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RESEARCH ARTICLE

Contemporary surgical options in large benign prostatic hyperplasia treatment

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What is not yet known about the issue addressed in the submitted manuscript

The surgical treatment of large benign prostate hyperplasia is a topic of great interest. The use of contemporary technologies in prostate surgery extends opportunities for minimally invasive treatment.

The research hypothesis

Transurethral prostate enucleation becomes the new "gold standard" for surgical treatment of large benign prostate hyperplasia.

The novelty added by the manuscript to the already published scientific literature

The implementation of laser and bipolar energy in the surgical treatment of large benign prostatic hyperplasia allows for improved functional postoperative results and reduces the recovery time and perioperative complication rate.

Abstract

Introduction. Specialists are currently interested in the method of choice for surgical treatment in patients with enlarged benign prostate hyperplasia (> 80 cm^3). The introduction of laser and bipolar technologies for benign prostate hyperplasia surgery has allowed effective treatment regardless of the size of the prostate gland.

Material and methods. During 2020-2021, 65 patients underwent surgical treatment for large benign prostate hyperplasia. Depending on the type of surgical treatment performed, 3 study groups were identified: 22 patients underwent transurethral Thulium: YAG laser prostate vapoenucleation; 21 patients underwent transurethral bipolar prostate enucleation; and 21 patients underwent a simple prostatectomy. All patients were examined before and after surgery (at 3 and 6 months) using the International Prostate Symptom Score, Quality of Life Score, prostate-specific antigen assessment, transrectal prostate ultrasound examination, and uroflowmetry to assess residual urine volume. Postoperative complications were recorded in accordance with the 2004 Clavien-Dindo classification.

Results. There was a significant difference in the mean operative time ranging from 72±19 min (ThuVEP group) vs. 56±10 min (SP group) and 70±15 min (TUEB group), as well as a decrease in hemoglobin levels, viz. 1.2±0.4 g/dl vs. 2.6±1.1 g/dl vs. 1.6±0.5 g/dl (ThuVEP vs. SP vs. TUEB). The catheterization lasted for 2±1 days (ThuVEP) vs. 10±1 days (SP) vs. 3±1 days (TUEB). A significant improvement in Qmax was registered in the ThuVEP group (122.9%) and in the TUEB group (111.7%). However, patients after a simple prostatectomy showed an increase in Qmax of only 94%. The PVR values were reported to be the same. ThuVEP is an effective surgical technique for large BPH patients. The reduced trauma and lower complication rate of ThuVEP, as well as its effectiveness, have confirmed the need for widespread implementation of minimally invasive laser interventions.

Keywords: laser, bipolar enucleation, prostate.

Introduction

Benign prostatic hyperplasia (BPH) is one of the most common urinary tract pathologies that causes LUTS (lower urinary tract symptoms) [1]. The incidence of BPH increases with age and exceeds 90% by the age of 90 [2]. LUTS progression significantly affects the quality of life in elderly patients with BPH [3]. According to the recommendations of the American Urological Association and the European Society of Urology, only surgery is a radical treatment

for BPH. Transurethral resection of the prostate (TUR-P), which is currently the „gold standard", is well known in patients with small- (< 30 cm3) and medium-sized (< 80 cm3) total prostate volume [4, 5, 6]. The recommendations for patients with a large prostate volume (> 80 cm3) are less accurate and vary. Thus, according to the recommendations of the European Association of Urology, simple prostatectomy (SP), TUR-P, transurethral bipolar enucleation of the prostate, and transurethral laser enucleation of the prostate can be used in patients with a large prostate volume [4, 6]. Recommended surgical techniques totally vary depending on the procedure, surgical trauma, and postoperative recovery. It is noteworthy that at present, SP is the benchmark for assessing postoperative outcomes and is the oldest surgical method used [7, 8]. Over several decades, numerous attempts have been made to replace open surgical treatment in patients with large benign prostatic hyperplasia. For this purpose, the use of TUR-P is difficult and risky due to its long operative time and significant complication rate, making it the choice of only some specialists in transurethral resection. Since the 1990s, bipolar surgery has been introduced into the treatment of large BPH (6, 9). Bipolar transurethral enucleation of the prostate has paved the way for endourological treatment of large BPH. However, SP is still widely used, particularly in developing countries. The latest innovation in transurethral BPH surgery is the use of laser energy [6, 7, 10]. The use of laser generators provides a safe and efficient surgical technique. According to the conducted studies, the functional results are comparable to those of SP, whereas the surgical safety is higher than in bipolar surgery. The obtained results are encouraging in terms of laser surgery durability [11, 12].

