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European Association of Urology

Review – Benign Prostatic Obstruction

A Review of the Recent Evidence (2006–2008) for 532-nm Photoselective Laser Vaporisation and Holmium Laser Enucleation of the Prostate

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Article info

Article history:
Accepted March 16, 2009
Published online ahead of print on April 3, 2009

Keywords:
Prostatic hyperplasia
Bladder outlet obstruction
Laser surgery
Holmium
Holmium laser
prostatectomy
Potassium titanyl
Phosphate lasers
Laser vaporisation

Abstract

Context: Holmium laser enucleation of the prostate (HoLEP) and 532-nm laser vaporisation of the prostate (with potassium titanyl phosphate [KTP] or lithium borate [LBO]) are promising alternatives to transurethral resection of the prostate (TURP) and open prostatectomy (OP).
Objective: To assess safety, efficacy, and durability by analysing the most recent evidence of both techniques, aiming to identify advantages, pitfalls, and unresolved issues.
Evidence acquisition: A Medline search of recently published data (2006–2008) regarding both techniques over the last 2 yr (January 2006 to September 2008) was performed using evidence obtained from randomised trials (level of evidence: 1b), well-designed controlled studies without randomisation (level of evidence: 2a), individual cohort studies (level of evidence: 2b), individual case control studies (level of evidence: 3), and case series (level of evidence: 4).
Evidence synthesis: In the last 2 yr, several case-control and cohort studies have demonstrated reproducibility, safety, and efficacy of HoLEP and 80-W KTP laser vaporisation. Four randomised controlled trials (RCTs) were available for HoLEP, two compared with TURP and two compared with OP, with follow-up >24 mo. Results confirmed general

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 doi:10.1016/j.eururo.2009.03.070

efficacy and durability of HoLEP, as compared with both standard techniques. Only two RCTs were available comparing KTP laser vaporisation with TURP with short-term follow-up, and only one RCT was available comparing KTP laser vaporisation with OP. The results confirmed the overall low perioperative morbidity of KTP laser vaporisation, although efficacy was comparable to TURP in the short term, despite a higher reoperation rate.
Conclusions: Although they are at different points of maturation, KTP or LBO laser vaporisation and HoLEP are promising alternatives to both TURP and OP. Sufficient data proves HoLEP's durability for most prostate sizes at long-term follow-up; KTP laser vaporisation needs further evaluation to define the reoperation rate. Increasing the number of quality prospective RCTs with adequate follow-up is mandatory to tailor each technique to the right patient.

1. Introduction

Transurethral resection of the prostate (TURP) and open prostatectomy (OP) for large prostates are currently the gold standards in the treatment of advanced stages of bladder outlet obstruction (BOO) due to benign prostatic enlargement (BPE). Both procedures provide excellent long-term results in terms of reoperation rate and complication rate and have certainly passed the test of time [1]. Even today, however, both procedures can be associated with considerable perioperative morbidity that, albeit small, can offer room for improvement [2,3]. Patients undergoing treatment for BOO are progressively older with more comorbidities; therefore, the need for even more minimally invasive surgical techniques is constantly growing to treat every prostate size. Currently, holmium laser enucleation of the prostate (HoLEP) and 80-W high-powered laser vaporisation (with potassium titanyl phosphate [KTP]) are the most studied options, with accumulating evidence suggesting that they have the potential to become valid alternatives to both OP and TURP [4]. To date, 80-W KTP laser vaporisation, the recently introduced 120-W laser vaporisation with lithium borate (LBO), and HoLEP are at different points in their clinical maturation; thus, data published in the last 2 yr are unbalanced. Safety and feasibility studies were reported predominantly for KTP and LBO laser vaporisation, while long-term data predominantly became available for HoLEP.

This review will focus on each approach to assess safety, efficacy, and durability and will aim to identify any areas of uncertainty and any specific advantages.

2. Evidence acquisition

A Medline search over the last 2 yr (January 2006 to September 2008) was performed using evidence obtained from randomised trials (level of evidence: 1b), well-designed controlled studies without randomisation (level of evidence: 2a), individual cohort studies (level of evidence: 2b), individual case control studies (level of evidence: 3), and case series (level of evidence: 4).

The latest version of the level-of-evidence rating system was used [5].

3. Evidence synthesis

3.1. *KTP and LBO laser vaporisation of the prostate*

3.1.1. *Technical aspects*

The green light of the so-called photoselective vaporisation of the prostate (PVP) is generated by passing a neodymium:yttrium aluminium garnet (Nd:YAG) laser with 1064-nm laser light through a frequency-doubling crystal, reducing the wavelength by half to 532 nm. Frequency-doubling crystals consist of KTP or LBO. The older 80-W laser device uses the KTP crystal, and the latest generation uses the LBO crystal with a 120-W power setting. At the end of 2008, the majority of articles published were based on the 80-W KTP laser.

