Surgical Intervention for Male Lower Urinary Tract Symptoms with Benign Prostatic Hyperplasia

Chung-Jing Wang, M.D.
Division of Urology, Department of Surgery, Saint Martin De Porres Hospital, Chiayi, Taiwan

ABSTRACT

Surgical intervention for LUTS with BPH has changed significantly over the past two decades. This paper reviews the treatment options available to the urologist in the surgical treatment of LUTS with BPH. A comprehensive MEDLINE (1970-December 2007) search of the English literature was performed to identify articles on the surgical treatment of LUTS with BPH. This literature review summarizes the studies to date and make recommendations for practicing urologists.
Key words: benign prostatic hyperplasia, lower urinary tract symptoms, urethral stents, transurethral thermotherapy, laser therapy

INTRODUCTION

Benign prostatic hyperplasia (BPH) is a non-malignant enlargement of the prostate, the incidence of which increases with age. Progressive enlargement can lead to bladder outlet obstruction, which can give rise to lower urinary tract symptoms (LUTS) or complications such as urinary retention. BPH is also a complicated condition that may negatively interfere with quality of life (QoL), causing lower urinary tract symptoms (LUTS) [1]. Uncomplicated LUTS are usually initially managed with lifestyle modification and drug treatment. According to the 2003 American Urological Association (AUA) Practice Guidelines Committee [2], men with mild LUTS and without bothersome symptoms may be managed with watchful waiting and periodic reevaluation. Pharmacotherapy is the most widely used therapy for mild-to-severe LUTS secondary to BPH [3]. α-Adrenergic blockers and 5-α-reductase inhibitors provide relief of symptoms with fewer and less serious adverse effects than surgery [2], but a significant number of patients inevitably demand intervention. Medications may have undesirable side effects and often may not provide adequate relief for chronic severe BPH. Patients with bothersome LUTS refractory to medical management and those with complications of BPH are usually considered for surgical intervention, in these cases, surgery or minimally invasive procedures may be offered. Surgical management of LUTS with BPH is a more definitive, longer-lasting option than pharmacotherapy; these therapies, however, often involve higher morbidity and a risk of mortality.

Transurethral resection of the prostate (TURP) was itself introduced as a minimally invasive alternative to open prostatectomy in the surgical management of bladder outlet obstruction secondary to BPH. TURP meant a reduced hospital stay and lower post-operative analgesia requirements, although initial reports found higher re-treatment rates than those described with open prostatectomy. Its perceived advantages meant that TURP rapidly became the surgical treatment of choice for BPH, with open prostatectomy still having a role in the management of larger glands. TURP improves both urine flow and symptoms, but it requires general or regional anesthesia and is not without risks. These include significant blood loss requiring transfusion, infection, systemic water absorption (giving rise to transurethral resection [TUR] syndrome), retrograde ejaculation, impotence and incontinence.

TURP is the gold-standard therapy for the treatment of BPH and associated LUTS [2]. Recent technological advances and improvements in technique have dramatically decreased TURP-related morbidity [4]. The development of dedicated bipolar electrosurgical generators enables saline use for current conduction which more effectively reduces granulation tissue and tissue charring compared with monopolar TURP. The availability of video technology has eased procedure training and mastery. In recent years, less invasive alternatives have sought to minimize or eradicate undesirable results, so there has been a reduction in the number of surgical resections for BPH. This may be explained, in part, by the coincident increase in the use of pharmacological agents as first-line therapy. The popularity of medical therapy might also account for the increase in the average age of patients now undergoing transurethral resection which has been noted in some reports. While this has been offset by better surgical and anaesthetic techniques, the morbidity and mortality associated with TURP has served to maintain an interest in developing alternative minimally invasive techniques.

Minimally invasive therapy consists of transurethral needle ablation (TUNA), transurethral microwave therapy (TUMT), chemotherapy and urethral stents. These modalities, as well as laser vaporization, coagulation, and enucleation are discussed below, as well as the role of electrovaporization.

DATA SOURCES

A literature search was conducted via MEDLINE (1970-December 2007) using the key terms benign prostatic hyperplasia, lower urinary tract symptoms, chemotherapy, urethral stents, water induced thermotherapy, transurethral thermotherapy, laser therapy, and transurethral therapy of the prostate as well as the MeSH headings benign prostatic hyperplasia and lower urinary tract symptoms. Further studies were located using bibliographic review. *In vivo* trialsevaluating surgical treatment for benign prostatic hyperplasia were reviewed. All of the trials were published in English-language, peer-reviewed journals.

Received: November 11, 2008 Accepted: December 19, 2008
Address correspondence to: Dr. Chung-Jing Wang, Division of Urology, Department of Surgery, Saint Martin De Porres Hospital, 565, Section 2, Daya Road, Chiayi, Taiwan
E-mail: jing@stm.org.tw

URETHRAL STENTS

Investigative use of intraluminal stents into the peripheral arterial system to prevent stenosis after balloon angioplasty began in 1969. In 1980, stents for patients at high surgical risk were introduced, avoiding the use of an indwelling catheter or intermittent catheterization [2, 5]. Prostatic stents are coil-or spring-shaped wire devices placed in the prostate channel to keep it open. The stent's insertion into the prostatic urethra pushes away obstructive tissue. These devices are typically used in patients who cannot tolerate a surgical procedure with general or spinal anesthesia due to another medical condition [2]; stents are inserted most commonly into frail, elderly patients. Stents take nearly 30 minutes to place under local anesthesia. Major problems associated with stents include irritation and debris accumulation around the stent, stent migration, and an increased incidence of urinary tract infection.

