Rev. Roum. Sci. Techn.– Électrotechn. et Énerg.
Vol. **66**, *1*, pp. 59–62, Bucarest, 2021

Génie biomédicale

BIPOLAR TRANSURETHRAL RESECTION OF THE PROSTATE – THE MODERN APPROACH

VICTOR CAUNI[2], IRINA CIOFU[1], MIHAI DRAGUTESCU[2], BOGDAN MIHAI[2], CRISTIAN PERSU[1]

Key words: Bipolar transurethral resection, Prostate, Benign prostatic hyperplasia, Surgical technique.

Benign prostatic hyperplasia (BPH) is a common condition of the aging male, affecting a significant percentage of the population. The last decades were marked by a continuous evolution of the surgical treatment for BPH, with newer technologies promising less invasive approaches, better outcomes and less complications. Bipolar transurethral resection (B-TURP) is the latest development in the field and it already proved its superiority over its predecessors. Our paper aims to review the technology behind this surgical technique, its main advantages and the limits of the method. We highlight the indications, main complications and results of this surgical technique, while comparing the data with the "classical" TURP. We conclude that the advances made by technology bring a real benefit both for the patients and medical professionals involved in the treatment of BPH.

1. INTRODUCTION

Benign prostatic hyperplasia (BPH) is a common condition among elderly men. Due to important cell proliferation and prostate size increase, if not treated, this benign condition leads to urinary symptoms that decrease quality of life, and which can trigger major complications and potentially life-threatening situations.

BPH mostly affects men aged 60 to 79 years old. It is estimated that by the age of 80 years old, 90 % of men are afflicted with it [1]. As a consequence of life expectancy increase throughout the last decades, the incidence is rising, and BPH has become an important public health issue with associated high costs generated by diagnosis and treatment.

Risk factors for BPH include both modifiable and non-modifiable factors. The prevalence of the condition correlates with age, geography, and genetic inheritance. Previous theories of direct correlation between testosterone levels and prostate size have been refuted in recent studies [2]. However, higher levels of DHT and its metabolites, which play central roles in BPH pathology, are directly associated with the condition [3]. The risk of BPH also increases with body weight, body mass index and waist circumference [4].

If left untreated, BPH causes bladder outlet obstruction (BOO) and subsequent lower urinary tract symptoms (LUTS - urinary hesitancy, weak stream, straining, prolonged voiding), recurrent urinary tract infections, urinary retention, bladder lithiasis, and even renal failure.

The diagnostic approach starts with diligent history evaluation of LUTS, analysis of chronic medication that could have an impact on the urinary tract, and validated questionnaires such as The American Urological Association Symptom Index (AUASI) and the International Prostate Symptom Score (IPSS). The digital rectal examination assesses the size, shape, consistency, and mobility of the prostate, and any changes that might have occurred in between examinations. Ultrasound examinations assess the size and shape of the prostate, and also the postvoid residual volume in case of moderate to severe symptoms. The prostate-specific antigen (PSA) levels correlate with prostate size, with levels of 1.5 ng/mL or higher often typical for BPH [5].

2. TREATMENT

Treatment for BPH implies medical and surgical approaches. Medical treatment relies on α1-adrenoceptor antagonists and 5α-reductase inhibitors. According to The European Association of Urology (EAU), α1-blockers should be the first-line treatment for male lower urinary tract symptoms (LUTS) considering their good efficacy, the rapid onset of action, and the low rate of adverse events. They reduce urinary symptoms and increase the peak urinary flow rate (Qmax) (level of evidence 1a) but have a higher risk of ejaculatory dysfunction (level of evidence 1a) and do not prevent urinary retention or need for surgery. α1-blockers are more effective for prostate volumes lower than 40 ml. 5α-reductase inhibitors are preferred for moderate to severe LUTS, in prostates larger than 40 mL and in high PSA levels (> 1.4-1.6 ng/mL). Their slow onset of action makes them suitable only for long-term use. They also have a positive effect on BPH secondary hematuria, lower the long-term risk of urinary retention and the need for surgery [6]. A combination of the two drugs has a higher efficacy than monotherapy, but the rate of adverse events is higher as well [7]. For patients with both LUTS symptoms due to BHP and erectile dysfunction, the phosphodiesterase-5 inhibitor tadalafil has good efficacy and safety. A meta-analysis found that a 5 mg dose improves Qmax, IPSS, and international index of erectile function (IIEF) scores [8].

