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**STUDY ON THE TREATMENT OUTCOMES OF
BENIGN PROSTATIC HYPERPLASIA BY
BIPOLAR TRANSURETHRAL ENUCLEATION
OF THE PROSTATE**

PHD DISSERTATION IN MEDICINE

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ABBREVIATIONS

Abbreviations	Full Phrase
B-TUVP	Bipolar TransUrethral Vaporization of the Prostate
B-TUEP	Bipolar Transurethral Enucleation of the Prostate
M-TUEP	Monolar Transurethral Enucleation of the Prostate
ICBPH	International Consultation on Benign Prostatic Hyperplasia
IPSS	International Prostate Symptom Score
LUTS	Lower Urinary Tract Symptoms
PSA	Prostatic Specific Antigen
PVR	Post Void Residual
QoL	Quality of Life
TURP	TransUrethral Resection of the Prostate
BPH	Benign Prostatic Hyperplasia

LIST OF RELATED PUBLICATIONS

1. **Pham Thanh Hai , Pham Van Duyet, Do Ngoc The (2025).** Factors associated with the outcomes of benign prostatic hyperplasia using bipolar transurethral enucleation at 108 military central hospital. *Vietnam Journal of Community Medicine*, Vol. 66, Special Issue 11, 344-349
2. **Pham Thanh Hai , Pham Van Duyet, Do Ngoc The (2025).** Results of prostate symptom improvement in patients with benign prostatic hyperplasia treated with transurethral enucleation using bipolar energy at 108 military central hospital. *Journal of Military Pharmaco-medicine*, 50(10): 96-105.
3. **Pham Thanh Hai , Pham Van Duyet, Do Ngoc The (2025).** Factors associated with the duration of urethral catheterization following benign prostatic hyperplasia using bipolar transurethral enucleation at 108 military central hospital. *Vietnam Journal of Community Medicine*, Vol. 66, Special Issue 9, 360-366

INTRODUCTION

Benign prostatic hyperplasia (BPH) causes lower urinary tract symptoms, severely reducing the patients' quality of life. When medical treatment fails or complications arise (such as urinary retention, bladder stones, and renal failure), surgical intervention is mandatory. Transurethral resection of the prostate (TURP) was once the "gold standard" but has revealed many drawbacks for large prostates (>80g), including prolonged operative time, massive bleeding risk, fluid absorption syndrome (TUR syndrome), and a high recurrence rate. To overcome these issues, laser enucleation (HoLEP, ThuLEP) was introduced, but it faces significant barriers due to expensive equipment costs and a long learning curve for surgeons.

In this context, bipolar transurethral enucleation of the prostate (B-TUEP) emerges as an optimal and highly practical alternative. B-TUEP utilizes the existing resection systems in hospitals, using inexpensive and reusable electrodes, which minimizes the economic burden. Technically, B-TUEP uses normal saline (0.9% NaCl) as the irrigation fluid, completely eliminating the risk of TUR syndrome. The large contact surface of the electrode allows for simultaneous coagulation and immediate hemostasis over a wide area, creating a bloodless and clear surgical field. The combination of mechanical enucleation mimicking the finger dissection in open surgery and resection energy helps to completely remove the prostatic adenoma with a significantly shorter learning curve compared to laser surgery.

Although B-TUEP has proven its safety and efficacy, domestic studies are currently modest and lack comprehensiveness. Most reports lack systematic follow-up on the changes in core parameters (IPSS, QoL, Qmax, PVR) at critical postoperative milestones. Furthermore, the relationship between perioperative factors, anatomical characteristics, and the patients' recovery outcomes has not been thoroughly analyzed.

Therefore, to provide reliable scientific evidence, we conducted the research topic: **"Study on the treatment outcomes of benign prostatic hyperplasia by bipolar transurethral enucleation of the prostate"**, with two objectives:

1. To evaluate the outcomes of bipolar transurethral enucleation for benign prostatic hyperplasia at the 108 Military Central Hospital.
2. To analyze the factors associated with the surgical outcomes of bipolar transurethral enucleation for benign prostatic hyperplasia in the aforementioned patient group.

New contributions of the study:

For the first time, this study provides a comprehensive system of scientific evidence regarding the safety and efficacy of B-TUEP in Vietnamese patients. The research has demonstrated the superior bleeding control capability of the bipolar electrode, which completely eliminates the risk of transurethral resection (TUR) syndrome, allowing safe surgery even for large-sized prostates (>80 grams). Through multivariate analysis, the study elucidates the relationship between clinical factors, anatomical characteristics (prostate volume and morphology) and complications as well as recovery outcomes.

The success of the thesis affirms that B-TUEP is an optimal alternative to traditional open surgery or monopolar resection techniques. Utilizing the existing equipment available in most medical facilities helps minimize the economic burden for both the hospitals and the patients, compared to investing in expensive Laser systems. The short hospital stay, low complication rate, and rapid efficacy in recovering urinary function demonstrate the immense practical value of B-TUEP. These results create a solid foundation for standardizing the technical protocol and widely applying this method in hospitals nationwide, especially in the context of limited healthcare resources.

Structure of the dissertation

The dissertation consists of 132 pages, 32 tables, 36 charts, 12 figures, and 127 references, including 98 foreign references. The introduction section covers 2 pages, literature review 34 pages, subjects and research methods 18 pages, research results 31 pages, discussion 44 pages, and conclusions and recommendations 3 pages.

CHAPTER 1. LITERATURE REVIEW

1.1. Concepts and pathology of the prostate

1.1.1. Concepts

Benign Prostatic Hyperplasia (BPH): A pathology characterized by the benign proliferation of epithelial, smooth muscle, and stromal cells, primarily in the transition zone of the prostate gland.

1.1.2. Anatomy – Histopathology

Structure: The prostate is divided into 4 glandular zones (peripheral, central, transition, and periurethral). The transition zone, although accounting for only 5-10% of the normal gland volume, is the origin of BPH and can enlarge to occupy up to 95% of the pathological gland volume.

Surgical capsule: This is a crucial anatomical landmark in enucleation surgery, allowing the complete dissection of the adenoma from the normal prostatic tissue.

