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ORIGINAL PAPER

MODERN APPROACHES IN MINIMALLY INVASIVE SURGERY FOR BENIGN PROSTATIC HYPERPLASIA

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Abstract

Introduction. Benign prostatic hyperplasia (BPH) is one of the most common urological conditions affecting older men. Advances in minimally invasive surgery and the use of laser technologies have opened promising perspectives in the surgical management of BPH. While short-term outcomes are well-established, long-term efficacy and safety remain issues of ongoing interest and debate.
The objective of the study was to compare the outcomes of bipolar transurethral surgery and laser surgery in the treatment of large-volume BPH.
Material and methods. A total of 135 patients diagnosed with large-volume BPH, defined as prostate volume >80 cm³, were included. The patients were randomized into two groups: the Thulium laser vapoenucleation (ThuVEP) group (68 patients) and the bipolar vapoenucleation (PKVEP) group (67 patients). All patients underwent preoperative evaluation and were followed up at 6 months, 1, 2, and 3 years.
Results. Morphofunctional outcomes were similar between groups and remained relatively stable throughout the follow-up. However, the incidence of complications was significantly lower in the ThuVEP group.

Résumé

Approches modernes de la chirurgie mini-invasive pour l'hyperplasie bénigne de la prostate

Introduction. L'hyperplasie bénigne de la prostate (HBP) est l'une des affections urologiques les plus fréquentes chez l'homme âgé. Les progrès de la chirurgie mini-invasive et l'utilisation des technologies laser ont ouvert des perspectives prometteuses dans la prise en charge chirurgicale de l'HBP. Si les résultats à court terme sont bien établis, l'efficacité et la sécurité à long terme restent des sujets d'intérêt et de débat.
L'objectif de cette étude était de comparer les résultats de la chirurgie transurétrale bipolaire et de la chirurgie laser dans le traitement de l'HBP de volume important.
Matériel et méthodes. Cent trente-cinq patients présentant une HBP de volume important, définie par un volume prostatique > 80 cm³, ont été inclus. Ils ont été randomisés en deux groupes: le groupe de vaporisation au laser thulium (ThuVEP) (68 patients) et le groupe de vaporisation bipolaire (PKVEP) (67 patients). Tous les patients ont bénéficié d'une évaluation préopératoire et ont été suivis à 6 mois, 1 an, 2 ans et 3 ans.

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The reduced rate of postoperative complications indicates a better safety profile associated with laser-based techniques in the treatment of BPH.
Conclusions. Both laser vapoenucleation and bipolar vapoenucleation are effective and safe methods for treating large-volume BPH. Their implementation expands the indications for endourological treatment. Laser technology provides additional advantages while maintaining durable functional outcomes.

Keywords: laser, vapoenucleation, benign prostatic hyperplasia.

List of abbreviations:
BPH – benign prostatic hyperplasia
ThuVEP – Thulium:YAG transurethral prostate vapoenucleation
PKVEP – bipolar transurethral prostate vapoenucleation
TRUS – transrectal ultrasound
IPSS – International Prostate Symptom Score
QoL – Quality of Life score
LUTS – lower urinary tract symptoms
PSA – prostate-specific antigen
IIEF-5 – International Index of Erectile Function
Qmax – maximum urinary flow rate
TURP – transurethral resection of the prostate
TUIP – transurethral incision of the prostate

Résultats. Les résultats morphofonctionnels étaient similaires entre les groupes et sont restés relativement stables tout au long du suivi. Cependant, l'incidence des complications était significativement plus faible dans le groupe ThuVEP. La réduction du taux de complications postopératoires indique un meilleur profil de sécurité associé aux techniques laser dans le traitement de l'HBP.
Conclusions. La vapoénucléation laser et la vapoénucléation bipolaire sont toutes deux des méthodes efficaces et sûres pour le traitement de l'HBP de volume important. Leur mise en œuvre élargit les indications du traitement endourologique. La technologie laser offre des avantages supplémentaires tout en maintenant des résultats fonctionnels durables.

