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Recent advances in the surgical treatment of benign prostatic hyperplasia

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Abstract: TURP for many years has been considered the gold standard for surgical treatment of BPH. Symptoms relief, improvement in Maximum flow rate and reduction of post void residual urine have been reported in several experiences. Notwithstanding a satisfactory efficacy, concerns have been reported in terms of safety outcomes:intracapsular perforation, TUR syndrome, bleeding with a higher risk of transfusion particularly in larger prostates have been extensivelyreported in the literature.

In the recent years the use of new forms of energy and devices suchas bipolar resector, Ho:YAG and potassium-titanyl-phosphate laserare challenging the role of traditional TURP for BPH surgical treatment.

In 1999 TURP represented the 81% of surgical treatment for BPHversus 39% of 2005. Is this a marketing driven change or is there areal advantage in new technologies?

We analyzed guidelines and higher evidence studies to evaluate therole of the most relevant new surgical approaches compared to TURPfor the treatment of BPH.

In case of prostates of very large size the challenge is ongoing, withminimally invasive laparoscopic approach and most recently roboticapproach. We will evaluate the most recent literature on thisemerging field.

Keywords: Benign prostatic hyperplasia, treatment, surgery, TURP, Laser, Holep, RASP

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Introduction

Benign prostatic hyperplasia (BPH) is a histological diagnosis that refers to the proliferation of smooth muscle and epithelial cells within the prostatic transition zone [Lee *et al.* 1997, 1995]. The enlarged gland is thought to lead to disease manifestations via two routes: (1) the static component: direct bladder outlet obstruction (BOO) from enlarged tissue; and (2) the dynamic component: from increased smooth muscle tone and resistance within the enlarged gland. Therapy for BPH typically targets one or both of the disease components (static or dynamic) to provide relief. Surgical intervention is an appropriate treatment alternative for patients with moderate-to-severe lower urinary tract symptoms (LUTS) and for patients who have developed acute urinary retention (AUR) or other BPH-related complications. In addition, medical therapy may not be viewed as a requirement because some patients may wish to pursue the most effective therapy as a primary treatment if their symptoms are particularly bothersome.

The 2003 AUA Guideline recognized that transurethral resection of prostate (TURP) remained the benchmark for therapy as it permits a high success rate in symptom scores, urinary flow, postvoid residue and low retreatment rate on long-term follow up. However, multiple complications can be observed after TURP: perioperative bleeding, blood transfusions, transurethral resection (TUR) syndrome, prolonged catheterization, long hospital stay, urinary incontinence, and retrograde ejaculation are the most important. In an effort to keep the same efficacy of TURP while reducing the related complications, various surgical techniques have been developed in recent years. In the present paper we review the surgical treatment options currently available for BPH.

TURP

Since the pioneering procedures performed in the 1960s and 1970s, TURP has undergone many changes: the development of optics, light sources, surgical and anaesthesia techniques, and the

introduction of bipolar technology with the consequent use of physiological solution as intraoperatory bladder washing system, have greatly modified the procedure. In 1980, TURP was the second most frequent surgical procedure after phacoemulsification [Wei *et al*. 2005]. With the development of pharmacological therapies and minimally invasive techniques, the number of TURPs gradually decreased from 229.2 to 268.3 per 100,000 people in 1980–1991 to 131.3 per 100,000 people in 1994. In 2005 TURP represented 39% of BPH procedures compared with 81% in 1999.

The usual indications for TURP are acute urinary retention, bladder stones, obstructive kidney failure, and hematuria [Nudell and Cattolica, 2000].

Presurgical evaluation

TURP can be performed either with general or spinal anaesthesia; the latter is characterized by less blood loss and earlier diagnosis of bladder boring and/or of water intoxication [Malhotra, 2000]. Antibiotic therapy is recommended in every patient perioperatively and may consist of chotrimossazole, a second- or third-generation cephalosporin, ampicillins, lactamase inhibitors or fluoroquinolones [European Association of Urology, 2010].

The surgical technique has not been modified much: the patient is placed in the lithotomy position. Many instruments have been introduced into surgical practice to improve the quality of resection as loops differing in shape and dimensions to obtain a homogeneous resection.