The first temporary stents on the market were the Prostakath (Doctors and Engineers, Copenhagen, Denmark) and Urospiral (Porges, Paris, France). Both stents were made from stainless steel and resembled a spring. They were initially used in patients with urinary retention whowere a high surgical risk, and a high rate of complications soon emerged, including stent migration, obstruction, encrustations, irritative symptoms, and perineal discomfort. Because of this high complication rate, stents required removal in 30% of cases [5]. However, the procedure was shown to be viable because it was possible to reestablish urinary flow in many patients, with a higher rate of success seen in acute than in chronic obstruction. The use of internal stents for permanent use arose at the same time as that for temporary use. As of July 2003, one prostatic stent (Urolume; American Medical Systems, Minnetonka, MN) was approved by the US Food and Drug Administration for the treatment of symptoms secondary to BPH. Made from a metal alloy, this stent has sizes measuring 1.5, 2.0, 2.5 and 3.0 cm. It is a braided mesh cylinder designed to expand radially, applying constant gentle pressure to hold open the sections of the urethra that obstruct urine flow. The open, diamond-shaped cell design of the stent allows it to eventually become embedded in the urethra, thus minimizing risk of encrustation and migration. The procedure can be performed within 15 minutes under local anesthesia.

Approved BPH-related indications are to relieve prostatic obstruction secondary to BPH in men at least 60 years old, or men under 60 who are poor surgical candidates [2]. Limited evidence suggests that a fixed stent may be more efficacious than other types of stents; however, these patients experienced more transient irritative symptoms. The AUA 2003 guidelines [2] state that "because prostatic stents are associated with significant complications, such as encrustation, infection, and chronic pain, their placement should be considered only in high-risk patients, especially those with urinary retention."

Ultimately, this quick procedure involves very low risk. Urethral stents are associated with improvement in subjective (60%-90%) and objective (55%) parameters, and 95% of patients with indwelling catheters return to spontaneous voiding after stenting. However, nearly 10% of the stents become displaced and a 23% removal rate within 7 years of placement has been reported [6]. Other reported complications include hematuria, stricture formation, worsening of LUTS, acute retention and recurrent urinary tract infections.

CHEMOABLATION

The first report of intraprostatic injection is attributed to Stoll in 1877 for the treatment of a prostatic abscess [7]. Since then, many reports have been published on this injection, mainly for the treatment of BPH in high-risk surgical candidates. The most widely used agent is anhydrous ethanol (98%), either via transrectal, transperineal, or transurethral approach. The transurethral approach is the most commonly preferred method [7]. A physician inserts a cystoscopic injection device into the urethra with a cystoscope. The needle tip is inserted into the urethral wall of the prostate and alcohol is injected at two to five points, depending on the size of the prostate. The injection induces necrosis and sclerosis of the obstructing prostate tissue. The advantage of transurethral injection over other techniques is the maintenance of the prostatic pseudocapsule. This procedure is usually performed on an outpatient basis in 30 minutes with local anesthesia or intravenous sedation. Typically, patients are catheterized for 1 to 2 days after the procedure. The most common side effects include dysuria and hematuria.

Initial promising reports with this Japanese technology led to studies with dogs in the United States, and then a single-center experience involving 15 patients in 2002 [2]. In 2004, a European prospective, multicenter trial evaluated transurethral anhydrous alcohol injection in 115 patients [8]. Symptom scores, flow rates, QoL, and post-void residual (PVR) improved significantly after treatment. These results were sustained for up to 12 months. Recently, other agents have also been used to ablate prostate tissue. Botulinum toxin type-A has been demonstrated to reduce prostatic volume by nearly 15% and improve flow rates by 50% at the 1-year follow-up. In this series, there were no local or systemic complications [9], but further studies are needed. The 2003 AUA BPH guidelines [2] state that alcohol injection is considered investigational and should not be offered outside the framework of clinical trials. Overall, although ethanol ablation remains an investigational treatment modality, outpatient procedures involve very low risk.

Transurethral Electrovaporization of the Prostate (TUVP)

Transurethral electrovaporization of the prostate (TUVP) is associated with short term results comparable to TUR-P in terms of symptomatic improvement, urinary flow rate and QoL parameters, but with higher rates of storage LUTS, urinary retention and incontinence [10, 11].

Transurethral Vaporization Resection of the Prostate (TUVRP)

TUVRP is a modification of the standard TURP, in which a thick loop is used in conjunction with increased electrosurgical settings. A prospective randomized study from Riyadh by Talic et al [12] looked at 68 patients assessed to have prostatic outflow obstruction. These patients were randomized into TURP and TUVRP groups. The outcomes assessed included efficacy (evaluated by the International Prostate Symptom Score [IPSS]), maximum flow rate, operative time, catheterization time, changes in hemoglobin and hematocrit values, changes in sodium levels, and complications. The groups were well matched on the basis of age, presentation, and prostate size. The mean follow-up periods were 8.8 months (for the TURP group) and 9.2 months (for the TUVRP group).