Mots-clés: laser, vapoénucléation, hyperplasie bénigne de la prostate.

Introduction

Benign prostatic hyperplasia (BPH) is one of the most common urological conditions affecting older men. Globally, over 70% of older men exhibit clinical or morphological changes suggestive of this condition, while associated mortality remains extremely low, estimated at approximately 0.001%[1]. Nevertheless, the impact of the disease on quality of life is quite significant, and its characteristic clinical manifestations are represented by lower urinary tract symptoms (LUTS), such as nocturia, urinary urgency, progressive dysuria, and urge incontinence[2]. These symptoms directly affect patients' overall health status and daily comfort.

Currently, most patients with BPH and LUTS are initially managed pharmacologically. Medical therapy can alleviate symptoms and slow disease progression, thereby delaying the need for surgical intervention. In many cases, conservative treatment provides effective long-term symptom control, regardless of prostate volume[3].

Regarding surgical treatment, the management of small (< 40 cm^3) and medium – sized (40 – 80 cm^3) prostates is well-standardized, with interventions performed predominantly via transurethral approach, in accordance with current international urological guideline recommendations. In contrast, the surgical management of large-volume BPH (>80 cm^3) has, until relatively recently, been reserved for open procedures, such as transvesical adenomectomy (Fuller–Freyer) and retropubic adenomectomy (Millin)[4]. Although these techniques are still mentioned in specialty guidelines, they are associated with increased operative trauma and a prolonged postoperative recovery period.

The need to reduce surgical morbidity has led to the development and implementation of modern endourological techniques in the treatment of large-volume BPH. In this context, recent international guidelines include advanced transurethral methods, such as bipolar vapoenucleation and laser enucleation of the prostate.

Advances in minimally invasive surgery and the use of laser technologies have opened promising perspectives in the surgical management of BPH. Alongside classic monopolar transurethral resection, techniques based on vaporization and enucleation using bipolar energy or laser systems have rapidly evolved. Bipolar surgery has enabled the expansion of

indications for transurethral interventions, making it possible to treat the prostate regardless of its volume.

In parallel, the use of the Thulium:YAG laser system in endourological practice has demonstrated a wide range of applications in prostatic surgery, including incision, resection, vaporization, and enucleation of prostatic tissue. The versatility of these techniques, along with their potential for combination, allows for individualized treatment based on patient characteristics and prostate volume[5].

However, despite the reported advantages, each surgical approach has specific benefits and limitations. Although short-term outcomes are well-established, long-term efficacy and safety remain subjects of ongoing interest and debate within the literature[6].

The objective of the study was to compare the outcomes of bipolar transurethral surgery and laser surgery in the treatment of large-volume BPH, by analyzing the functional efficacy and safety profile of the respective techniques.

Materials and methods

This study was conducted over a 4-year period and included 135 patients diagnosed with large-volume BPH, defined as a prostate volume >80 cm^3. The patients were randomized into two groups: the Thulium laser vapoenucleation (ThuVEP) group (n = 68) and the bipolar vapoenucleation (PKVEP) group (n = 67).

All patients were informed regarding the randomized study protocol, the type of surgical intervention, and the duration of the postoperative follow-up period, established at 36 months, after providing written informed consent to participate in the study.

The preoperative evaluation protocol included urinalysis, complete blood count (CBC), urine culture, measurement of total prostate-specific antigen (PSA), and transrectal ultrasound (TRUS) to assess prostate volume and postvoid residual urine volume, as well as uroflowmetry and completion of validated questionnaires: International Prostate Symptom Score (IPSS), Quality of Life (QoL) Score, and International Index of Erectile Function (IIEF-5).

In the immediate postoperative period (24 hours post-intervention), hemoglobin levels were measured to assess perioperative blood loss. Subsequently, patients were monitored at 6, 12, 24, and 36 months postoperatively through total PSA determination, completion of IPSS, QoL, and IIEF-5 questionnaires, uroflowmetry, and prostatic ultrasound for residual urine volume assessment. Throughout the follow-up period, all postoperative complications were recorded and classified according to the Clavien–Dindo system.

