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**EVALUATION OF TRANSURETHRAL THULIUM LASER
ENUCLEATION OF THE PROSTATE IN THE
MANAGEMENT OF BENIGN PROSTATIC
HYPERPLASIA**

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LIST OF RESEARCH WORKS RELATED TO THE THESIS BY THE AUTHOR

1. Hoai Nam Tran, Van Hinh Tran, Viet Cuong Nguyen (2025), “Comparative outcomes of thulium laser enucleation by prostate volume: a three-group analysis from a single-center study in Vietnam”, *African Journal of Urology*, (2025) 31:7.

2. Tran Hoai Nam, Tran Van Hinh, Nguyen Viet Cuong (2025), “Clinical outcomes of transurethral thulium laser enucleation of the prostate in management of benign prostatic hyperplasia”, *Journal of Military Pharmaco-medicine*, N^o4-2025:191-198.

3. Trần Hoài Nam, Trần Văn Hinh, Nguyễn Việt Cường (2024), “Kết quả sớm phẫu thuật bóc nhân tuyến tiền liệt qua niệu đạo sử dụng Laser Thulium (ThuLEP)”, *Tạp chí y dược Huế*, Số đặc biệt, 8-2024:353-358. Hội nghị khoa học hội tiết niệu - thận học Việt Nam (VUNA) lần XVIII, Hội tiết niệu - Thận học Thừa Thiên - Huế (HueUNA) lần thứ XVI

4. Trần Hoài Nam, Trần Văn Hinh, Nguyễn Việt Cường (2024), “Bóc nhân tuyến tiền liệt qua niệu đạo sử dụng Laser Thulium: kỹ thuật En-Bloc và kết quả”, *Tạp chí y học Việt Nam*, tập 544 - tháng 10 - số chuyên đề - 2024:96-105. Hội nghị khoa học thường niên lần thứ X - VUNA-North - Hội tiết niệu thận học Việt Nam.

INTRODUCTION

Benign prostatic hyperplasia (BPH) is a common condition in elderly men, often leading to lower urinary tract symptoms (LUTS) and significantly impairing quality of life. Surgical intervention is indicated when BPH results in recurrent complications or when medical therapy proves ineffective. Transurethral resection of the prostate (TURP) remains the gold standard surgical treatment for BPH. However, TURP has notable limitations, particularly in cases involving large prostates (>80 ml), with lower efficacy and a higher incidence of complications such as bleeding, transurethral resection (TUR) syndrome, urinary tract infections, and even mortality. As a result, TURP is mainly indicated for prostates with a volume of 30 - 80 ml [1], [2].

To improve treatment outcomes and reduce complications associated with TURP, various new surgical techniques have been developed, including prostate enucleation procedures. Multiple meta-analyses have demonstrated that enucleation techniques outperform TURP in terms of shorter hospital stays, reduced blood loss, fewer complications, and faster recovery. Among the energy sources used for prostate enucleation, Thulium laser has emerged as a suitable option due to its continuous 2-micrometer wavelength and excellent hemostatic properties. Therefore, Thulium Laser Enucleation of the Prostate (ThuLEP) via transurethral approach is not only safe and effective but also offers several advantages, including suitability for large prostates, reduced risk of bleeding and complications, and favorable long-term outcomes [3], [4]. However, there is still an ongoing global debate regarding whether prostate enucleation should

be considered the current gold standard or the future standard for BPH treatment [5], [6].

In Vietnam, ThuLEP has been introduced in several major medical centers and has shown initial safety and efficacy. Nevertheless, the number of procedures remains limited. The level of scientific evidence from domestic studies remains low, characterized by a limited number of studies and a lack of comprehensive evaluation. Given these limitations in both practical application and theoretical evidence, the question remains: Does the implementation and development of ThuLEP in Vietnam truly offer promising outcomes? And what factors influence the surgical outcomes of ThuLEP in clinical practice?

Therefore, in response to the urgent needs of clinical practice and the necessity for scientific evidence in Vietnam, we conducted the study: "Evaluation of the Outcomes of Thulium Laser Enucleation of the Prostate for the Treatment of Benign Prostatic Hyperplasia", with two primary objectives:

1. *To evaluate the outcomes of Thulium Laser Enucleation of the Prostate for the treatment of benign prostatic hyperplasia at Military Hospital 175.*

2. *To identify factors associated with the surgical outcomes of Thulium Laser Enucleation of the Prostate.*

URGENCY OF THE TOPIC:

Benign prostatic hyperplasia (BPH) is a common condition in elderly men, often leading to urinary disorders and a decline in quality of life. When medical treatment is ineffective or complications occur, surgery becomes a necessary option. Currently, Thulium Laser Enucleation of the Prostate (ThuLEP) is highly valued due to its favorable therapeutic outcomes and low complication rates. However, in Vietnam, research data on this technique remain limited, necessitating further evidence to confirm the safety and effectiveness of ThuLEP.