The most frequent indication for surgical treatment is the failure of the medical therapy to relieve symptoms related to BOO. Strong indications are: repeated acute urinary retention, secondary hematuria not responsive to 5α-reductase inhibitors, renal failure, upper urinary tract dilation, bladder lithiasis or repeated urinary tract infections. It should be noted that an episode of uncomplicated acute urinary retention (AUR) should benefit of a trial without catheter at 3-5 days; up to 20 % of the patients will not require surgery in the long run. Concomitant bladder lithiasis can be resolved during the main surgical procedure.

The optimal time of surgery is still under debate. There is some data suggesting that timely intervention has better outcomes compared to surgery following watchful waiting

[1] "Carol Davila" University of Medicine and Pharmacy, Bucharest, email: ggabi@yahoo.com
[2] Colentina Clinical Hospital, Department of Urology

strategies. This might be due to secondary detrusor damage. However, when approaching patients with high postvoid residual volume, transurethral resection of the prostate should be considered.

3. BIPOLAR TURP – TUR IN SALINE (TURIS)

Over the last 60 years, transurethral resection of the prostate (TURP) has been the gold standard for the treatment of bladder outlet obstruction symptoms related to BPH. Monopolar TURP (M-TURP) is a highly effective procedure, with durable results. However, avoiding complications such as significant hemorrhage, severe hyponatremia, and especially post-TURP syndrome that can lead to coma and death, led to technological advances in offering equally safe and effective procedures.

Among major innovations is the bipolar transurethral resection of the prostate (B-TURP), which uses saline instead of the nonconductive solutions which are linked to hyponatremia and post-TURP syndrome.

As opposed to monopolar TURP, where current arcs between an active electrode and the target tissue, being subsequently dissipated through the patient's body which is attached to a grounding pad to complete the circuit, in bipolar TURP the electrical current flows between two poles of the resection tool through a conductive irrigation fluid - saline solution. The latter method leads to better outcomes in both precision and in post-operative complication rates.

A functional system for B-TURP consists of a main unit (Fig. 1) – responsible for power conversion and modulation, a passive working element – which is handled by the surgeon and to which additional components can be attached, and a resectoscope – attached to the working element (Fig. 3). A fiber-optic light-guide cable, a visual acquisition system and a saline irrigation system must all be attached to the ensemble.

The working principle of the instruments used in TURP is that of creating a plasma channel or field in a supporting medium. Although for industrial purposes plasma is obtained in various mediums, in this case saline solution is used due to its biological compatibility and electrochemical properties. Plasma is preferred in medical applications due to precision and very low thermal diffusion, allowing the surgeon to precisely target the affected area without damaging healthy or otherwise functional tissue.

Fig. 1 – Main unit for B-TURP.

The tools deployed in bipolar TURP focus an RF (radiofrequency) electrical field to form a precise plasma-promoting channel. Using appropriate power and frequency modulation – computed automatically by the resection device, NaCl-doped liquid is instantaneously heated and vaporized, and a maintainable plasma channel is created. The aspect of the plasma field depends on the shape of the resectoscope’s tip, as seen in Figure 3; the hemispherical tool (button-type, bottom) creates a plasma field shaped like a dome which is useful in ablation and surface vaporization, while the wire-loop tool (semicircular, top) channels the plasma along the loop surface and allows for resection and tissue retrieval for further investigations. The surgeon can choose between multiple tool shapes and sizes within the commercially available catalogs, depending on case particularities, as well as to customize the optics of the endoscopic device.

