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**PVP VERSUS HOLEP CURRENT OUTCOMES AND FUTURE STRATEGIES**

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**Summary.-** Photoselective vaporization of the prostate (PVP) with a potassium titanyl phosphate (KTP) laser and Holmium laser enucleation of the prostate (HoLEP) currently represent the most promising new technologies applied to the treatment of benign prostatic hyperplasia (BPH) associated with benign prostatic obstruction (BPO). The specific laser-light characteristics and the optimal interactions between lasers and prostatic tissue result in an even and efficient ablation of the prostate resulting in the formation of a clearly de-obstructed prostate cavity. PVP and HoLEP can be considered day-case procedures, as they require only a few hours of catheterization and are associated with minimal postoperative discomfort, while at the same time they offer results at least equivalent to the reference standards transurethral resection of the prostate and open prostatectomy. There is no doubt that larger studies with longer follow up are necessary to further define the durability of results of PVP and HoLEP in the management of BPH, this review will address current issues regarding how both techniques are performed, their results and limitations as well as their role in the future management of BPH.

**Keywords:** Vaporization of the prostate. Holmium laser. Prostatectomy. Enucleation of the prostate.

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**Resumen.-** La vaporización foto selectiva de la próstata (VFP), con un láser de fosfato de titanio y potasio (KTP) y la enucleación de la próstata (HoLEP) representan en la actualidad las técnicas más prometedoras en el tratamiento de la hiperplasia benigna de próstata (HBP) asociada con obstrucción benigna de próstata (OBP). Las características específicas del láser y las interacciones óptimas entre el láser y el tejido prostático resultan en una uniforme y eficiente ablación de la próstata con la consiguiente formación de una celda prostática claramente desobstruida. El KTP y el HoLEP pueden ser considerados procedimientos ambulatorios, ya que solo requieren unas pocas horas de cateterización y están asociados con mínimo desconfort postoperatorio, mientras que al mismo tiempo ofrecen resultados al menos equivalentes a los estándares de referencia de la resección transuretral de próstata y la prostatectomía abierta. No hay duda de que se necesitan grandes estudios con seguimiento más largo para definir con mayor precisión la duración de los resulta-
INTRODUCTION

The search for the ideal modality for relieving lower urinary tract symptoms (LUTS) suggestive of BPH and associated with benign prostatic obstruction (BPO) is still ongoing. However the ideal day-case procedure that can offer durable and rapidly effective results with minimal morbidity is still far from everyday practice. Transurethral resection of the prostate (TURP) although it has been on the market for more than half a century is still considered the gold standard for the management of symptomatic bladder outlet obstruction (BOO) with regard to durable and successful relief from symptoms (1).

On the other hand and despite the recent refinements and technological advancements in conventional transurethral electrosurgery (bipolar TURP, plasmakinetic vaporization of the prostate) the procedure is still associated with not negligible perioperative morbidity. This is becoming even more important in light of the fact that nowadays the population referred for surgical management of BPO is constantly getting older and carries more comorbidities (2-4).

Therefore it goes without saying that minimally invasive is the way to go with this patient population. In an effort to overcome the limitations of TURP, and in light of recent evidence questioning the long-term efficacy of medical treatment for BPH, minimally invasive, laser-based treatments for BPH have emerged in the field during the last decade.

Lasers had been greeted with high expectations when first introduced in the early 1990s for the treatment of obstructive benign prostatic hyperplasia (BPH). Since then, the clinical safety, efficacy, and durability of different forms of lasers in treating BPH have been extensively tested. Some of the early laser applications gradually lost their appeal over time and were withdrawn as they failed to come up with consistent and durable results compared with the reference standard transurethral resection of the prostate (TURP). Recently, however, new technological improvements and better understanding of tissue-laser interactions have paved the way for re-embracing the use of laser-based treatments for BPH.

Currently, holmium laser enucleation of the prostate (HoLEP) and high-powered photoselective laser vaporisation (PVP) of the prostate represent two of the most widely adopted and therefore studied laser-based therapies, with a potential to emerge as valid alternatives to TURP and open prostatectomy for the treatment of symptomatic BPO (5).