In fact, as suggested by Issa, haemostasis is determined by certain parameters relating to the energy and its delivery into the tissue [Issa, 2008]; a balance occurs between the wattage power, voltage, surface contact and exposure time among other things. Haemostasis can be enhanced during resection by lowering the energy density and increasing tissue contact time. Issa recommends lowering the cutting energy to 80–100 W instead of the usual 200 W, choosing a 'blend' instead of 'pure' cutting setting on the generator, and slowing down the speed with which the wire loop travels through the tissue so to increase the duration of tissue contact.

Nonconductive irrigation fluid solutions such as glycine 1.5%, sorbitol 3% or mannitol 3% are preferred as bladder washing systems. These solutions are not isotonic and can cause TUR syndrome if excessively adsorbed: the patient reports nausea, hypertensive crisis, bradycardia, confusion, and sight trouble; if this syndrome is not diagnosed, it can progress to lung or cerebral oedema [Rassweiler *et al*. 2006]. Its pathogenesis is represented by hyponatremia caused by massive absorption of hypotonic bladder irrigation fluid, which is why its incidence is higher in cases of time demanding resection, or capsule or venous vessel perforation. Its therapy is with furosemide or hypertonic saline solution injection [Fitzpatrick, 2007]. To avoid this complication instruments able to work using physiologic solutions became more widespread.

Traditional monopolar TURP is characterized by electric energy supplied from the resector loop and received by the electrode placed on patient's skin, so the electric circuit created needs electric energy circulating into the patient to close itself [European Association of Urology, 2010]. In bipolar TURP there is a closed circuit in the resector loop; the generated energy turns the physiologic solution, used as bladder irrigation, into an ionized particle plasma able to destroy tissue molecular ligaments and make resection possible [Ho and Cheng, 2008; Smith *et al*. 2005].

Many comparative studies have been performed to compare monopolar to bipolar resection of prostate. Between December 2005 and August 2008, Fagerström and colleagues randomized 202 patients to undergo TURP using either a TURis (transurethral resection in saline) system (Olympus, Japan) or the conventional monopolar technique [Fagerström *et al*. 2009]. However, the TURis system is a halfway technology as it does not meet the bipolar definition and criteria set by the International Electrosurgical Commission, which requires both active and return electrodes to be attached to a single support system. Similar to other monopolar circuitry, the TURis system has a standard TURP loop (active electrode) from which the energy is released. The return electrode in the TURis systems is incorporated into the outer sheath of the resectoscope instead of being at the skin. As such, the electric circuit is completed with energy returning back to the generator entirely through the urethra/penis. The system offered 'pseudo-bipolar' functionality

with its use of normal saline irrigation to decrease the risk of hyponatremia and TUR syndrome.

TURis produced similar results to monopolar TURP for commonly used measures of surgical efficiency (e.g. the amount of resected tissue per unit of time). However, TURis resulted in 34% less bleeding during surgery and was followed by a significantly lower need for blood transfusions.

Autorino and coworkers analysed functional results on 70 patients randomized to have a monopolar versus bipolar TURP [Autorino *et al.* 2009]. At 4-year follow up, there were no differences in international prostate symptom score (IPSS), quality of life (QoL), peak flow rate (Q_{max}), or postvoid residual urine (PVR).

Ahyai and coworkers performed a meta-analysis of functional outcomes and complications following many transurethral procedures [Ahyai *et al.* 2010]. No differences were found between monopolar and bipolar TURP in IPSS, QoL, Q_{max}, or PVR. Moreover, they analysed intraoperative, perioperative and late complications. No significant differences were found between bipolar *versus* monopolar TURP intraoperative complications ($p = 0.407$), perioperative ($p = 0.029$), late ($p = 0.392$), or overall complications ($p = 0.058$). The risk of blood transfusion in both techniques is comparable and none of the analysed trials mentioned TUR syndrome as an adverse event of bipolar TURP.

Simple prostatectomy

Open simple prostatectomy can be still considered a recommended treatment in the case of an enlarged prostate [Fitzpatrick, 2007].

The upper volume of prostate over which simple prostatectomy is the gold standard is still discussed, usually 100 g is considered the limit of volume even if urologists trained in endoscopy can perform TURP also in these cases. Simple prostatectomy is an appealing technique in the case of concomitant pathologies needing a surgical approach as vesical stones, diverticula, voluminous adenomas, and inguinal hernia. Simple prostatectomy can be performed with retropubic or, more frequently, sovrapubic (transvesical) approach.