Important anatomical landmarks: The verumontanum is the absolute distal limit of enucleation surgery, helping to preserve the external sphincter to maintain urinary continence. The ureteral orifices and the bladder neck must also be carefully protected.

1.2. Diagnosis and treatment of BPH

1.2.1. Diagnosis

Based on clinical symptoms, digital rectal examination, and paraclinical tests: Ultrasound, uroflowmetry, PSA test, and urine culture. Pelvic MRI is indicated when malignancy is suspected or to assess detailed anatomy prior to enucleation.

1.2.2. Treatment

Medical treatment: This is the initial priority to reduce symptoms and improve Quality of Life (QoL) (using alpha-blockers, 5-ARIs).

Surgical intervention: Absolute indications arise when complications occur (recurrent urinary retention, bladder stones, renal failure, hematuria) or when medical treatment fails.

Surgical methods:

Monopolar transurethral resection of the prostate (TURP): The standard for prostates <80g but reveals many limitations (bleeding, TUR syndrome, recurrence) for large prostates.

Laser enucleation (HoLEP, ThuLEP): High efficacy but expensive equipment costs and a long learning curve.

Open prostatectomy: Only reserved for extremely large prostates or when endoscopy is contraindicated; however, recovery time is prolonged with multiple complications.

1.3. Bipolar transurethral enucleation of the prostate (B-TUEP)

1.3.1. History and Introduction

B-TUEP combines the principle of complete anatomical dissection of open surgery with the minimally invasive advantages of bipolar endoscopy. This technique uses an electrosurgical electrode (cutting loop, button, or spoon) to enucleate the hyperplastic adenoma along the surgical capsule, after which the adenoma is pushed into the bladder and morcellated for suction. B-TUEP utilizes the commonly available endoscopic resection systems, offering significant economic benefits compared to Lasers.

1.3.2. Technical procedure in selected studies

B-TUEP surgery includes the following main steps:

Endoscopic examination: Evaluate the anatomy and identify landmarks (verumontanum, ureteral orifices).

Mucosal incision and finding the surgical capsule: Create incisions at the 5 o'clock and 7 o'clock positions from the verumontanum up to the bladder neck, finding the surgical plane between the adenoma and the prostatic capsule.

Enucleation: Dissect the adenoma using an *en-bloc* or lobe-by-lobe technique. Use the mechanical action of the electrode combined with bipolar energy to cut the fibrous bands and achieve hemostasis.

Completion and pushing the adenoma: Once completely detached, the adenoma is pushed into the bladder.

Morcellation: Use a specialized morcellator to shred the tissue mass in the bladder and suction it out, ensuring specimens are collected for histopathological examination.

1.3.3. Advantages and disadvantages of B-TUEP

Advantages: Immediate broad-area hemostasis, minimizing the risk of massive bleeding and the blood transfusion rate (<1%). The use of normal saline (0.9% NaCl) as irrigation fluid eliminates fluid absorption syndrome (TUR syndrome), allowing safe surgery for very large prostates (>80g, even >100g). Superior and long-lasting improvements in clinical parameters (IPSS, Qmax, PVR, PSA) equivalent to open surgery or Laser. Short catheterization and hospitalization times.

Disadvantages: Requires a certain learning curve to master the technique of finding and dissecting along the prostatic capsule. Operative time may be longer than TURP in the initial phase. Risk of injury to the sphincter or bladder (during morcellation) if the maneuver is imprecise. Retrograde ejaculation rates still exist, similar to other endoscopic interventions.

1.4. Overview of studies on B-TUEP

Safety: The average operative time ranges from 70-120 minutes depending on the surgeon's experience and prostate size. The complication rates (capsular perforation, mucosal injury, bleeding) are low. Catheterization time (1.5-3 days) and hospital stay (3-4 days) are significantly shortened compared to open surgery or TURP.

Efficacy: Spectacular improvements in clinical indices (IPSS sharply reduced to a mild level, significantly improved QoL) and paraclinical indices (Qmax doubles/triples, markedly decreased PVR, deep reduction in postoperative prostate volume and PSA).

Associated factors: Prostate size, growth morphology (especially median lobe enlargement), the degree of inflammatory adhesion, and the surgeon's experience are factors directly affecting operative time,

complication risks, and recovery outcomes. However, comprehensive studies with multivariate analyses are still needed for a more accurate prognosis of this method's outcomes in Vietnam.

CHAPTER 2. SUBJECTS AND RESEARCH METHODS

2.1. Research subjects

The study was conducted on patients diagnosed with benign prostatic hyperplasia (BPH) who had indications for surgical intervention by bipolar transurethral enucleation of the prostate (B-TUEP). The location of the study was the Lower Urinary Tract Department, 108 Military Central Hospital, from December 2023 to July 2025.

Inclusion criteria: BPH with surgical indications. Prostate volume: Moderate and large, measured by ultrasound (transabdominal or transrectal). Surgical conditions: Eligible for transurethral endoscopic surgery. Postoperative histopathology: Benign prostatic hyperplasia. Patients consent to participate in the study.

Exclusion criteria: Lower urinary tract obstruction due to other causes (bladder stones, urethral stricture, etc.). Recurrent BPH after surgical or minimally invasive interventions. Acute urinary retention with suprapubic bladder drainage.

2.2. Research methods

Study design: A prospective descriptive case series study. Evaluations were conducted preoperatively, intraoperatively, postoperatively, and at follow-up visits after 1 month and 3 months.

Sample size and sampling method:

Calculated using the formula:

$$n = \frac{Z_{1-\alpha/2}^2 p (1 - p)}{d^2}$$

Where $p = 4.07\%$, 95% confidence level, and margin of error $d = 0.05$. The minimum required sample size was 61 patients. The actual study selected 68 patients using purposive convenience sampling.

Equipment: 4K endoscopy system, AUTOCON III 400 bipolar high-frequency electrosurgical unit, Uromat pressure-sensing irrigation pump, UNIDRIVE SIII tissue morcellator, and Urofcap III uroflowmetry machine.