NOVEL CONTRIBUTIONS OF THE DISSERTATION:

This dissertation provides practical data on the efficacy and safety of ThuLEP in the treatment of BPH in Vietnam, affirming that the technique significantly improves symptoms, quality of life, and postoperative sexual function.

The dissertation identifies several associated factors that influence operative time, blood loss, duration of postoperative care, and intraoperative complications in ThuLEP procedures.

STRUCTURE OF THE DISSERTATION:

The dissertation consists of 131 pages. In addition to a 2-page introduction and a 2-page conclusion, it includes four chapters: Literature Review (32 pages), Subjects and Methods (29 pages), Results (32 pages), and Discussion (33 pages); comprising 59 tables, 10 charts, 3 diagrams, and 8 figures.

Chapter 1. LITERATURE REVIEW

1.1. Anatomy relevant to prostate enucleation surgery

The prostate is a gland that surrounds the urethra, located below the bladder, with four surfaces, a base, and an apex. In adult males, the prostate weighs between 15 and 25 grams, and typically measures 4 cm in width, 3 cm in height, and 2.5 cm in thickness. The anterior surface of the prostate is adjacent to the Santorini venous plexus and the pubic bone. The posterior surface lies against the anterior rectal wall and is separated by Denonvilliers' fascia. The lateral surfaces are closely related to the neurovascular bundles near the prostatic apex.

The blood supply to the prostate is divided into two groups: the urethral group and the capsular group. Venous drainage is primarily through the periprostatic venous plexus, which empties into the dorsal venous complex. The prostatic capsule is a fibromuscular structure surrounding the gland, composed mainly of smooth muscle fibers and connective tissue [9]. According to Udeh F.N. (1982), the capsule consists of a pseudo-capsule (derived from the endopelvic fascia) and a true capsule (from the periprostatic connective tissue) [10]. The capsule thickness ranges from 0.5 to 2 mm [11].

The outer layer of the capsule is derived anteriorly and laterally from the pelvic fascia, and posteriorly from the vesicorectal fascia. Just beneath this outer layer lies the periprostatic venous plexus, which drains into the deep dorsal vein of the penis.

Benign prostatic hyperplasia (BPH) typically presents as a rounded or oval mass comprising two or three lobes that approximate anteriorly and adhere tightly posteriorly. As the hyperplastic tissue

enlarges, it extends peripherally and may project into the bladder lumen or rectum, sometimes elevating the bladder trigone. The normal peripheral prostate tissue is displaced and compressed, forming a capsule that encases the hyperplastic adenoma. This anatomical arrangement allows for enucleation of the adenomatous tissue from the fibrous capsule.

1.2. Diagnosis of benign prostatic hyperplasia

The diagnosis of BPH involves evaluating lower urinary tract symptoms (LUTS) and confirming the benign nature of prostatic enlargement. The diagnostic process follows the Decision No. 1531/QĐ-BYT issued by the Ministry of Health of Vietnam, as well as guidelines from the Vietnam Urological Association and the European Association of Urology. The diagnostic algorithm for BPH is summarized in Diagram 1.1, as recommended by the Vietnam Urological Association.

1.3. Surgical management of benign prostatic hyperplasia

According to the European Association of Urology (2024), BPH treatment should be based on a comprehensive assessment of disease severity, the potential for symptom improvement, patient expectations regarding treatment efficacy, side effects, and post-treatment quality of life [21].

Surgical indications for BPH are outlined in guidelines from the Vietnam Urological Association (2019), the Ministry of Health (2023), and the European Association of Urology, and are summarized in Diagram 2.2.

Surgical approaches for BPH are classified into groups based on their shared principles. According to the European Association of

Urology (2025), the surgical modalities for BPH include five major groups [22]: Resection; Enucleation; Vaporisation; Alternative ablative techniques; and non-ablative techniques.

Various laser technologies have been applied in BPH treatment, including Nd: YAG, Holmium: YAG, KTP: YAG, Tm: YAG, and diode lasers. Thulium laser (Tm: YAG) has demonstrated excellent coagulative and vaporization properties, making it suitable for a wide range of procedures [52].