The Calabro-Sicilian Society of Urology [Serretta *et al.* 2002] has published one of the major present day series of simple prostatectomies performed between 1997 and 1998. Of 31,558 patients treated for symptomatic BPH, 5636 underwent surgery. Open prostatectomy accounted for 32% ($n = 1804$) of all surgical treatment. The postoperative median hospitalization time was 7 days. Concomitant lower urinary tract disease was present in 25% of the patients. Severe bleeding occurred in 11.6% of open prostatectomies. Blood transfusions were given in 8.2% of cases. Sepsis was reported in 8.6% of the patients. Reinterventions, within 2 years, mainly due to bladder neck stenosis, were reported in 3.6% of cases. The authors concluded that this procedure, even if performed today in Western countries, shows the same significant rate of early and late complications reported in the past or in less-developed countries

Laparoscopic simple prostatectomy

In 2002, Mariano and colleagues described the first laparoscopic simple prostatectomy [Mariano *et al.* 2002]. The patient was placed in a steep Trendelenburg position and five intraperitoneal trocars were placed. After vascular control was achieved, the prostatic capsule and bladder neck were opened in the midline, and adenoma was enucleated.

McCullough and colleagues compared 96 extraperitoneal laparoscopic simple prostatectomies with 189 open procedures; surgical time was longer in laparoscopy (95.1 ± 32.9 minutes) than in the open approach (54.7 ± 19.7 minutes) [McCullough *et al.* 2009]. Whereas patients who had undergone laparoscopic surgery needed a shorter hospital stay and time of catheterization, there were no differences in terms of blood loss and postsurgical bladder washing.

Similar results, in terms of lower hospitalization (5.1 ± 1.8 days laparoscopic group *versus* 8 ± 4.8 days open group) and duration of catheterization (4 ± 1.7 days laparoscopic group *versus* 6.8 ± 4.7 days open group) in laparoscopic procedures were reported by Baumert and colleagues in a comparative study between 30 open and 30 laparoscopic procedures [Baumert *et al.* 2006].

In 2008, a Cleveland Clinic group described the first laparoscopic single-port, simple prostatectomy [Desai *et al.* 2008]; the trocar is placed into the bladder that is then straightened with CO_2. They described three procedures whose surgical time decreased from 6 to 1.5 hours; they did

not report any data about blood loss or functional outcomes.

A theoretical advantage of the laparoscopic approach is the reduction of bleeding during adenoma excision thanks to the pressure created by the insufflation into the bladder.

Desai and colleagues described their experience on 34 cases of single-port transvesical enucleation of the prostate (STEP) [Desai *et al.* 2010]. The mean operative duration was 116 min, and the estimated blood loss was 460 ml. There were three complications during STEP (one death, one bowel injury and one haemorrhage) and five afterwards (four bleeding, one epididymo-orchitis). Open conversion was necessary in two patients for complications, and extension of the skin incision by 1–2 cm was necessary in two to expedite apical digital enucleation. The mean hospital stay was 3 days. Authors concluded that STEP is an effective treatment option for selected patients with large-volume obstructive BPH.

Robotic simple prostatectomy

Sotelo and colleagues described the first robotic simple prostatectomy, with a surgical technique similar to laparoscopy [Sotelo *et al.* 1992]. Seven procedures were performed: average blood loss was 382 ml, average surgical time was 195 minutes and average hospital stay was 1.33 days. No functional outcome was described. Numerous groups have reported various techniques for this operation. John and colleagues described an extraperitoneal approach with a 3-arm Da Vinci Surgical System [John *et al.* 2008]. They performed 13 cases and obtained an overall operative time of 210 minutes (range 150–330 minutes) and blood loss was 500 ml (range 100–1100 ml). Moreover, in a finger-assisted variant technique described by the same authors, the enucleation step was performed using the finger of the surgeon. In this case the operative time decreased to 140 minutes ($p = 0.007$) and blood loss to 250 ml ($p = 0.02$). No open conversions were necessary.

Coelho and colleagues described a new technique of robotic-assisted simple prostatectomy (RASP) that includes the standard operative with the addition of some technical modifications during the reconstructive part of the procedure [Coelho *et al.* 2011]. Following the resection of the adenoma, instead of performing the classical 'trigonization' of the bladder neck and closure of the prostatic capsule, they performed three modified surgical steps: plication of the posterior prostatic capsule, a modified van Velthoven continuous vesicourethral anastomosis and, finally, suture of the anterior prostatic capsule to the anterior bladder wall.