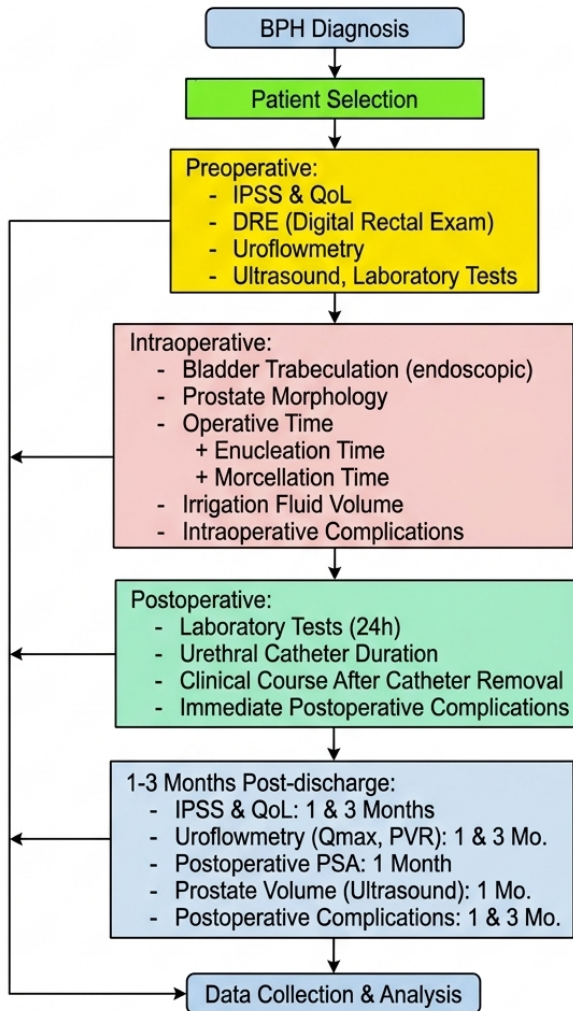


Figure 2.1. Research procedure

2.3. Research contents and variables

General characteristics: Age, reasons for admission (urinary retention, dysuria...), comorbidities.

Preoperative clinical and paraclinical features: Evaluation of IPSS score (mild 0-7, moderate 8-19, severe 20-35) and QoL (0-6). Uroflowmetry measurement to obtain Qmax (mild >15, moderate 10-15, severe <10 ml/s) and post-void residual PVR (mild <50, moderate 100-150, severe >150 ml). Ultrasound to measure prostate volume (moderate 30-<80, large 80-150, very large >150 ml). Tests included PSA, MRI (PI-RADS), hematology, blood biochemistry, and urine culture.

Intraoperative outcomes: Degree of bladder trabeculation, prostate morphology. Operative time (enucleation time, morcellation time). Volume of irrigation fluid using 0.9% NaCl. Recording of complications (TUR syndrome, bladder mucosal injury, capsular perforation).

Postoperative outcomes: Complications (bleeding, infection, urinary retention after catheter removal), duration of catheterization, and length of hospital stay.

Follow-up outcomes (1 and 3 months): Re-evaluation of IPSS, QoL, Qmax, PVR, ultrasound prostate volume, PSA quantification. Detection of late complications (urethral stricture, urinary incontinence). Overall assessment of surgical outcomes: Good (Clavien-Dindo grade I), Moderate (grade II, IIIa), or Poor (grade $\geq$ IIIb).

Analysis of associated factors: Evaluation of the influence of independent variables on operative time, complications, hospital stay, and the degree of improvement in lower urinary tract symptoms.

2.4. Technical procedure of B-TUEP

Step 1: Endoscopic examination of the urethra and bladder, identifying the verumontanum and two ureteral orifices.

Step 2: Using a bipolar electrode to incise the mucosa at the 5 o'clock and 7 o'clock positions from the verumontanum up to the bladder neck, finding the surgical plane between the adenoma and the surgical capsule.

Step 3: Enucleating the adenoma using the en-bloc or lobe-by-lobe principle. Using the mechanical action of the electrode combined with bipolar energy to cut fibrous bands and achieve hemostasis. The completely detached tumor is pushed into the bladder.

Step 4: Introducing the tissue morcellator into the bladder to fragment and suction the tissue out for histopathological examination.

Step 5: Checking, coagulating oozing blood, placing a 3-way 20-22Fr

Foley catheter, inflating the balloon, and initiating continuous bladder irrigation.

Postoperative care: Continuous bladder irrigation, antibiotic treatment, and pain relief. Catheter removal before 48 hours when the urine is clear.

2.5. Data processing and bias control

Data processing: Data was managed using Microsoft Excel and analyzed using STATA 14.0. Qualitative variables were presented as frequencies and percentages; quantitative variables as Mean $\pm$ SD (if normally distributed) or Median and IQR (if non-normally distributed). Comparisons were made using Chi-square, Fisher's exact, T-test, or Wilcoxon test. Correlation was assessed via univariate and multivariate linear regression. Statistical significance was set at $p < 0.05$.

Bias control: Selection bias was avoided by comprehensive purposive sampling. Information bias was avoided by cross-checking medical records. Terminology, measurement methods, and equipment were standardized.

2.6. Research ethics

The research protocol and technical procedures were approved by the Ethics Committee and the Scientific Council of the 108 Military Central Hospital and Hai Phong University of Medicine and Pharmacy. Patients were thoroughly informed and voluntarily participated in the study.

CHAPTER 3. STUDY RESULTS

3.1. Characteristics of the Study Sample

The mean age of the patients was 72.4 ± 6.7 years, with a median of 72 (IQR 67-77.5). The most common reason for admission was dysuria (64.7%), followed by urinary retention (33.8%) and hematuria (1.5%). Comorbidities included hypertension (45.6%) and diabetes mellitus (23.5%). Other conditions such as COPD, bronchial asthma, and heart failure accounted for a low proportion (under 3%).

Clinical characteristics: Mean IPSS score: 25.5 ± 5.8 , mean Qmax: 7.2 ± 2.7 ml/s; mean Post-Void Residual (PVR): 59.0 ± 45.5 ml. Paraclinical characteristics: Mean prostate volume was 73.7 ± 20.1 ml, mean PSA was 8.4 ± 5.7 ; PI-RADS I-II-III accounted for 93.8%, and PI-RADS IV was 6.2%. Histopathology revealed that all patients had benign prostatic hyperplasia (BPH), of which 2.9% were associated with acute inflammation and 4.4% with chronic inflammation. There were 8.8% positive first urine cultures. These cases were all treated with preoperative antibiotics, and the second preoperative urine cultures were all negative.