In the present review on laser surgery for BPH, we will introduce the technological aspects of both modalities, discuss their current applications, outcomes and efficacy and position in the constantly evolving field of surgical treatment of BPH.

PVP-Technical characteristics

Doubling the frequency of the pulsed neodymium:yttrium aluminium garnet (Nd:YAG) with 1064-nm laser light can be achieved by passing it through a frequency-doubling crystal. This leads to the creation of a 532-nm wavelength laser with substantially different laser–tissue interaction properties compared with its predecessor, the Nd:YAG. Such frequency-doubling crystals may consist of potassium titanyl phosphate (KTP) or lithium borate (LBO). Unlike the 1064-nm Nd:YAG light beam that virtually approaches the infrared portion of the electromagnetic spectrum, the halved wavelength of KTP laser is within the visible green area of the electromagnetic spectrum (green-light laser) which can partly account for the significantly different optical and energetic interactions compared with other laser systems (6).

The KTP laser beam at a wavelength of 532 nm is selectively absorbed by the oxyhemoglobin rather than by water within the targeted tissue (absorption coefficient, 102/cm). This results in the KTP laser energy being selectively absorbed by tissue with a high oxyhemoglobin content, such as prostatic tissue (7). The increased absorption by hemoglobin leads to trapping of the laser energy in the superficial area of the tissue, which is quickly vaporized. The high rate of laser energy absorption from hemoglobin and the concentration of heat in a small volume of tissue within a very short time are responsible for the enhanced hemostatic properties of PVP. Vaporisation causes heat-induced coagulation of superficial blood vessels which makes prostate surgery an ideal application for KTP lasers (8).
The selective absorption of the KTP laser light by hemoglobin within prostatic tissue, is the reason KTP laser vaporization prostatectomy was called photoselective vaporization of the prostate. Absorption of the green laser light causes ablation of prostatic tissue by a rapid photothermal vaporization of heated intracellular water. The KTP laser’s wavelength’s short extinction length (optical penetration depth into tissue for KTP 532 nm is 0.8 mm) and quasi-continuous laser emission confine laser energy to a superficial layer of prostatic tissue that is rapidly vaporized, with only a 1- to 2-mm rim of coagulation (7,9,10).

Additionally it has been recently demonstrated that the enhanced vaporization and haemostatic efficacy of the KTP laser are not affected by downregulation of intraprostatic angiogenesis by 5α-reductase inhibitors (11).

**PVP technique**

Cumulative experience has shown that PVP is a safe and reproducible procedure that provides symptomatic relief from LUTS due to BPH by creating a transurethral resection (TUR)—like cavity (10,12). However in contrast to TURP, PVP can be performed using saline for irrigation thereby minimizing the risk of TUR syndrome (13). This fact is of particular interest when KTP laser vaporization is applied to large prostates, as an alternative to open prostatectomy or HoLEP.

The goal of creating of a TURP-like prostatic cavity can be achieved by several different techniques of ablation of the obstructive prostatic tissue (14). To ensure maximum delivery of laser energy to the prostate, a near-contact mode (0.5-mm distance between laser fiber and tissue) is optimal. Should this distance increase, the predominant effect would be unwanted coagulation necrosis. Visible formation of bubbles is evidence of efficient tissue vaporization, whereas bubble diminishment is a sign that ablation has been carried close enough to the prostatic capsule, where vaporization efficiency of the laser is hampered by the relatively hypovascular nature of the fibrous capsule (15).

Malek et al. introduced the side-to-side sweeping technique starting at the bladder neck and moving toward the verumontanum in a clockwise—counter clockwise fashion (16). This technique better suits prostates with a large median lobe in order to ensure sufficient irrigation and vision throughout the rest of the case (17). Due to the very close application of the laser beam, vaporization of apical tissue can be performed with accuracy. However, one should be cautious not to harm the verumontanum and the external sphincter from backward scatter of laser energy, direct contact with the laser beam (12,18) or energy dispersion caused by deterioration of the laser fibers (19).