The vaporisation power is delivered as a quasi-continuous-wave–laser rapid pulse [6]. The high absorption of the laser, predominantly by haemoglobin rather than by water, offers enhanced haemostatic properties; therefore, vaporisation is achieved by concentrating heat in a small volume within a very short time. It has been demonstrated that downregulation of angiogenesis by 5α-reductase inhibitors does not alter the haemostatic effects and the vaporisation proprieties of the KTP laser [7].

The procedure has been shown to be safe and reproducible, providing a transurethral resection (TUR)–like cavity [6,8,9]. The use of saline as an irrigant avoids the risk of TUR syndrome, as measured by expired-breath ethanol [10]. Furthermore, no difference in vision quality was reported when comparing water and saline irrigation during PVP [11]. These findings are of particular interest when using KTP laser vaporisation for large prostates, as an alternative to OP or HoLEP. A comprehensive overview of available and recommended 532-nm laser vaporisation techniques has been published recently [12]. One of the major drawbacks of 80-W KTP laser vaporisation is the relatively slow vaporisation time and the lack of specimen for pathologic assessment [13]. Therefore, the vaporisation volume and speed during PVP are difficult to calculate due to the lack of tissue retrieved [14].

The new high-performance system (HPS) has been introduced recently, generating a laser with up to 120 W using an LBO crystal, with promising results; the objective is to increase speed of ablation [15].

3.1.2. *Safety issues*

The combination of tissue ablation and coagulation ensures good haemostasis, offering a practically bloodless surgical field. These properties have allowed the use of this technique for larger prostates [16], for patients on ongoing anticoagulation therapy [17], for patients with high cardiovascular and pulmonary risk [18], or for patients with acute urinary retention [19]. The laser currently is being evaluated both in experimental and in clinical settings to assess the safety of different power settings. In an experimental study on canine prostates, the histopathologic effects of 80- and 120-W lasers were compared [20]. The 120-W HPS laser demonstrated a higher rate of vaporisation; particularly, the depth of vaporisation injury was associated either with a lengthier time of vaporisation or with higher laser power applied. Interestingly, although more tissue was vaporised in less time during HPS, the depth of coagulation decreased, even after increasing power or duration. Although these findings require evaluation in a clinical setting, they do permit some conclusions. First, coagulation for haemostasis should be conducted at low power. Second, and most important, as full thickness vaporisation is more likely, the surgeon must control the working distance to avoid unwanted damage. Tissue damage could be also related to the energy dispersion caused by deterioration of the fibres. This issue was assessed by Hermanns et al [21], who evaluated the relationship between loss of power and fibre deterioration after or during 80-W vaporisation. The authors demonstrated a median power drop of >80% compared with baseline after the application of 275 kJ. A significant decrease of the median power output was found in 90% of the fibres during vaporisation; furthermore, severe damage (melting) of the tip was reported after application of 200 kJ. This damage particularly seemed to occur around the region of emission due to melting and carbonisation effect, leading to potential energy dispersion.

3.1.3. *Intra- and perioperative morbidity*

Attractive features of KTP laser vaporisation include the relatively short learning curve and the low rate of intra- and perioperative complications [22]. Overall operative times of KTP laser vaporisation from the current largest series are reported in Fig. 1. Table 1 details perioperative data of series from high-volume centres. Ruszat et al [14], in particular, compared outcomes in a two-centric, nonrandomised study comparing TURP to KTP (127 vs 269 patients, respectively). The study demonstrated safety of the laser vaporisation procedure regardless of prostate size, with lower rates of transfusion, capsule perforation, and clot retention compared with TURP. These data are all the more convincing because, although some methodologic flaws are present in patient selection (eg, in the KTP group prostates were larger [mean: 63.4 vs 48.1 ml]), patients were older and had a higher rate of anticoagulation therapy. These findings were confirmed by similar nonrandomised series [23–25] and by data from the only two available randomised controlled studies comparing TURP and KTP laser vaporisation [26,27].

