Acta Clin Croat (Suppl. 2) 2023; 62:104-109
doi: 10.20471/acc.2023.62.s2.14

Original Scientific Paper

THULIUM:YAG LASER ENUCLEATION OF THE PROSTATE (ThuLEP) – OUR EXPERIENCE IN 246 PATIENTS

Nikola Zebić[1], Velimir Terzić[2,4] and Vinko Krajina[3,4]

[1]Department of Urology, Hospital Rotthalmünster, Health facilities District of Passau, Germany
[2]Department of Urology, Vinkovci General County Hospital, Vinkovci, Croatia;
[3]Department of Urology, Osijek University Hospital Center, Osijek, Croatia;
[4]Faculty of Medicine Osijek, Josip Juraj Strossmayer University of Osijek, Osijek, Croatia

SUMMARY – New minimally invasive procedures to treat benign prostatic hyperplasia (BPH) have been developed in the last 20 years. With the introduction of laser enucleation techniques in prostate surgery, previous standard surgical procedures (open retropubic or transvesical adenectomy and transurethral resection of the prostate) have become less relevant, especially in case of very large prostates. The objective of this paper is to describe the experience and results of thulium:YAG laser application in BPH treatment in our department. In the last five years, 246 patients underwent thulium:YAG laser enucleation of the prostate (ThuLEP) due to BPH or lower urinary tract symptoms following complete urologic evaluation. The mean age of our patients was 73 (range 51-95) years and mean duration of surgery was 92 minutes. The mean weight of enucleated tissue was 73 grams. A low rate of intraoperative and early postoperative complications and short length of stay proved minimal invasiveness of this procedure, which results in significant improvements in urodynamic parameters and substantially reduces the postvoid residual urine volume. The most important surgical and technical characteristics (enucleation and low-power laser application) make ThuLEP a safe and efficient surgical method not limited by the prostate volume. ThuLEP has a potential to displace the current standard surgical procedures to treat BPH.

Key words: *Benign prostatic hyperplasia; Minimally invasive surgery; Thulium:YAG laser*

Introduction

Thulium:Yttrium-Aluminum-Granat (YAG) laser enucleation of the prostate (ThuLEP) is a minimally invasive surgical method which represents a more recent benign prostatic hyperplasia (BPH) treatment method.

Open adenectomy (transvesical or retropubic) and transurethral resection of the prostate (TURP) are traditional surgical methods to treat benign prostatic hyperplasia (BPH). Open adenectomy with complete prostate adenoma removal produces good long-term results, but it is also associated with high perioperative morbidity. In contrast, TURP has lower perioperative morbidity rates, but also worse long-term results due to incomplete first resection and recurrence[1]. During TURP, resection of the prostatic tissue can damage blood vessels and increase the intraoperative risk of transurethral resection syndrome and perioperative bleeding, which also limits the time available to perform surgery. These technical limitations show clear limits of applicability of TURP, which requires seeking new solutions to combine the benefits of both previously described methods.

The development of modern medical techniques has made it possible for urologists to test various alternative methods in BPH surgery. Many new surgical methods have been developed, particularly over the

Correspondence to: *Nikola Zebić, MD, PhD*, Urologische Abteilung Landkreis Passau GE, Simbacher Straße 35, D-94094 Rotthalmünster, Germany
E-mail: nzebic@ge-passau.de

last 20 years, such as incision, retraction, vaporization/ablation, resection and enucleation of the prostate. Moreover, different energy sources, instruments and surgical techniques are being tested, which also considerably expands the range of surgical procedures available. Numerous medical centers introduce simpler laser methods first, such as vaporization and vaporesection of the prostate.

Gaining more experience in surgery makes it possible to move on to endoscopic enucleation of the prostate using various energy sources. At the moment, thulium laser (ThuLEP) and holmium laser (HoLEP) endoscopic enucleation of the prostate are the most common techniques. Unlike holmium laser, which emits pulse energy, thulium laser emits energy in a continuous wave at a wavelength of 1940, 2010 or 2013 nm. Prostatic tissue penetration depth of thulium laser is lower compared to other lasers (Fig. 1). Due to its excellent absorption in water and good hemodynamic and cutting properties, it has quickly emerged as an energy source used in prostate surgery.