Starting the procedure with vaporization of the lateral lobes has also been described for the occasional huge prostate with an enlarged median lobe. In the “spiral” technique, vaporization starts with the middle lobe and bladder neck and is then carried to the lateral lobes, ending at the prostatic apex. The principle of this technique is to adequately laser a certain area of tissue before moving to the next, as lasered tissue quickly becomes dense, thus decreasing subsequent laser efficiency (20).

In the challenging scenario of a large prostate, a modified technique described as the vaporization- incision technique (VIT) can also prove of help. According to this technique a midline incision in the median lobe is carried down to the trigone, followed by the lateral lobes, and finally the apex (21). The VIT technique, although useful in tackling large intravesically protruding glands, should not be an option for the less experienced laser surgeon (7).

Hemostasis is usually easily achieved with PVP. Arterial or venous bleeders can be coagulated either by spraying the laser beam from a distance of 3 to 4 mm or by reducing the laser power to 30 to 40 W and adopting a near contact technique (17). At the end of the procedure, a catheter may or may not be left in place, depending on the surgeon’s experience, the patient’s age and medical history, the size of the gland, and the type of anesthesia used. In case a catheter is placed it is rarely left overnight except in case of a large prostate or in a surgeon’s first cases (20). Routine continuous bladder irrigation is rarely used as significant hematuria with clot formation is rarely an issue. Patients can be discharged as soon as they recover from anesthesia, proving PVP to be an outpatient, day-case procedure. However, in patients with a known history of large residuals or retention and in the occasional case of an underactive detrusor, postoperative drainage via a suprapubic catheter would be advised. This measure would allow for repeated voiding trials to take place, facilitating the measurement of post-void residual volume (PVR) (22).

One of the drawbacks encountered with the use of the 80-W KTP laser is the relatively slow vaporisation time compared to the speed of resection...
during TURP and the lack of specimen retrieved for pathologic assessment. Therefore, the vaporization volume and speed during PVP are difficult to calculate due to the lack of tissue retrieved (23,24).

In the majority of available studies PVP was performed with the older 80-W laser device using the KTP crystal. The latest generation high-performance system (HPS) uses the LBO crystal with a 120-W power setting.

**Applications, safety and efficacy**

There is no absolute contraindication for PVP. The combination of effective prostate tissue ablation and coagulation ensures adequate haemostasis, thereby creating a practically bloodless surgical field. These properties coupled with the fact that PVP can be performed using saline for irrigation have allowed PVP to be safely used for larger prostates (25,26), patients in retention (27), patients on ongoing anticoagulation therapy (28), or patients that are considered of high surgical risk (29,30).

Initial outcomes from uncontrolled clinical trials with a maximum follow-up of 1 year were encouraging. These trials treated 759 men (aged 45–90 years), with prostate volumes ranging from 15 to 250 ml (mean volume ~49.6). Mean operative time was 53.7 min and the procedures were performed under general or regional anesthesia. Some studies excluded men with urinary retention (18), very large prostates, or a prostate-specific antigen (PSA) higher than 10 ng/dl (31). Reduction in prostate volume ranged from 37% (31) to 53% and was comparable to that after TURP (32).

Mean catheterization time ranged from 6 to 69 hours, while in one study, in one third of patients no catheter was left at the end of the procedure (31). No significant bleeding occurred and no blood transfusion was required. The efficacy of the procedure was mirrored in the excellent results of maximum flow rate (Qmax) and International Prostate Symptom Score (IPSS) improvements. Mean improvement in Qmax was 13.6 mL/sec from baseline, and there was a 14 point fall in mean IPSS.

Later results from a multicenter study with a 3-year follow-up of 139 men treated with the 80W KTP laser confirmed the efficacy of the procedure. However significant differences in improvement levels for patients with a baseline PSA greater than 6 ng/dl may raise skepticism about the efficacy of PVP in very large prostates (33). Regarding the safety of the procedure, the main complications encountered in these series consisted of urinary retention ranging from 1% to 15.4%, dysuria ranging from 6.2% to 30%, and minor hematuria (≤ 18%).