The IPSSs and the maximum flow rates were better in the TUVRP group than in the TURP group. At the 6-month follow-up, the IPSSs were 4 ± 3.4 and 5.6 ± 3.1 and the maximum flow rates were 19 ± 6.5 mL/s (P=0.03) and 15.2 ± 10 mL/s (P=0.01) for the TUVRP and TURP groups, respectively. The resection time was longer in the TUVRP group (42.5 ± 15 min versus 35.9 ± 12.8 min; P=0.02). This was attributed to the slower swipes necessary for vaporization. The catheterization time was shorter in the TUVRP group. Ninety-four percent of the patients in the TUVRP group had their catheters removed within 24 h; this compares with 60% of patients in the TURP group.

The changes in hemoglobin, hematocrit and sodium levels were statistically significant, in favor of TUVRP, but were not clinically significant in this study. There were no major complications, no one experienced TUR syndrome, and no blood transfusions were required in either group. The authors of this study concluded that TUVRP is as safe and effective as TURP, and also has the advantages of less bleeding (yielding improved visualization), greater debulking (as tissue is being simultaneously resected and vaporized), and shorter catheterization times.

Transurethral Resection of the Prostate (TURP)

Collective data show that TURP reduces symptom scores, increases mean urinary flow rate by 9.7mL/s, reduces the PVR by 60% and improves QoL by 34%-62% [13]. Strong correlations were found between improvement in QoL and the presence of bladder over-activity or severity of symptoms before surgery. Complications of TURP include hemorrhage (2.5%-7.2%), TUR syndrome (3.4%-4.7%), urinary incontinence (0.7%-1.4%), urethral strictures (3.8%) and bladder neck sclerosis (4%) [13].

Antibacterial and antithrombotic prophylaxis is recommended before surgery to reduce the risk of intra-operative and postoperative septic complications and to avoid hypercoagulability induced by pelvic surgery [14,15]. Intra-operative mortality during TURP was lower than 0.25% in some studies, while the mortality rate within 30 days of open prostatectomy is 0.62%. Long term mortality rates, when adjusted for the presence of co-morbidities, were not significantly different between interventions [13,15]. Over an 8-year period, the re-intervention rate was 12%-15.5% after TURP and 3.1%-4.5% after open prostatectomy [13-17].

Transurethral Incision of the Prostate (TUIP)

TUIP was found to produce a subjective improvement similar to that obtained with TURP in patients with prostate volumes ≤30 mL [18] . Fewer complications and reduced surgery and recovery times have been reported with TUIP compared with TURP, although re-intervention rates appear to be slightly higher with TUIP (9.3 vs. 5.3%) [18].

The choice of the type of surgery should be based on the operator's experience, the size of the prostate and the presence of co-morbid conditions. Since there is no compelling evidence favoring one particular technique based on prostate volume, it endoscopic interventions are recommended instead of open prostatectomy in patients with prostate volumes < 40-50 mL. Likewise, no conclusive data has emerged on the appropriate length of follow-up and, therefore, a minimum follow-up of 3-6 months is recommended.

Open Prostatectomy

Open prostatectomy reduces symptom scores, increases mean urinary flow rate by 20.4 mL/s, reduces PVR by 92-121 mL and improves QoL significantly [19,20]. The complications include hemorrhage (12.4%-13%), urinary incontinence (0.1%-10%), urethral strictures (2%) and bladder neck sclerosis (2.5%) [19-21].

High-Intensity Focused Ultrasound (HIFU)

Transrectal HIFU therapy is the only technique that provides non-invasive tissue ablation; however, general anaesthesia or at least heavy intravenous sedation is required. Improvement of urinary symptoms is in the range 50%-60% and the Qmax increases by a mean 40%-50%. Long-term efficacy is limited, with a treatment failure rate of approximately 10% per year. No data are yet available from randomized, controlled trials [22].

Transurethral Microwave Thermotherapy (TUMT)

Several transurethral microwave thermotherapy (TUMT) devices have been developed for the treatment of BPH. These include CoreTherm (ProstaLund), Prostcare (HighTechCare), Prostatron and Targis (Urologix). While they differ in how they deliver the energy and how they monitor its effects, they are conceptually the same. All require the insertion of a specially designed urethral catheter that locates a microwave antenna within the prostate. The antenna produces microwaves that pass into the prostate tissue where they are absorbed, causing heat production that results in cellular destruction.

Treatments typically last between 10 minutes and one hour with some machines tailoring the duration of treatment specifically to the individual. Thermotherapy causes a significant amount of tissue edema which requires a period of urethral catheterization after the procedure, typically one to two weeks. More recently, prostatic bridge catheters have been used, which negate the inconvenience and complications associated with indwelling catheters [23-26].

Studies comparing TUMT with 'sham' treatment have reported reductions in urological symptom scores on the order of 50% after TUMT. While most noted reductions in symptoms in those patients receiving 'sham' treatment, these reductions were significantly less than in patients receiving TUMT, thereby confirming a mechanism of action other than simply placebo [27].

A recent systematic review identified six distinct randomized controlled trials comparing TUMT with TURP in men with symptomatic BPH. The pooled mean symptom score for men receiving TUMT decreased 65% in 12 months, compared with 77% for men undergoing TURP. A mean increase in the peak urinary flow rate of 70% was noted following TUMT, compared with 119% after TURP. While retreatment rates were significantly higher after TUMT, adverse events were generally lower compared with TURP [28].