They obtained significant improvement from baseline reported in the average IPSS (average preoperative *versus* postoperative, 19.8 ± 9.6 *versus* 5.5 ± 3.1, $p = 0.01$) and in mean maximum urine flow (average preoperative *versus* postoperative 7.75 ± 3.3 *versus* 18.2 ± 6.5 ml/s, $p = 0.019$) at 2 months after RASP. As far as functional outcome is concerned, all patients were continent 2 months after RASP.

Laser vaporization

Prostate laser vaporization has been developed in the last 15 years as an alternative to TURP. Laser resections can be performed using different kinds of energy:

- coagulative laser: neodymium: yttrium–aluminium–garnet (Nd:YAG), diode laser;
- cutting laser: holmium:YAG (Ho:YAG) and thulium:YAG (Tm:YAG);
- vaporizing laser: Nd:YAG, Ho:YAG, diode, KTP (potassium–titanyl–phosphate) and lithium triborate (LBO).

These energy sources have been tested and compared with TURP and their outcomes proved not to be lasting and effective enough compared with the gold standard.

Costello and colleagues tested the Nd:YAG laser [Costello *et al.* 1992], demonstrating that this energy source is characterized by a major incidence of postoperative dysuria and longer catheterization [Hoffman *et al.* 2003].

Malek and colleagues published their experience in green laser prostate vaporization, obtaining interesting results in terms of outcomes, comorbidities, costs and technical feasibility [Malek *et al.* 1998].They treated 10 men with BOO due to BPH. None of the 10 patients had any significant blood loss or any fluid absorption. Foley catheters were removed less than 24 hours postoperatively. The mean peak urine flow rate increased from 8 ± 1.3 ml/s preoperatively to 19.4 ± 8.4 ml/s (142%,

$p = 0.003266$) 24 hours postoperatively. PVRs remained essentially unchanged from their preoperative levels, as expected ($p = 0.767423$). One patient had urgency, none had dysuria, hematuria or incontinence, or required recatheterization.

The difference between Nd:YAG laser and KTP or LBO is the wavelength, which is double for Nd:YAG (1064 nm) compared with KTP and LBO (532 nm). KTP and LBO are selectively absorbed by haemoglobin present in prostate tissue causing a photoselective vaporization of the tissue [Lee *et al.* 2006].

The short wavelength of the laser shaft also causes an optic penetration into the tissue of 0.8 mm with a coagulation zone of 1.2 mm, compared with 4–7 mm for the YAG laser; this is why the green laser causes a lower incidence of dysuria and obstructive symptoms than the YAG laser [Te, 2006].

The laser vaporization learning curve is significantly shorter than for TUR holmium laser enucleation of the prostate (HoLEP), about 5–20 procedures [de la Rosette and Alivizatos, 2006], with comparable outcomes in terms of blood loss, Q_{max}, QoL and postmicturition vesical residue [Seki *et al.* 2008].

In patients having normal urodynamic characteristics, the urinary catheter can be removed 1 hour after the end of the procedure, which can be performed in an outpatient setting. On the other hand, patients reporting previous episodes of acute urinary retention and/or having alterations of their urodynamic curve, little compliance or significant postmicturition residue, the vesical catheter must be removed 48 hours after the procedure.

The latest innovation today is represented by the green light laser HPS 120W that can be used also for prostates larger than 80 g.

Indications for prostate laser vaporization, according to the American Urological Association and European Urological Association guidelines are patients using anticoagulant therapy who cannot be interrupted before the procedure, patients who cannot undergo TURP or patients wishing for a regular ejaculation after the surgery.

HoLEP

Since the first description by Gilling and colleagues, HoLEP has been increasingly used for the surgical management of BOO as an alternative to traditional TURP [Gilling *et al.* 1995]. Multiple studies report that it is a safe and effective procedure for treating symptomatic BPH, independent of prostate size, and with low morbidity and a short hospital stay.

Nevertheless, Shah and colleagues showed that a limitation of this technique is the experience and training required [Shah *et al.* 2007]: the learning curve is the most important impediment for adopting this attractive technique. They reported data from their initial experience on 280 patients: eight required conversion to TURP, due to failure to progress during enucleation of the lateral lobes. Their most common complication was capsular perforation which occurred in 9.6% of cases. No patient had any evidence of TUR syndrome.