Horasanli et al randomised a total of 76 patients (37 and 39 in the TURP and the KTP groups, respectively) with large prostates (88 ± 9.2 ml and 86.1 ± 8.8 ml) [26]. Bouchier-Hayes et al randomised 95 patients, but only 76 were evaluated (38 in both

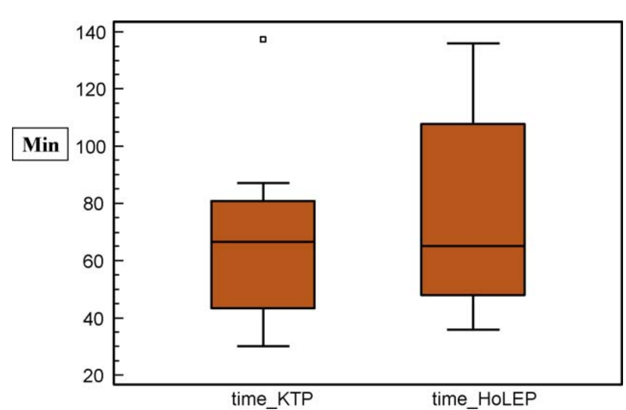

Fig. 1 – Box plots comparing average laser time (minutes) in recent series between potassium titanyl phosphate (KTP; Table 1, 12 studies) laser vaporization and holmium laser enucleation of the prostate (HoLEP; Table 2, 8 studies).

Table 1 – Perioperative results, postoperative outcome, and complications of 80-W potassium titanyl phosphate (KTP) laser vaporization

Author	Level of evidence	No. of patients	Follow-up, mo	Mean preoperative prostate weight, ml ± SD	Preoperative Q_{max}	Preoperative IPSS	Operation time, min	Energy delivered, kJ	Fibres used per case, *n*	Mean catheterisation time	Mean hospital stay, d	Blood transfusion, %
Bouchier-Hayes et al [27]	1b	76	12	33.2	NA	NA	30.2	NA	NA	12.2 h	1.08 ± 0.28	0
Te et al [31]	4	139	36	54.6 ± 31.7	7.8	NA	38.7 ± 23.3	103 ± 64.5	NA	14.1 ± 14.7 h	NA	0
Monoski et al [34]	4	40	NA	110.7 ± 47.9	7.3 ± 3.4	17.5 ± 8.5	137.3 ± 63.4	NA	NA	NA	NA	NA
Araki et al [7]	4	117	12	72.8 ± 49.5	10.7 ± 5.8	26.9 ± 6.9	32.0 ± 27.6	97.4 ± 91.6	NA	NA	NA	0
Rajbabu et al [16]	4	54	24	135 ± 52	8	22.9 ± 6.8	81.6 ± 22.9	278 ± 60	1.29	23 ± 17.1 h	11.0 ± 10.8	0
Heinrich et al [6]	4	140	6	43 ± 22	13.0 ± 10.3	19.7 ± 6.3	53 ± 16	181 ± 58	NA	1.4 ± 0.8 d	3.6 ± 1.5	0
Ruszat et al [17]	4	116	24	62 ± 34	7.2 ± 3.0	18.6 ± 6.5	67 ± 28	210 ± 104	NA	1.8 ± 1.4 d	3.8 ± 2.7	0
Horasanli et al [26]	1b	39	6	86.1 ± 8.8	8.6 ± 5.2	18.9 ± 5.1	87 ± 18.3	247 ± 31	NA	1.7 ± 0.8 d	2 ± 0.7	0
Pfitzenmaier et al [29]	4	173	12	45	8	20	76	241.6	1.11	1 (0–5) d	NA	0.5
Ruszat et al [8]	4	500	60	56.1 ± 25.3	8.4 ± 5.0	20	66.4	206 ± 94	NA	1.8 ± 1.2 d	3.7 ± 2.9	0
Alivizatos et al [28]	1b	65	12	93	8.6	20	80	196 ± 51.8	1.32	24 h	2	0
Hamann et al [32]	4	45	12	47.63	7.9	20.7 ± 7.6	47.8	151	NA	NA	NA	0

Author	Reduction in prostate volume, %	Recatherization, %	UTI, %	Stress urinary incontinence, %	Urge incontinence, %	Urethral stricture, %	Bladder neck contracture, %	Postoperative Q_{max}	Reoperation for residual tissue, %	Postoperative IPSS
Bouchier-Hayes et al [27]	NA	3.9	NA	0.0	10.5	0.0	0.0	NA	5.6	NA
Te et al [31]	29	5	2.2	0	6.5	0.7	1.4	NA	4.3	NA
Monoski et al [34]	NA	NA	NA	NA	NA	NA	NA	15.5 ± 7.8	0	9.7 ± 7.6
Araki et al [7]	NA	13.6	6.8	0	0	5.1	6.8	21.5 ± 8.4	NA	6.6 ± 4.3
Rajbabu et al [16]	54	7.5	9.2	0	22	3.7	NA	19.3	6	5.7 ± 3.6
Heinrich et al [6]	NA	3.5	7.1	0	6.4	0	2.6	18.6 ± 11.8	0	8.8 ± 6.5
Ruszat et al [17]	NA	11.2	7.8	2.6	8.6	5.2	1.7	19.2 ± 5.6	1.7	5.6 ± 4.7
Horasanli et al [26]	40.5	15.3	15.3	0	0	5.1	NA	13.3 ± 7.9	17.9	13.1 ± 5.8
Pfitzenmaier et al [29]	NA	10.4	4.6	1.1	25.7	NA	NA	23	13.3	5.0
Ruszat et al [8]	NA	11	6.8	1.2	2.4	4.4	3.6	17.5 ± 7.5	6.8	5
Alivizatos et al [28]	–	7.69	17	0	0	1.54	0	16	1.5	9
Hamann et al [32]	NA	0	NA	0	20	NA	NA	18.6	0	7.3 ± 3.6