Material and methods

During 2020-2021, 65 patients with BPH underwent surgical treatment for large BPH. Depending on the surgical approach used, 3 study groups were identified: 22 patients underwent transurethral Thulium:YAG laser vapoenucleation of the prostate (ThuVEP), 21 patients underwent bipolar transurethral vapoenucleation of the prostate (TUEP), and 21 patients underwent transvesical adenomectomy. All patients were assessed preoperatively and postoperatively (at 3 and 6 months) using the International Prostate Symptoms Scale (IPSS), Quality of Life (QoL), physical examination and digital rectal examination, serum prostate-specific antigen (PSA) assessment, uroflowmetry (Qmean and Qmax), transrectal ultrasound with prostate volume, and postvoiding residual urine volume (PVR) measurements. Postoperative complications were recorded according to the 2004 Clavien-Dindo classification. Inclusion criteria: total prostate volume ≥ 80 cm^3, age ≤ 80 years, post-void residual (PVR) ≥ 70 mL, Qmax ≤ 10 mL/s. ThuVEP was performed during the lithotomy positioning of the body. Exclusion criteria: prostate cancer at histological examination. ThuVEP was performed in all cases using a Karl Storz 26Fr continuous saline irrigating resectoscope. Tissue vapo-enucleation was performed using a Thulium:YAG laser (Revolix Duo, LisaLaser, Germany) set to 80W. The laser energy was delivered via a RigiFib 550mc optical fiber with terminal emission.

After performing a vapoenucleation plan along the pathway of the prostatic pseudocapsule, the prostatic nodules were detached concomitant with continuous hemostasis. Vapoenucleated nodules were removed from the bladder lumen by resection of devascularized pedunculated tissue. At the end of the surgery, all patients were fitted with a biluminal Foley type 20Fr autostatic urethrovesical catheter for postoperative bladder drainage. The removed tissues were sent for histological examination. In the case of severe hematuria in the early postoperative period, a continuous irrigation system was installed.

Bipolar transurethral vapoenucleation of the prostate was performed under spinal anesthesia, with the patient in the lithotomy position. The Olympus 26Fr continuous-flow resectoscope with saline irrigation (Sol. NaCl 0.9%) was used in all cases. The Olympus generator was used as the bipolar power source (200 W for vaporization and 120 W for coagulation). A three-lobar technique was used for vapoenucleation, and separate retrograde detachment of the hyperplastic nodules from the prostatic capsule was performed. Vapoenucleated tissue was subsequently fragmented by resection. Postoperative bladder drainage was provided by the installation of a Foley 20Fr biluminal autostatic probe for a period of at least 24 hours. Continuous bladder lavage was performed only in cases of significant postoperative hematuria. Histological examination of the vapoenucleated tissue was performed in all cases.

SP was performed under spinal anesthesia using the Fuller-Freyer procedure, which involves bimanual enucleation of adenomatous nodes. All patients underwent biluminal autostatic Foley catheterization and cystostomy. A continuous lavage system was installed for 24 hours to prevent the formation of blood clots in the bladder lumen. Histological examination of the BPH was performed in all cases.

After the removal of the urethrovesical catheter, all patients were followed up in the urology department within 24 hours.