Ahyai and colleagues randomized 200 patients with urodynamic proven obstruction and a prostate volume less than 100 ml to HoLEP or TURP [Ahyai *et al.* 2007]; after 2 and 3 years of follow up, HoLEP micturition outcomes were better than TURP, and late complications were similar.

In the study published by Wilson and colleagues, 61 patients with prostate size 40–200 g, were randomized to TURP or HoLEP; 6 months postoperatively [Wilson *et al.* 2006]. HoLEP was urodynamically superior to TURP in relieving BOO, while at 24 months, there was no significant difference. Two patients in the TURP group and no-one in the HoLEP group required re-operation.

Rigatti and colleagues randomized 100 consecutive patients with BPH with obstructive LUTS to surgical treatment with either HoLEP (group 1, $n = 52$) or TURP (group 2, $n = 48$) from January to October 2002 [Rigatti *et al.* 2006]. They reported that transitory LUTS after 3 months of follow up and dysuria were more frequent in the HoLEP group than in the TURP group, although at 12 months of follow up the results were comparable. They confirmed that HoLEP can guarantee a shorter catheterization time and hospital stay with longer operative times.

Mavuduru and colleagues randomized 30 patients with symptomatic BPH to surgical

treatment with TURP or HoLEP [Mavuduru *et al*. 2009]. They showed that HoLEP is safe and effective in the surgical management of BPH, with the advantage of reduced intraoperative haemorrhage and perioperative morbidity even if the surgical time is longer.

Briganti and colleagues compared the impact of HoLEP and TURP on sexual function obtaining no differences between the techniques [Briganti *et al*. 2006]: both significantly lowered the international index of erectile function (IIEF) orgasmic function domain because of retrograde ejaculation.

As far as a comparison between HoLEP and open transvesical prostatectomy is concerned, Kuntz and colleagues performed a randomized study on 120 patients, urodynamically obstructed, with prostates >100 g [Kuntz *et al*. 2004]. HoLEP entailed significantly less blood loss and a much shorter catheter time and hospital stay. The rate of late complications was equally low with each procedure. The postoperative micturition improvement was significant and equivalent between the two groups, confirming HoLEP to be an endourologic alternative to open surgical enucleation of the prostate for large glands.

Minimally invasive treatments

For patients at high operative risk, a minimally invasive technique, which could be performed without anaesthesia, is required as an alternative treatment modality.

Thermotherapy, where heat energy is delivered to the prostatic tissue, causes haemorrhagic necrosis around the urethra which is about 10–25 mm in diameter and is surrounded by cells with apoptotic features [Brehmer, 1997; Nissenkorn *et al*. 1993]. Histological changes induced by heating are directly dependent on the temperature achieved in the tissue. Thermocoagulation is obtained above 45°C and thermoablation above 60°C [Devonec *et al*. 1993].

The first study for the treatment of BPH under an FDA-approved protocol was in 1991. The development of transurethral microwave heat treatment was partially prompted by the failure of the transrectal or transurethral hyperthermia devices. Five years later, after rigorous testing, the Prostatron device, manufactured by Urologix, received final FDA approval. Nowadays there are many different types of thermotherapy for BPH.

Prostatron

The first experience of the Prostatron Cooperative study was published in 1993 [Blute *et al*. 1993]. A total of 150 men between 43 and 83 years old were enrolled at five different centres. The treatment catheter emits a radio frequency of 1296 MHz via a 3.4 cm microwave antenna; the maximal power possible was 60 W and the total duration of the treatment was 60 min. Of 150 patients, 118 were evaluated at 12 months. Peak urinary flow rates were measured at baseline, at 6 weeks, and 3, 6 and 12 months intervals and it was significantly better at each evaluated interval. A change in Madsen symptom score from 13.7 at baseline to 5.4 at 12 months was observed.

Targis

The Targis system is characterized by a special microwave antenna with a helical dipole design which provides elevated temperatures in the anterolateral and posterior prostate, while the posterior side temperature is modestly lower than the anterolateral. Larsonon and colleagues first described their experience using this device on 22 patients enrolled in two different centres [Larsonon *et al*. 1998]. All patients tolerated microwave thermoablation treatment and no procedure-related adverse events were experienced. The microwave thermoablation system used achieved marked temperature elevations within the prostate gland as high as 80°C with little or no rise in urethral or rectal temperatures.