IPSS = International Prostate Symptom Score; Q_{max} = maximum flow rate; SD = standard deviation; UTI = urinary tract infection; NA = not available.

* Data presented as mean and standard deviation (SD) of the mean.

groups) [27]. Results confirmed the overall advantages in terms of mini-invasiveness of KTP laser vaporisation compared with TURP (transfusion rate: 0% vs 8.1%, $p = 0.001$) [26], of shorter catheter time (mean: 12.2 h vs 44.52 h, $p < 0.0005$), and of shorter hospital stay (mean: 1.08 d vs 3.4 d, $p < 0.00001$) [27].

Rajbabu et al [16] treated 54 patients with prostates >100 ml using 80-W KTP laser vaporisation. The procedure proved to be safe, and complications were relatively low. KTP laser vaporisation was also compared with OP in a randomised study [28] for the treatment of large prostates (median: 93 ml and 96 ml in the KTP and the OP groups, respectively). KTP laser vaporisation was shown to be safer than OP in the perioperative period, requiring a lower number of blood transfusions (0% vs 13.3%, $p = 0.002$) and recatheterisations (7.7% vs 16.7%, $p = 0.132$).

3.1.4. *Efficacy and postoperative morbidity*

In 2006, the International GreenLight Users (IGLU) group was formed by the nine leading centres with extensive experience in KTP laser vaporisation [15]. The group recently published interesting data regarding the state of the art of KTP and LBO laser techniques, offering an insight into surgical recommendations and guidelines. The study group concluded that long-term efficacy data are still lacking, and, thus, the durability of the procedure still needs to be assessed.

Pfitzenmaier et al compared the outcomes of patients with prostates < 80 ml and with larger prostates (>80 ml) in a prospective single-centre study [29]. Results indicated overall improvement in flow at the 12-mo follow-up (mean maximum flow rate [Q_{max}]: >20 ml/s in both groups), confirming the previously reported data on large prostates [14,26,28,30]. Postoperative data from the two randomised studies comparing KTP laser vaporisation with TURP [26,27] are available in the literature. Bouchier-Hayes et al [27] were able to demonstrate equivalence in terms of obstruction relief from both KTP laser vaporisation and TURP after 1 yr, although only 38 patients per group were available for evaluation. In the other randomised study evaluating short-term follow-up, Horasanli et al [26] compared TURP to KTP laser vaporisation for larger prostates (>70 ml) and found better functional results at the 6-mo follow-up in the TURP arm (Q_{max}: 20.7 ± 11.3 vs 13.3 ± 7.9, $p = 0.02$; residual bladder volume: 22.9 ± 18.7 ml vs 78.9 ml, $p = 0.01$).

When considering larger prostates (mean: 135 ± 42 ml) [16] at 3-mo follow-up, prostate size was shown to drop to a median of 75.9 ml from the preoperative value of 134 ml ($p < 0.001$). This finding, coupled with a significant drop of serum prostate-specific antigen (PSA) levels from baseline (mean: from 11.8 ng/dl to 6.4 ng/dl at 12-mo follow-up) demonstrated an immediate, effective disobstruction which proved durable at the 24-mo follow-up.

Medium-term data [8,31] seem to suggest durable functional results of KTP laser vaporisation in experienced and high-volume centres, although only 47 of 139 patients (33.8%) and 27 of 500 patients (5.4%) were available for evaluation at the 36- and 60-mo follow-up, respectively. Ruszat et al [14] recently updated their two-centric, nonrandomised-experience study comparing TURP and KTP laser vaporisation. At the 24-mo follow-up, 96 of 269 patients (35.6%) and 76 of 127 patients (59.8%) were available for analysis in the KTP and TURP groups, respectively. Disobstruction in terms of Q_{max} was shown to be clinically effective in both groups, although there was an age-dependent increase in Q_{max} for the two procedures, with patients aged <70 yr showing a greater increase in Q_{max} than those aged 70–80 yr. The increase, however, was greater after TURP in both age categories and was statistically significant at 1-, 3-, and 6-mo follow-up for patients aged <70 yr and at 6- and 12-mo for those aged >70 yr. Fig. 2 highlights functional results