The inclusion criteria were: age 50–90 years, IPSS ≥ 20, PSA ≤ 4 ng/mL, prostate volume ≥ 80 cm^3 on ultrasound, postvoid residual volume > 50 mL, and maximum urinary flow rate (Qmax) ≤ 10 mL/s.

The exclusion criteria were represented by prior lower urinary tract surgery, neurogenic voiding dysfunction, acute urinary tract infection, incidentally detected prostate cancer on histopathological examination, and severe comorbidities precluding surgical treatment.

All procedures were performed via a transurethral approach with the patient in the lithotomy position. Isotonic saline solution (0.9% NaCl) was used for both intraoperative and postoperative irrigation in all cases.

For the PKVEP procedure, a 26 Fr Karl Storz continuous-flow bipolar resectoscope connected to a BOWA ARC 400 generator was used. The ThuVEP procedure was performed using a 26 Fr Karl Storz laser resectoscope and the Revolix Duo laser system, equipped with a 550 µm end-firing PercuFib laser fiber (Thulium:YAG), set at a power of 80 W.

The transurethral vapoenucleation technique was similar for both methods. The procedure began with a circumferential incision of the presphincteric mucosa, followed by incisions at the 5 and 7 o'clock positions down to the surgical capsule. Retrograde enucleation of the median lobe was then performed. This was followed by an incision at the 12 o'clock position and retrograde enucleation of the lateral lobes along the surgical capsule.

Enucleated prostatic tissue was removed by resection of devascularized adenomatous nodules, followed by bladder irrigation. Intraoperative hemostasis was meticulous in all cases. Postoperative bladder drainage was achieved using a 20 Fr two-way Foley catheter in all patients. Resected tissue was sent for histopathological evaluation in all cases.

Results

The comparative evaluation of the two surgical techniques was based on the analysis of perioperative parameters, functional and morphological outcomes, and postoperative complications during the 36-month follow-up period.

The decrease in hemoglobin at 24 hours postoperatively was comparable between groups (10 g/L in the ThuVEP group vs 11 g/L in the PKVEP group). However, the duration of postoperative hematuria was longer in the PKVEP group (1.6 days), resulting in prolonged catheterization.

Table 1. Early postoperative period (135 patients).

Parameter	ThuVEP (68 patients)	PKVEP (67 patients)
Hemoglobin decrease, g/L	10	11
Duration of hematuria, days	1,3	1,6
Duration of catheterization, days	1,5	2,1

ThuVEP – *Thulium:YAG laser transurethral vapoenucleation of the prostate*; PKVEP – *Bipolar transurethral vapoenucleation of the prostate.*

Table 2. Postoperative follow-up (135 patients).

	ThuVEP (68 patients)				PKVEP (67 patients)			
	6 months	1 year	2 years	3 years	6 months	1 year	2 years	3 years
IPSS	5.3	4.7	4.9	5.1	6.1	6	6.6	7.1
QoL	1.6	1.2	1	1	2.0	1	1	1.3
IIEF-5	7.2	7.4	7.1	7.2	7.9	8.0	8.0	7.6

ThuVEP – *Thulium:YAG laser transurethral vapoenucleation of the prostate*; PKVEP – *Bipolar transurethral vapoenucleation of the prostate*; IPSS – *International Prostate Symptom Score*; QoL – *Quality of Life score*; IIEF-5 – *International Index of Erectile Function-5.*

Table 3. Postoperative ultrasound and urodynamic findings (135 patients).

	ThuVEP (68 patients)				PKVEP (67 patients)			
	6 months	1 year	2 years	3 years	6 months	1 year	2 years	3 years
Prostate volume, cm^3	23.7	21.2	22.4	23.9	30.3	28.1	28.9	30.4
Post-void residual urine, mL	7.6	4.6	5.7	6.8	8.7	6.2	7.4	9.8
Qmax, mL/s	17.2	20.2	19.8	19.1	15.2	20.3	19.4	18.3

ThuVEP – *Thulium:YAG laser transurethral vapoenucleation of the prostate*; PKVEP – *Bipolar transurethral vapoenucleation of the prostate*; Qmax – *Maximum urinary flow rate.*

A higher incidence of postoperative dysuria was also observed in the PKVEP group (21%), likely reflecting deeper thermal tissue injury associated with bipolar energy (Table 1). Episodes of urinary urgency were reported exclusively in the bipolar group, occurring in 2 patients (2.98%).

