HIGH POWER TRANSURETHRAL THULIUM:YAG LASER VAPOENUCLEATION OF PROSTATE – A NEW STANDARD IN BENIGN PROSTATE HYPERPLASIA SURGERY

Abstract. According to current recommendations, open adenomectomy is considered the most efficient surgical option for patients with large benign prostatic hyperplasia. In order to reduce surgical trauma and to improve postoperative recovery, there have been proposed several minimally invasive techniques for the treatment of large benign prostatic hyperplasia, the most innovative being laser surgery. High power Thulium:YAG laser vapoenucleation of prostate is becoming popular for minimal invasive surgical management of benign prostate hyperplasia.

Keywords: prostate, laser, vapoenucleation

Introduction

Benign prostatic hyperplasia (BPH) is one of the most common diseases of older men with lower urinary tract symptoms (LUTS) with a negative impact on quality of life (QoL). (1) For more than a century, open adenomectomy has been
considered standard in the surgical treatment of large BPH. Several surgical techniques of open adenomectomy (AE) have been proposed, currently transvesical adenomectomy and retropubic adenomectomy are used. The effectiveness of these procedures is proven over time. At the same time, the increased trauma and the high rate of postoperative complications prove the need to implement minimally invasive techniques in the treatment of large BPH.

Numerous attempts have been made to implement minimally invasive surgical treatment of large BPH with different interventional efficacy and safety. Recently, several transurethral surgical methods have been implemented using laser energy. One of the most effective is the application of Thulium: YAG laser energy in BPH surgery. This type of laser allows several types of surgery to be performed: resection, vaporization, enucleation and vapoenucleation(2). Enucleation and vapoenucleation are destined for the surgical treatment of large BPH. The postoperative results obtained are very promising for a long term, are independent of prostate volume and demonstrate a low complication rate (3–5).

Material and methods

Between November 2019 and February 2020, 43 patients with BPH were included in the study on surgical treatment: ThuVEP (22 patients) and AE (21 patients). All patients were evaluated preoperatively and postoperatively at 1,3 and 6 months by International Prostate Symptom Score (IPSS), Quality of Life Score (QoL), physical examination, digital rectal examination, prostate specific serum antigen (PSA) assessment, ultrasound examination with assessment of residual urine volume (PVR), transrectal ultrasound of the prostate with determination of prostate volume, uroflowmetry with measurement of Qmean and Qmax. On the first day postoperatively, a reduction in hemoglobin level was determined. Postoperative complications were recorded according to the Clavien-Dindo classification, 2004. The inclusion criteria were total prostate volume ≥ 80 cm3, residual urine volume (PVR) ≥ 70ml, Qmax ≤10ml / s. Exclusion criteria were neurogenic bladder, confirmed prostate or bladder cancer.

In ThuVEP patients were positioned in the lithotomy position. The Karl Storz 26Fr resectoscope with continuous flow and saline irrigation was used to perform
ThuVEP in all cases. The 120W settings of the Thulium: YAG laser (Revolix Duo, LisaLaser, Germany) were used for vapoenucleation of the tissue. The laser energy was delivered through RigiFib 550mc fiber optics with terminal emission.

Initially, a superficial circular incision of mucosa of the prostatic urethra posterior to the seminal colliculus is made using 20 W laser energy (Ω-sign technique). After the creation of the dissection plan on the path of the prostate pseudocapsule, the prostate nodules were vapoenucleated with the concomitant hemostasis and vaporization of the tissue. The vapoenucleated nodules were evacuated from the lumen of the urinary bladder using the resection the devascularized tissue on the pedicle. Postoperative bladder drainage was provided by a biluminal Foley 20Fr catheter. The removed tissue was sent for histological examination. The continuous washing system was not used.