ThuLEP laser enucleation of the prostate was first described by Herrmann *et al.* in 2010[2]. The most significant surgical and technical factors of this method include blunt enucleation of the adenoma with a resectoscope and minimal application of laser energy used exclusively to achieve hemostasis. Initially, a 120-W thulium laser with a 550-µm laser fiber was used, which was applied using two power settings (70-90 W for tissue cutting and 30 W for coagulation). Herrmann *et al.* then described the retrograde three-lobe technique with enucleated lobes placed in the bladder. Wolters *et al.* described the two-lobe technique[3], while Kim *et al.* described the *en bloc* enucleation technique[4].

Unlike other surgical methods, with this type of enucleation technique the risk of capsular perforation and the rate of postoperative irritation symptoms caused by the heat is minimal. Although a direct comparison of ThuLEP and HoLEP is not easy to make considering the number of surgical techniques and the variety of instruments available today, studies carried out by Netsch *et al.* confirmed that these two techniques were equally efficient[5].

The objective of this paper is to describe minimal invasiveness and other benefits of this surgical method by evaluating personal experience gained in the last five years.

Patients and Methods

In a five-year period, all patients were operated on with the ThuLEP method at the Bayreuth Urological Clinic and Urological Department of the Rotthalmünster Hospital by the same urologist. Inclusion criteria were prostate volume up to 30 g, repeated episodes of acute urinary retention, indwelling urinary catheter, recurrent urinary tract infection, recurrent hematuria due to BPH, and International Prostate Symptom Score (IPSS) >15. Exclusion criteria were voiding disorders not caused by BPH, previous urethral, bladder neck or prostate surgery, and a history of prostate cancer.

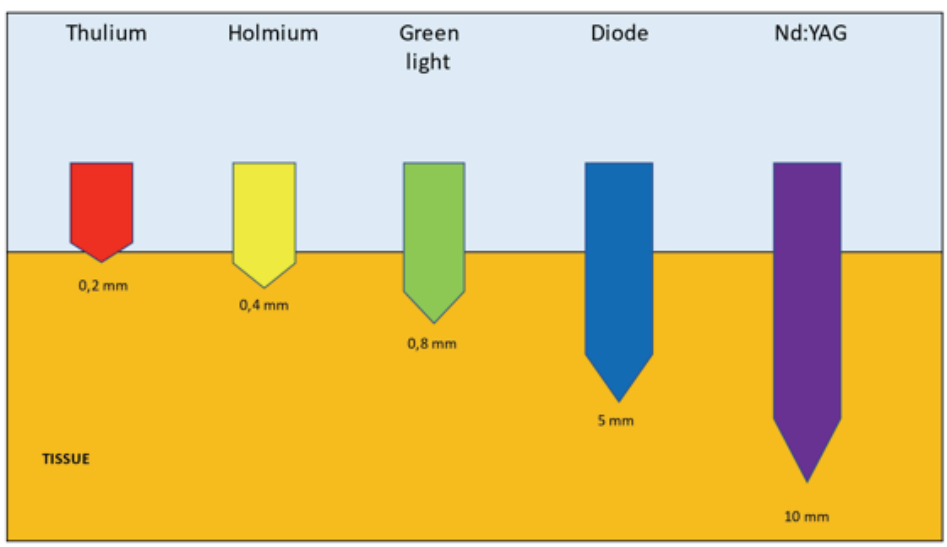

Fig. 1. Prostatic tissue penetration depth.

The patients who underwent ThuLEP surgery were middle-aged and elderly adults (51-95 years of age). They underwent complete urologic evaluation, i.e., medical history, laboratory blood and urine tests, symptom score according to the American Urological Association symptom index for benign prostatic hyperplasia[6], digital rectal examination, ultrasound scan, uroflowmetry, and the prostate-specific antigen (PSA) test.