TUMT therefore provides a one-off treatment for symptomatic BPH that is superior in terms of efficacy and durability to medical therapy or watchful waiting, and safer than TURP. Furthermore, it does not require general anesthesia and can be performed on an out-patient basis.

Transurethral Needle Ablation (TUNA)

Transurethral needle ablation (TUNA) uses radiofrequency energy to cause heating and ablation of the prostate. Like TUMT, coagulative necrosis is achieved at temperatures higher than 45˚C and its tissue effects can be adjusted by altering the treatment settings, thereby tailoring the treatment to the individual. Radio waves are delivered to the prostate by means of two sheathed needles placed within the prostate. The procedure can be performed using local anesthesia, usually with sedation. Preservation of the prostatic urothelium minimizes irritative voiding, hematuria and urinary retention after the procedure. A catheter is normally left in place for between one and three days after treatment, while the procedure-related edema resolves.

A recent meta-analysis assessed the effectiveness of TUNA. Two randomized controlled trials, two comparative studies and nine case series were identified. A total of 1,244 patients had an evaluable IPSS and estimates of maximum urine flow rates were given for 1,331 patients. TUNA was found to reduce the IPSS by a mean 12.1 points and increase the maximum urine flow rate by approximately 70% from baseline at one year, although significantly greater improvement in symptoms and urine flow rates were observed after TURP. Assessment at five years suggested that these improvements were durable [29,30].

Transient dysuria and hematuria are commonly reported after TUNA. A randomized controlled trial comparing TUNA with TURP reported fewer adverse events with TUNA. Rates of retrograde ejaculation, erectile dysfunction, urinary incontinence and stricture formation were lower after TUNA than after TURP. Retreatment rates were higher after TUNA, with 13.8% of patients requiring further intervention for symptoms of BPH during the five-year follow-up.

A single treatment with TUNA can provide a level of efficacy approaching that of TURP, but with fewer complications. It is an 'office' procedure that does not require hospitalization and allows the patient to return rapidly to normal function. Symptomatic improvement may not be as durable as TURP.

Interstitial Laser Coagulation (ILC)

Interstitial laser coagulation (ILC) is performed by inserting a fiberoptic laser probe through a cystoscope into the prostate at fixed points. Laser energy is applied (Nd:YAG or diode) for nearly 3 minutes to coagulate each area of the obstructing prostate, thereby producing tissue necrosis [2]. The laser applicator may emit energy in all directions or only circumferentially forward. This technique delivers energy directly into an adenoma to produce coagulation necrosis. Unlike other laser treatments that cause postprocedural tissue sloughing following surface treatment, the treated tissue atrophies are absorbed over several weeks. Initially, this technology was developed for use with an Nd: YAG laser of 1.024 nm but has since been modified for use with a diode laser of 805 to 980 nm [2]. This procedure can be performed in the office or an outpatient setting in a short time; postprocedure catheterization may require 7 to 21 days. Like other laser procedures, ILC destroys tissue and tissue is not generally available for histological examination.

Two randomized and three nonrandomized trials enrolling nearly 500 patients have compared ILC with TURP [31]. In general, these trials found similar improvements in IPSS symptom scores and flow rates between the two groups. However, when a diode laser was used to apply low-power energy (10 W maximum), the results were not as efficacious as TURP in terms of QoL improvement, symptom score, or flow-rate improvement. Limited evidence is available for comparison with TUMT; however, there appears to be a higher rate of minor complications with ILC.

Visual Laser Ablation of the Prostate (VLAP)
Contact Laser Ablation of the Prostate (CLAP)

The Nd:YAG laser is most commonly used for its coagulative effect although higher power settings do result in tissue vaporization. Examples of treatments that utilize the neodymium laser include visual laser ablation of the prostate (VLAP), contact laser ablation of the prostate (CLAP) and interstitial laser coagulation of the prostate (ILC).

VLAP and CLAP were found to induce subjective and objective improvement comparable to TURP, with a significantly lower incidence of blood loss and retrograde ejaculation (22%). However, the catheterization time appears to be longer (up to 120 days) and the incidence of post-operative storage LUTS is higher (80%). Re-treatment rates (up to 44% at 5 years) also seem to be significantly higher after laser therapy than after TURP [32,33].

Potassium Titanyl-Phosphate Laser (KTP Laser)

The KTP laser has been used for thermal ablation of prostatic tissue (Green Light PV and HPS; American Medical Systems, Minnetonka, MN). When the Nd:YAG laser passes through a KTP crystal, it doubles its frequency and halves its wavelength to 532 nm [4]. The laser emits a visible green light that is highly absorbed by hemoglobin but not water. Thus, green laser light is strongly absorbed within a very superficial layer of tissue because the blood vessels and hemoglobin contained therein serve as primary absorbers. This photoselective vaporization of the prostate (PVP) leads to heat formation and vaporization of prostatic tissue [34,35]. Ex vivo studies have demonstrated a coagulative zone depth of 1 to 2 mm, making this technique a relatively bloodless ablative procedure. The prostate tissue is vaporized under direct vision using the laser fiber in a side-firing, near-contact sweeping technique. A TURP-like cavity is achieved with this procedure.

