser enucleation of the prostate.

KEYWORDS: Laser. Prostatectomy. Thulium. Hyperplasia. Learning.

INTRODUCTION

A century after its anatomical description in 1,550, Herr theorized that an enlarged prostate could lead to urinary retention by impeding urine flow[1]. Since then, there has been an enormous increase in our understanding of the pathophysiology of benign prostatic hyperplasia (BPH) and its treatment options. More than 210 million men worldwide are currently diagnosed with BPH[2]. Transurethral resection of the prostate (TUR-P) remains the gold standard for the interventional treatment of symptomatic BPH, despite the remarkable advances in technology and surgical equipment that have led to the emergence of numerous new choices[3]. Studies suggest that laser enucleation of the prostate (LEP) is safer than monopolar transurethral resection of the prostate (TURP) for small to medium-sized prostate glands due to reduced catheter time and decreased risk of bleeding, even in patients receiving anticoagulation or antiplatelet therapy[4]. In conclusion, LEP has been incorporated into recommendations for prostates of more than 80 mL[5].

Thulium:yttrium aluminum garnet (Tm:YAG) lasers are one of the tools in the LEP field to this day[6]. Theoretically, depending on the manufacturer, Tm:YAG continuous wave lasers can produce beams between 2010 and 2013 nanometer wavelengths. At these wavelengths, with an optical penetration depth of about 0.2 mm, electromagnetic energy is converted into heat, causing evaporation of the prostate tissue[7,8]. It has been reported that the relatively short depth of penetration of the Thulium laser compared with the Holmium laser (0.45 mm) makes it more reliable and easier to learn[9,10].

As crucial as the type of laser energy utilized in LEP is the enucleation method employed. The three-lobed procedure, which was initially created and popularized in this operation, consists of three longitudinal incisions through which the median lobe is excised, and subsequently both lateral lobes are enucleated. Later, many adaptations of this procedure and en bloc enucleation techniques were documented and presented to the urological society. None of the recent procedures have been adopted as the standard for LEP as of yet[11].

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After acquiring a 200 W Tm:YAG laser and training under an experienced mentor, our urology clinic shifted its enucleation method preference toward the previously reported 'en bloc with early apical release'[12]. Based on our observations that this procedure might have a steep learning curve, we report the outcomes of the initial 60 consecutive patients of a single surgeon in groups for a comparative analysis in this study.

METHODS

Between October 2021 and August 2022, we collected information regarding the initial 60 patients who underwent Thulium LEP (ThuLEP) by a single surgeon to treat symptoms of benign prostatic hyperplasia in our clinic. The research project we conducted was sanctioned by the university's board of ethics (80576354-050-99/177). The Helsinki Declaration's ethical guidelines were strictly followed. The study did not include patients with a history of urethral stricture or bladder outlet obstruction surgery, neurogenic bladder, or prostate cancer. The specialist undertaking surgical operations has a background in endourology spanning over a decade. The operative surgeon worked as an assistant for approximately 40 cases with an endourologist who had performed over 200 en bloc LEPs before beginning the operations.

Patients had both a thorough physical examination and a set of laboratory tests, including measurement of prostate-specific antigen (PSA), and data were recorded alongside demographic information. If the patient had a high PSA level or a suspicious digital rectal examination, a 12-core transrectal ultrasonography-guided prostate biopsy was performed. In addition, preoperative uroflowmetry and postvoid residual volume (PVR) evaluations were carried out as part of the standard preoperative procedures (if the patient did not have a catheter). Also, all patients had to go through a detailed ultrasonic evaluation, and prostate volumes were calculated. Additionally, patients were asked to complete three validated questionnaires preoperatively and at postoperative follow-up. These were the International Index of Erectile Function (IIEF)-5, the International Prostate Symptom Score (IPSS), and the IPSS-Quality of Life Index (QoL).