Excel tables were used to process the data. Data is presented in absolute and relative terms, as well as mean and standard deviation. Descriptive statistics.

Results

All patients underwent similar examinations during the follow-up. During their visits, all parameters presented in the study were evaluated. At the end of the follow-up, all data were analyzed using the Student's t-test. The study groups were homogeneous (Table 1). Operative indices were also recorded and analyzed (Table 2). The operation lasted longer in the ThuVEP and TUEB groups, mostly due to complete enucleation and subsequent fragmentation of hyperplastic prostate tissue. At the same time, a more significant hemoglobin drop was found in the SP group. Bladder catheterization in patients who underwent SP lasted much longer (+400%) due to surgical trauma to the bladder and the impossibility of performing definite he-

mostasis. The hospital stay length was determined by the duration of postoperative catheterization, thus being comparably longer in patients who underwent SP (+250%). The period of macrohematuria in patients after TUEB lasted on average one day longer compared to the ThuVEP group, thus resulting in a longer catheterization and hospitalization.

Table 1. Preoperative assessment (65 patients).

	ThuVEP	TUEB	SP
No. patients	21	22	21
Age, years	64±4	63±3	65±3
Q_{max}, mL/s	8.3±1.4	8.5±2	8.3±1.5
Q_{mean}, mL/s	7.7±1.2	7.8±1.4	7.5±1.3
IPSS	27±2	28±2	27±1
QoL	5±1	5±1	5±1
Prostate volume, mL	89±7	88±5	90±6
PVR, mL	91±11	85±10	87±11
PSA, ng/mL	2.6±1.1	2.3±1.2	2.5±1.3

Note: *ThuVEP – transurethral Thulium:YAG laser prostate vapoenucleation; SP – simple prostatectomy; TUEB – transurethral bipolar enucleation; Q_{max} – maximum urinary flow rate; Q_{mean} – average urinary flow rate; IPSS – International Prostate Symptom Score; QoL – quality of life index; PVR – postvoiding residual urine volume; PSA – prostate specific antigen.*

Table 2. Surgical data (65 patients)

	ThuVEP	TUEB	SP
Operating time, min	72±19	70±15	56±10
Hemoglobin drop, g/l	1.2±0.4	1.6±0.5	2.6±1.1
Catheterization duration, days	2±13	3±1	10±1
Hospital stay length, days	5±1	6±1	12±2

Note: *ThuVEP – transurethral Thulium:YAG laser prostate vapoenucleation; SP – simple prostatectomy; TUEB – transurethral bipolar enucleation.*

At 6 months of follow-up, no significant differences were detected between the 3 groups regarding IPSS and QoL. At the same time, 3 months after the operation, patients who underwent ThuVEP noted a more significant improvement in IPSS and QoL values. Thus, at the 6-month check-up, the values were almost the same. A faster recovery to baseline indices can be easily explained by the less traumatic techniques of ThuVEP and TUEB (Table 3).

Table 3. Postoperative dynamics of symptoms (65 patients).

	Preoperative	Postoperative	
		3 months	6 months
IPSS			
ThuVEP	27±2	12±2	6±1
TUEB	28±2	13±2	6±1
SP	27±1	15±2	10±1
QoL			
ThuVEP	5±1	3±1	1±1
TUEB	5±1	3±1	1±1
SP	5±1	3±1	2±1

Note: *ThuVEP – transurethral Thulium:YAG laser prostate vapoenucleation; SP – simple prostatectomy; TUEB – transurethral bipolar enucleation; IPSS – International Prostate Symptom Score; QoL – quality of life index.*

Considering the technical features of the surgical approaches (ThuVEP, TUEB and SP), namely the complete enucleation of hyperplastic prostate tissues, the prostate ultrasound in the postoperative period showed a significant decrease in prostate volume in all three groups. At the same time, PVR changes reported during the follow-up period differed among the study groups. PVR in the ThuVEP group had a significantly faster positive trend and a considerable improvement at 6 months after surgery (-76.4%) compared to other groups. The changes recorded in the TUEB group were almost the same as in the ThuVEP group, and only the reduction in PVR was slightly lower (73.8% vs. 76.4%) (Table 4). The slower improvement in the SP group may be explained by more significant traumatic injuries, which required a longer recovery time.