The endpoint of a PVP procedure is noted by a significant reduction in the generation of vapor bubbles, indicating that the adenoma has been completely removed. Although the cavity created by a PVP is not as smooth as after a TURP, capsular fibers can be seen. With all these properties, 80 W KTP laser vaporization of the prostate seems to combine the tissue-debulking properties of TURP with the well-known hemostatic properties of other lasers. The indications for PVP are the same as those for TURP (there are no exclusion criteria for PVP in terms of median-lobe enlargement or prostate size).

A short-term study revealed improvement in symptom scores, flow rate, and PVR [36]. In this series, two patients with a prostate gland larger than 100 g underwent a staged procedure without complications. Prostate volume reduction ranged from 30% to 44% with an average prostate-specific antigen reduction of 30% [35,36]. A significant decrease in IPSS values (11.2 to 18.9 points), as well as an increase in flow rates (11.0 to 19.3 mL/sec) were seen the first postoperative year [35,37]. Comparison between TURP and PVP revealed a shorter surgical time for TURP (49 vs. 59 min). Despite longer operative times, PVP allowed earlier catheter removal, earlier discharge, less need for analgesics, and reduced decreases in hemoglobin and sodium levels [34]. After a 6-month follow-up, TURP and PVP had similar flow rates, symptom scores, and PVR and QoL data. Another study revealed stable results through the first year [38]. The incidence of urethral strictures and dysuria with PVP was comparable to published TURP data.

When PVP was performed in 24 men with anticoagulant therapy, it proved to be safe and effective [37]. No thromboembolic events, gross hematuria, clot retention, or need for transfusion were seen. Also, flow rates, symptom scores, and PVR improved up to 12 months after the procedure.

This procedure is safe for patients taking anticoagulants and offers good results for larger prostates and those with a median lobe. Most patients have a short hospital stay or it can be done an outpatient procedure. It requires local anesthesia with or without sedation in most patients. It does not provide tissue for pathology, however, and it requires laser safety equipment and caution.

Recently, Ruszat and colleagues found the procedure led to immediate and sustained improvement in voiding parameters, and it could even be used in patients receiving oral anticoagulation [39]. The team studied 500 patients at a single center with LUTS secondary to BPH who underwent GreenLight PVP using an 80 Watt system and were followed-up for a median of 30.6 months. The mean age of the patients was 71.4 years, and the mean pre-operative prostate volume was 56.1 mL. The mean energy delivered was 206 kJ during a mean operation time of 66.4 minutes. Despite ongoing oral anticoagulation in 45% of the patients, there were no severe intra-operative complications. The mean catheterization and postoperative hospitalization times were 1.8 and 3.7 days, respectively. A three-year follow-up in 131 patients showed that the mean IPSS was reduced from 18.3 at baseline to 8.0, and the mean quality-of-life questionnaire score from 3.0 to 1.3. Furthermore, the maximal flow rate improved from 8.4 to 18.4 mL/sec, and post-void residual volume decreased from 208 to 28 mL. Retreatment occurred in 6.8% of patients due to insufficient first vaporization or regrowth of prostatic tissue. Urethral and bladder neck strictures were observed in 4.4% and 3.6% of the patients, respectively, leading to a total reoperation rate of 14.8%. The authors noted that mean energy delivery was significantly lower in men needing retreatment than others, at 184 versus 208 kJ, respectively and suggest that adequate energy delivery is necessary to achieve a satisfactory outcome.

Holmium Laser Ablation of the Prostate (HoLAP)
Holmium Laser Resection of the Prostate (HoLRP)
Holmium Laser Enucleation of the Prostate (HoLEP)

Surgical use of a holmium laser for BPH has evolved since its introduction in 1994. Initially, holmium laser ablation of the prostate (HoLAP) involved the use of side-firing and end-firing laser fibers to vaporize and ablate prostate tissue [2]. Relief of obstruction is immediate, unlike other laser procedures such as VLAP in which benefits are seen only after a delay. However, HoLAP does not yield tissue for histologic analysis, therefore surgeons later developed holmium laser resection of the prostate (HoLRP). In HoLRP, the surgeon resects prostate tissue into pieces small enough to be removed with bladder irrigation and a grasping forceps or a modified resectoscope loop. Compared with TURP, however, HoLRP yields less tissue for analysis, and the available tissue is of lower quality due to thermal artifacts. These problems, in addition to relatively long operative times, motivated the development of holmium laser enucleation of the prostate (HoLEP) in conjunction with a tissue morcellator. In HoLEP, an entire prostate lobe can be separated from connective tissue by dissecting between the surgical capsule and adenoma, much like shelling out an adenoma during open prostatectomy and depositing it in the bladder [40,41]. The laser fiber tracks the exact plane as the surgeon's index finger when performing open surgery. The lobes are then removed from the bladder using a tissue morcellator [4].

Decisions to use the holmium laser procedure are based on prostate size. Patients with small prostates are candidates for HoLAP. Patients with moderately sized prostates can be treated with HoLRP. In an experienced surgeon's hands, HoLEP can be used to treat very large prostates (>100 g). The major advantage of the holmium laser is its ability to coagulate tissue simultaneously with tissue incision, vaporization, resection, or enucleation. This markedly reduces postoperative as well as intraoperative bleeding. These lasers are expensive, however, and require extensive surgical training. There is a steep learning curve associated with holmium laser use; at least 25 HoLEP procedures on small prostates may be necessary before a surgeon feels comfortable treating a patient with a large prostate [42].