The occurrence of retrograde ejaculation was evaluated to range between 36% and 55% in previously potent men (34,35).

Complications described were transient dysuria (6%), hematuria (3%), bladder neck contracture (2%), and retention (1%). Whatever the significance of these shortcomings, at 5 years, 79% of treated patients maintained a 100% improvement from baseline in Qmax, whereas all patients maintained an improvement from baseline of at least 50% in their symptoms per IPSS (36). The conclusion that the outcomes of PVP are durable too seems substantiated.

In a large series reporting complication rates after PVP, 406 patients including men in retention, on anticoagulation therapy, and of an advanced age were treated and followed up for 3 years (37). No serious bleeding or TURP syndrome was observed. Bladder irrigation was required for 9.6% of patients, most of which were on anticoagulants. Postoperative retention and re-catheterization rate was 9.6%, and strongly correlated with age but not prostate volume at baseline. Also, in 2.2% of the procedures, a transient conversion to TURP for electrocoagulation of troublesome capsular bleeding was necessary. Late complications included a 6.3% urethral stricture rate, whereas 21 patients (5.2%) returned with recurrence of LUTS due to insufficient initial vaporization.

**High Performance System KTP Laser: Present and Future**

The 80W KTP laser system has shown efficacy and safety in the treatment of BPH; however, the vaporization procedure for very large glands remains a tedious and time-consuming task due to the limited rate of power delivered per unit of time. To overcome these limitations and in view of the favorable results so far, the new and improved GreenLight High Performance System (HPS; American Medical Systems, Minnetonka, MN) was recently introduced. This advanced diode-pumped solid-state laser system delivers the same 532-nm wavelength in a power setting of 20 to 120 W instead of the 30 to 80 W average power level of its predecessor. The laser beam itself is improved, and maximum focus with negligible divergence of power is now maintained even within a distance of 3 to 5 mm from the fiber, allowing for vaporization to be consistently efficient despite variable changes in distance between fiber...
and tissue. The fiber is covered with a highly reflective coating in order to limit the back-scatter effect and the resultant inadvertent lasering of tissue. The HPS system also incorporates a dual-power mode function using two pedals, one for vaporizing tissue (60–120 W) and another for coagulating at lower power settings (20–40 W), although power is now delivered in 10 W instead of 5 W increments (38).

**Surgical technique and precautions with the HPS system**

These modifications in beam and fiber quality, combined with the higher power available, result in significant modifications in vaporization technique compared with the previous GreenLight PVP system. Actually, the role of the surgeon performing PVP with the HPS system is upgraded and more demanding than it had previously been because more variables are currently controlled by the surgeon such as power selection, switching from vaporization to coagulation, and variable working distance between fiber and tissue. It is suggested that in a medium-sized gland, initial starting power should not exceed 80 W, which is sufficient to vaporize the prostate effectively. In cases of larger or more fibrous glands, power may be increased, provided that enough space is maintained between the fiber and the tissue to exercise a true noncontact vaporization technique. Additionally an adequate flow of irrigant is provided for cooling of fiber and tissue to prevent fiber degradation due to prolonged rubbing against the tissue and to limit coagulation necrosis secondary to heat-transduction effects from the point of vaporization. The fiber should not be too close to the scope because the high laser power could damage the lens and the metallic sheath in seconds. Furthermore, a constant sweeping movement should be maintained at this power level for quick vaporization of large areas. Stationary laser application at high powers should be avoided because it may lead to a rapid development of a deep defect. Power should be lowered to 80 W when approaching the surgical end point near the capsule to prevent inadvertent capsular perforation.