Transvesical adenomectomy was performed after positioning the patient in supine position under the protection of spinal anesthesia. The Fuller-Freyer procedure was used to enucleate the hyperplastic prostate tissue. Urinary bladder was accessed by the lower median laparotomy. The enucleation of BPH nodules was performed after cystotomy. An anatomical dissection plan was created under digital transrectal control. Subsequently, hyperplastic tissue was detached by circular movements on the enucleation path. Hemostasis was ensured by applying 3% H2O2 solution, and transverse suturing of the prostate lodge. The Foley biluminal autostatic probe and cystostoma were placed in all patients. In all cases, a continuous washing system was installed for a period of 24 hours in order to prevent bladder tamponade. Enucleated nodules were sent for histological examination.

Postoperatively, the following values were recorded: operative duration, reduction of hemoglobin level, catheterization and hospital stay period. The patients undergone 24 hours surveillance after the urinary catheter removal.

Results

The patients included in the study completed the evidence questionnaires. During the visits, all the parameters were analyzed. There were no statistically significant differences in research groups. The groups examined were relatively homogeneous (Table 1).
Table 1

Preoperative evaluation (43 patients)

|                      | ThuVEP | AE  |
|----------------------|--------|-----|
| No. patients         | 21     | 22  |
| Age, years           | 67±3   | 68±4|
| $Q_{\text{max}}$, ml/s | 8,4±1,2| 8,1±1,1 |
| $Q_{\text{mean}}$, ml/s | 7,7±1,1| 7,8±1 |
| Urine output, ml     | 127±11 | 130±15 |
| IPSS                 | 28±3   | 27±2 |
| QoL                  | 5±1    | 5±1 |
| Volumul prostatei, ml| 97±10  | 92±9 |
| PVR, ml              | 93±11  | 91±8 |
| PSA, ng/ml           | 3,4±0,5| 3,1±0,3 |

Surgical indices were recorded (Table 2). The volume of the removed prostatic tissue was similar in both groups. At the same time, the duration of the intervention was longer in the ThuVEP group, which is explained by the complete vapoenucleation of the adenomatous tissue and its subsequent fragmentation. The reduction of hemoglobin level was greater in the AE group. The duration of catheterization after AE was substantially longer (+400%) due to operative trauma and the inability to perform good hemostasis. The duration of hospital stay was determined by the duration of postoperative catheterization and thus was essentially longer in patients in the AE group (+140%).

Table 2

Operative data (43 patients)

|                      | ThuVEP | AE  |
|----------------------|--------|-----|
| Operative time, min  | 117±10 | 61±11 |
| The volume of enucleated tissue, g | 75±10 | 65±8 |
| Blood loss, g/l      | 1,1±0,3| 2,6±1,1 |
| Catheterization time, days | 2±1  | 10±1 |
| Hospital stay length, days | 5±1  | 12±2 |

The improvement in symptom scores IPSS and QoL occurred substantially faster and significantly better in the ThuVEP group. Thus, at 1 month postoperatively, the patients from the ThuVEP group reported a good improvement of IPSS and QoL. A fast positive dynamics was also noted at 3 and 6 months.
postoperatively. This difference, compared to the AE group, is probably determined by reduced trauma and faster healing of the prostate lodge (Table 3).

**Table 3**

**Perioperative dynamics of symptomatic scores (43 patients)**

|          | Preoperative | Postoperative |
|----------|--------------|---------------|
|          | 1 month      | 3 months      | 6 months      |
| IPSS ThuVEP | 28±3         | 11±1          | 9±1           | 8±1           |
| AE       | 27±2         | 14±2          | 12±2          | 9±1           |
| QoL ThuVEP | 5±1          | 2±1           | 2±1           | 2±1           |
| AE       | 5±1          | 3±1           | 3±1           | 2±1           |

The volume of residual urine underwent similar positive changes in both groups during the surveillance. Transrectal ultrasound examination of the prostate demonstrated a similar and constant reduction of the total prostate volume over the duration of surveillance (Table 4).