3.2. Results of Bipolar Transurethral Enucleation of the Prostate (BipoleP) at the 108 Military Central Hospital

3.2.1. Cystoscopic and Prostatic Imaging

Grade 1 bladder trabeculation accounted for 79.4%; grades 2 and 3 were 16.2% and 4.4%, respectively. Bilateral lobe enlargement was the most common at 66.2% (45 patients), trilobar enlargement was 25.0%; isolated median lobe enlargement was the least common at 8.8%.

3.2.2. Intraoperative Results

3.2.2.1. Operative Time

Table 3.1. Enucleation Time (n=68)

Enucleation Time (minutes)	Quantity	Percentage (%)
< 30	38	55.9
30 – 60	28	41.2
>60	2	2.9
Total	68	100
$\bar{x} \pm SD$: 34,5 $\pm$ 12,5; median 30 (IQR 25-45), minimum 15, maximum 65		

The mean enucleation time was 34.5 $\pm$ 12.5 minutes; median 30 (IQR 25-45).

Table 3.2. Morcellation Time (n=68)

Morcellation Time (minutes)	Quantity	Percentage (%)
< 15	15	22.1
15 – 30	46	67.7
>30	7	10.3
Total	68	100
$\bar{x} \pm SD$: 19.7 $\pm$ 9,4; median 20 (IQR 15-25), minimum 5, maximum 55		

The mean morcellation time was 19.7 $\pm$ 9.4 minutes; median 20 (IQR 15-25).

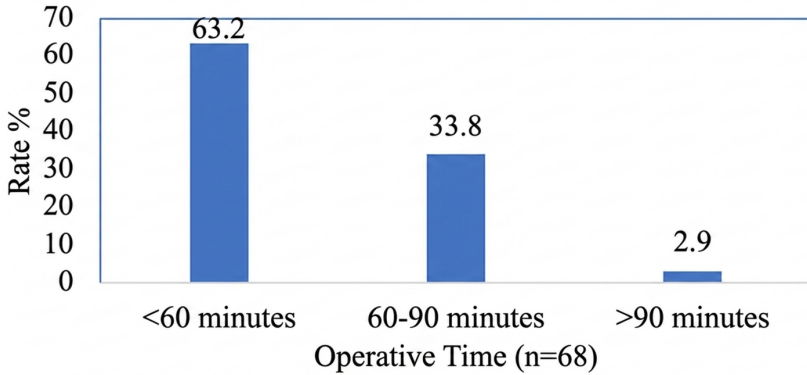


Chart 3.1. Operative Time (n=68)

The mean operative time was 54.2 ± 17.5 minutes; median 50 minutes (IQR 40-65).

3.2.2.2. Intraoperative Irrigation Fluid

Table 3.3. intraoperative irrigation fluid volume (n=68)

Irrigation fluid volume (lit)	Quantity	Percentage (%)
≤ 9	0	0
10 – 19	11	16.2
20 – 29	25	36.8
30 – 39	21	30.9
40 – 49	10	14.7
≥ 50	1	1.5
Total	68	100

$\bar{x} \pm SD$: 28.8 ± 9.1 ; median 27 (IQR 21-35), minimum 14, maximum 50

The mean irrigation fluid volume was 28.8 ± 9.1 liters.

3.2.2.3. Intraoperative Complications

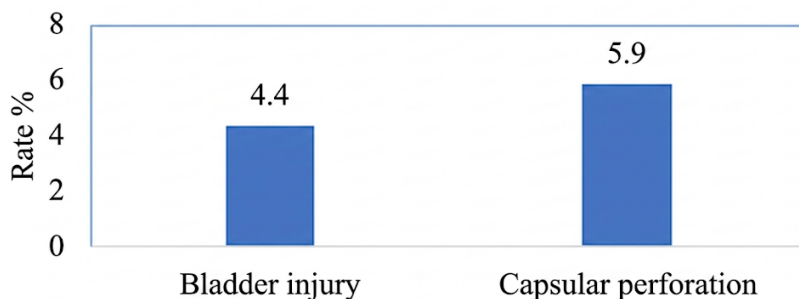


Chart 3.2. Intraoperative Complications (n=68)

There were 7 intraoperative complications, accounting for 10.3% of cases. Of these, 3 were bladder mucosal injuries (4.4%), and 4 were capsular perforations (5.9%). All were minor complications.

3.2.3. Immediate Postoperative Results

3.2.3.1. Complications during catheterization and after catheter removal

Table 3.4. Duration of Catheterization (n=68)

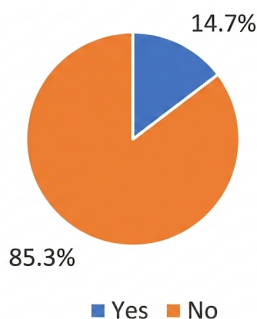
Number of Days	Quantity	Percentage (%)
1	14	20.6
2	38	55.9
3	8	11.8
4	4	5.9
≥5	4	5.9
Total	68	100
$\bar{x} \pm SD$: 2,3±1,4, median 2 (IQR 2-2), minimum 1, maximum 9		

Study results show that the mean duration of catheterization $\pm$ SD was 2.3 ± 1.4 days; median 2 days (IQR 2-2).

Table 3.5. Complications During Postoperative Catheterization (n=68)

Complication	Quantity	Percentage (%)
Postoperative bleeding not requiring blood transfusion	1	1.5
Postoperative bleeding requiring blood transfusion + reoperation for hemostasis	1	1.5
Total	2	2.9

There were 2 cases of complications during postoperative catheterization, accounting for 2.9%.

**Chart 3.3. Urinary retention after catheter removal requiring recatheterization (n=68)**

The rate of urinary retention after catheter removal requiring recatheterization was 10 cases, accounting for 14.7%.