Postoperative LUTS were effectively controlled in all cases with nonsteroidal anti-inflammatory drugs and alpha-blockers.

Postoperative quality-of-life outcomes were comparable between the two groups. The IPSS demonstrated a significant reduction following surgery, reaching the lowest value at 12 months (4.7 in the ThuVEP group vs 6.4 in the PKVEP group). These findings support the durability of both techniques, with IPSS values remaining stable throughout the 36-month follow-up (5.1 vs 7.1, respectively).

A similar trend was observed for the IIEF-5 score, with a transient decline at 6 months (7.2 in the ThuVEP group vs 7.9 in the PKVEP group). However, recovery of erectile function was not significantly influenced by the type of intervention, with IIEF-5 scores returning to baseline at approximately 12 months postoperatively.

During subsequent follow-up, a gradual decline in IIEF-5 scores was observed, likely reflecting aging and progression of associated comorbidities (Table 2).

The radicality of the surgical intervention was evaluated through the analysis of postoperative prostatic volume, revealing a significant reduction in both groups. At 6 months postoperatively, the mean prostatic volume was 23.7 cm^3 in the ThuVEP group, and 30.3 cm^3 in the PKVEP group. The durability of the therapeutic effect was further supported by the relative stability of prostate volume throughout follow-up.

Functional efficacy was demonstrated by a significant increase in maximum urinary flow rate (Qmax) among the patients included in the study, assessed at 12 months postoperatively. Mean Qmax reached 20.3 mL/s in both groups (ThuVEP and PKVEP) and remained stable throughout follow-up (Table 3).

Postvoid residual volume represents another indirect functional marker of treatment efficacy. A marked reduction was observed in both groups, with values of 7.6 mL in the ThuVEP group and 8.7 mL in the PKVEP group at 6 months, remaining stable thereafter.

Overall, morphofunctional outcomes were comparable between the two techniques despite the use

Table 4. Postoperative complications according to the Clavien – Dindo classification (135 patients).

		Treatment			
		ThuVEP		PKVEP	
		n	%	n	%
Urethritis		2	2.94	1	1.49
Prostatitis		0	-	0	-
Epididymo-orchitis		0	-	1	1.49
Urethral stricture		1	1.47	2	2.98
Bladder neck sclerosis		1	1.47	1	1.49
Recatheterization		3	4.41	5	7.46
Clavien – Dindo Grade	I	2	2.94	2	2.98
	II	3	4.41	3	4.47
	IIIa	2	2.94	5	7.46

ThuVEP – *Thulium:YAG laser transurethral vapoenucleation of the prostate*; PKVEP – *Bipolar transurethral vapoenucleation of the prostate.*

of different energy sources. Furthermore, the durability of the therapeutic effect was similar, supporting the use of both methods in the treatment of patients with large-volume benign prostatic hyperplasia.

However, the analysis of postoperative complications showed a higher incidence in patients treated with PKVEP (Table 4). Complications were categorized as inflammatory or sclerotic.

The incidence of inflammatory complications (urethritis, prostatitis, epididymo-orchitis) was comparable between the two cohorts. In contrast, sclerotic complications, including urethral stricture and bladder neck sclerosis, were more frequently observed in the PKVEP group. This finding may be related to the deeper thermal tissue injury associated with bipolar energy.

Inflammatory complications were managed conservatively with antibacterial therapy, initially empirical and subsequently tailored based on urine culture results. Sclerotic complications required endourological interventions, including optical internal urethrotomy for urethral strictures and bladder neck incision for bladder neck sclerosis.