Table 4. Dynamics of ultrasound parameters (65 patients).

	Preoperative	Postoperative, 3 months	Postoperative, 6 months
ThuVEP			
Prostate volume, mL	89±7	22±3 -75.2%	21±3 - 76.4%
PVR,mL	91±11	21±7 -76.9%	14±5 -84.6%
TUEB			
Prostate volume, mL	88±5	23±4 -73.8%	23±2 -73.8%
PVR, mL	85±10	22±5 -74.1%	17±5 -80%
SP			
Prostate volume, mL	90±6	24±5 -73.3%	23±4 -74.4%
PVR, mL	87±11	30±5 -65.5%	20±5 -77%

Note: *ThuVEP – transurethral Thulium YAG laser prostate vapoenucleation; SP – simple prostatectomy; TUEB – transurethral bipolar enucleation; PVR – postvoiding residual urine volume.*

Similar urodynamic changes were reported in both the TUEB and ThuVEP groups postoperatively, due to the use of the same enucleation procedure and the relatively rapid recovery time of the postoperative prostate. Thus, Qmax increased by 122.9% in the ThuVEP group and by 111.7% in the TUEB group. However, Qmax at 6 months after open adenomectomy showed an improvement of only 94% (Table 5).

Table 5. Changes in urodynamic values (65 patients).

	Q_{max} preoperative, mL/s	Q_{max} postoperative, mL/s	
		3 months	6 months
ThuVEP	8.3±1.4	17.2±1 +107%	18.5±1 +122.9%
TUEB	8.5±2	17±1 +100%	18±1 +111.7%
SP	8.3±1.5	14.1±1 +69.8%	16.1±1 +94%

Note: *ThuVEP – transurethral Thulium:YAG laser prostate vapoenucleation; SP – simple prostatectomy; TUEB – transurethral bipolar enucleation; Q_{max} – maximum urinary flow rate.*

The incidence of postoperative complications varied significantly in the study groups (Table 6), mainly due to the extremely different surgical techniques, different surgical injuries, and long-term catheterization in patients who underwent open surgery. In groups with transurethral vapoenucleation, the frequency of reported complications did not differ significantly. Sexually active patients reported postoperative retrograde ejaculation: 17 of 21 patients (80.9%) in the ThuVEP group and 19 of 21 patients (90.4%) in the SP group. The incidence of retrograde ejaculation after TUEB was 81.8%. It was found that retrograde ejaculation was stable and irreversible in all the patients under study. During the follow-up period, several complications of varying severity were diagnosed; however, they did not pose a threat to the lives of the patients. There were no cases of massive bleeding in the ThuVEP and TUEB groups. At the same time, one patient from the SP group required a blood transfusion. Postoperatively, 2 patients (9.5%) in the ThuVEP group and 3 patients (13.6%) in the SP group had complaints of transient urinary incontinence, which spontaneously resolved within 3 months of follow-up. Patients reported stress urinary incontinence in 13.6% of cases after TUEB. Urinary tract infections were registered preoperatively in one patient (4.76%) from the ThuVEP group, in one patient (4.54%) from the TUEB group, and in two patients (9.52%) from the SP group. The antibacterial treatment proved to be appropriate in all cases, in accordance with the urine culture. One episode of acute urinary retention was reported in both the TUEB and AE groups. This complication was resolved by re-catheterization within 48 hours and the administration of non-steroidal anti-inflammatory drugs. At 6 months, there was one case of urethral stricture in the TUEB group and one case of bladder neck sclerosis in the SP group. These complications were treated surgically with a cold-blade stricture incision and a bipolar bladder neck incision. At the same time, after ThuVEP, no sclerotic complications were reported during the follow-up period. The high incidence of infectious-inflammatory complications after SP is probably due to long-term urinary catheterization during the postoperative period. Cases of TUR syndrome were not recorded in the present study. The lowest overall rate of complications was reported in the ThuVEP group (14.27%) due to less traumatic injuries and the physical and surgical properties of the Thulium:YAG laser, whereas the overall incidence of complications in the TUEB group was insignificantly higher (18.1%) due to a minimally invasive approach. Open surgical treatment showed a very high complication rate of 42.85%. Such a high complication rate may be due to extensive surgical trauma and long-term postoperative catheterization.