All patients had post-void residual (PVR) urine determined using suprapubic ultrasound and the prostate volume measured by transrectal ultrasound. The patients had an IPSS higher than 15, maximum urine flow rate (Qmax) under 15 mL/s or complete urinary retention. During preoperative preparation, patients with higher PSA levels underwent transrectal prostate biopsy. Surgical procedures were performed using either general or spinal anesthesia, depending on indications or patient preference. Patients taking acetylsalicylic acid did not have to stop their therapy, unlike those taking drugs such as phenprocoumon and rivaroxaban. They received low-molecular-weight heparin bridging treatment and stopped taking rivaroxaban 48 hours before surgery. Surgeries were performed using the 120-W RevoLix laser and 150/20-W RevoLix Duo laser (Lisa Laser, Germany). RexScope 26F laser resectoscope and RigiFib 550-µm laser fibers (Lisa Laser, Germany) were used. Morcellator (Piranha, Richard Wolf, Germany) was used to remove enucleated adenoma. Each of the three techniques specified above (the three-lobe technique, two-lobe technique, and *en bloc*) were used depending on the size of prostate and the number of lobes. Antimicrobial therapy was administered based on the urine antibiotic sensitivity report. Laboratory blood test was done on postoperative day one. On postoperative day 3, the indwelling urinary catheter was removed and maximum urine flow rate and PVR urine were measured.

On statistical analysis of the processed data, the mean, standard deviation (SD) and range were calculated.

Results

In the period from March 2017 to March 2022, 246 patients underwent ThuLEP due to ailments caused by prostate enlargement or lower urinary tract symptoms (Table 1). The mean age of patients undergoing surgery was 73 (range 51-95) years (Table 1). The mean IPSS was 19 (9-32) and the quality of life with urinary disorders was rated 5 (2-6) on average. The mean prostate weight was 75 (30-200) grams (Table 1). Anticoagulant therapy was taken by 33% of patients and 41% of patients were provided with an indwelling urinary catheter due to urinary retention. The mean total duration of surgery was 92 minutes and the mean weight of enucleated tissue was 73 grams (Table 2). Loss of hemoglobin *per* patient was 0.9 g/dL. The duration of postoperative urinary bladder catheterization was three days (Table 2).

The mean Qmax was 5.1 (4.0-15) mL/s, while the mean preoperative PVR urine volume was 135 (15-300) mL. Postoperative follow-up examinations of patients indicated a significant improvement in terms of

Table 1. Thulium:YAG laser enucleation of the prostate (ThuLEP) – preoperative data

Number of patients	N=246
Age (years)	73±4.2 (mean, SD)
TRUS (prostate volume) (mL)	75±21 (mean, SD)
Preoperative urinary retention (%)	41
PSA (ng/mL)	4.2±1.1 (mean, SD)
Anticoagulant therapy (%)	33

TRUS = transrectal ultrasound; PSA = prostate-specific antigen

Table 2. Thulium:YAG laser enucleation of the prostate (ThuLEP) – surgical procedure data

Number of patients	N=246
Total duration of surgery (min)	92±52 (mean, SD)
Tissue removed (g)	73±50 (mean, SD)
Duration of catheterization (days)	3.0±0.1 (mean, SD)
Length of stay (days)	3.5±0.7 (mean, SD)
Postoperative hemoglobin loss (g/dL)	0.9±0.28 (mean, SD)

Table 3. Thulium:YAG laser enucleation of the prostate (ThuLEP) – results

Number of patients		N=246
Qmax (mL/s)	Preoperative Postoperative	5.1 (4.0-15) 28.5 (5.5-60) (mean, range)
PVR (mL)	Preoperative Postoperative	135 (15-300) 17.5 (0-130) (mean, range)
41% with preoperative urinary retention		

Qmax = maximum urine flow rate; PVR = post-void residual urine volume

Table 4. Thulium:YAG laser enucleation of the prostate (ThuLEP) – intraoperative and early postoperative complications

Number of patients	N=246
Urinary bladder injury	3 (1.2%)
Surgical reintervention in cases of bleeding	11 (4.4%)
Acute urinary retention	3 (1.2%)
Urge incontinence	13 (5.3%)
Stress incontinence	7 (2.8%)
Other	8 (3.2%)

Qmax, with a mean value of 28.5 (range 5.5-60) mL/s, as well as a significant decrease in the PVR urine volume, with a mean value of 17.5 (range 0-130) mL (Table 3). In terms of intraoperative and early postoperative complications (Table 4), three (1.2%) patients suffered injuries to the urinary bladder, which were inflicted at the very beginning of the second part of the operation, i.e., in the morcellation phase. These injuries were detected on time, managed by coagulation, and required no further interventions except for longer duration of indwelling catheterization (for three additional days). Eleven (4.4%) patients required a postoperative intervention due to bladder tamponade. They belonged to the group of patients receiving anticoagulant therapy, but no blood transfusion was required.