The Thulium laser, formally known as Thulium:yttrium-aluminium-garnet (Tm:YAG), emits energy at a wavelength of approximately 2013 nm in continuous wave mode. The continuous emission provides stable energy delivery, suitable for tissue incision, vaporization, and hemostasis. Thulium laser energy is well absorbed in water, with a tissue penetration depth of approximately 250 μm .

Transurethral prostate enucleation techniques

Based on the type of energy used, enucleation techniques are classified as HoLEP (Holmium laser), ThuLEP (Thulium laser), GreenLEP (Greenlight laser), DiLEP (diode laser), and B-TUEP (bipolar electrosurgical).

Based on the surgical dissection approach, transurethral enucleation techniques are categorized into three main types: Three-Lobe, Two-Lobe, and En-bloc techniques [56].

The En-bloc technique has been described using various terms such as "En-bloc," "All-in-one," "Three horseshoe-like incision," "Omega technique," and "ArTH." Despite differences in nomenclature, these techniques share the same fundamental principle: complete enucleation of the adenomatous tissue as a single mass and

pushing it into the bladder. Among these, "En-bloc" is the most widely accepted term, with more than 2,430 scientific articles indexed in PubMed using the term as of 2024.

1.4. Global and national research status on ThuLEP

1.4.1. Global status

Currently, ThuLEP is being adopted in many centers using the three-lobe, two-lobe, and En-bloc techniques. Additionally, Thulium Laser Vapo-Enucleation of the Prostate (ThuVEP) combines both enucleation and vaporization.

Compared with monopolar TURP (M-TURP), ThuLEP shows longer operative time and shorter catheterization time; compared with bipolar TURP (B-TURP), it results in shorter hospital stays. ThuLEP is associated with lower blood transfusion rates than M-TURP, lower clot retention rates than B-TURP, and comparable rates of other complications [3], [25].

In terms of short-term efficacy (Qmax, IPSS, and QoL scores), no clinically significant differences have been reported between ThuLEP, M-TURP, and B-TURP [3], [25].

1.4.2. National status (Vietnam)

Thulium laser has been introduced into clinical practice in Vietnam since the early 2010s, primarily for transurethral resection and vaporization of the prostate. However, research on its application remains limited due to a lack of access to Thulium laser equipment. Dương Hoàng Lân (2020) reported the outcomes of a three-lobe ThuLEP technique in 30 BPH cases at Binh Dan Hospital. The average operative time was 64.93 minutes, hemoglobin reduction was 1.04 g/dL, and significant improvements in IPSS, QoL, and Qmax were

observed. This remains one of the few domestic studies on ThuLEP to date. In recent years, the implementation, application, and research of ThuLEP in Vietnam have remained limited, mainly due to technical constraints (lack of Thulium laser systems, morcellators, and endoscopic enucleation instruments) and initial learning curve challenges. Although ThuLEP has now been applied in several hospitals, as of 2024, reports on ThuLEP presented at national or regional urology conferences remain scarce.

Chapter 2. SUBJECTS AND METHODS

2.1. Study Population

The study included patients with benign prostatic hyperplasia (BPH) who had surgical indications and underwent transurethral enucleation of the prostate using Thulium Laser (ThuLEP) following the En-bloc technique.

Study site: Military Hospital 175

Study period: From September 2023 to December 2024

2.2. Study Design

A prospective, descriptive study with pre- and post-operative comparisons.

Evaluation time points: preoperative, intraoperative, during postoperative hospitalization, and at 1, 3, and 6 months after surgery.

Sample size: Convenience sampling.

Surgical procedure: Transurethral enucleation of the prostate using the En-bloc technique (abbreviated as En-bloc ThuLEP), consistent with the overview description and detailed in studies by Kim Y.J. et al. (2015) and Saredi G. et al. (2017) [64], [66].

Step 1: Incision at the apex of the prostate

Step 2: Enucleation of the gland as a single piece

Step 3: Tissue morcellation

2.3. Research Contents

Characteristics of the study population

Outcome indicators according to Objective 1: Symptoms and treatment efficacy were evaluated based on the criteria proposed by Homma Y. (1996)

Successful surgery: Completion of the En-bloc ThuLEP procedure without severe complications or conversion to another method.

Evaluation of factors associated with surgical outcomes according to Objective 2.