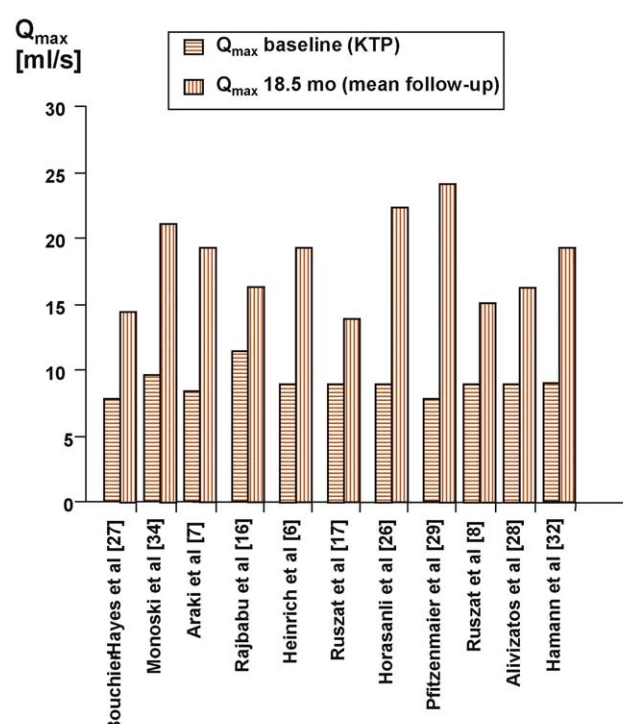

Fig. 2 – Preoperative and postoperative functional results (mean maximum flow rate [Q_{max}]) from recent series of potassium titanyl phosphate (KTP) laser vaporization from high-volume centres.

between baseline and the postoperative period in terms of mean Q_{max} from large KTP centres. A comparison of the data on KTP laser vaporisation and OP [28] showed that functional results were generally satisfactory and comparable after 12 mo but, surprisingly, the flow rate was relatively low for both procedures (Q_{max}: 15.1 ml/s and 16 ml/s in the OP and the KTP groups, respectively).

Postoperative storage symptoms and urge incontinence are often reported after laser treatments. In the largest series reported, such adverse events were usually self-limiting (ie, resolving either spontaneously within the 3-mo period or with the help of anti-inflammatory drugs or antibiotic therapy), ranging from 0% to 25.7% (Table 1) and generally higher than those reported after standard TURP. Data regarding symptomatic improvement, however, are strongly supported by objective urodynamic data [32–35]. Hamann et al demonstrated a reduction in the Schäfer grade by 68.5% at 12 mo postoperatively, associated with an improvement in the urethral opening pressure and the detrusor pressure at Q_{max} [32].

3.1.5. *Medium- to long-term morbidity*

Although long-term data are still scant, KTP laser vaporisation has been shown to be a generally safe intervention with low medium-term morbidity. Urethral strictures have been reported from 0% to 5.1%, and bladder neck contractures have been reported from 0% to 6.8% (Table 1). Retreatment rate ranged significantly from 6.7% at 24 mo [14] to 17.9% at 6-mo follow-up when treating larger prostates (>70 ml) [26]. In another study evaluating safety of KTP for large prostates, the reoperation rate related to insufficient tissue removal was significantly higher in the >80-ml group compared with the <80-ml group at the 12-mo follow-up (10.4% vs 23%, $p = 0.09$) [29].

3.1.6. *Learning curve and economics*

KTP or LBO laser vaporisation is considered to be a urologist-friendly procedure, from a purely technical point of view, but no study to date has correctly assessed the learning curve. It is suggested that prior to treating challenging large prostates, at least 10–20 procedures should be performed on small prostates (<40 ml) to avoid complications related to potential thermal damage [22].

Seki et al [36] performed a retrospective evaluation of the learning curve for KTP laser vaporisation, evaluating 74 cases (mean prostate volume: 53.2 ml). Vaporisation time, total energy delivered, and vaporisation weight were significantly lower during the first cases, but the International Prostate Symptom Score (IPSS), quality-of-life index, Q_{max} rates, and postvoid urine residual at 12-mo follow-up did not change significantly with the increase in experience. Furthermore, the authors reported a low rate of adverse events throughout the experience.

Economic analysis of treatments performed in different countries and at different times are often difficult to interpret and to compare. Stovsky et al [37] performed a cost and outcome analysis comparing TURP, PVP with interstitial laser coagulation, transurethral needle ablation, and transurethral microwave thermotherapy. The authors demonstrated that, generally, ablative techniques were clinically efficacious and cost effective, considering retreatments and adverse events. The main limitations of the study were related to the lack of consistent, homogeneous data available from the literature and the short period of time evaluated (2 yr).