Fig. 2 – Working element with resectoscope for B-TURP

Because the human body model impedance of the patient is at least an order of magnitude larger than that of the conductive fluid, in bipolar TURP the patient's body does not significantly participate in the electrical circuit. A grounding pad is not necessary, as the current return path is mostly through the tool itself (*i.e.* the electrical current circuit is closed).

Fig. 3 – Resection loops for B-TURP.

Among other benefits, the risks of stimulating the obturator nerve, which is responsible for adductor muscle contraction, and that of subsequent bladder perforation is drastically reduced, as is the chance for the electrical current to find alternate return paths to ground (*e.g.* through a cardiac pacemaker).

Anticoagulant therapy should be ceased for three days before the intervention. The procedure is done with the patient in lithotomy position, under spinal or general anesthesia.

The first incision should be made proximally to verumontanum, using electric current. Once the surgical capsule has been identified, the prostate is dissected in a retrograde manner using the resectoscope, until the circular fibers of the bladder neck are reached (Fig. 4). Pulsatile, arterial bleeding should be coagulated before venous hemorrhage.

Sometimes, they require additional tissue resection.

The resectoscope loop tip is used for quick resection of the prostate into fragments. It also achieves immediate coagulation of vessels as they are being detached. The bladder neck should be resected only if it is enlarged; the anterior commissure should only be resected if it creates obstruction.

Fragments are less adherent when using B-TURP, so they are easily removed using the Ellik evacuator. The prostatic fossa should be reexamined to ensure good hemostasis. A catheter is inserted for bladder irrigation.

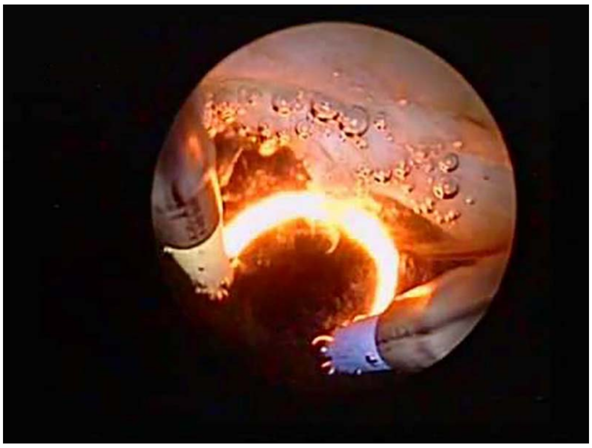

Fig. 4 – Intraoperative image during prostate resection (B-TURP) from the personal library of C. Persu.

In the post-operative setting, information is needed regarding serum sodium and hemoglobin levels. The patients remain under medical surveillance and additional exams such as flowmetry might be required.

4. RESULTS

TURP is a safe and effective treatment of BPH that rapidly improves the patient's lower urinary tract symptoms. Comparative studies show no significant differences in postoperative Qmax (maximum flow rate), post void residual volume (PVR), quality of life score (QoL score), and international prostate symptom score (IPSS) between monopolar and bipolar TURP [9,10].

However, the safety of the bipolar technique is greater in terms of bleeding, dilutional hyponatremia and post-TURP syndrome [11]. The hemostatic capacity of the bipolar TURP is superior, achieving profound coagulation that exceeds the maximum diameter of the prostatic micro-vessels [12].

The technique can also be used in cases with large volume prostates, unlike M-TURP that usually allows only smaller prostates (less than 85ml, according to EAU Guidelines) to be resected in a single session. B-TURP should be considered as an alternative to open surgery for large, greater than 80 mL prostate adenomas [13].

The impact on sexual function has been assessed in multiple studies, and recent ones found no statistical differences in erectile dysfunction and retrograde ejaculation rates between patients who underwent monopolar and bipolar TURP [14,15].

COMPLICATIONS

Complications of B-TURP are similar to those of M-TURP, except for the post-TURP syndrome, but their incidence is lower.

Intraoperative hemorrhage rate has decreased over time as a result of technological advances. Intraoperative bleeding is correlated with preoperative urinary tract infections (16) and prostatitis [17].