2.4. Data Collection and Analysis

Data were collected after approval by the Ethics Committee; individual patient data were obtained upon informed consent

The study was approved by the Ethics Committee of the Military Medical Academy under approval number 07/2022/CNChT-HĐĐĐ dated December 12, 2022.

Ethical approval was also obtained from the Ethics Committee in Biomedical Research of Military Hospital 175 under approval number 3377/GCN-HĐĐĐ dated September 6, 2023.

Chapter 3. STUDY RESULTS

This study was conducted on 92 patients with benign prostatic hyperplasia (BPH), who underwent transurethral enucleation of the prostate using a Thulium laser (ThuLEP) at Military Hospital 175, from September 2023 to December 2024.

3.1. Characteristics of the Study Population

The mean age was 69.38 ± 7.09 years (range: 50–87 years).

Comorbidities: Hypertension was the most common (71.7%), followed by diabetes mellitus (25.0%). A total of 30.4% of patients had more than two comorbidities.

Antiplatelet therapy: 9.8% of patients were on antiplatelet agents, including 8.7% on clopidogrel 75 mg and 1.1% on aspirin 81 mg.

ASA classification: ASA II accounted for the majority (63.0%), followed by ASA III (35.9%), and only 1.1% were ASA I.

Mean prostate volume was 72.48 ± 33.79 (range: 31–183 ml).

Table 3.4. Distribution of patients by prostate volume

Prostate Volume (ml)	Number of Patients	Percentage (%)
< 50	31	33,7
50 - 80	28	30,4
> 80	33	35,9
Total	92	100

Urinary retention: 45 patients experienced urinary retention, while 47 did not.

Prostate biopsy: 26 patients (28.3%) had a history of prostate biopsy prior to surgery, and all preoperative pathology results confirmed BPH. Among them, 13 patients had their biopsies performed at other institutions. The mean pre-biopsy PSA in these 13 patients was 17.04 ± 8.06 ng/ml (range: 4.64–32.38 ng/ml). Prostate MRI revealed PI-RADS III–IV lesions. Transrectal ultrasound-guided biopsy with 12 cores was performed. All biopsy results before surgery confirmed BPH, and postoperative histopathological analysis

reconfirmed BPH.

Recurrent BPH: 7 out of 92 patients (7.6%) had recurrent BPH, all of whom had previously undergone TURP.

Table 3.6. Baseline parameters of lower urinary tract symptoms (LUTS)

Parameter	n	Mean $\pm$ SD	Min	Max
IPSS (points)	92	28,65 $\pm$ 4,23	12	35
QoL (points)	92	5,79 $\pm$ 0,41	5	6
Qmax (ml/s)	47	5,25 $\pm$ 1,97	2,55	9,6
PVR (ml)	47	64,06 $\pm$ 56,79	10	150

Remarks: The average scores of the LUTS indicators indicate a severe level of symptoms.

Disease severity: 100% of patients had severe BPH symptoms. No patients presented with mild or moderate disease.

Sexual activity: Most patients reported no sexual activity in the 6 months before surgery. A total of 35 patients (38%) remained sexually active preoperatively.

Mean preoperative IIEF-5 score was 14.83 ± 4.87 points. The proportion of patients with no or mild erectile dysfunction was low.

3.2. Outcomes of Transurethral Thulium Laser Enucleation of the Prostate

3.2.1. Intraoperative Results

The most common prostate morphology was tri-lobar enlargement, accounting for 81.5% of cases.

In the majority of patients, the prostate protruded into the bladder lumen, but both ureteral orifices remained visible.

Notably, in 10 patients, the ureteral orifices were not visible at

the beginning of the procedure due to obstruction by the enlarged prostate lobes. In 3 of these cases, the resectoscope could not reach the bladder neck because of the combination of a long and bulky penis and large tri-lobar prostatic enlargement.

Table 3.12. Intraoperative Time Parameters (n = 92)

Procedure Component (min)	Mean $\pm$ SD	Minimum	Maximum
Total operative time	84,46 $\pm$ 35,63	30	180
Enucleation time	57,07 $\pm$ 25,36	20	120
Morcellation time	11,64 $\pm$ 6,32	3	40

The average surgical, enucleation, and morcellation speeds were 0.92 ml/min, 1.36 ml/min, and 7.27 ml/min, respectively.

Table 3.15. Changes in Hematologic Parameters Before and After Surgery (n = 92)

Parameter	Preoperative	Postoperative	Change	p*
	Mean ± SD			
RBC (T/L)	4,60 ± 0,60	4,26 ± 0,65	0,34 ± 0,39	< 0,001
Hb (g/dL)	13,53 ± 1,34	12,48 ± 1,42	1,06 ± 1,12	< 0,001
HCT (%)	40,77 ± 3,85	37,74 ± 4,42	3,03 ± 3,45	< 0,001

*Paired-samples t-test.