Table 6. Postoperative complications, 2004 Clavien-Dindo classification (65 patients).

	ThuVEP, No. patients (%)	TUEB, No. patients (%)	SP, No. patients (%)	Severity of complications
Transient urinary incontinence	2 (9.51%)	2 (9.09%)	3 (14.28%)	Grade I
Re-catheterization	-	1 (4.54%)	1 (4.76%)	
Blood transfusion	-	-	1 (4.76%)	Grade II
Urinary infections	1 (4.76%)	1 (4.54%)	2 (9.51%)	Grade III
Urethral stricture	-	-	1 (4.76%)	
Bladder neck sclerosis	-	-	1 (4.76%)	Grade IIIb
TURP syndrome	-	-	-	Grade IV
Total	3 (14.27%)	4 (18.1%)	9 (42.85%)	

Note: *ThuVEP – transurethral Thulium:YAG laser prostate vapoenucleation; SP – simple prostatectomy; TUEB – transurethral bipolar enucleation; TURP syndrome – Transurethral resection of the prostate* syndrome.

Discussions

The postoperative assessment of patients showed a significant progressive improvement in the patients' overall condition according to the IPSS scale and QoL in all groups. A positive tendency for Qmax and urine flow rate was also recorded. The ultrasound exam showed a significant decrease in the total prostate volume and post-void residual urine volume. At the same time, the assessed methods showed different results. The patients undergoing ThuVEP and TUEB exhibited a significantly faster postoperative recovery and improvement in baseline indices. This is due to massive surgical injuries in SP, resulting in a prolonged recovery time of the prostate gland during the postoperative period. The impossibility of performing a high-quality primary hemostasis in SP may lead to longer hematuria and catheterization, which entails greater risks of bleeding as well as a prolonged hospitalization. Patients diagnosed with infravesical obstruction caused by large BPH (>80 cm^3) and severe lower urinary tract symptoms have a higher rate of therapeutic failure, which commonly requires surgical treatment. In these cases, qualified specialists will recommend first-line surgical methods such as endoscopic enucleation with bipolar energy, endoscopic enucleation with laser energy, and SP [13]. Despite the development of new technologies, SP remains the standard treatment for large BPH due to the limited availability of new technologies within healthcare facilities, as well as the frequent need for concomitant surgical treatments such as cystolithotomy and diverticulectomy. However, SP is known to be invasive and shows a higher morbidity rate, followed by higher bleeding and transfusion rates ranging from 7 to 14% [14, 15, 16], bladder neck sclerosis up to 6% [16, 17], and repeated surgeries up to 3.6% [18]. The introduction of bipolar surgery has allowed for the radical treatment of bulky BPH by significantly reducing surgical injuries and hospital stay. Thus, a decrease in blood loss (1.7 vs. 3.1 g/dL), postoperative hematuria (2.9% vs. 12.9%), and postoperative hospital stay (2.1 vs. 6.9 days) is being reported compared to SP [19]. At the same time, the functional results obtained after TUEB are similar to those obtained after open surgery, as confirmed by other studies as well.