Table 3.6. Complications after catheter removal (n=68)

Complication	Quantity	Percentage (%)
Edema of the prostatic fossa causing urinary retention	4	5,9
Blood clots in the prostatic fossa causing urinary retention	5	7,4
Weak bladder tone causing urinary retention	1	1,5
Fever after catheter removal	1	1,5
Total	11	16,2

The complication rate after catheter removal was 16.2%. Paraclinical indices: Red blood cells 4.4 ± 0.5 (T/L) and hemoglobin 130.0 ± 16.5 (g/L), slightly decreased compared to normal levels; white blood cells 12.0 ± 3 (G/L), slightly increased; Urea and Creatinine were within normal limits.

3.2.3.2. Postoperative Hospital Stay

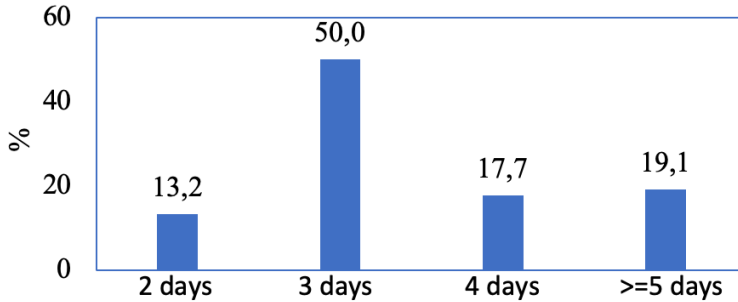


Chart 3.4. Postoperative Hospital Stay (n=68)

The mean postoperative hospital stay was 3.8 ± 2.0 days, median 3 (IQR 3-4)

3.2.3.3. Evaluation of Surgical Outcomes

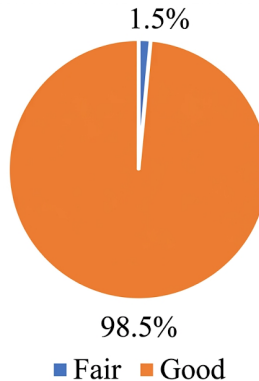


Chart 3.5. Evaluation of Surgical Outcomes (n=68)

The surgery was 100% successful, of which 98.5% were good and 1.5% were fair.

3.2.4. Follow-up results after discharge

Table 3.7. Complications at 1-month postoperative follow-up

Complication	Quantity	Percentage (%)
Urethral stricture (1 membranous and 1 penile)	2	3.3
Transient urinary incontinence	3	5.0
No complications	55	91.7

There were 5 cases with complications detected at the 1-month postoperative follow-up, accounting for 8.3%.

Table 3.8. PSA Monitoring over time

Level	Preoperative		1 month postoperative	
	n (n=68)	%	n (n=60)	%
Low (<4 ng/mL)	19	27.9	57	95.0
Medium (4-10 ng/mL)	26	38.2	3	5.0
High (>10 ng/mL)	23	33.8	0	0
Total	68	100	60	100
$\bar{x} \pm SD$	8.4±5.7		1.3±1.6	
Median (IQR)	7.1 (3.8-11.1)		0.8 (0.4-1.5)	

The mean preoperative PSA was 8.4 ± 5.7 ng/mL, which decreased to 1.3 ± 1.6 ng/mL.

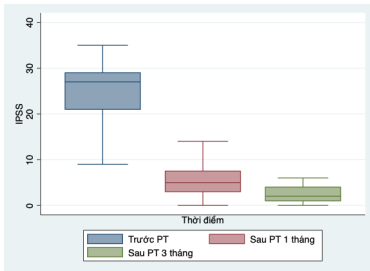


Chart 3.6. IPSS Monitoring Over Time

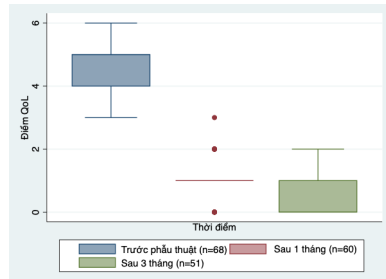


Chart 3.7. QoL Score Monitoring Over Time

Both IPSS and QoL showed significant improvement at 1 month and 3 months postoperatively ($p < 0.001$).

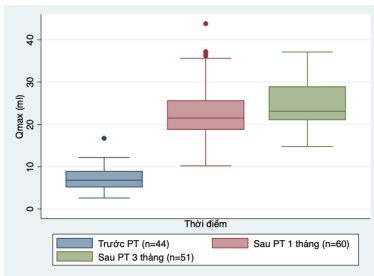


Chart 3.8. Qmax monitoring over time

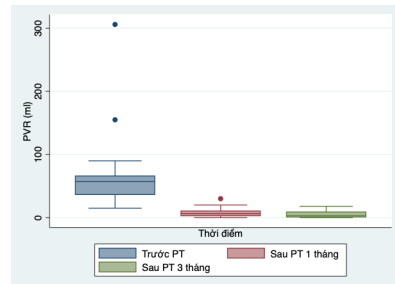


Chart 3.9. PVR monitoring over time

Both Qmax and PVR showed significant improvement at 1 month and 3 months postoperatively ($p < 0.001$).

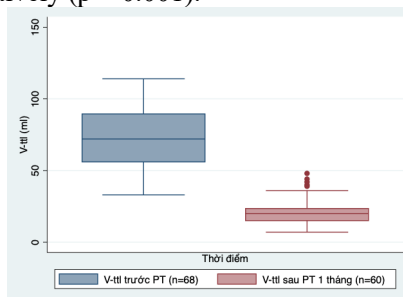


Chart 3.10. Prostate volume monitoring over time

Postoperative prostate volume decreased significantly compared to preoperative volume.

3.3. Factors related to the outcomes of bipolar transurethral enucleation of the prostate

3.3.1. Factors related to intraoperative outcomes

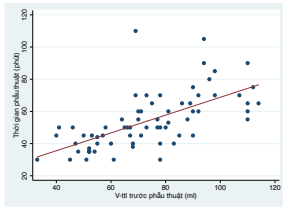


Chart 3.11.
**Relationship between
operative time and
prostate volume (n=68)**

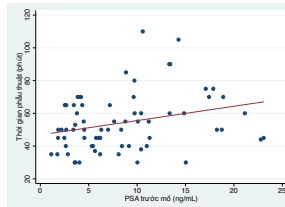


Chart 3.12.
**Relationship between
operative time and
preoperative psa**

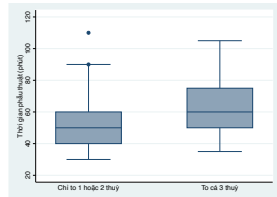


Chart 3.13.
**relationship
between operative
time and prostate
morphology (n=68)**

The results showed that factors related to operative time included prostate volume, preoperative PSA, and prostate morphology ($p < 0.05$). The study found no statistically significant relationship between intraoperative complications and these factors ($p > 0.05$).