3.1.7. *Sexual function*

Sexual dysfunction following KTP laser vaporisation has been rarely described [22]. Only one paper specifically evaluated sexual function following KTP laser vaporisation [38]; therefore, it is difficult to correctly assess the true impact of the technique in this respect. Improvements in all of the International Index of Erectile Function (IIEF) domains at 6-mo follow-up from a baseline mean of 27.4 ± 3.8 to 34.9 ± 3.7 ($p = 0.010$) were reported. Particularly, the erectile function domain increased from a baseline of 11.3 ± 1.8 to 14.7 ± 1.7 ($p = 0.015$), indicating a general improvement in erectile dysfunction related to lower urinary tract symptoms.

When comparing KTP laser vaporisation and OP, no difference at the 12-mo follow-up was seen in IIEF-5 changes from baseline ($p = 0.964$) [28]. In another study, retrograde ejaculation was reported in 56.7% of patients after KTP laser vaporisation compared with 49% in the TURP arm ($p = 0.21$), demonstrating an effective removal of the adenoma [26].

3.2. *Holmium laser enucleation of the prostate*

3.2.1. *Technical aspects*

Holmium:yttrium aluminium garnet (Ho:YAG) laser is a solid-state pulsed laser with a wavelength of 2010 nm that is highly and rapidly absorbed by water (absorption peak of water: 1.940 nm), which constitutes 60–70% of the prostate. The tissue penetration is only 0.4 mm, predominantly causing vaporisation. Coagulation is achieved simultaneously via dissipating heat, with minimal evidence of coagulative tissue necrosis. The physical proprieties of this laser make it suitable for use in different tissues, including stones, due to the fact that water makes up a significant component of most calculi. Soon after it was first introduced into clinical practice in 1994 [39], the high-powered (>60 W) holmium laser was shown to have the ideal physical properties to achieve accurate haemostasis in prostatic tissue. The enucleation technique (ie, HoLEP), rather than the earlier vaporisation (holmium laser ablation of the prostate [HoLAP]) and resection (holmium laser resection of the prostate [HoLRP]) techniques, has proven to be the best use of the laser: HoLEP is a potentially effective alternative to TURP, especially after the development of a mechanical morcellator to retrieve prostatic fragments in 1996 [40].

A growing amount of recent data on the treatment of different prostate sizes [41,42], the learning curve [43–45], the treatment of high-risk patients [46], the impact on erectile function [47], the feasibility of radical prostatectomy post-HoLEP [48], and the concomitant use for bladder stone treatment [49] have been widely reported by different centres.

3.2.2. *Safety issues*

As already reported in the literature prior to 2006 [50], recent reports on HoLEP have confirmed its safety for different prostate sizes [42,51–53], including for larger prostates (>200 g), as an alternative to both OP [54,55] and TURP [56,57]; these reports prove that HoLEP's efficiency increases with the increase of prostate volume. Because operating time increases linearly with prostate size, fluid absorption can become an issue. It has been calculated that up to 26% of patients experience fluid absorption during HoLEP [58], even after a prolonged procedure (ie, >60 min). As the irrigant is typically physiologic saline, it is not surprising that there has been no evidence of TUR syndrome reported in the literature [13]. Overall operative times of HoLEP from the current largest series are reported in Fig. 1.

3.2.3. *Intra- and perioperative morbidity*

In each of the studies reported, HoLEP proved to be at least equal to both TURP and OP in terms of relief from BOO while providing all of the advantages of a minimally invasive approach, including reduced morbidity, short catheterisation time, and short hospital stay [54–57].

In an effort to compare HoLEP with other minimally invasive ablative procedures that are gaining credibility in the literature, Gupta et al prospectively compared HoLEP in a randomised study to TURP and to transurethral vaporesection of the prostate [59]. Fifty patients were enrolled per arm, and blood loss, catheter and nursing time, and recatheterisation were found to be significantly lower in the HoLEP group.

3.2.4. *Efficacy and postoperative morbidity*

In the last 2 yr, data regarding medium- and long-term urinary functional results have been published, helping to define the durability of HoLEP [45,54–57,60,61]. A total of 607 patients were available for analysis at a mean follow-up of 43.5 mo (Table 2). Functional results proved durable, with a mean Q_{max} of 21.9 ml/s and a mean reoperation rate of 4.3% (range: 0–14.1%) (Fig. 3). A significant drop in serum PSA levels from baseline (mean: from 6.3 ng/dl to 1.63 ng/dl, postoperatively) [45,56,61] and in prostate volume at transrectal ultrasound (mean: from 68 ml to 27.2 ml, postoperatively) [56,61] confirmed an effective anatomic disobstruction.