Using ThuVEP seems to make even more sense. Thus, the conducted study proved maximum efficacy, comparable to SP, as well as better surgical safety. ThuVEP has been shown

to be a size-independent, safe, and effective treatment for large BPH [20]. Bach et al. evaluated the safety and efficacy of ThuVEP in patients with a total prostate volume of 108.6 mL (80-200 mL). At 12 months postoperatively, an 86% (67-99%) reduction in prostate volume and an 88% (58-100%) reduction in PSA levels were recorded [10]. Functional outcomes were comparable to those of open adenomectomy in most studies [21]. Given the significantly faster postoperative recovery, ThuVEP can be considered the treatment of choice for the management of large BPH [20-24].

Conclusions

The advantages of ThuVEP compared to TUEB and especially to SP are obvious. Thus, the maximum improvement in PVR was obtained in the ThuVEP group and amounted to 84.6%. The Qmax values in this group of patients also showed an excellent +122% increase. Considering the similar postoperative urodynamic results obtained after all types of surgical interventions, which were assessed within the present research (ThuVEP, TUEB, and SP), as well as a significantly lower complication rate (14.27%) found in the ThuVEP group, we consider it rational to use Thulium:YAG laser energy in the treatment of large BPH.

Declaration of conflicting interests

Nothing to declare.

Authors' contribution

All authors contributed equally to the elaboration of the manuscript. The final version has been read and approved by all authors.

References

1. Launer B, McVary K, Ricke W, Lloyd G. *et al.* The rising worldwide impact of benign prostatic hyperplasia. *BJU. Int.,* 2021; 127 (6): 722-728. doi: 10.1111/bju.15286.
2. Vuichoud C, Loughlin K. Benign prostatic hyperplasia: epidemiology, economics and evaluation. *Can. J. Urol.,* 2015; 22 (1): 1-6.
3. Egan K. The Epidemiology of Benign Prostatic Hyperplasia Associated with Lower Urinary Tract Symptoms: Prevalence and Incident Rates. *Urol. Clin. North. Am.,* 2016; 43 (3): 289-297. doi: 10.1016/j.ucl.2016.04.001.
4. Chua M, Mendoza J, See M. *et al*. A critical review of recent clinical practice guidelines on the diagnosis and treatment of non-neurogenic male lower urinary tract symptoms. *Can. Urol. Assoc. J.,* 2015; 9 (7-8): E463-E470. doi: 10.5489/cuaj.2424.
5. McVary K, Roehrborn C, Avins A. *et al.* Update on AUA guideline on the management of benign prostatic hyperplasia. *J. Urol.,* 2011; 185 (5): 1793-1803. doi: 10.1016/j.juro.2011.01.074.
6. Herrmann T, Liatsikos E, Nagele U. *et al.* EAU Guidelines Panel on Lasers, Technologies. EAU guidelines on laser technologies. *Eur. Urol.,* 2012; 61 (4): 783-795. doi: 10.1016/j.eururo.2012.01.010.
7. Braeckman J, Denis L. Management of BPH then 2000 and now 2016 - From BPH to BPO. *Asian J. Urol.,* 2017; 4 (3): 138-147. doi: 10.1016/j.ajur.2017.02.002.
8. Ugwumba F, Ozoemena O, Okoh A. *et al.* Transvesical prostatectomy in the management of benign prostatic hyperplasia in a developing country. *Niger. J. Clin. Pract.,* 2014; 17 (6): 797-801. doi: 10.4103/1119-3077.144402.
9. Chung A, Woo H. Update on minimally invasive surgery and benign prostatic hyperplasia. *Asian J. Urol.,* 2018; 5 (1): 22-27. doi: 10.1016/j.ajur.2017.06.001.
10. Bach T, Netsch C., Pohlmann L. *et al.* Thulium:YAG vapoenucleation in large volume prostates. *J. Urol.,* 2011; 186 (6): 2323-2327. doi: 10.1016/j.juro.2011.07.073.
11. Sun F, Han B, Cui D. *et al.* Long-term results of thulium laser resection of the prostate: a prospective study at multiple centers. *World J. Urol.,* 2015; 33 (4): 503-508. doi: 10.1007/s00345-014-1456-5.
12. Netsch C, Engbert A, Bach T. *et al.* Long-term outcome following Thulium VapoEnucleation of the prostate. *World J. Urol.,* 2014; 32 (6): 1551-1558. doi: 10.1007/s00345-014-1260-2.
13. Herrmann T, Gravas S, de la Rosette J. *et al.* Lasers in Transurethral Enucleation of the Prostate-Do We Really Need Them. *J. Clin. Med.,* 2020; 9 (5): 1412. doi: 10.3390/jcm9051412.
14. Li M, Qiu J, Hou Q. *et al.* Endoscopic enucleation versus open prostatectomy for treating large benign prostatic hyperplasia: a meta-analysis of randomized controlled trials. *PLoS One,* 2015; 10 (3): e0121265. doi: 10.1371/journal.pone.0121265.
15. Varkarakis I, Kyriakakis Z, Delis A. *et al.* Long-term results of open transvesical prostatectomy from a contemporary series of patients. *Urology,* 2004; 64 (2): 306-310. doi: 10.1016/j.urology.2004.03.033.
16. Kuntz R, Lehrich K, Ahyai S. Holmium laser enucleation of the prostate versus open prostatectomy for prostates greater than 100 grams: 5-year follow-up results of a randomised clinical trial. *Eur. Urol.,* 2008; 53 (1): 160-166. doi: 10.1016/j.eururo.2007.08.036.
17. Tubaro A, Carter S, Hind A. *et al.* A prospective study of the safety and efficacy of suprapubic transvesical prostatectomy in patients with benign prostatic hyperplasia. *J. Urol.,* 2001; 166 (1): 172-176.
18. Serretta V, Morgia G, Fondacaro L. *et al.* Open prostatectomy for benign prostatic enlargement in southern Europe in the late 1990s: a contemporary series of 1800 interventions. *Urology,* 2002; 60 (4): 623-627. doi: 10.1016/s0090-4295(02)01860-5.
19. Geavlete B, Stanescu F, Iacoboaie C. *et al.* Bipolar plasma