One study reporting a mean HoLAP follow-up of 89 months evaluated 43% of the initial cohort [40]. This group received a durable improvement in urinary parameters after 3 months and 7 years follow-up (Qmax, 14.5 mL/sec and 16.8 mL/sec, respectively; IPSS, 8.3 and 10.0). A satisfactory result was achieved after a long follow-up, but the mean surgical time of 75 minutes versus the TURP mean surgical time of 40 minutes indicates use in small prostates only [41].

Limited evidence demonstrates that HoLRP and TURP improve symptoms to a similar degree. No published controlled trials have compared the use of different HoLRP devices. Data from three trials suggest that HoLRP takes longer to perform compared with TURP (41 vs. 25 min); however, patients who received HoLRP had statistically shorter hospital stays (1.1 vs. 2.0 d) and catheterization times (0.8 vs. 1.6 d). Two years after HoLRP treatment, nearly 8% of patients required an additional surgical procedure [41].

Trials involving HoLEP only have enrolled patients with large prostates. A prospective study comparing HoLEP to TURP showed that although HoLEP had significantly longer operative times, it had greater tissue removal efficiency, as well as a decreased need for irrigation, shorter catheter times, and reduced hospital stay [42]. Researchers performed urodynamic studies at 6 months and demonstrated a significant improvement in flow rates and Schaefer grade in the HoLEP group. Another randomized trial compared HoLEP with open prostatectomy for large prostates (>100 g, range 100 to 230 g) [43]. Both treatments had similar preoperative volume and weight of tissue removed, but the operative time was significantly longer for HoLEP (140 vs. 90 min). Blood loss, catheter time, and hospital stay were reduced for patients undergoing HoLEP.

In terms of advantages, HoLAP involves low morbidity and requires local anesthesia in an outpatient setting for small prostates only. No tissue is obtained for histologic analysis, however, and HoLAP is associated with prolonged postoperative catheterization rates [44,45].

New data from randomized controlled trials confirm that HoLEP has an efficacy profile comparable to TURP, with similar improvements versus baseline in IPSS scores (by 76%-92%), QoL (70%-83%) and urodynamic parameters (2- to 4-fold increases In Qmax), and similar 1-year complication rates such as urethral strictures (1.7%-3.8%) and stress incontinence (1.1%-2%)[43]. In the peri-operative period HoLEP offers advantages in terms of a shorter catheterization time and hospital stay, but it seems to be associated with a higher rate of transient dysuria and stress incontinence (probably due to morcellation). In patients with larger prostates (>100 mL), HoLEP compares favourably with open prostatectomy in terms of catheterization time, hospital stay and blood transfusions [43].

HoLEP is safe for patients on anticoagulants or with bleeding disorders, as well as those with large prostates (>100 g). Compared with TURP, it provides tissue for histologic analysis and earlier catheter removal and discharge. HoLEP has a steep learning curve and is associated with longer operative times. However, HoLEP has been shown to achieve results comparable to TURP and open prostatectomy [19,46], but these data need confirmation because of the short duration of the studies and the high percentage of patients who were lost to follow-up.

Elzayat et al reported a retrospective analysis of 118 patients who underwent HoLEP between March 1998 and February 2001[47]. The mean patient age was 76.5 years (range: 59-93) and the mean preoperative prostate volume was 59.3 mL (range: 20-172). The mean follow-up period was 49.4 ± 28.1 months. The mean catheter time and hospital stay were 1.3 and 1.5 days, respectively. Seventy-eight percent of the patients were discharged home within 24hours after surgery. For the patients (n=26) who had objective data 6 years postoperatively, the mean maximum flow rate increased from 6.3 to 16.2 mL/s and the mean postvoid residual urine decreased from 232 to 41.2 mL ($p< 0.0001$). The mean IPSS improved from 17.3 to 5.6 ($p<0.0001$). Bladder-neck contracture and urethral stricture developed in 0.8% and 1.7% of patients, respectively. The reoperation rate for recurrent benign prostatic hyperplasia obstruction was 4.2%. The authors concluded that HoLEP represents a safe and effective treatment for patients with symptomatic enlarged prostates. The improvement in outcome parameters is durable, and the rates of late complications and reoperation are very low.

DISCUSSION

The search continues for a minimally invasive treatment for BPH that is as effective as TURP but has less associated morbidity. Existing minimally invasive treatments for BPH are generally considered to be less effective than TURP, but carry less risk. Given this balance between safety and efficacy it is extremely important to consider an individual patient's situation when evaluating these treatments. For example, an elderly patient with significant co-morbidity might be willing to have a less durable and even less effective treatment if it allows spontaneous voiding and a quick return to normal activity. A young patient may choose a potentially less durable treatment, accepting the likely need for further intervention, if the risks associated with the more invasive alternative can be avoided or at least deferred. Each of the minimally invasive procedures considered in this review may therefore have a place in the management of BPH. Further research concentrating on long-term safety and efficacy outcomes will define their role more precisely.

CONCLUSIONS

Despite the development of new technologies, transurethral resection of the prostate TURP is still considered the gold standard for surgical treatment of LUTS with BPH. In general, new minimally invasive treatments have not demonstrated better outcomes than TURP in the evidence- based medical trials published to date, and should be reserved for patients who prefer to avoid surgery, who are unsuitable candidates for surgery or who no longer respond favorably to medication. While TURP is an effective and time-tested treatment option, in certain situations other approaches may be more appropriate as the search continues for a new "gold standard".