Interpretation: Blood loss occurred during surgery, as evidenced by a statistically significant reduction in hematologic parameters, although the absolute changes remained within acceptable clinical limits. Normal saline was used for intraoperative irrigation.

The average irrigation fluid volume was 44.49 $\pm$ 18.06 liters (range: 10–95 liters).

Serum sodium and potassium levels showed no significant changes postoperatively compared to preoperative values (p > 0.05).

Table 3.17. Duration of Urethral Catheterization Postoperatively

Catheterization	No. of Patients	Percentage (%)
1 day (24 hours)	20	21,7
2 days	35	38,0
3 days	27	29,3
≥ 4 days	10	10,9
Total	92	100

The mean duration of urethral catheterization was 2.45 ± 1.53 days. Notably, 21.7% of patients had their catheter removed on the first postoperative day. The mean length of postoperative hospitalization was 3.51 ± 1.72 days (range: 1–14 days).

Histopathological findings: All resected specimens were confirmed as benign prostatic hyperplasia (BPH), with 34.8% of cases also exhibiting chronic prostatitis.

3.2.2. Treatment Outcomes

3.2.2.1. Symptom Score Improvement

Table 3.20. Mean values, absolute changes, and percentage improvement in IPSS at postoperative compared to baseline

Timepoint	n	Mean IPSS	Preop - Postop	% Improvement	p*
		Mean ± SD			
Preoperative	92	28,65 ± 4,23	-	-	-
1 month	82	3,18 ± 2,03	25,23 ± 4,96	88,18 ± 10,4	< 0,001
3 months	58	1,98 ± 1,69	26,52 ± 4,45	92,76 ± 6,95	< 0,001
6 months	52	1,25 ± 1,01	26,83 ± 4,52	95,37 ± 4,08	< 0,001

*p: Paired Samples T Test

Interpretation: The mean IPSS significantly decreased one month after surgery and remained at a low level at both 3-month and 6-month follow-ups.

3.2.2.2. Functional Improvement

Table 3.23. Mean values, absolute changes, and % improvement in Qmax among patients without preoperative urinary retention

Timepoint	n	Qmax	Preop Postop	% Improvement	p*
		Mean ± SD			
Preoperative	47	5,25 ± 1,97	-	-	-
1 month	43	19,67 ± 7,23	14,26 ± 7,59	324,67 ± 247,08	< 0,001
3 months	35	19,27 ± 5,86	13,81 ± 6,24	302,23 ± 197,74	< 0,001
6 months	34	23,65 ± 9,78	18,47 ± 10,21	442,0 ± 365,81	< 0,001

*p: Paired Samples T Test

Interpretation: There was a significant improvement in mean Qmax at all postoperative time points compared to preoperative values. All patients with preoperative urinary retention were able to void spontaneously after surgery. Based on postoperative Qmax values across all revisiting patients, most were categorized as having mild obstruction, with no cases remaining in the severe category.

3.2.2.3. Anatomical Improvement

The mean postoperative prostate volume was significantly reduced, with a mean residual volume of 25.47 $\pm$ 12.64 ml. The anatomical outcome was classified as excellent in most cases. No patients were categorized as having poor anatomical outcomes at the 1-month follow-up.

3.2.2.4. Quality of Life (QoL) Improvement

The mean QoL score improved significantly at all follow-up time points, with statistically significant changes ($p < 0.001$). 100% of

patients were classified as having mild symptoms during all follow-up periods, with no cases remaining in the moderate or severe categories.

3.2.3. Sexual Activity and Erectile Function Outcomes

Table 3.31. Evaluation of sexual activity before and after surgery

Sexual activity		No n (%)	Yes n (%)	Total n (%)	p*
Before surgery		57 (62,0)	35 (38,0)	92 (100)	
After 3 months	No	29 (50)	5 (8,6)	34 (58,6)	1,000
	Yes	4 (6,9)	20 (34,5)	24 (41,4)	
After 6 months	No	25 (48,1)	2 (3,8)	27 (51,9)	0,683
	Yes	4 (7,7)	21 (40,4)	25 (48,1)	

* McNemar Test

The proportion of patients who resumed sexual activity after surgery showed a slight increase compared to the preoperative period; however, the change was not statistically significant.