Thalmann and colleagues investigated the long-term efficacy of Targis thermotherapy for decreasing outflow obstruction caused by BPH [Thalmann *et al*. 2002]. In 162 patients evaluated 6 months after treatment the median IPSS decreased from 23 points (range 10–34) before treatment to 3 (range 0–21) and remained stable at 12 and 24 months. Median maximum flow increased from 6 ml/s (range 1–15) before treatment to 14.5 (range 4–50) 6 months after treatment and remained stable at 12 and 24 months. Median PVR decreased from 170 ml (range 35–720) before treatment to 17 (range 0–327) after 6 months and then remained unchanged. Urodynamic evaluation in the 162 patients after 6 months showed a decrease from pretreatment median detrusor opening pressure of 87.5 to 53 cm. At the 24-month follow up, the authors

repeated a urodynamic evaluation on 59 of the 129 evaluable patients. Pressure flow analysis revealed a decrease in median minimal urethral opening pressure from 70 to 40 cm water at 6 months and to 38 cm water at 24 months ($p < 0.0001$). Median detrusor pressure at maximum flow decreased significantly from the pretreatment value of 86 to 55 cm water at 6 months and 58 cm water at 24 months ($p < 0.0001$). The authors concluded that transurethral microwave thermotherapy (TUMT) provides excellent long-term subjective and objective results.

Coretherm (ProstaLund)

With the ProstaLund Feedback Treatment (PLFT) technique, the intraprostatic temperature is measured by three intraprostatic sensors placed in a temperature probe that is introduced into the prostate at approximately the 2 o'clock position by way of the urethral treatment catheter. The temperature is continuously checked during the treatment and displayed on the device computer, which calculates the extent of coagulation necrosis. Thus, the treatment is individualized and stopped when adequate tissue destruction is considered to have been achieved.

Gravas and colleagues studied the efficacy and safety of PLFT in 41 patients with BPH [Gravas *et al.* 2003]. They recorded all adverse events, the IPSS, bother score, sexual function, and Q_{max} at 3, 6 and 12 months. In addition, determination of prostate volume measurement of residual urine volume were repeated at the 6- and 12-month visits. A total of 33 of the patients completed the 12-month visit. There was a statistically significant decrease in IPSS and bother score at the 12-month visit. The mean Q_{max} improved from 8.4 ml/s at baseline to 17.8 ml/s at 12 months. The mean change in prostate volume was 16 ml at 6 months and 19 ml at 12 months. The procedure was well tolerated. The mean posttreatment catheterization time was 17.90 days. Bladder spasms and urinary tract infection were the most common adverse events. Coitus ability remained practically unchanged after treatment (from 71% to 74.3%), but the number of patients with ejaculation decreased (from 78% to 51.4%).

Transurethral needle ablation

Transurethral needle ablation (TUNA) is characterized by a specific catheter connected to a radiofrequency generator; the catheter tip contains two needles that deploy an acute angle to each other and to the catheter. Each needle's retractable shield controls the urethral temperature and lesion geometry. During the treatment, the temperature is checked in the urethra, in the prostate gland and in the rectum, where a specific probe with a thermocouple is placed.

Schulman and colleagues performed a pilot study to evaluate TUNA feasibility [Schulman *et al.* 1993]. Twenty patients were treated using TUNA prior to scheduled retropubic prostatectomy. The surgical prostatic specimens were recovered from 1 day to 1 month after TUNA and were examined histologically. Macroscopic examination of the specimens demonstrated localized lesions averaging 12 mm × 7 mm. Microscopic examination showed larger lesions of extensive coagulative necrosis averaging 30 mm × 15 mm. Preservation of urethra and capsule integrity were noted. Seventeen patients were treated without anaesthesia and tolerated the procedure well.