REFERENCES

1. O'Leary MP: Lower urinary tract symptoms/benign prostatic hyperplasia: Maintaining symptom control and reducing complications. Urology 2003; **62(3 suppl 1)**:15-23.
2. AUA guideline on management of benign prostatic hyperplasia (2003). Chapter 1: Diagnosis and treatment recommendations. J Urol 2003; **170**:530-547.
3. Chapple CR: Pharmacological therapy of benign prostatic hyperplasia/lower urinary tract symptoms: An overview for the practicing clinician. BJU Int 2004; **94**:738-744.
4. Rassweiler J, Teber D, Kuntz R, Hoffman R: Complications of transurethral resection of the prostate (TURP)-- incidence, management, and prevention. Eur Urol 2006; **50**:969-980.
5. Kletscher BA, Oesterling JE: Prostatic stents. Current perspectives for the management of benign prostatic hyperplasia. Urol Clin North Am 1995; **22**:423-430.
6. Perry MJ, Roodhouse AJ, Gidlow AB, Spicer TG, Ellis BW: Thermo-expandable intraprostatic stents in bladder outlet obstruction: An 8-year study. BJU Int 2002; **90**:216-223.
7. Plante MK, Folsom JB, Zvara P: Prostatic tissue ablation by injection: A literature review. J Urol 2004; **172**:20-26.
8. Grise P, Plante M, Palmer J, et al: Evaluation of the transurethral ethanol ablation of the prostate (TEAP) for symptomatic benign prostatic hyperplasia (BPH): A European multi-center evaluation. Eur Urol 2004; **46**:496-502.
9. Chuang YC, Chiang PH, Yoshimura N, De Miguel F, Chancellor MB: Sustained beneficial effects of intraprostatic botulinum toxin type A on lower urinary tract symptoms and quality of life in men with benign prostatic hyperplasia. BJU Int 2006; **98**:1033-1037.
10. Hammadeh MY, Madaan S, Hunes J, Philp T: 5-year outcome of a prospective randomized trial to compare transurethral electrovaporization of the prostate and standard transurethral resection. Urology 2003; **61**:1166-1171.
11. Gallucci M, Puppo P, Perachino M, et al: Transurethral electrovaporization of the prostate vs. transurethral resection. Results of a multicentric, randomized clinical study on 150 patients. Eur Urol 1998; **33**:359-364.
12. Talic R, El Tiraifi A, El Faqih SR, et al: Prospective randomized study of transurethral vaporization resection of the prostate using the thick loop and standard transurethral prostatectomy. Urology 2000; **55**:886-891.
13. Madersbacher S, Marberger M: Is transurethral resection of the prostate still justified? BJU Int 1999; **83**:227-237.
14. Scholtz M, Luftenegger W, Hannuth H, Wolf D, Holtl W: Single-dose antibiotic prophylaxis in transurethral resection of the prostate: A prospective randomized trial. Br J Urol 1998; **81**:827-829.
15. Bell CR, Murdock PJ, Pasi KJ, Morgan RJ: Thrombotic risk factors associated with transurethral prostatectomy. BJU Int 1999; **83**:984-989.
16. Sidney S, Queensberry Jr CP, Sadler MC, Cattolica EV, Lydick EG, Guess HA: Reoperation and mortality after surgical treatment of benign prostatic hypertrophy in a large prepaid medical care program. Med Care 1992; **30**:117-125.
17. Semmens JB, Wisniewski ZS, Bass AJ, Holman CD, Rouse IL: Trends in repeat prostatectomy after surgery for benign prostate disease: Application of record linkage to healthcare outcomes. BJU Int 1999; **84**:972-975.
18. Yang Q, Peters J, Donovan JL, Abrams P: Transurethral incision compared with transurethral resection of the prostate for bladder outlet obstruction: A systematic review and meta-analysis of randomized controlled trials. J Urol 2001; **165**:1526-1532.
19. Kuntz RM, Lehrich K: Transurethral holmium laser enucleation versus transvesical open enucleation for prostate adenoma greater than 100 gm: A randomized prospective trial of 120 patients. J Urol 2002; **168**:1465-1469.
20. Tubaro A, Carter S, Hind A, Vicentini C, Miano L: A prospective study of the safety and efficacy of suprapubic transvesical prostate-

ctomy in patients with benign prostatic hyperplasia. J Urol 2001; **166**:172-176.