The mean IIEF-5 score improved from 14.83 ± 4.87 before surgery to 19.65 ± 5.13 at 6 months postoperatively, and the difference was statistically significant ($p < 0.01$).

The incidence of retrograde ejaculation at 6 months postoperatively among patients who were sexually active was 42.9%.

3.2.4. Complications

The overall rate of complications, classified according to the modified Clavien-Dindo system for transurethral endoscopic surgeries, was 11.96%, of which 8.70% were grade II or higher. Cases of urinary incontinence (3.26%) were all temporary and resolved within three months. Instances of urethral stricture (3.36%) were all located at the meatal site.

3.2.5. Overall Surgical Outcomes

Table 3.37. Summary of surgical outcomes

Surgical outcome		n	Proportion (%)
Success	Good	84	91,30
	Fair	8	8,70
Failure		0	0
Total		92	100

The majority of patients achieved a good surgical outcome, while 8.7% were rated fair, corresponding to patients who experienced Clavien-Dindo grade II - IIIa complications. No cases of surgical failure were recorded.

3.3. Factors Associated with the Outcomes of Thulium Laser Enucleation of the Prostate (ThuLEP)

3.3.1. Factors Associated with Operative Time

There was a positive correlation between prostate volume and operative time (OT); the larger the prostate volume, the longer the OT. This correlation was statistically significant ($p < 0.001$).

Larger prostate volumes were also associated with higher enucleation efficiency, with statistical significance ($p < 0.001$).

There was a statistically significant difference in OT among the three types of prostatic growth morphology ($p = 0.003$). However, no significant difference was found in enucleation efficiency among these groups.

Patients with preoperative urinary retention had significantly longer OT compared to those without urinary retention ($p = 0.025$), but there was no difference in surgical efficiency between the two groups.

There were no significant differences in OT or enucleation

efficiency between patients with benign prostatic hyperplasia (BPH) alone and those with BPH combined with chronic prostatitis.

No significant differences in OT or surgical efficiency were observed between patients with and without preoperative prostate biopsy ($p > 0.05$).

Patients with recurrent BPH had longer OT and higher surgical efficiency than those with primary BPH. The difference in surgical efficiency was statistically significant ($p = 0.037$), while the difference in OT was not statistically significant ($p > 0.05$).

3.3.2. Factors Associated with Intraoperative Blood Loss

No statistically significant differences were observed in hemoglobin (Hb) reduction, red blood cell (RBC) count reduction, or hematocrit (Hct) reduction between hypertensive and non-hypertensive patients ($p > 0.05$).

There were no significant differences in perioperative blood loss parameters (Hb, RBC count, Hct) between patients on anticoagulants and those not taking anticoagulants ($p > 0.05$).

No significant correlation was found between prostate volume and the decrease in Hb, RBC count, or Hct levels.

There were no significant differences in perioperative Hb, RBC count, or Hct reductions among the three prostate volume groups.

No significant differences in perioperative blood loss indicators (Hb, RBC, Hct) were found between patients with and without preoperative urinary retention.

No significant differences in blood loss parameters were found between patients with recurrent and non-recurrent BPH.

3.3.3. Factors Associated with Complications

In our study, the overall complication rate was low (as presented in Table 3.37), with each type of complication occurring in only 1 to 3 patients. Statistical analysis did not reveal any significant association between specific factors and the occurrence of complications.

3.3.4. Factors Related to Postoperative Outcomes

Patient age had no impact on the postoperative treatment duration.

Preoperative prostate volume did not affect the length of hospital stay after surgery.

There was a positive correlation between operative time and postoperative hospital stay ($R^2 = 0.119$, $p < 0.001$).

There was no correlation between preoperative prostate volume and the percentage improvement in IPSS.

There was no correlation between preoperative prostate volume and the percentage improvement in Qmax.

There was no correlation between preoperative prostate volume and the percentage improvement in QoL.

The mean postoperative Qmax in patients without preoperative urinary retention was higher than in those with preoperative urinary retention; however, the difference was not statistically significant ($p > 0.05$) at 1-, 3-, and 6-month follow-ups.

Chapter 4. DISCUSSION

4.1. Characteristics of the Study Population

The preoperative characteristics of our patients were comparable to those reported in various international studies on ThuLEP, ranging from the initial implementation phase to more recent research. The mean values of IPSS, QoL, Qmax, and PVR—though

differing slightly among studies—consistently reflect the severity of benign prostatic hyperplasia (BPH) in the study population.