enucleation of the prostate vs open prostatectomy in large benign prostatic hyperplasia cases - a medium term, prospective, randomized comparison. *BJU. Int.,* 2013; 111 (5): 793-803. doi: 10.1111/j.1464-410X.2012.11730.x.

20. Ghicavîi V, Plesacov A, Vladanov I. Early outcomes of transurethral Thulium laser vapoenucleation of prostate. *International medical congress MedEspera 2020: The 8th International Medical Congress for Students and Young Doctors, 24-26 september, Chişinău, Rep. Moldova: Abstract Book,* 2020; 436.
21. Ghicavîi V, Plesacov A, Vladanov I. Transurethral Thulium laser vapoenucleation of prostate – a good alternative for open surgery. *International medical congress MedEspera 2020: The 8th International Medical Congress for Students and Young Doctors, 24-26 september, Chişinău, Rep. Moldova: Abstract Book,* 2020; 436.
22. Hong K, Liu Y, Lu J. *et al.* Efficacy and safety of 120-W thulium:yttrium-aluminum-garnet vapoenucleation of prostates compared with holmium laser enucleation of prostates for benign prostatic hyperplasia. *Chin. Med. J.*, 2015; 128 (7): 884-889. doi: 10.4103/0366-6999.154282.
23. Chang C, Lin T, Huang J. Safety and effectiveness of high-power thulium laser enucleation of the prostate in patients with glands larger than 80 mL. *BMC. Urol.,* 2019; 19 (1): 8. doi: 10.1186/s12894-019-0437-9.
24. Gross A, Netsch C, Knipper S. *et al.* Complications and early postoperative outcome in 1080 patients after thulium vapoenucleation of the prostate: results at a single institution. *Eur. Urol.,* 2013; 63 (5): 859-867. doi: 10.1016/j.eururo.2012.11.048.

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