Technique

All operations were performed under general anesthesia. A Cyber TM 200 W device (Quanta System, Solbiate Olona, Varese, Italy) was used for every surgery, and a 26 French resectoscope (Karl Storz™) was used to send a 550 m laser fiber through it. Enucleation was done using the earlier-described en bloc technique with an early apical release technique[12]. Beginning at 1'o clock and extending clockwise and counterclockwise, the first incision in the en bloc with the early apical release method separates the prostate adenoma's apex from the urinary sphincter. The whole prostatic adenoma is enucleated in a retrograde direction, circumferentially going toward the bladder neck, after the proper plane has been identified. Later, the bladder neck is entered anteriorly. Finally, the fibers of the bladder neck from the prostate are divided clockwise and counterclockwise, sending the whole adenoma into the bladder in one piece. A Hawk morcellator (Hawk Medical Instrument Co. Ltd.) was used for all morcellation processes. Each patient had a 22 Fr three-way urethral catheter inserted, and their bladder was irrigated continuously until the urine turned a clear color. Enucleation time, morcellation time, and specimen weight were recorded for every instance.

Follow-up

Patients were assessed with PSA levels, uroflowmetry, and PVR as a part of the periodic examination. Additionally, the two valid questionnaires (IIEF and IPSS) that patients completed before the procedure were repeated, taking into account their altered condition, in the sixth postoperative month.

The cases were split into three groups, each consisting of 20 patients, consecutively (Group 1, Group 2, and Group 3). We used the modified Clavien-Dindo Scoring System to evaluate and classify the complications. All demographic data, laboratory findings, and valid questionnaire scores were given in a comprehensive manner.

SPSS version 22.0 was used for the statistical analysis (SPSS Inc., Chicago, IL, United States). The continuous variables were reported as median (25–75 IQR) and were then compared using the Kruskal-Wallis test. *Post hoc* comparisons were made using the Tukey's and Dunnett's tests. The p-value of 0.05 was defined as the threshold for statistical significance.

RESULTS

There was no significant difference between the groups' mean ages. A significant difference in preoperative PSA levels was seen between Group 1 and Group 3. Regarding the preoperative data such as hemoglobin levels, prostate volumes, PVR, and Q-max ratios, there were no statistically significant differences between the groups. Similarly, the groups' preoperative IPSS, QoL, and IIEF ratings were similar.

Enucleation times, morcellation times, enucleation weight, and enucleation efficiency were significantly different among the groups. However, there was no statistically significant difference in total operative time and morcellation efficiency.

Some specific parameters that differed significantly between groups are demonstrated in Figure 1.

In terms of postoperative statistics, the reduction in hemoglobin was significantly greater in Group 1 compared to Group 2. Six months after surgery, all groups had comparable validated ratings (IPSS, QoL, and IIEF-5) on postoperative examinations. Likewise, during the 6-month review, the groups exhibited comparable performance on metrics such as PVR Q-max. Group 3 had shorter hospitalization and catheterization times on an hourly basis. In addition, the percentage of PSA drop relative to the value at baseline was substantially greater in Group 3 compared to Groups 1 and 2. Patient characteristics, and perioperative and postoperative follow-up data are presented in Table 1.

According to Clavien-Dindo Scoring, there is a significant difference between groups when complications are classified as present or absent (chi-square test, p=0.025). Complications such as capsular perforation, injury to the bladder mucosa during morcellation, re-catheterization, and the need for resectoscope-assisted cauterization were numerically higher in Group 1. The categorization of complications according to the Clavien-Dindo classification and the distribution of some specific complications among the groups are presented in Table 2.