The durability of the results is likely to be related to the complete enucleation achieved, especially at the apex, a feature that is also typical of OP. Careful pre- and postoperative urodynamic assessment has confirmed that not only is the relief of obstruction with HoLEP superior [56], or at least equivalent [62], to TURP but that HoLEP is equivalent

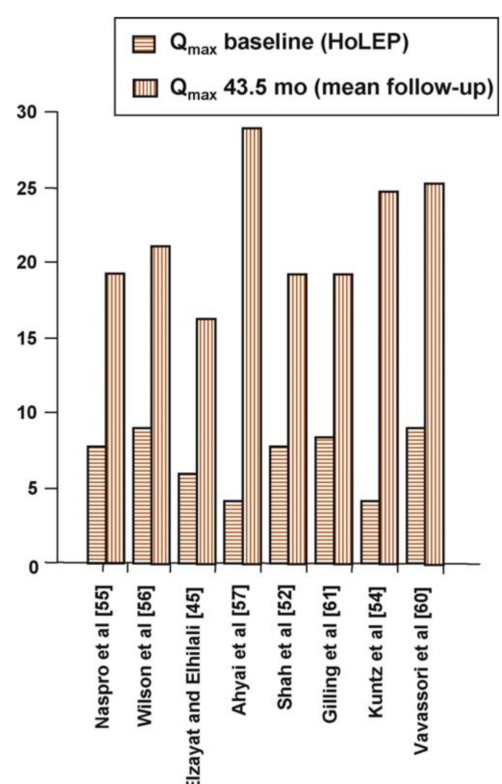

Fig. 3 – Preoperative and postoperative functional results (mean maximum flow rate [Q_{max}]) from recent series of holmium laser enucleation of the prostate (HoLEP) procedures from high-volume centres.

Table 2 – Perioperative results, postoperative outcome, and complications of holmium laser enucleation of the prostate (HoLEP) from papers with a follow-up >2 yr

Author	Year	Ref. no.	Leave of evidence	No. of patients	Power, W	Follow-up, mo	Preoperative prostate volume, ml	Total enucleation time, min	Total energy, kJ	Tissue retrieved, g	Stress urinary incontinence, %	Urge incontinence, %	Urethral stricture, %
Naspro	2006	55	1b	41	80/100	24	113.27 ± 35.33	65.05 ± 19.22	154 ± 35	59.33 ± 34.77	2.4	5.4	2.8
Wilson	2006	56	1b	22	100	24	77.8 ± 5.6	35.8 ± 2.9	NA	40.4 ± 5.7	3.2	0	3.2
Elzayat	2007	45	4	26	80/100	72	59.3 ± 31.2	112 ± 48	191 ± 95	30 ± 19	2.5	11	1.6
Ahyai	2007	57	1b	75	80/100	36	53.5	94.6 ± 35.1	142.2 ± 52.2	35.9 ± 16.4	NA	NA	4.1
Shah	2007	52	4	83	100	24	54.62	49.88	NA	29.8	0.7	10.7	2.1
Gilling	2008	60	4	38	100	72	58.5 ± 31.0	47 ± 28.1	NA	27.2 ± 25.2	1.4	9.8	1.4
Kuntz	2008	54	1b	60	80/100	60	114.6 ± 21.6	135.9 ± 31.2	212.25 ± 52.5	93.7 ± 23.2	NA	NA	3.3
Vavassori	2008	60	4	262	80/100	36	62 ± 34	45.4 ± 22.9	109 ± 42	40 ± 27	0.6	28	3

Author	Bladder neck contracture, %	Q_{max}, ml/s	AUA-SS	IPSS	Reoperation for residual tissue, %
Naspro	5.4	19.19 ± 6.3	NA	7.9 ± 6.2	5.4
Wilson	0	21.0 ± 2.0	6.1 ± 1.0	NA	0
Elzayat	0.8	16.2	NA	5.6	4.2
Ahyai	3.1	29 ± 11	2.7 ± 3.2	NA	1
Shah	0.4	19.1	5.1	NA	0
Gilling	0	19 ± 11.2	NA	8.5 ± 6.3	1.4
Kuntz	1.7	24.3 ± 10.1	3.0 ± 3.2	NA	0
Vavassori	0.6	25.1 ± 10.7	NA	0.7 ± 1.3	2.7

AUA-SS = American Urological Association Symptom Score; IPSS = International Prostate Symptom Score; Q_{max} = maximum flow rate; NA = not available.
* Data presented as mean and standard deviation (SD) of the mean.

urodynamically to OP [54]. Equally, this finding could account for the relatively mild storage symptoms which are generally present in approximately 30% of the patients 1 mo after surgery and which persist in 10% of patients at 3 mo. These symptoms, however, are generally self-limiting and can be successfully treated with nonsteroidal anti-inflammatory drugs and anticholinergics.