Upon removal of the indwelling urinary catheter, acute urinary retention occurred in three (1.2%) patients. It was necessary to put the catheter for the next ten days and simultaneously received antiedematous and antiphlogistic therapy. Postoperative urge incontinence was diagnosed in the first two weeks in 13 (5.3%) patients and was successfully treated with anticholinergics over the next six weeks. Postoperative stress incontinence occurred in seven (2.8%) patients and they underwent pelvic floor physical therapy and electrostimulation. Despite six-week therapy, a mild form of stress incontinence persisted in two patients, which required the use of one incontinence pad *per* day.

Discussion

In the last decade, the interest in surgical treatment of BPH using endoscopic laser enucleation of the prostate has been increasing. This has resulted from the verification of a more efficient method in comparison to TURP and open adenectomy due to a lower percentage of bleeding and fewer other complications[7,8]. Laser enucleation of the prostate is an endoscopic adenectomy characterized by more precise options of complete tissue removal and coagulation compared to other traditional TURP methods performed using mono- or bipolar instruments. In comparison with open adenectomy, endoscopic laser enucleation of prostate adenoma has demonstrated benefits in terms of obstruction removal, long-term retention of urinary function, and a low recurrence rate[2].

Despite ThuLEP being a more recent minimally invasive method than HoLEP, requiring slightly more time and involving fewer prostate capsule injuries, the results obtained so far have shown that both methods are equally efficient and safe, regardless of the prostate size and symptom severity in patients[9].

The results analyzed showed a low incidence of perioperative complications in 246 patients having undergone ThuLEP, comparable to other minimally invasive methods such as HoLEP[9-11]. The mean decrease in hemoglobin levels was 0.9 g/dL and no blood transfusion was required. No fatalities or requirements for major surgical interventions were reported.

Benefits of this surgical method were confirmed by a significant improvement in postoperative urodynamic parameters (mean preoperative Qmax was 5.1 mL/s, while postoperative Qmax was 28.5 mL/s), as well as by a significant reduction in residual urine levels (mean

preoperative PVR urine volume was 135 mL and postoperative PVR urine volume was 17.5 mL).

The minimal invasiveness of this surgical method is characterized by the low rate of intraoperative and early postoperative complications (urge incontinence 5.3%, bleeding 4.4% and stress incontinence 2.8%), as well as by the short length of hospital stay (3.5 days).

Conclusion

Thulium:YAG laser enucleation of the prostate with its most important surgical and technical characteristics (enucleation and low-power laser application) represents a safe and efficient surgical method not limited by prostate size. Therefore, it has been increasingly displacing standard surgical methods (open adenectomy and TURP) used in the treatment of BPH.