21. Shalev M, Richter S, Kessler O, Shpitz B, Fredman B, Nissenkorn I: Long-term incidence of acute myocardial infarction after open and transurethral resection of the prostate for benign prostatic hyperplasia. J Urol 1999; **161**:491-493.
22. EAU Practice Guidelines Committee: EAU guideline on management of benign prostatic hyperplasia.
23. Yerushalmi A, Fishelovitz Y, Singer D, et al: Localized deep microwave hyperthermia in the treatment of poor operative risk patients with benign prostatic hyperplasia. J Urol 1985; **133**:873-876.
24. Montorsi F, Galli L, Guazzoni G, et al: Transrectal microwave hyperthermia for benign prostatic hyperplasia: Long-term clinical, pathological and ultrastructural patterns. J Urol 1992; **148**:321-325.
25. Devonec M, Ogden C, Perrin P, St Clair Carter S: Clinical response to transurethral microwave thermotherapy is thermal dose dependent. Eur Urol 1993; **23**:267-274.
26. De la Rosette JJ, de Wildt MJ, Alivizatos G, Froeling FM, Debruyne FM: Transurethral microwave thermotherapy (TUMT) in benign prostatic hyperplasia: Placebo versus TUMT. Urology 1994; **44**:58-63.
27. Ogden CW, Reddy P, Johnson H, et al: Sham versus transurethral microwave thermotherapy in patients with symptoms of benign prostatic bladder outflow obstruction. Lancet 1993; **341**:14-17.
28. Hoffman RM, MacDonald R, Monga M, Wilt TJ: Transurethral microwave thermotherapy vs transurethral resection for treating benign prostatic hyperplasia: A systematic review. BJU Int 2004; **94**: 1031-1036.
29. Boyle P, Robertson C, Vaughan ED, Fitzpatrick JM: A meta-analysis of trials of transurethral needle ablation for treating symptomatic benign prostatic hyperplasia. BJU Int 2004; **94**:83-88.
30. Hill B, Belville W, Bruskewitz R, et al: Transurethral needle ablation versus transurethral resection of the prostate for the treatment of symptomatic benign prostatic hyperplasia: 5-year results of a prospective, randomized, multicenter clinical trial. J Urol 2004; **171**: 2336-2340.
31. Laguna MP, Alivizatos G, de la Rosette JJ: Interstitial laser coagulation treatment of benign prostatic hyperplasia: Is it to be recommended? J Endourol 2003; **17**:595-600.
32. Hoffinan RM, MacDonald R, Slaton JW, Wilt TJ: Laser prostatectomy versus transurethral resection for treating benign prostatic obstruction: A systematic review. J Urol 2003; **169**:210-215.
33. VanMelick HH, van Venrooij GE, Eckhardt MD, Boon TA: A randomized controlled trial comparing transurethral resection of the prostate, contact laser prostatectomy and electrovaporization in men with benign prostatic hyperplasia: Analysis of subjective changes, morbidity and mortality. J Urol 2003; **169**:1411-1416.
34. Bachmann A, Schurch L, Ruszat R, et al: Photoselective vaporization (PVP) versus transurethral resection of the prostate (TURP): A prospective bi-centre study of perioperative morbidity and early functional outcome. Eur Urol 2005; **48**:965-972.
35. Malek RS, Nahen K: Photoselective vaporization of the prostate (PVP): KTP laser therapy of obstructive benign prostatic hyperplasia. AUA Update 2004; **23**:153-160.
36. Sulser T, Reich O, Wyler S, et al: Photoselective KTP laser vaporization of the prostate: First experiences with 65 procedures. J Endourol 2004; **18**:976-981.
37. Sandhu JS, Ng CK, Gonzalez RR, Kaplan SA, Te AE: Photoselective laser vaporization prostatectomy in men receiving anticoagulants. J Endourol 2005; **19**:1196-1198.
38. Sarica K, Alkan E, Luleci H, Tasci AI: Photoselective vaporization of the enlarged prostate with KTP laser: Long-term results in 240 patients. J Endourol 2005; **19**:1199-1202.
39. Ruszat R, Seitz M, Wyler SF, et al: Green light laser vaporization of the prostate: Single-center experience and long-term results after 500 procedures. Eur Urol 2008; **54**:893-901.
40. Tan AH, Gilling PJ, Kennett KM, Fletcher H, Fraundorfer MR: Long-term results of high-power holmium laser vaporization (ablation) of the prostate. BJU Int 2003; **92**:707-709.
41. Gilling PJ, Cass CB, Cresswell MD, Malcolm AR, Fraundorfer MR: The use of the holmium laser in the treatment of benign prostatic hyperplasia. J Endourol 1996; **10**:459-461.
42. Tan AH, Gilling PJ, Kennett KM, Frampton C, Westenberg AM, Fraundorfer MR: A randomized trial comparing holmium laser enucleation of the prostate with transurethral resection of the prostate for the treatment of bladder outlet obstruction secondary to benign prostatic hyperplasia in large glands (40 to 200 grams). J Urol 2003; **170**:1270-1274.
43. Kuntz RM, Lehrich K, Ahyai S: Transurethral holmium laser enucleation of the prostate compared with transvesical open prostatectomy: 18-month follow-up of a randomized trial. J Endourol 2004; **18**:189-191.
44. Salonia A, Suardi N, Naspro R, et al: Holmium laser enucleation versus open prostatectomy for benign prostatic hyperplasia: An inpatient cost analysis. Urology 2006; **68**:302-306.
45. Fraundorfer MR, Gilling PJ, Kennett KM, Dunton NG: Holmium laser resection of the prostate is more cost effective than transurethral resection of the prostate: Results of a randomized prospective study. Urology 2001; **57**:454-458.
46. Vavassori I, Hurle R, Vismara A, Manzetti A, Valenti S: Holmium lase enucleation of the prostate combined with mechanical morcellation: 2 years of experience with 196 patients. J Endourol 2004; **18**:109-112.
47. Elzayat EA, Elhilali MM: Holmium Laser Enucleation of the Prostate (HoLEP): Long-term results, reoperation rate, and possible impact of the learning curve. Eur Urol 2007; **52**:1465-1472.