4.2. Evaluation of Treatment Outcomes of Benign Prostatic Hyperplasia by Transurethral Enucleation Using Thulium Laser

4.2.1. Evaluation of Surgical Parameters

The mean operative time was 84.46 ± 35.63 minutes, the mean enucleation time was 57.07 ± 25.36 minutes, and the mean morcellation time was 11.64 ± 6.32 minutes. These durations were within the average range compared to other published studies.

Intraoperative blood loss: The mean postoperative hemoglobin drop was 1.06 g/dL, indicating that bleeding did occur but was generally minimal.

Changes in serum sodium and TUR syndrome: The mean reductions in serum sodium and potassium were only 0.06 mmol/L and 0.02 mmol/L, respectively, with no statistically significant differences. This suggests that the use of isotonic saline in ThuLEP helped maintain stable electrolyte balance.

Pathological outcomes: Based on the criteria of Homma Y., 76.8% of patients had good results, 19.5% had fair results, 3.7% had acceptable results, and no patients were classified as poor.

Catheterization time: The average duration of urethral catheterization was 2.45 ± 1.53 days, with 89.1% of patients having the catheter removed within 3 days. The effective hemostasis of the thulium laser and the completeness of enucleation allowed early catheter removal with minimal complications.

4.2.2. Symptom Improvement After Surgery

Subjective symptom improvement: IPSS scores improved

significantly after surgery, consistent with findings from other international studies.

Objective improvement: Among patients with preoperative urinary retention, all were able to void postoperatively, demonstrating the effectiveness of the procedure. In patients without preoperative retention, Qmax improved markedly, reflecting enhanced urinary flow after ThuLEP.

Improvement in quality of life: The improvement in QoL scores postoperatively indicates a substantial benefit of ThuLEP on patients' overall well-being.

4.2.3. Sexual Function Outcomes

Sexual activity postoperatively: The rate of patients maintaining sexual activity increased to 41.4% at 3 months and 48.1% at 6 months postoperatively, although the difference was not statistically significant ($p > 0.05$). Given the average patient age of nearly 70 years, these results are encouraging and suggest that relief from bothersome urinary symptoms can improve general health and interest in sexual activity.

Erectile function: Improvement in IIEF-5 scores postoperatively indicated that ThuLEP did not negatively affect erectile function.

Ejaculatory function: Retrograde ejaculation was reported in 42.9% of patients at 6 months postoperatively. While some studies have noted complications such as hematospermia, painful ejaculation, or anejaculation, our study did not focus in-depth on ejaculatory outcomes.

4.3. Factors Associated with Surgical Outcomes

4.3.1. Factors Influencing Operative Time

Prostate volume was a major determinant of operative time in ThuLEP. Larger prostates correlate with wider enucleation planes,

requiring longer operative times for complete tissue removal. However, higher prostate volume was also associated with faster enucleation speeds, with a statistically significant correlation ($p < 0.001$). Larger prostates tend to have more developed glandular tissue and clearer dissection planes between the adenoma and the capsule.

Prostate morphology: Operative time was longer in patients with tri-lobar enlargement compared to those with predominant median lobe enlargement, likely due to overall volume differences. However, there was no statistically significant difference in enucleation speed among the three groups.

Preoperative urinary retention: Patients with urinary retention had longer operative times compared to those without retention. However, enucleation speed did not differ significantly between the two groups. Operative time in these cases mainly depended on prostate volume rather than retention status.

Chronic prostatitis: There was no statistically significant difference in operative time between patients with and without chronic prostatitis ($p = 0.119$).

Preoperative prostate biopsy: No significant difference in operative time was found between patients who had a preoperative biopsy and those who did not ($p = 0.080$). However, from a practical perspective, prior biopsy—especially if performed more than two weeks before surgery—can make identification of the dissection plane more difficult due to tissue changes.

Recurrent BPH: Patients with recurrent BPH who had undergone prior TURP showed no significant difference in operative time compared to those without previous surgery. If residual tissue

from prior TURP does not alter the surgical plane, the enucleation process in ThuLEP remains unaffected.

4.3.2. Factors Associated with blood loss

The results of this study showed no significant differences in the degree of red blood cell (RBC) count reduction, hemoglobin (Hb) concentration decrease, or hematocrit decline among the following subgroups: patients with and without hypertension; those using anticoagulants versus those not using them; different prostate volume groups; patients with and without urinary retention prior to surgery; patients with and without chronic prostatitis; and patients with recurrent versus non-recurrent prostate hyperplasia. These findings suggest that Thulium laser and the ThuLEP technique offer effective hemostasis and blood loss control.