Secondary hemorrhage, occurring between 48h and 30 days post-surgery, seems to be linked to platelet aggregation inhibitors (PAI) consumption; age, volume of the prostate and use of 5α-reductase inhibitors are not seen as risk factors [18]. Compared to M-TURP, B-TURP is associated with a lower incidence of clot retention and need for blood transfusion [19], as well as a lower drop in hemoglobin levels [20].

Postoperative urinary tract infections are linked to perioperative contamination, longer duration of the procedure, preoperative catheterizations and longer hospital stays. The incidence varies between 4 % and 20 % 77. Perioperative antibiotic prophylaxis is not recommended but should be considered in the situations previously mentioned.

Postsurgical urinary retention can occur in 3 to 9 % of the patients and is usually caused by detrusor dysfunction rather than insufficient resection [21]. Reinterventions should be postponed for at least 4 - 6 weeks since only 20 % of them show urodynamic obstruction in pressure-flow studies.

Out of the long-term complications**, urinary incontinence** is one of the most impactful. It can occur in 30 to 40 % of the patients, although only 0.5-1 % persists after 6 months. One can find urgency urinary incontinence due to detrusor instability, stress urinary incontinence due to excessive resection or coagulation around verumontanum, and total urinary incontinence, caused by external sphincter damage [22].

Retrograde ejaculation after TURP has been estimated at 65 % in the American Urology Association (AUA) guidelines [23]. Studies show that it can be prevented by avoiding the area surrounding verumontanum while resecting. Considering the risks, care should be taken when dealing with young patients; urodynamic studies can be considered to reveal bladder outlet obstruction and TURP should be done only after alternatives have failed, if the benefit outweighs the risks.

Erectile dysfunction has a lower incidence, of approximately 14 % after TURP [24]. Other studies show no negative influence of TURP on the quality of erections [25].

Another concern is **the urethral stricture** risk following bipolar TURP. Prophylactic measures were described for strictures at the meatus level or at the bulbar level, such as important lubrification of the resectoscope, minimal movement of the resectoscope and lower cutting power. Recent studies showed no difference between bipolar and monopolar TURP in rates of urethral stricture [26, 27]. A higher rate of urethral stricture may be linked to prostates larger than 70 mL [28].

Bladder neck contracture is rare, usually occurs within two years post TURP and has an incidence of 0 - 4.9 %. Although rare, it is a challenging complication with no clear guidelines of management [29]. It was proven that there is positive correlation between chronic prostatitis, the diameter of the resectoscope, the size of the prostate, as well as the use of urethral catheters and sclerotic changes in the urethra and bladder neck [30].

5. **CONCLUSIONS**

Bipolar TURP is a safe and effective alternative to monopolar TURP for patients with BPH. With similar results and better safety profile than M-TURP, it is estimated that B-TURP will become the new gold standard in BPH treatment. The advances made by technology allowed this minimally invasive approach to become safer without need for a significant learning curve for the medical professionals. Patient preference, another important element that needs to be taken into consideration, favorizes modern techniques, not only because of the better safety profile but also because a natural tendency towards choosing the latest medical technology.

ACKNOWLEDGEMENT

The authors want to thank Assoc. Prof. Marilena Stănculescu, form University Politehnica of Bucharest, for her support during the elaboration of this paper.