Discussion

Modern endourological surgery offers a broad spectrum of therapeutic options for the management of large-volume BPH. Conventional transurethral techniques, such as transurethral resection of the prostate (TURP) and transurethral incision of the prostate (TUIP), maintain a well-defined role within national and international urological guidelines[7].

However, these procedures are predominantly indicated for patients with small – to – medium volume BPH and may exhibit limitations in achieving a complete resection in cases where prostatic volumes are >80 cm^3.

Furthermore, the surgical management of patients with large-volume BPH is often complicated by the presence of comorbidities and associated chronic treatments, including anticoagulant therapy[8]. In this context, identifying effective and safe therapeutic modalities remains a priority for contemporary urological practice.

Initial attempts to replace open surgery with transurethral techniques were made in the late 1980s; however, the limitations of monopolar electrosurgery initially restricted their development[9]. Subsequently, significant evolution in endourological surgery was made possible by the introduction of bipolar electrosurgery and Thulium:YAG laser technology, which allowed for the expansion of indications for minimally invasive interventions[10].

Currently, PKVEP and ThuVEP are considered among the most promising approaches for the management of large-volume BPH[11,12]. Data from the literature, as well as the results of our study, indicate comparable functional efficacy between the two techniques. Objective parameters – specifically the increase in maximum flow rate (Qmax), the reduction in prostatic volume, and the decrease in post-void residual volume—show no statistically significant differences between the two methods.

Although the operative time may be slightly longer with ThuVEP, this is offset by a shorter duration of postoperative catheterization, facilitating earlier discharge, faster recovery of spontaneous voiding, and earlier socio-professional reintegration of patients.

A major advantage of laser technology, observed both in our study and in the literature, is reduced intraoperative blood loss compared with bipolar techniques, providing the ThuVEP procedure with a superior safety profile[13]. Furthermore, the use of

the Thulium:YAG laser allows procedures to be performed in patients receiving anticoagulant therapy without the need for its discontinuation, owing to its excellent hemostatic properties. This expands surgical indications to higher-risk patients who were previously limited to palliative options such as chronic bladder catheterization or cystostomy.

Regarding postoperative complications, endoscopic techniques are generally associated with a lower complication rate compared to open surgery[14,15]. In our study, the incidence of urinary tract infections was comparable between the two groups, aligning with findings reported in the literature. However, an overall lower complication rate was observed in the ThuVEP group, which may be attributed to the limited depth of thermal tissue injury (approximately 0.2 mm) characteristic of Thulium:YAG laser energy, thereby contributing to the durability of functional outcomes.

Erectile function represents an important parameter in the evaluation of postoperative outcomes, particularly given the increasing prevalence of erectile dysfunction with aging and associated comorbidities[16,17]. Our findings show that surgical treatment does not significantly affect IIEF-5 scores in the medium and long term. Nevertheless, a transient decline in erectile function may occur during the early postoperative period, followed by progressive recovery thereafter.

Conclusions

ThuVEP and PKVEP are effective and safe options for the management of large-volume BPH (>80 cm^3). Their implementation expands the indications for endourological treatment and reduces the need for open surgery.

Laser technology offers additional advantages, including improved intraoperative safety, reduced blood loss, and lower complication rates, while maintaining durable functional outcomes. These findings support the use of laser vapoenucleation as a preferred surgical approach in older patients with large-volume BPH.

Author Contributions:

Conceptualization, A.P., V.G. and B.B.; methodology, A.P.; software, A.P., M.M; validation, V.G., A.G.; formal analysis, A.P.; investigation, A.P; resources, A.P.; data curation, A.P., V.G., A.G.; writing – original draft preparation, A.P., M.M.; writing – review and editing, A.P., M.M.; visualization, A.G. and V.G.; supervision, V.G.; project administration, V.G. All the authors have read and agreed with the final version of the article.

Compliance with Ethics Requirements:

The study was conducted in accordance with the principles of the Declaration of Helsinki and was approved by the Ethics Committee of the "Nicolae Testemitanu" State University of Medicine and Pharmacy, Chisinau, Republic of Moldova (approval no. 3 from 16.12.2019). Written informed consent was obtained from all participants.

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