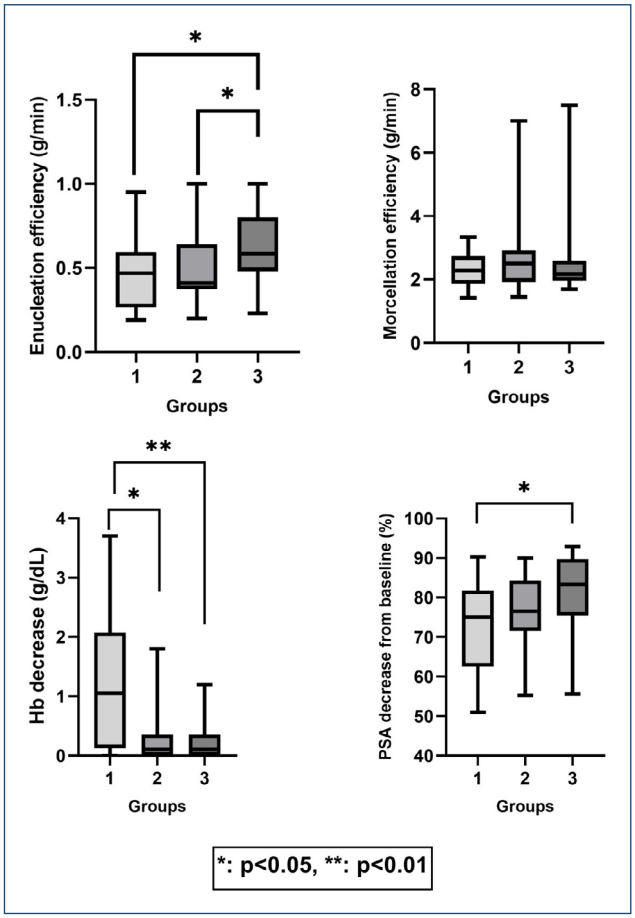

Figure 1. Some specific parameters that differed significantly between the groups.

DISCUSSION

The en bloc LEP learning curve following early apical release utilizing a high-power (200 W) Tm:YAG laser has not yet been the subject of any studies that have been reported in the literature. We must admit that before we begin the procedures, we believe this procedure may have a challenging learning curve. However, as the key conclusion of our research, we can state that after 40 instances, certain significant problems, such as capsular perforation, mucosal damage, and transitory stress incontinence, significantly decreased. After 20 cases, there was a considerable decline in Hb levels. In our final 20 patient group, a significant increase in enucleation efficiency was seen. One measure of enucleation effectiveness is the decline in PSA percentage levels from the baseline level, and this parameter significantly increased after the first 20 instances[13]. After the first 20 instances, we began to spend more attention on post-enucleation hemorrhage management. Thus, we obtained a clear image during morcellation. Therefore, while our enucleation times gradually decreased, no significant difference was observed between the groups in terms of total operation times. On the contrary, our mucosal injury rates decreased after the first 20 cases.

The learning curve for ThuLEP might be managed after more than 20 first instances, according to Aydogan et al. In their study, a high-power (200 W) T:YAG laser was employed, the same as in our investigation, but the three-lobe method of resection was selected. According to this study, complication rates started to drop after 20 cases. After 40 instances in our study, it can be claimed that we are in a safer region when parameters like capsular perforation, temporary incontinence (which in our experiment lasted for a maximum of 4 months), and resectoscope-assisted cauterization requirements are considered[14]. Tuccio et al.'s holmium LEP (HoLEP) series were evaluated comparatively according to the enucleation technique used. They showed that en bloc with an early apical release strategy can significantly have a shorter enucleation time and lower energy delivered. The stress incontinence rate at the 1-month follow-up was found to be significantly reduced in the en bloc group compared with the three-lobe technique. As a result, they stated that both methods can be used safely and effectively in the treatment of BPH[15]. According to Rapaport et al., due to the quick

identification of the surgical capsule and the appropriate layer, en bloc holmium enucleation of the prostate resulted in a shorter enucleation and overall surgical time compared to typical HoLEP. By employing this method, surgical trainees can learn holmium laser enucleation of the prostate more effectively[16]. Our study similarly showed that an experienced endourologist made significant progress for en bloc ThuLEP after 40 cases of experience. No complications were found on Clavien 3 in this process.