Hemostasis is achieved using a sweeping near-contact or contact coagulation technique by instantly selecting a low power of 20 to 30 W in the dual-mode power pedal. Certainly, the HPS system is not harmless and caution should be exercised especially in the higher power settings. The actual goal of HPS is to reduce the lasering-operative time in larger prostates and tackle the occasional fibrous gland more efficiently. High-power settings should be judiciously used in certain cases but certainly avoided in others. For instance, in high-risk patients on oral anticoagulants and in high–operative risk patients, the 60 to 80 W power settings are preferable for providing an optimum combination of hemostasis and effective vaporization. In cases of large prostates with intravesical protrusion, a power setting of 60 W to 80 W is also advised to treat the intravesical portion of the gland to minimize potential bladder wall lesions. Potential risks resulting from the use of high-power lasering include inadvertent deep incision into the bladder wall resulting in bladder perforation or injury to the orifices. Moreover, increased vaporization efficiency achieved with high-power settings can result in less hemostatic effects (7,15).

**PVP versus TURP**

**Safety and efficacy**

Photoselective vaporization of the prostate represents one of the latest modalities for the treatment of BPH challenging the reference standard TURP. In a randomized control study comparing PVP with conventional TURP, PVP was superior to TURP in terms of catheter drainage time and hospital stay, although PVP was somewhat lengthier than TURP (39). Intraoperative bleeding was a problem in 10.8% of cases of TURP but not in PVP. Early (6-month) results revealed similar improvements in voiding parameters, although prostate volume reduction was significantly greater in the TURP arm, thus questioning the durability of longer-term results of PVP. Nevertheless, the mean follow-up of 6 months a priori precludes any conclusions on durability.

The first randomized, although incomplete, study of 76 patients treated by TURP or PVP and then followed up for at least 6 weeks showed similar results in terms of voiding parameters (Qmax, IPSS) for the two arms (40). Data were preliminary and results biased in many ways (men with prostate volumes > 85 mL; men on retention and on anticoagulants were excluded; surgeons were inexperienced in PVP); however it was clear that PVP was superior to TURP in terms of earlier catheter removal, hospital stay, and rate of early complications. Data on reoperation rates and long-term efficacy of the procedures were, unfortunately, not available. Interim results from the same trial were recently published (41). Improvements in Qmax and symptom scores were equivalent for both treatments, and although the number of patients available for evaluation at 1 year (n = 59) was still far from optimal for drawing substantiated conclusions, early reoperation rate was in favor of TURP. However, in total, early complications were fewer and less severe in the PVP arm. A recent, prospective, nonrandomized study comparing PVP (n = 249) with TURP (n = 129)
revealed a significant difference in mean operative time between the two procedures (73 min for PVP vs 53 min for TURP) that was partly due to larger prostates assigned to the PVP group. PVP confirmed its superiority in terms of intraoperative safety and earlier discharge from the hospital. Both treatments resulted in similar improvements in IPSS, but Qmax was higher for TURP in the 2-year follow-up, and there was also a trend for higher reoperation rates for PVP in the long term (42).

However, the procedure can be sometimes lengthy, and laser costs can be difficult to justify, although preliminary data show PVP to actually be less expensive than TURP (43).

Learning curve

The learning curve of a procedure has a crucial role in its overall applicability and cost-effectiveness. For example, the significantly shorter learning curve of KTP laser as opposed to holmium laser enucleation of the prostate (HoLEP) is the main reason for the popularity and wider applicability of the former (44).

However, there are intrinsic difficulties in accurately quantifying the concept of a learning curve. It relies on the surgeon’s subjective estimations and is biased by the level of experience and quality of training and education that each surgeon has received from mentors. Nevertheless, PVP is considered easier to learn and perform than TURP. Most urologists would feel comfortable performing TURPs after about 50 procedures (41). Others authors considered a series of 5 to 10 procedures enough for gaining competence in small prostates (<40 ml) using the 80 W KTP laser while larger prostates can be confidently managed after about 20 cases (20,41). A short mentorship period is necessary for one to adequately perform PVP.