3.3.2. Factors Related to Immediate Postoperative Outcomes

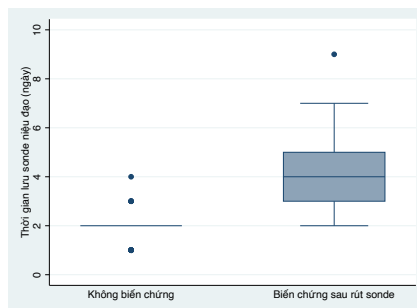


Chart 3.14. Relationship between duration of catheterization and complications during catheterization (n=68)

There was a relationship between the duration of catheterization and complications during catheterization ($p < 0.05$). Preoperative prostate volume

and the duration of catheterization were related to complications after catheter removal ($p < 0.05$).

3.3.3. Factors related to lower urinary tract symptom improvement at 1 month postoperatively

IPSS at 1 month postoperatively was related to intraoperative complications, duration of catheterization, urinary retention requiring recatheterization, and postoperative hospital stay ($p < 0.05$). QoL at 1 month postoperatively was related to the duration of catheterization ($p < 0.05$). Qmax at 1 month postoperatively was related to complications after catheter removal and PVR at 1 month postoperatively ($p < 0.05$). PVR at 1 month postoperatively was related to bladder trabeculation and prostate volume at 1 month postoperatively ($p < 0.05$).

3.3.4. Factors related to lower urinary tract symptom improvement at 3 months postoperatively

IPSS at 3 months postoperatively was related to complications during catheterization, postoperative hospital stay, IPSS at 1 month postoperatively, QoL at 1 month postoperatively, Qmax at 1 month postoperatively, and QoL at 3 months postoperatively ($p < 0.05$). QoL at 3 months postoperatively was related to age, duration of catheterization, QoL at 1 month postoperatively, Qmax at 1 month postoperatively, Qmax at 3 months postoperatively, and PVR at 3 months postoperatively ($p < 0.05$). Qmax at 3 months postoperatively was related to patient age and Qmax at 1 month postoperatively ($p < 0.05$). No statistically significant relationship was found between PVR at 3 months postoperatively and the evaluated factors ($p > 0.05$).

CHAPTER 4. DISCUSSION

4.1. Characteristics of the study sample

In our study, the mean age of the patients was 72.4 ± 6.7 years, with the 70-79 age group being the majority (47.1%). This characteristic accurately reflects the epidemiology of benign prostatic hyperplasia (BPH), as the incidence and severity of urinary obstruction are proportional to age, leading to the elderly group having the most indications for surgical intervention. This result is completely consistent with large domestic and international studies such as those by Tran Quoc Hoa (2024), Zhao (2010), and Wei (2016). The main reasons for admission were dysuria (64.7%) and urinary retention (33.8%). A specific difference is that the rate of urinary retention in our study was lower than that of some domestic authors like Duong Cao Tri (72.5%), but it reflects a common reality: Vietnamese patients often present to the hospital at a late stage when complications have already occurred, unlike in

developed countries where patients mainly seek early examination for dysuria.

The study sample recorded a high rate of patients with a history of hypertension (45.6%) and diabetes mellitus (23.5%). Notably, bipolar transurethral enucleation of the prostate (B-TUEP) demonstrated superior safety when successfully applied to patients with severe respiratory and cardiovascular comorbidities (COPD, heart failure in ASA groups II, III) due to the short operative time and the use of normal saline, which helps prevent circulatory overload. Clinically, the preoperative symptom burden of the patients was substantial, reflected by a mean IPSS score of 25.5 ± 5.8 (83.8% at the severe level) and a QoL score of 4.9 ± 0.8 . Mechanical obstruction was clearly evident with a very low maximum urinary flow rate (Q_{max}) of only 7.2 ± 2.7 ml/s (97.7% moderate and severe obstruction), along with a mean post-void residual (PVR) volume of 59.0 ± 45.5 ml. Paraclinically, the mean preoperative prostate volume was 73.7 ± 20.1 ml, with 36.8% of patients having large prostates over 80 ml. The mean PSA concentration was 8.4 ± 5.7 ng/ml. Notably, 33.8% of patients had PSA > 10 ng/ml, but 100% were thoroughly screened for cancer using pelvic MRI (PI-RADS) and preoperative biopsy; histopathological results confirmed that this PSA elevation was mainly due to the large prostate volume combined with chronic or acute inflammation. Hematological, biochemical, and electrolyte indices (mean Na⁺ 137.1 mmol/L) were all within normal limits, creating favorable conditions for surgery.

4.2. Evaluation of the outcomes of bipolar transurethral enucleation of the prostate

4.2.1. Evaluation of safety

The mean total operative time for B-TUEP was 54.2 ± 17.5 minutes, of which the enucleation time was 34.5 ± 12.5 minutes and the morcellation time was 19.7 ± 9.4 minutes. Comparatively, the enucleation time of B-TUEP was significantly shorter than the Holmium Laser Enucleation of the Prostate (HoLEP) method by Do Truong Thanh (50.76 minutes), and the total operative time was also shorter than the monopolar enucleation method by Vu Minh Duc (65.4 minutes). This superiority stems from the simultaneous cutting and coagulating (hemostasis) capability of bipolar energy, which keeps the surgical field consistently clear. Analysis of surgeries lasting over 90 minutes showed that the main causes were excessively large adenomas (>80 ml), chronic inflammatory adhesions blurring the dissection plane, and partly the surgeons' learning curve in the initial phase.