**Table 4**

**Perioperative ultrasonographic changes (43 patients)**

|          | Preoperative | Postoperative |
|----------|--------------|---------------|
|          | 1 month      | 3 months      | 6 months      |
| PVR, ml ThuVEP | 93±1      | 22±10         | 21±10         | 12±5          |
| AE       | 91±8         | 25±9          | 23±11         | 15±7          |
| Prostate volume, cm³ ThuVEP | 97±10     | 25±3          | 23±4          | 23±4          |
| AE       | 92±9         | 30±4          | 29±5          | 27±3          |

An important landmark in the postoperative evaluation of patients is the change in uroflowmetric values. Thus, a rapid positive postoperative dynamics was observed in the ThuVEP group. Uroflowmetric changes in patients after AE were slower and less expressed during the surveillance. Qmax increased with 115% in the ThuVEP group and with 98% in the AE group. The increase in urinary output volume took place in both groups, being more expressed in the ThuVEP group (+62%) (Table 5).
The incidence of postoperative complications was significantly higher in the AE group. This may be motivated by an expressed trauma of open surgery, imperfect hemostasis and long duration of postoperative catheterization. Transitional incontinence was found in 2 patients (9.52%) after ThuVEP and 3 patients (13.63%) after AE. This type of complication significantly affects the quality of life of patients and requires the administration of non-steroidal anti-inflammatory medication. In all cases, transient urinary incontinence disappeared during 3 months of surveillance. Repeated catheterization was required in only 1 patient (4.54%) after AE. After NSAID administration and recatheterization for 48 hours, the patient resumed urination. Urinary tract infections were detected in 1 patients (4.76%) after ThuVEP and 2 patients (9.08%) after AE in the early postoperative period. One patient (4.54%) developed urethral stricture after AE, which was subsequently resolved by internal optical urethrotomy. TUR syndrome and massive bleeding were not recorded in the study.

**Table 6**

| Postoperative complications, cl. Clavien-Dindo, 2004. (43 patients) |
|---------------------------------------------------------------|
| **ThuVEP, no. patients (%)** | **AE, no. patients (%)** | **Severity of complications** |
| Transitory urinary incontinence | 2 (9.52%) | 3 (13.63%) | Grade I |
| Recateterisation | - | 1 (4.54%) | |
| Blood transfusions | - | - | Grade II |
| Urinary infections | 1 (4.76%) | 2 (9.08%) | Grade III |
| Urethral strictures | - | 1 (4.54%) | Grade IIIb |
| TUR syndrome | - | - | Grade IV |
| **Total** | 3 (14.28%) | 7 (31.81%) | |
Discussions

In the present study, high power 120W ThuVEP was compared with transvesical adenomectomy. Not surprisingly, both procedures removed prostate adenoma with high efficiency and satisfactory functional results were obtained. At the same time, the incidence of complications was significantly lower in the high power ThuVEP group. Catheterization time and hospital stay were much shorter in the ThuVEP 120W group. Similar results have been obtained by other researchers (6–9).

Thulium: YAG 120W laser ensured rapid enucleation due to hemostasis and rapid vapoenucleation of prostate tissue. It has been proven that increasing the power of the Thulium: YAG laser from 70W to 120W significantly increases the rate of prostate tissue ablation without increasing surgical risks. In an ex vivo evaluation of BPH surgery using Thulium: YAG laser, Bach et al. observed that the tissue ablation rate was improved by almost 70% (from 9.80 g / 10 min to 16.41 g / 10 min) when the laser emission power increased from 70 W to 120 W (10). Netsch et al. reported that 120W Thulium:YAG laser system improved the efficiency of ThuVEP compared to 70W Thulium:YAG device, in terms of enucleation speed (11). The effectiveness and safety of ThuVEP can be attributed to the physical properties of the laser. Thulium:YAG laser wavelength is 2013 nm and it use water as a cromophore. Thulium: YAG laser can efficiently vaporize prostate tissue with a superficial optical penetration of approximately 0.2 mm (12). The continuous mode of radiation emission allows the Thulium: YAG laser to perform efficient resection and simultaneous vaporization with optimal coagulation and hemostasis effects (8). Therefore, due to its excellent ablation capacity, the Thulium:YAG laser can easily vaporize and detach the prostate tissue from the surgical capsule with almost no bleeding (13–15).