HoLEP

The aim of any surgical treatment for lower urinary tract symptoms suggestive of benign prostatic hyperplasia is the removal of as much of benign prostatic tissue as possible. Minimally invasive treatment is defined as any surgical procedure less invasive than open surgery. Towards this end, laser technology has been applied to the treatment of BPH more than 15 years ago. The Holmium:ytrrium aluminium Garnet (Ho:YAG) laser possesses several properties that make it an ideal incisional tool for soft tissue. It is a pulsed laser in the near infrared range of the wavelength spectrum (2,140 nm), allowing it to be transmitted down fine flexible optical fibers. Each pulse of energy is in the kilowatt range, and as it is highly absorbed by water, the depth of penetration is relatively short at 0.4 mm. These properties create a high-intensity thermal effect in tissue vaporization at the tip of the fiber, avoiding forward scatter of energy into deeper tissue. The holmium laser also possesses good hemostatic properties, thereby decreasing the risk of postoperative hematuria and need for continuous bladder irrigation. Also it can be used with saline as the irrigant, thereby minimizing the risk of dilutional hyponatremia.

The equipment necessary and in use today are: a 80-100 Watt holmium laser; a 550 _m end firing fiber; a 27F modified continuous flow resectoscope with normal saline for irrigation; a ureteric catheter to stabilize the laser fiber; a 26F rigid nephroscope and a transurethral morcellator.

Preoperative evaluation and surgical technique

Currently indications for HoLEP are the same as for TURP and open prostatectomy: symptomatic lower urinary tract obstruction due to BPH. Voiding uroflowmetry with the addition of pressure flow urodynamics are performed where indicated. Initially HoLEP was applied for the treatment of small and mid-sized prostate glands; recently however it has been proposed as a new gold standard for the treatment of patients with very large glands.

The current technique of HoLEP involves the enucleation of whole anatomical hyperplastic lobes of the prostate. In this setting, the laser fiber acts as the surgeon’s index finger during an open prostatectomy, shelling the adenoma from the surgical capsule of the prostate. The lobes are then chopped up into small fragments by a transurethral soft tissue morcellator that simultaneously removes the morcellated tissue (47,48).

Although HoLEP is relatively bloodless, patients are still advised to discontinue treatment with warfarin prior to surgery. Our current practice is to routinely evaluate the prostate volume by TRUS prior to surgery. This gives a rough estimation about operative time as the size of the prostate correlates well with the difficulty and the length of the procedure (49).
Additionally preoperative ultrasound helps to identify other pathology such as bladder stones that can be dealt with by the holmium laser in the same setting. It is not necessary to cross-match blood for this procedure as the transfusion rate is less than 0.2%. The procedure is performed under spinal or general anesthesia. The technique of HoLEP procedure has been very well described by Peter Gilling (50).

The holmium laser currently used is the 100 W Versapulse Holmium Laser (Lumenis, Tel Aviv, Israel) with a 550 μm end-firing fiber. The power is usually set at 2.0 J at 50 Hz (100 W). The fiber is placed through a 6 French (F) ureteric catheter in order to protect the scope and stabilize the fiber. The fiber is delivered through a 27F continuous flow resectoscope with a 30 degree scope. The inner sheath is modified to incorporate a laser fiber channel at the tip to guide the fiber, and a bridge at the other end through which the laser fiber and ureteric catheter are stabilized with a Luer-Lok. The irrigating solution used is normal saline. A 26F nephroscope is used for morcellation. An adaptor is used to connect this to the outer sheath. The Versacut morcellator (Lumenis) is composed of a hand piece with hollow reciprocating blades, high suction roller-pump/control box, and a variable speed foot pedal.

**Step 1: bladder neck incisions**

The first step of the procedure is to create bladder neck incisions (BNIs) at 5 and 7 o’clock down to the surgical capsule which is identified by circular fibers running transversely. In small prostates (<40 mL), this may suffice for relief from symptoms. It is important to define the capsule accurately at this stage, as this will serve as an anatomic landmark for the rest of the procedure. The incisions are carried down and medially to a point on each side of the verumontanum. The laser fiber is kept close to the edge of the resectoscope so that the ceramic beak of the scope can be used to dissect tissue. The incisions are widened laterally and undermine the lateral lobes. This helps to define the plane for dissection of the lobes later on while it improves the flow of irrigation. Bleeding vessels often encountered around the verumontanum can be coagulated effectively by slightly retrieving the scope and defocusing the laser beam.