The mean irrigation fluid volume was 28.8 ± 9.1 liters. Thanks to the characteristic of the bipolar electrode allowing the use of 100% isotonic normal saline solution (0.9% NaCl), the study recorded 0% of patients experiencing transurethral resection (TUR) syndrome, even in cases with large prostates and significant bleeding requiring over 50 liters of irrigation fluid. This is a revolutionary difference in safety compared to the monopolar electrode method (such as the study by Nguyen Dinh Lien where up to 9.3% suffered from this syndrome due to using hypotonic Sorbitol solution).

The intraoperative complication rate was controlled at a very low level (10.3%), with no cases of bladder perforation or bladder neck injury. We recorded 3 cases (4.4%) of bladder mucosal injury caused by the morcellator suctioning the mucosa when the bladder was collapsed or when the patient strained. Prostatic capsular perforation occurred in 4 cases (5.9%). A thorough analysis of these 4 cases revealed that the core risk factors included: (1) Large prostate size (80-100g) distorting the dissection boundary; (2) Tightly adhered capsule due to a history of chronic inflammation; (3) Excessively thin prostatic capsule near the bladder neck. However, thanks to the excellent coagulation and hemostasis of the bipolar electrode, all cases of capsular perforation were detected and successfully managed conservatively during surgery without needing conversion to open surgery or blood transfusion.

The mean catheterization time was very short, at only 2.3 ± 1.4 days, with 76.5% of patients having their catheters removed within 1-2 days. Regarding postoperative bleeding complications, we only recorded 2 cases (2.9%). One case of oozing bleeding due to a spike in blood pressure was successfully managed conservatively by irrigation and applying traction to the Foley balloon. One case of severe, bright red bleeding causing catheter blockage in a patient with an extremely large prostate (110g) and chronic inflammation necessitated emergency endoscopic surgery to suction blood clots and recoagulate the bleeding vessel at the 7 o'clock position; the patient subsequently stabilized and was discharged on the 4th day. This rate of bleeding requiring intervention is very low and consistent with international literature, affirming that B-TUEP provides significantly better hemostasis than open surgery or the monopolar electrode. Acute urinary retention after urethral catheter removal occurred in 10 cases (14.7%). The causes identified via endoscopy were blood clots, residual necrotic tissue fragments, edema of the prostatic fossa, and weak bladder tone due to prolonged obstruction. These cases were managed by reinserting the catheter for extended drainage, combined with irrigation, medication, and electroacupuncture for functional

rehabilitation, enabling the patients to urinate well afterward. Urinary tract infection was only observed in 1 case (1.5%), much lower than with the monopolar electrode due to the short catheterization time.

Follow-up after 1 month recorded 3 cases (5.0%) of transient urinary incontinence (stress incontinence, urgency) which all fully recovered by the 3rd month. This difference indicates that B-TUEP protects the external urethral sphincter very well, avoiding permanent urinary incontinence. Urethral stricture was observed in 2 cases (3.3%), which were mild and successfully treated with urethral dilation; the cause was related to the insertion of the morcellator in cases with large prostates. The total mean hospital stay was only 3.8 days, the surgical success rate reached 100%, and there were no fatalities or life-threatening complications.

4.2.2. Evaluation of efficacy Improvement in oncological index (PSA)

The PSA index decreased spectacularly from 8.4 ± 5.7 ng/ml preoperatively to a physiological safety level of 1.3 ± 1.6 ng/ml after 1 month ($p < 0.001$). Notably, 100% of patients with a PSA level > 10 ng/ml experienced a deep reduction to below 4 ng/ml. This is strong clinical evidence showing that the "enucleation" principle of B-TUEP has thoroughly removed the entire hyperplastic adenoma along the surgical capsule exactly like open surgery, completely eliminating the cause of elevated PSA.

The efficacy of B-TUEP is clearly demonstrated through the sustained reduction in symptom scores. The IPSS score dropped sharply from 25.5 ± 5.8 (severe level) to 5.9 ± 4.1 after 1 month, and to only 2.6 ± 1.6 after 3 months ($p < 0.001$). Similarly, the Quality of Life (QoL) score improved from 4.9 ± 0.8 (unhappy) to 1.1 ± 0.7 (after 1 month) and reached 0.6 ± 0.6 (excellent) after 3 months. These indices are equivalent to the results of Holmium Laser Enucleation of the Prostate (HoLEP) and far superior to monopolar transurethral resection (TURP) or vaporization (TUVF), confirming that B-TUEP completely resolves the mechanical obstruction, helping the bladder recover its storage function.

The maximum urinary flow rate (Qmax) surged from a severe obstruction threshold of 7.2 ± 2.7 ml/s to a clear level of 22.8 ± 6.8 ml/s (after 1 month) and maintained an upward trend reaching 24.5 ± 5.2 ml/s (after 3 months). Concurrently, the post-void residual (PVR) volume dropped deeply from 59.0 ± 45.5 ml to only 7.2 ml and 4.9 ml at the respective milestones. The improvement in these objective urodynamic parameters is much higher than that of other minimally invasive methods (such as embolization or UroLift) and equivalent to open surgery, proving the absolute efficacy of B-

TUEP in clearing mechanical obstacles. The prostate volume on ultrasound also decreased from 73.7 ml to just 20.8 ml after 1 month.

4.3. Analysis of factors related to surgical outcomes

4.3.1. Factors related to intraoperative outcomes

Regression analysis and testing showed that prostate size and morphology are two determining factors. There is a strong positive correlation between prostate volume and operative time ($\beta=0.55$, $p<0.001$). The larger the gland, the more time the surgeon spends on dissection and hemostasis. Additionally, the patient group with trilobar enlargement had a significantly longer operative time (62.8 minutes) compared to the bilobar enlargement group (51.4 minutes), due to the complex anatomical structure requiring more incisions and more difficult bleeding control. Multivariate analysis confirmed that prostate volume is the only statistically significant independent predictor of operative time. Although statistical testing found no significant difference ($p>0.05$) between age, prostate volume, IPSS, and the complication rate due to the modest sample size and very low complication rate, clinical practice showed that large tumors and chronic inflammatory adhesions were direct causes of capsular tears. Controlling the electrosurgical energy level (cutting 130-280W, coagulation 60-110W) plays a pivotal role in precise cutting without causing thermal necrosis leading to subsequent urethral strictures.