Conclusions

The advantages of ThuVEP over AE are obvious. The biophysical properties of this method bring indisputable advantages, ensuring good hemostasis and reduced operative trauma. Considering the superior functional postoperative results and a significantly lower complication rate in the high power ThuVEP group, we consider
it advisable to use high power Thulium: YAG laser vapoenucleation as a first line option in the surgical treatment of large BPH.

References:
1. N. L, L.-B. M, F. H, G.-L. H, H. W, G.-Z. L, et al. Multiple factors related to detrusor overactivity in Chinese patients with benign prostate hyperplasia. Chin Med J (Engl). 2012;
2. Herrmann T, Liatsikos E, Nagele U, Traxer O, Merseburger A. EAU guidelines panel on lasers, technologies. EAU guidelines on laser technologies. Eur Urol. 2012;
3. T. B, C. N, L. P, T.R.W. H, A.J. G. Thulium:YAG vapoenucleation in large volume prostates. Journal of Urology. 2011.
4. Gross AJ, Netsch C, Knipper S, Hölzel J, Bach T. Complications and early postoperative outcome in 1080 patients after thulium vapoenucleation of the prostate: Results at a single institution. Eur Urol. 2013;
5. Netsch C, Engbert A, Bach T, Gross AJ. Long-term outcome following Thulium VapoEnucleation of the prostate. World J Urol. 2014;
6. Chang CH, Lin TP, Chang YH, Huang WJ, Lin AT, Chen KK. Vapoenucleation of the prostate using a high-power thulium laser: A one-year follow-up study. BMC Urol. 2015;
7. Hauser S, Rogenkofer S, Ellinger J, Strunk T, Müller SC, Fechner G. Thulium laser (Revolix) vapoenucleation of the prostate is a safe procedure in patients with an increased risk of hemorrhage. Urol Int. 2012;
8. Netsch C, Pohlmann L, Herrmann TRW, Gross AJ, Bach T. 120-W 2-μm thulium:yttrium-aluminium-garnet vapoenucleation of the prostate: 12-Month follow-up. BJU Int. 2012;
9. Hong K, Liu YQ, Lu J, Xiao CL, Huang Y, Ma LL. 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 (Engl). 2015;
10. Bach T, Huck N, Wezel F, Häcker A, Gross AJ, Michel MS. 70 vs 120 W thulium: Yttrium-aluminium-garnet 2 μm continuous-wave laser for the treatment of benign prostatic hyperplasia: A systematic ex-vivo evaluation. BJU Int. 2010;
11. Netsch C, Bach T, Herrmann TR, Gross AJ. Thulium:YAG VapoEnucleation of the prostate in large glands: A prospective comparison using 70- and 120-W 2-vm lasers. Asian J Androl. 2012;
12. Bach T, Muschter R, Sroka R, Gravas S, Skolarikos A, Herrmann TRW, et al. Laser treatment of benign prostatic obstruction: Basics and physical differences. European Urology. 2012.
13. Bach T, Netsch C, Haecker A, Michel MS, Herrmann TRW, Gross AJ. Thulium:YAG laser enucleation (VapoEnucleation) of the prostate: Safety and durability during intermediate-term follow-up. World J Urol. 2010;

14. Sun DC, Yang Y, Wei ZT, Hong BF, Zhang X. Transurethral dividing vaporesection for the treatment of large volume benign prostatic hyperplasia using 2 micron continuous wave laser. Chin Med J (Engl). 2010;

15. Y. X, D.C. S, Y. Y, Z.T. W, B.F. H, X. Z. [5-year follow-up to transurethral vaporesection of the prostate using the 2 micron continuous wave laser for the treatment of benign prostatic hyperplasia]. Zhonghua Wai Ke Za Zhi. 2013;