**Step 2: enucleation of the median lobe**

The median lobe is dissected off the surgical capsule in a retrograde fashion by joining the two bladder neck incisions just proximal to the verumontanum with a transverse incision. The beak of the resectoscope can be used to push the adenoma up toward the bladder during dissection. Care must be taken not to undermine the bladder neck. The median lobe is then detached at the bladder neck and allowed to float into the bladder.

**Step 3: enucleation of the lateral lobes**

Extending the initial bladder neck incisions laterally at the verumontanum commences the undermining of the lateral lobes. The dissection continues in a circumferential manner toward the 11- and 1-o’clock positions on either side. Should the correct plane is found, the lobes are peeled off the capsule with the laser fiber as is done with the index finger of a surgeon during an open prostatectomy.

A third bladder neck incision is next made at 12 o’clock, and the upper part of the lateral lobes is detached from the surgical capsule using a lateral sweeping motion. These are continued downward and distally until the incisions are being joined at the apex. The challenging step is determining where the upper and lower incisions will meet. Coming back too far with the top incision may damage the sphincter, whereas failure to extend the top incision enough before sweeping down will create a false dissection plane and lead to an inefficient and more troublesome enucleation. Once the two incisions are joined, the dissection is carried on along in a retrograde fashion towards the bladder neck where the lobe is detached and left to float into the bladder. Throughout the enucleation, the holmium laser coagulates small venus and arterial bleeders as they are encountered. Excellent hemostasis is crucial prior to morcellation.

**Step 4: morcellation of enucleated fragments**

Morcellation of the enucleated fragments takes place through a 26 F nephroscope with a 5 mm working channel. The morcellator produces suction through the hollow blades thus engaging the lobes within the blades. The high-speed blades then reciprocate back and forth to slice off fragments with a guillotine movement. The fragments are suctioned through the blades and on through tubing attached to the back of the hand piece to the roller pump and then into a sieve.

Morcellation can remove tissue at a rate of up to 10 g/min, although 4 g/min is the average, and any small remaining fragments are evacuated with a Toomey syringe. The size of the prostate gland does not seem to have an impact on the efficiency of morcellation (51).

Morcellation is best performed with a full bladder to avoid trapping of the bladder wall in the blades of the morcellator. Usually injury to the
bladder wall is generally minor and the procedure is not compromised. Major bladder injury is very rare, but may lead to troublesome bleeding or urine and irrigant extravasation. Occasionally morcellation can be troublesome due of the fibrous nature of the prostatic tissue, suboptimal visibility or extravasation of fluid leading to inability to adequately distend the bladder. In cases like these a catheter can be left in place and morcellation be postponed for a week or the tissue fragments can be removed through a small suprapubic cystotomy (52).

At the conclusion of the case a 2-way 20F Foley catheter is left in place with the balloon inflated to 20 mL with sterile water. The vast majority of patients require no bladder irrigation. Catheters are removed the following day if hematuria is satisfactorily light, and the patients are discharged from the hospital after they have had 2 or 3 successful voids.

As with any type of prostate surgery, patients are routinely advised that although obstructive voiding symptoms may markedly improve, storage symptoms such as frequency, urgency, and nocturia may take weeks to months to improve. The risks and potential complications of HoLEP include the risks of anesthesia, infection, bladder perforation during morcellation, bleeding, late development of urethral stricture and bladder neck stenosis, stress incontinence, and decreased potency.

### Outcomes compared to TURP and OP

HoLEP has been compared with TURP for prostates in the 40 to 200 gr range in a randomized trial with one year of follow-up. Although the mean operative times for HoLEP were longer than for TURP, HoLEP patients on average had their catheters removed earlier, were discharged earlier, and suffered less morbidity than those in the TURP group. More prostate tissue was removed in the HoLEP group compared with the TURP group. The clinical outcomes at the 12-month follow-up were comparable with respect to improvements in symptom scores and peak flow rates. Relief of urodynamic obstruction however was significantly better in the HoLEP group, which is probably a reflection of the greater amount of tissue removed (53).