References

1. Madersbacher S, Lackner J, Brössner C, Röhlich M, Stancik I, Willinger M, *et al*. Reoperation, myocardial infarction and mortality after transurethral and open prostatectomy: a nation-wide, long-term analysis of 23,123 cases. Eur Urol. 2005;47(4):499-504. doi: 10.1016/j.eururo.2004.12.010. PMID: 15774249
2. Herrmann TR, Bach T, Imkamp F, Georgiou A, Burchardt M, Oelke M, *et al*. Thulium laser enucleation of the prostate (ThuLEP): transurethral anatomical prostatectomy with laser support. Introduction of a novel technique for the treatment of benign prostatic obstruction. World J Urol. 2010;28(1):45-51. doi: 10.1007/s00345-009-0503-0. PMID: 20063164
3. Wolters M, Huusmann S, Oelke M, Kuczyk MA, Herrmann TR. Anatomical enucleation of the prostate with thulium:YAG support: redefinition of the surgical approach in two-lobe technique. Videourology. 2016;30(6). https://doi.org/10.1089/vid.2016.0029
4. Kim YJ, Lee YH, Kwon JB, Cho SR, Kim JS. A novel one lobe technique of thulium laser enucleation of the prostate: 'all-in-one' technique. Korean J Urol. 2015;56(11):769-74. doi: 10.4111/kju.2015.56.11.769. PMID: 26568795
5. Netsch C, Becker B, Tiburtius C, Moritz C, Venneri Becci A, Herrmann TR, *et al*. A prospective, randomized trial comparing thulium vapoenucleation with holmium laser enucleation of the prostate for the treatment of symptomatic benign prostatic obstruction: perioperative safety and efficacy. World J Urol. 2017;35(12):1913-21. doi: 10.1007/s00345-017-2071-z. PMID: 28698991
6. Barry MJ, Fowler FJ Jr, O'Leary MP, Bruskewitz RC, Holtgrewe HL, Mebust WK, *et al*. The American Urological Association symptom index for benign prostatic hyperplasia. The Measurement Committee of the American Urological Association. J Urol. 1992;148(5):1549-57. doi: 10.1016/s0022-5347(17)36966-5. PMID: 1279218
7. Ahyai SA, Lehrich K, Kuntz RM. Holmium laser enucleation *versus* transurethral resection of the prostate: 3-year follow-up results of a randomized clinical trial. Eur Urol. 2007;52(5):1456-63. doi: 10.1016/j.eururo.2007.04.053. PMID: 17499427
8. Kuntz RM, Lehrich K, Ahyai SA. Holmium laser enucleation of the prostate *versus* open prostatectomy for prostates greater than 100 grams: 5-year follow-up results of a randomized clinical trial. Eur Urol. 2008;53(1):160-6. doi: 10.1016/j.eururo.2007.08.036. PMID: 17869409
9. Zhang F, Shao Q, Herrmann TR, Tian Y, Zhang Y. Thulium laser *versus* holmium laser transurethral enucleation of the prostate: 18-month follow-up data of a single center. Urology. 2012;79(4):869-74. doi: 10.1016/j.urology.2011.12.018. PMID: 22342411
10. 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;63(5):859-67. doi: 10.1016/j.eururo.2012.11.048. PMID: 23245687
11. Vavassori I, Valenti S, Naspro R, Vismara A, Dell'Acqua V, Manzetti A, *et al*. Three-year outcome following holmium laser enucleation of the prostate combined with mechanical morcellation in 330 consecutive patients. Eur Urol. 2008;53(3):599-604. doi: 10.1016/j.eururo.2007.10.059. PMID: 17997021

Sažetak

ENUKLEACIJA PROSTATE TULIJ:YAG LASEROM (ThuLEP) – NAŠA ISKUSTVA KOD 246 OPERIRANIH BOLESNIKA

N. Zebić, V. Terzić i *V. Krajina*

Tijekom posljednja dva desetljeća bilježi se pojava novih minimalno invazivnih zahvata u liječenju benigne hiperplazije prostate (BPH). Uvođenjem enukleacijskih laserskih tehnika u kirurgiju prostate dosadašnji standardni operacijski zahvati (otvorena retropubična ili transvezikalna adenektomija, transuretralna resekcija prostate) sve više gube na značenju, osobito pri većim volumenima prostate. Cilj ovoga rada je prikazati iskustva i rezultate primjene tulij:YAG lasera u liječenju BPH. U posljednjih pet godina 246 bolesnika podvrgnuto je minimalno invazivnoj metodi laserske enukleacije prostate (ThuLEP) zbog simptoma BPH ili simptoma donjeg mokarćnog sustava. Prethodno je učinjena cjelovita urološka dijagnostika. Prosječna dob bolesnika bila je 73 godine, a prosječna duljina trajanja operacijskog zahvata 92 minute. Enukleacijom uklonjeno tkivo iznosilo je prosječno 73 grama. Nizak postotak intraoperacijskih i ranih poslijeoperacijskih komplikacija, kao i kratko vrijeme hospitalizacije potvrdile su se kao odlike minimalne invazivnosti ove operacijske metode koja rezultira značajnim poboljšanjem urodinamskih parametara i znatnom redukcijom ostatne mokraće. Može se istaknuti kako je ThuLEP sa svojim najvažnijim operacijsko-tehničkim čimbenicima (enukleacija, aplikacija male laserske energije) sigurna i djelotvorna operacijska metoda koja nije ograničena volumenom prostate te ima potencijal potisnuti ili u potpunosti zamijeniti dosadašnje standardne operacijske metode u liječenju BPH.

Ključne riječi: *Benigna hiperplazija prostate; Minimalno invazivne metode; Thulium:YAG laser*