4.3.4. Complications and Related Factors

The overall complication rate according to the Clavien-Dindo classification was 11.96%. This rate is comparable to other international studies. Statistical analysis did not identify any significant factors associated with complications or adverse events.

4.3.3. Factors Related to Treatment Outcomes

Prostate volume and patient age did not affect the duration of postoperative hospital stay. A positive correlation was observed between operative time and hospital stay ($R^2 = 0.119$, $p < 0.001$). Regarding factors influencing treatment outcomes, prostate volume had no impact on the improvement of IPSS, Qmax, or QoL. The difference in postoperative Qmax between patients with and without preoperative urinary retention at 1, 3, and 6 months was not statistically significant.

CONCLUSIONS

From the analysis of 92 patients with benign prostatic hyperplasia (BPH) undergoing transurethral enucleation of the prostate using Thulium laser, with a mean prostate volume of 72.48 ± 33.79 mL, we concluded:

I. Efficacy and Safety of Thulium Laser Enucleation of the Prostate (ThuLEP)

1. Surgical Outcomes: 100% of procedures were successfully completed using the En-bloc ThuLEP technique, with no intraoperative failures. Mean operative time: 84.46 minutes. Mean catheterization time: 2.45 days. Mean hospital stay: 3.51 days. Mean hemoglobin decrease: 1.06 g/dL. Complication rate including 1 patient requiring blood transfusion, 1 with urinary tract infection, 3 with temporary urinary incontinence, and 3 with urethral meatus stricture.

2. Treatment Effectiveness: Preoperative IPSS was 28.65 points. At 1, 3, and 6 months postoperatively, the scores were 3.18 (88.18% improvement), 1.98 (92.76%), and 1.25 (95.37%), respectively. All patients with preoperative urinary retention were able to void spontaneously after surgery. Among patients with preserved voiding function preoperatively, the mean Qmax improved from 5.25 mL/s to 19.67, 19.27, and 23.65 mL/s at 1, 3, and 6 months, respectively. The proportion of patients achieving $Q_{\max} \geq 15$ mL/s was 76.5%, 81.0%, and 82.7% at 1, 3, and 6 months, respectively. QoL scores improved from 5.79 preoperatively to 0.62, 0.34, and 0.13 at 1, 3, and 6 months, respectively.

IIEF-5 scores improved from 14.83 preoperatively to 19.65 at 6 months postoperatively. Retrograde ejaculation occurred in 42.9% of patients.

II. Factors Influencing Surgical Outcomes of ThuLEP

1. Factors Related to Operative Time: A positive correlation was observed between prostate volume and both operative time and surgical speed (Pearson's $R^2 = 0.217$ and 0.28 , respectively; $p < 0.001$). No significant differences in operative time were found between patients with different prostate morphologies, with or without prostatitis, or with or without recurrent BPH.

2. Factors Related to Blood Loss: Prostate volume was not significantly associated with hemoglobin decrease ($R^2 = 0.015$, $p = 0.248$). Hemoglobin decreased across subgroups: With vs. without hypertension: 0.90 vs. 1.00 g/dL ($p = 0.525$) With vs. without anticoagulant use: 0.70 vs. 0.90 g/dL ($p = 0.906$) With vs. without prostatitis: 0.90 vs. 1.00 g/dL ($p = 0.588$), Recurrent vs. non-recurrent BPH: 1.00 vs. 0.90 g/dL ($p = 0.947$)

3. Factors Related to Treatment Outcomes: No factors were identified to be associated with complications. Prostate volume did not correlate with postoperative hospital stay ($R^2 = 0.008$, $p = 0.396$). Age was not associated with hospital stay ($R^2 = 0.008$, $p = 0.393$). Operative time was positively correlated with hospital stay duration ($R^2 = 0.119$, $p < 0.001$). Prostate volume did not significantly affect improvement in IPSS ($R^2 = 0.000$, $p = 0.988$), Qmax ($R^2 = 0.05$, $p = 0.659$), or QoL ($R^2 = 0.028$, $p = 0.126$). Comparing Qmax in patients with and without preoperative urinary retention at 1 month (19.67 vs. 18.39 mL/s), 3 months (19.27 vs. 20.16 mL/s), and 6 months (23.65 vs. 22.03 mL/s) showed no statistically significant differences ($p = 0.378$, 0.610 , and 0.548 , respectively).