Results from two other randomized trials comparing HoLEP to TURP confirmed the significant less morbidity of HoLEP compared to TURP. Evidence showed that even prostate glands greater than 100 g can be safely enucleated without the risks of bleeding or irrigant absorption that are present with TURP (54,55).

<table>
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<th>Author</th>
<th>Year</th>
<th>N of Patients</th>
<th>Preoperative prostate volume</th>
<th>Tissue retrieved (gr)</th>
<th>IPSS before</th>
<th>IPSS after</th>
<th>Q max before</th>
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<td>9±3.1</td>
<td>9±3.1</td>
<td>25.1±10.7</td>
<td>25.1±10.7</td>
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</table>
With regard to the efficacy of HoLEP compared to open prostatectomy Kuntz and Lehrich performed the first randomized trial showing operative times to be longer in the HoLEP group (138.4 vs 90 minutes), while catheterization times and hospital stay were significantly less in the HoLEP group (24 vs 144 hours and 48 vs 240 hours, respectively). At 12-months follow-up, the clinical outcomes in both groups were equivalent. HoLEP was therefore as effective as open prostatectomy although associated with significantly less perioperative morbidity (56).

Results from the most recent studies have confirmed HoLEP to be a safe and effective procedure which has comparable results to TURP and OP and is equally suitable for small, medium and large prostate glands. The objective and subjective improvements remained sustained at 6 year follow-up (57-62). Data on the efficacy of HoLEP are shown in Table I.

Moreover according to the same studies the rates of complications for HoLEP are lower than that reported for TURP and open prostatectomy (Table II).

Holmium laser prostatectomy consists of a laser enucleation technique, combined with transurethral morcellation of whole prostatic lobes. HoLEP can be performed irrespective of the prostate size, and has been proved highly effective at treating urinary retention. The main advantages of HoLEP are the short catheterization time and hospital stay, the good haemostatic properties, the use of saline irrigation and that tissue is retrieved for histopathological analysis. On the other hand, the operative times are generally longer than those seen in TURP since, on average, more tissue is removed with the HoLEP procedure (63).

Clinical outcomes in terms of symptom improvement and relief from obstruction are equivalent to TURP and OP. Additionally HoLEP can tackle larger glands than TURP emerging as the endourologic equivalent of open prostatectomy.

Currently the main hurdle before the wider adoption of HoLEP is the significant learning curve. HoLEP is by most considered to be more difficult than TURP most probably because it requires a different technique to that of loop resection which most urologists are familiar with. An average of 50 cases was considered sufficient for one to get familiar with the technique before tackling larger prostate. On the contrary El-Hakim and Elhilali support that after performing 20 procedures under supervision, a urology resident could reasonably be expected to achieve outcomes similar to that of a more experienced surgeon (64).
CONCLUSIONS

The evolution and maturation of laser treatments for prostatic hyperplasia are currently posing a serious threat to TURP and open prostatectomy, the long-established reference standard treatments of BPH. The high power KTP laser and HoLEP are rapidly gaining popularity thanks to their ability to safely de-obstruct the prostatic urethra by the creation of a TURP-like cavity with minimal bleeding. Moreover PVP offers the added benefit of little-to-no learning curve and the prospect of a day-case, catheter-free procedure. On the other hand HoLEP, although slightly more difficult to learn, is able to safely tackle larger prostates that would be otherwise treated with open prostatectomy with its significant morbidity. Also the lack of comparable data on the durability of PVP raises concerns regarding the long term efficacy of PVP of the procedure compared to HoLEP.

The increase in expertise worldwide in laser-based treatments for BPH together with the development of lasers that are faster at ablating tissue and can have other urological uses (e.g. thulium) may threaten the longevity of TURP and open prostatectomy. However other urological uses (e.g thulium) may threaten the raise concerns regarding the long term efficacy of PVP of the procedure compared to HoLEP.

REFERENCES AND RECOMMENDED READINGS
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