Received on March 19, 2021

REFERENCES

1. D. Skinder, I. Zacharia, J. Studin, J. Covino, *Benign prostatic hyperplasia: a clinical review*. JAAPA **29**, pp. 19-23 (2016)
2. S.A. Kaplan, E. O'Neill, R. Lowe, M. Hanson, A.G. Meehan, *Prevalence of low testosterone in aging men with benign prostatic hyperplasia: Data from the Proscar Long-term Efficacy and Safety Study (PLESS) Aging Male*, **16**, pp. 48-51 (2013).
3. J.K. Parsons, K. Palazzi-Churas, J. Bergstrom, E. Barrett-Connor, *Prospective study of serum dihydrotestosterone and subsequent risk of benign prostatic hyperplasia in community dwelling men: The Rancho Bernardo Study*, J Urol, **184**, pp. 1040-1044 (2010).
4. J.K. Parsons, A.V. Sarma, K. McVary, J.T. Wei, *Obesity and benign prostatic hyperplasia: Clinical connections, emerging etiological paradigms and future directions*, J. Urol., **189**, pp. 102-106 (2013).
5. Sausville J, Naslund M., *Benign prostatic hyperplasia and prostate cancer: an overview for primary care physicians,* Int. J. Clin. Pract. **64,** *13,* pp. 1740-1745 (2010).
6. ∴ EAU Guidelines, Edn., presented at the EAU Annual Congress Amsterdam (2020).
7. A.V. Sarma, J.T. Wei, *Clinical practice. Benign prostatic hyperplasia and lower urinary tract symptoms*. N Engl J Med., **367,** *3*, pp. 248–257.
8. Y. Dong, L. Hao, Z. Shi, G. Wang, Z. Zhang, C. Han, *Efficacy and safety of tadalafil monotherapy for lower urinary tract symptoms secondary to benign prostatic hyperplasia: a meta-analysis*. Urol Int., **91**, *1*, pp. 10-18 (2013).
9. D.S. Engeler, C. Schwab, M. Neyer, T. Grün, A. Reissigl, H.P. Schmid, *Bipolar versus monopolar TURP: a prospective controlled study at two urology centers*, Prostate Cancer Prostatic Dis. **13,** *3*, pp. 285-291 (2010).
10. M.I. Omar, T.B. Lam, C.E. Alexander, J. Graham, C. Mamoulakis, M. Imamura, S. Maclennan, F. Stewart, J. N'dow, *Systematic review and meta-analysis of the clinical effectiveness of bipolar compared with monopolar transurethral resection of the prostate* (*TURP*). BJU Int., Epub 2013 Oct 24. PMID: 24053602, **113,** *1*, pp. 24-35 (2014).
11. V.K. Madduri, M.K. Bera, D.K. Pal, *Monopolar versus bipolar transurethral resection of prostate for benign prostatic hyperplasia: Operative outcomes and surgeon preferences, a real-world scenario*, Urol. Ann., **8,** *3*, pp. 291-296 (2016).
12. X. Huang, X.H. Wang, H.P. Wang, L.J. Qu, *Comparison of the microvessel diameter of hyperplastic prostate and the coagulation depth achieved with mono- and bipolar transurethral resection of the prostate. A pilot study on hemostatic capability*, Scand. J. Urol. Nephrol., **42,** *3*, pp. 265-268 (2008).
13. A. Corona, S. Serra, M. Deplano, A. De Lisa, *La resezione endoscopica con resettore bipolare gyrus nelle ghiandole di volume superiore a 80 ml: nostra esperienza a 12 mesi di follow-up* [*Endoscopic prostate resection by bipolar gyrus resector for prostates over 80 ml: our experience after a 12-month follow-up*], Urologia, **30**,*79*, Suppl. 19, pp. 30-36 (2012).
14. M.A. Egui-Rojo, L. Redón-Gálvez, M. Álvarez-Ardura, H. Otaola-Arca, A. Páez-Borda, *Comparación entre resección monopolar vs. resección bipolar transuretrales de próstata y su impacto sobre la función sexual* [*Comparison of monopolar versus bipolar transurethral resection of the prostate: Evaluation of the impact on sexual function*]. Rev. Int. Androl., **18,** *2*, pp. 43-49 (2020).