Kampantais et al. analyzed the results of 24 studies evaluating the learning curve of HoLEP in their published systematic review. With the caveat of careful case selection, such as avoiding patients with prostates larger than 80 cm^3, cancer or postradiotherapy cases, anticoagulant users, or catheterized patients, the caseload for a surgeon to safely perform the procedure with satisfactory efficiency and outcomes may be estimated at 50 cases. This can drop to less than 25 cases in the presence of a structured mentoring program and simulation training[17]. Inclusion in this study is not contingent on a particular method of enucleation. Neither the trilobed bilobed nor the en bloc approaches were differentiated from one another. Using high-energy thulium, this study aims to highlight the steepness of the learning curve associated with the en bloc approach. Our results revealed that after 40 cases

Table 1. Patient characteristics and perioperative outcomes between the groups.

	Group 1		Group 2		Group 3		p	p (Group 1–2)	p (Group 1–3)	p (Group 2–3)
Age (years)	66	(62–75)	70	(64–73)	69	(62–80)	0.614			
PSA (ng/mL)	4.20	(2.35–7.40)	2.70	(1.30–4.40)	1.70	(1.20–2.50)	**0.015**	0.317	**0.014**	0.604
Prostate volume (mL)	99	(68–120)	78	(67–95)	73	(55–119)	0.339			
PVR preop. (mL)	250	(135–316)	168	(95–333)	109	(66–200)	0.180			
Q-max preop. (mL/s)	9.7	(6.9–12.1)	5.7	(1.8–10)	8.6	(8.1–12.8)	0.316			
Enucleation time (min)	120	(97–128)	70	(58–79)	48	(42–69)	**<0.001**	**0.001**	**<0.001**	0.076
Morcellation time (min)	20	(10–28)	14	(10–15)	10	(10–20)	0.101			
Total operative time (min)	80	(51–116)	68	(53–81)	59	(44–85)	0.503			
Enucleation weight (g)	50	(34–60)	30	(26–35)	24	(20–40)	**0.002**	**0.012**	**0.001**	0.362
Preop. Hb (g/dL)	14.3	(12.6–14.8)	12.9	(11.5–14.7)	13.1	(12.4–14.1)	0.315			
Postop. Hb (g/dL)	12.3	(11.4–13.9)	13.1	(11.1–14.3)	13.3	(12.1–13.9)	0.622			
Enucleation efficiency (g/min)	0.47	(0.28–0.59)	0.41	(0.38–0.64)	0.59	(0.48–0.80)	**0.019**	0.986	**0.015**	**0.014**
Morcellation efficiency (g/min)	2.28	(1.87–2.66)	2.50	(1.95–2.91)	2.18	(1.98–2.58)	0.766			
Hb decrease (g/dL)	1.05	(0.15–1.95)	0.10	(0–0.30)	0.10	(0–0.30)	**0.003**	**0.008**	**0.002**	0.627
IPSS preop.	20	(18.5–25)	20.5	(17–27)	22.5	(19.5–24)	0.614			
IPSS postop. 6 months	6	(3.5–9)	4.5	(3–7)	5	(2–6)	0.093			
QoL score preop.	4	(3–4)	4	(3–4)	4	(3.5–4)	0.635			
QoL score postop.	1	(1–2)	1	(1–2)	1	(1–1.5)	0.426			
Catheter stay time (h)	42.5	(36.5–48)	40.5	(31.5–44)	24.5	(17–36.5)	**<0.001**	0.674	**<0.001**	**0.024**
Hospitalization (h)	50	(44.5–55.5)	46	(35.5–52)	28	(21–41)	**<0.001**	0.402	**0.005**	0.282
PSA postop. 6 months (ng/mL)	1.13	(0.55–1.74)	0.55	(0.22–1.52)	0.29	(0.10–0.46)	**0.006**	0.317	**0.011**	0.604
PSA decrease from the baseline (%)	75.05	(63.1–81.1)	76.55	(71.6–83.8)	83.3	(75.8–89.4)	**0.026**	0.139	**0.030**	1.000
Q-max postop. 6 months (mL/s)	23.5	(17.4–31.4)	22	(19–31.6)	24	(21–32)	0.420			
PVR postop. 6 months (mL)	23	(0–50)	0	(0–50)	0	(0–25)	0.252			
IIEF-5 score preop.	14	(12–16)	14	(11.5–17.5)	15	(13–17)	0.533			
IIEF-5 score postop. 6 months	14	(12–16)	15	(13.5–17.5)	15	(13.5–17.5)	0.291			