Zlotta and colleagues presented the clinical outcome of patients treated by TUNA and followed for 5 years [Zlotta *et al.* 2003]. A total of 188 patients with symptomatic BPH were treated with TUNA. At a mean follow up of 63 months, mean urinary peak flow rate increased from 8.6 to 12.1 ml/s ($p < 0.01$, Student's *t*-test), IPSS and PVR decreased from 20.9 and 179 ml to 8.7 and 122 ml, respectively (both $p < 0.001$, Student's *t*-test). The percentage of patients who improved by at least 50% their peak uroflow and IPSS was 24% and 78%, respectively. Mean prostate volume and prostate-specific antigen (PSA) levels did not change significantly (53.9 *versus* 53.8 ml and 3.3 *versus* 3.6 ng/ml, respectively, at 5 years, both *p* values > 0.05, Student's *t*-test). Two patients died of unrelated comorbidities and 10 were lost to follow up. Medical treatment was given to 12 patients (6.4%), a second TUNA performed in 7 patients (3.7%) and surgery indicated in 22/186 (11.1%). Overall 23.3% required additional treatment at 5 years follow up following the original TUNA procedure.

According to an FDA suggestion, microwave thermotherapy for BPH should be excluded in patients with a prior radiation therapy to the pelvic area, as they have a bigger risk of rectal fistula formation. Moreover, the FDA recommend care not to oversedate the patient, as patient perception of pain is an important safety

mechanism to ensure that the heating of the tissue is not excessive. General or spinal anaesthesia should not be used.

de la Rosette and colleagues surveyed 854 certified urologists during the XVIth Annual EAU Meeting in Geneva in 2001 in order to assess the trend among European urologists with regard to the application of new technologies in BPH [de la Rosette *et al.* 2003]. They showed that TURP remains the gold-standard surgical option for the treatment of BPH among European urologists, with an average 27.9 procedures per month. Also, transurethral prostate incision, vapour resections and open prostatectomies are performed frequently (4.2%, 2.6% and 10%, respectively). However, when asked what kind of equipment they would like to have access to among alternative minimally invasive techniques, 40% preferred holmium laser, 11% electrovaporization, 5% TUNA, 5% TUMT, 4% Gyrus and 3% interstitial laser coagulation.

TUMT

In 2008, Hoffman and colleagues published a review collecting all randomized controlled trials evaluating TUMT for men with symptomatic BPH [Hoffman *et al.* 2008]. Comparison groups included TURP, minimally invasive prostatectomy techniques, sham thermotherapy procedures and medications. Outcome measures included urinary symptoms, urinary function, prostate volume, mortality, morbidity and retreatment. Fourteen studies involving 1493 patients met inclusion criteria, including six comparisons of microwave thermotherapy with TURP, seven comparisons with sham thermotherapy procedures and one comparison with an alpha blocker. Study durations ranged from 3 to 60 months.

The pooled mean urinary symptom scores decreased by 65% with TUMT and by 77% with TURP. The pooled mean peak urinary flow increased by 70% with TUMT and by 119% with TURP. Compared with TURP, TUMT was associated with decreased risks for retrograde ejaculation, treatment for strictures, hematuria, blood transfusions and the TUR syndrome, but increased risks for dysuria, urinary retention and retreatment for BPH symptoms. Microwave thermotherapy improved symptom scores (IPSS WMD –4.75, 95% confidence interval [CI] –3.89 to –5.60) and peak urinary flow (WMD 1.67 ml/s, 95% CI 0.99–2.34) compared with sham procedures. Microwave thermotherapy also improved symptom scores (IPSS weighted mean difference (WMD) –4.20, 95% CI –3.15 to –5.25) and peak urinary flow (WMD 2.30 ml/s, 95% CI 1.47–3.13) in the one comparison with alpha blockers. No studies evaluated the effects of symptom duration, patient characteristics, PSA levels or prostate volume on treatment response.

The authors concluded that microwave thermotherapy techniques are effective alternatives to TURP and alpha blockers for treating symptomatic BPH for men with no history of urinary retention or previous prostate procedures and prostate volumes between 30 and 100 ml. However, TURP provided greater symptom score and urinary flow improvements and reduced the need for subsequent BPH treatments compared with TUMT.

Conclusions

Open prostatectomy and monopolar TURP remain as gold standards by which newer transurethral approaches must be compared. Nowadays TURP and its alternative techniques seem to have comparable efficacy and overall morbidity. Bipolar TURP and HoLEP have more consistent data and passed the phase of feasibility, while TUVP, KTP and minimally invasive treatments need more evidence and longer follow up. Laparoscopic and robotic approaches are under investigation.

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Conflict of interest statement

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