15. A. El-Assmy, A. Elshal, R. Mekkawy, H. El-Kappany, E. Ibrahiem, *Erectile and ejaculatory functions changes following bipolar versus monopolar transurethral resection of the prostate: a prospective randomized study,* International Urology and Nephrology. **50,** pp. 1-8, (2018).
16. E.M.A. ElMalik, A.I.A. Ibrahim, A.M. Gahl, M.S.M. Saad, Y.B. Bahar*, Risk Factors in Prostatectomy Bleeding: Preoperative Urinary Infection is the only Reversible Factor*, Eur. Urol., **37**, pp. 199-204 (2000).
17. B.M. Shrestha, K. Prasopshanti, S.S. Matanhelia, W.B. Peeling, *Blood loss during and after transurethral resection of prostate: a prospective study*, Kathmandu Univ. Med. J. (KUMJ), **6,** *23*, pp. 329-334 (2008).
18. C.H. Yee, J.H. Wong, P.K. Chiu et al., *Secondary hemorrhage after bipolar transurethral resection and vaporization of prostate*, Urol. Ann., **8,** *4,* pp. 458-463 (2016).
19. K. Raghuvanshi et al., *Comparative assessment of monopolar versus bipolar transurethral resection of prostate for the management of benign prostatic enlargement,* Urological Science, **30**, *6*, pp. 262 (2019).
20. M.I. Omar, T.B. Lam, C.E. Alexander, J. Graham, C. Mamoulakis, M. Imamura, *Systematic review and meta-analysis of the clinical effectiveness of bipolar compared with monopolar transurethral resection of the prostate* (*TURP*), BJU Int., **113**, pp. 24-35 (2014).
21. J. Rassweiler, D. Teber, R. Kuntz, R. Hofmann, *Complications of transurethral resection of the prostate* (*TURP*)*-incidence, management, and prevention*, Eur. Urol., **50,** *5*, pp. 969-979, discussion 980 (2006).
22. S. Mukherjee, R.K. Sinha, N. Ghosh, D. Karmakar, *Urinary incontinence following transurethral prostatectomy presenting as self inflicted penile gangrene*, BMJ Case Rep., 2015, bcr2014206902 (2015 Jun 8).
23. H.E. Foster, M.J. Barry, P. Dahm, M.C. Gandhi, S.A. Kaplan, T.S. Kohler, L.B. Lerner, D.J. Lightner, J.K. Parsons, C.G. Roehrborn, C. Welliver, T.J. Wilt, K.T, McVary, *Surgical Management of Lower Urinary Tract Symptoms Attributed to Benign Prostatic Hyperplasia: AUA Guideline*, J. Urol., **200,** *3*, pp. 612-619 (2018).
24. A. Taher, *Erectile dysfunction after transurethral resection of the prostate: incidence and risk factors*, World J. Urol., **22**, *6*, pp.457-460 (2004).
25. M. Muntener, S. Aellig, R. Kuettel, C. Gehrlach, T. Sulser, R.T Strebel, *Sexual function after transurethral resection of the prostate (TURP): results of an independent prospective multicentre assessment of outcome*, Eur. Urol., **52**, *2*, pp. 510-515 (2007).
26. B.N. Kumar, A. Srivastava, T. Sinha, *Urethral stricture after bipolar transurethral resection of prostate – truth vs hype: A randomized controlled trial*, Indian J. Urol., **35**, *1*, pp. 41-47 (2019).
27. A.A. Zamel, A.I. Kassem, T.Z. Orban, I.R. Saad, A.S. Bedair, *Urethral stricture disease after bipolar prostatectomy: Is it a concern?* Afr. J. Urol., **24**, pp. 24–27 (2018).
28. K. Komura, T. Inamoto, T. Takai, et al., *Urethral stricture incidence and bipolar TURP*, BJU Int., **115**, pp. 644-652 (2015).
29. J. Wen, B. Nørby, P.J.S. Osther, *Bladder Neck Contracture after Transurethral Resection of the Prostate for Benign Prostatic Hyperplasia Treated with a Thermo-Expandable Metal Stent* (*Memokath® 045*), Case Rep. Urol., **2018**, *2439421* (2018).
30. A. Grechenkov, R. Sukhanov, E. Bezrukov, et al., *Risk factors for urethral stricture and/or bladder neck contracture after monopolar transurethral resection of the prostate for benign prostatic hyperplasia,* Urologia J., **85**, *4,* pp. 150-157 (2018).