Data are given as median-(IQR); the Kruskal-Wallis test was used. PSA: prostate-specific antigen; PVR: post-void residual urine; Preop.: preoperative; Postop.: postoperative; Hb: hemoglobin; QoL: quality of life; IPSS: International Prostate Symptom Score; IIEF-5: International Index of Erectile Function-5; Q-max: maximal flow rate. Bold indicates statistically significant p-value.

Table 2. Number and classification of perioperative and postoperative complications.

	Group 1	Group 2	Group 3
Clavien-Dindo classification			
Absent*	9 (45%)	14 (70%)	17 (85%)
1	8 (40%)	4 (20%)	2 (10%)
2	2 (10%)	2 (10%)	0
3a	1 (5%)	0	1 (5%)
Column sclerosis	1 (5%)	0	0
Urethral stricture	0	0	1 (5%)
Capsular perforation	3 (15%)	1 (5%)	0
Re-catheterization	2 (10%)	0	0
Mucosal injury during morcellation	2 (10%)	0	0
Cauterization with resectoscope	3 (15%)	1 (5%)	1 (5%)
Stress incontinence	1 (5%)	1 (5%)	0

Data are presented as numbers and percentages. *According to Clavien-Dindo Scoring, there is a significant difference between groups when complications are classified as present or absent (χ^2 test, p=0.025).

of en bloc ThuLEP, an experienced endourologist made significant improvements.

Saredi et al. used a simulator program to assess the learning curve for ThuLEP without the assistance of a mentor. Visits to several centers with HoLEP and ThuLEP expertise served as the starting point for the learning process. The ThuLEP method was then practiced using the brand-new simulator Cybersim. The majority of surgical complications were from morcellation rather than the actual enucleation and were quickly resolved. The study's findings are consistent with other case studies for laser treatments of BPH in the literature. Their findings indicate that fewer instances than those for HoLEP are required for an endoscopically skilled urological surgeon to learn ThuLEP, and mentoring is not required for this method. They discovered that a single operator may pass the learning curve after practicing the process in 30 cases[18].

The functional outcomes of our investigation demonstrated that erectile functions were comparably retained 6 months following surgery as compared to the preoperative period. On the contrary, the patient's symptoms in the lower urinary tract dramatically improved. Our functional results and those from prior research on this topic in the literature show remarkable overlap[19].

The purpose of this study was to measure the steepness of the learning curve by tracking how many cases were handled. However, it is important to keep in mind that the learning curve may also be influenced by other factors. According to the research, the threshold for expert performance varies across different outcome metrics. Prostate size before surgery, total number of procedures, and case density are the primary factors affecting the shape of the curve. Increased success rates would result from intensive one-on-one training for surgeons and a high number of cases[20].

CONCLUSION

Our research confirmed that an experienced endourologist can perform ThuLEP surgery with the en bloc early apical release technique without a steep learning curve. Due to training from an experienced mentor, findings at the start of the learning curve are similar to those of other methods. In the early postoperative period, complications are manageable, but beyond 40 cases, results can be in a safer area regarding complications and efficacy.

AUTHORS' CONTRIBUTIONS

ÜY: Conceptualization, Data curation, Formal Analysis, Funding acquisition, Investigation, Methodology, Project administration, Resources, Software, Supervision, Validation, Writing – original draft, Writing – review & editing. **ME**: Conceptualization, Investigation, Methodology, Writing – original draft, Writing – review & editing. **MU**: Investigation, Methodology, Resources. **BÖ**: Methodology, Software, Supervision, Validation, Visualization.

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