4.3.2. Factors related to immediate postoperative outcomes Hospital stay and catheterization time

Regression analysis indicates a very tight positive correlation between catheterization time and postoperative hospital stay ($\beta=1.2$, $p<0.001$). Patients are typically discharged only after the catheter has been removed and they can urinate successfully on their own. Notably, prolonged catheterization time increased the rate of complications (such as urinary tract infection, urethritis, and dysuria) (4.45 days in the group with complications vs. 1.88 days in the group without complications). An interesting finding was that patients with a moderate prostate volume had a higher rate of urinary retention after catheter removal than those with an extremely large volume. The reason may be that in smaller prostates, the surgical space is narrow, and the apical region is close to the external sphincter, causing the energy manipulation to easily result in temporary sphincter edema. Furthermore, prolonged catheterization > 3 days also increased the risk of urinary retention (87.5%) due to mechanical inflammatory reactions.

4.3.3. Factors related to recovery after 1 month

At 1 month, the IPSS symptom score recovered more slowly (higher score) in the group with intraoperative complications (10.8 points vs. 5.3 points) and the group with urinary retention requiring recatheterization (9.5 points vs. 5.3 points). The linear regression model confirmed that catheterization time, hospital stay, and QoL score had a strong positive correlation with the IPSS score. Conversely, the Qmax flow rate had a strong negative correlation with the PVR volume ($\beta=-0.549$, $p<0.001$), demonstrating that the stronger the urine flow rate, the more completely the bladder empties. The more thoroughly the prostate tissue is enucleated, the more the residual PVR decreases.

4.3.4. Factors related to recovery after 3 months

At 3 months, the improvement in IPSS and QoL was entirely dependent on the recovery momentum established in the first month (strong positive correlation, $p<0.001$). The most critical clinical finding at this stage was the negative correlation between the patient's age and the Qmax flow rate ($\beta=-0.270$, $p=0.017$). This correlation affirms that, although B-TUEP has completely cleared the mechanical obstacle (tumor), in older patients, the decline in muscle tone and the natural aging of the detrusor muscle will cause the recovery of the voiding flow rate to be significantly slower than in younger patients. Therefore, for the elderly patient group, expecting an immediate strong urine stream is unrealistic; the bladder muscle needs time to train and gradually recover.

CONCLUSIONS

1. Outcomes of bipolar transurethral enucleation for benign prostatic hyperplasia

*Safety of B-TUEP:

- The median operative time was 50 minutes (IQR: 40-65); the median duration of urethral catheterization was 2 days (IQR: 2-2), and the median postoperative hospital stay was 3 days (IQR: 3-4). The mean volume of irrigation fluid used was 28.8 ± 9.1 liters (using 100% normal saline 0.9% NaCl).

- Intraoperative complications: TUR syndrome 0%, bladder mucosal injury 4.4%, capsular perforation 5.9%.

- Postoperative complications: Postoperative bleeding 2.9% (requiring blood transfusion 1.5%), urinary tract infection 1.5%, acute urinary retention after catheter removal 14.7%; urethral stricture 3.3%, transient urinary incontinence 5.0%.

- The success rate of B-TUEP was 100% (Good results 98.5%, moderate 1.5%).

*Efficacy of B-TUEP:

- Efficacy in improving lower urinary tract symptoms:

- The median IPSS score decreased sharply from 27 points preoperatively to 5 points (after 1 month) and 2 points (after 3 months). The median Quality of Life (QoL) score decreased from 5 points to 1 point (after 1 month) and 0 points (after 3 months).

- The median maximum urinary flow rate (Qmax) increased from 6.8 ml/s to 21.5 ml/s (after 1 month) and 23.1 ml/s (after 3 months). The median post-void residual (PVR) volume decreased from 57 ml to 6.5 ml (after 1 month) and 3.0 ml (after 3 months).

- Prostate volume and PSA: The median prostate volume decreased from 72 ml to 20 ml after 1 month. The median PSA level decreased from 7.1 ng/mL to 0.8 ng/mL after 1 month.

2. Factors associated with the outcomes of bipolar transurethral enucleation for benign prostatic hyperplasia

- *Factors associated with intraoperative outcomes:* Operative time: Preoperative prostate volume and prostate growth morphology had a strong positive correlation with operative time ($p < 0.001$).

- *Factors associated with immediate postoperative outcomes:* Duration of catheterization: Associated with complications after catheter removal, intraoperative complications, and prostate morphology ($p < 0.001$). Hospital stay: Significantly associated with the duration of catheterization and complications after catheter removal ($p < 0.001$).

- *Factors associated with the improvement of lower urinary tract symptoms:* Postoperative IPSS and QoL scores at 3 months had a strong positive correlation with the recovery status of lower urinary tract symptoms at 1 month ($p < 0.05$). The patient's age had a negative correlation with the recovery of the maximum urinary flow rate (Qmax) at 3 months ($p = 0.017$, coefficient $\beta = -0.270$), reflecting the mechanism that the older the patient, the slower the recovery of bladder tone to improve the urine stream.

RECOMMENDATIONS

1. The study has demonstrated with actual data that the B-TUEP technique is safe and effective, with low equipment investment costs. It is recommended that qualified specialized medical facilities consider adopting and widely implementing this technique.

2. Based on the results indicating that the rate of acute urinary retention after urethral catheter removal remains at a noteworthy level (14.7%), we recommend that clinicians personalize the postoperative care protocols. For high-risk patient groups (such as those with large prostate volumes, a history of chronic urinary retention leading to poor bladder tone, or the elderly), consideration should be given to prolonging the duration of urethral catheterization (from 3 to 5 days) combined with the use of medications to increase bladder muscle tone prior to catheter removal, rather than attempting early removal non-selectively.

3. Due to the limitations of the current study regarding the sample size and the medium-term follow-up period (3 months), we recommend continuing to conduct prospective, multicenter studies with larger sample sizes and long-term follow-up periods (from 1 to 5 years). This aims to comprehensively evaluate the sustainability of the treatment efficacy, the ability to preserve sexual function, the recurrence rate, as well as the occurrence of late complications associated with B-TUEP surgery.