3.2.5. *Late morbidity*

Table 2 details complication rates in the series with the longest follow-up. As expected, the overall reintervention rate is very low (0–5.4%). Potentially, the release of energy specifically in the capsular plane could also explain the overall low number of bladder-neck contractures, compared with those generally accepted in the literature for other procedures [1]. Interestingly, Shah et al reported a distribution of complications stratified evenly among all sizes of prostates analysed, with a higher percentage (4.8%) of urethral strictures in prostates >100 g [41], as already demonstrated by Kuntz et al [50].

3.2.6. *Learning curve and economics*

The reasons for the relatively limited uptake of the procedure have traditionally been ascribed to the perception of a steep learning curve and to the costs of the equipment, which seemed high in the early days of HoLEP. Recent studies in naïve centres [43] and in high-volume centres [44] have established reproducibility and safety of HoLEP during the learning curve in a mentor- and non-mentor–aided setting, with encouraging results. HoLEP is a challenging technique; currently, at least 50 patients are estimated to be sufficient to complete the initial learning curve if the technique is self-taught [43]. Adequate mentoring, however, can possibly shorten this learning curve.

In a cost analysis comparing HoLEP and OP, it was evident that HoLEP resulted in a significant reduction of blood loss, with fewer homologous blood transfusions necessary when compared with the OP group. Moreover, a significantly shorter catheterisation time and hospital stay occurred in the HoLEP group. Interestingly, this early catheter removal (usually 24 h after surgery) produced a dramatically reduced length of hospital stay after HoLEP, resulting in a significantly greater cost reduction for this procedure when compared with open surgery [63].

3.2.7. *Sexual function*

The impact of HoLEP on sexual function has not yet been investigated thoroughly. It was demonstrated recently that HoLEP and TURP had a similar yet limited impact on erectile function [47]. It appeared that retrograde ejaculation lowered the IIEF orgasmic function domain in both groups to a similar extent. Similar to OP, no significant reduction in the IIEF erectile function domain score was reported between baseline (20.3 ± 6.6) and 24-mo follow-up (22.3 ± 4.0) in the HoLEP group [55]. Interestingly, Gilling et al reported retrograde ejaculation in 76% (25 of 33) of sexually active patients after 6 yr from HoLEP [61]. The erectile function score of the IIEF, however, was only 9.6 overall, as the mean age at follow-up was 75.7 yr.

3.3. *Discussion*

TURP is considered to be the gold standard for the surgical treatment of BOO due to BPE. The true anatomic gold standard, however, is OP in terms of completeness of disobstruction, degree of symptomatic improvement, and durability [2,3]. HoLEP mimics OP, since the adenomatous tissue is peeled off of the surgical capsule in both procedures. The completeness of adenomatous tissue removal results in an average postoperative decrease in PSA and prostate volumes in the range of 70–90% of the preoperative value [13]. This result contrasts with those of all vaporising techniques such as 60–80-W KTP laser, HPS laser, or HoLAP: These procedures result in a postoperative reduction of PSA and prostate volume only in the range of 35–45% [31]. Therefore, one might expect that long-term results of vaporising techniques will not equal those of enucleation. Reliable long-term data must be awaited.

Although holmium-laser devices offered encouraging clinical results that were comparable or, in some respects, even better than TURP, this technique is still restricted largely to a few centres worldwide. Due to the learning curve and the challenging surgical technique, Ho:YAG enucleation did not initially gain the acceptance that it has at present in the urologic community [40]. This is changing, and a variety of new laser devices is emerging on the market [13]; however, except for information on KTP and holmium lasers, published data are rare or are missing.

The introduction of the 80-W KTP laser brought new enthusiasm for large prostatic surgery [64]. Compared to former prostate laser systems based on 1064 nm, the KTP laser removed prostatic tissue immediately and subjective and objective parameters improved rapidly after catheter removal. Unlike TURP, both KTP laser vaporisation and HoLEP have been used safely for the treatment of large prostates (>100 g) because of the good intraoperative haemostasis, and high risk patients could be treated while on anticoagulation therapy [17,46]. Distribution of KTP and LBO laser techniques in the urologic community, however, moved faster than the available literature, particularly regarding the availability of long-term data and randomised controlled trials. This lack raised important issues from a safety and marketing point of view.

A true economic analysis is a tough task to perform in any surgical field, and data from the current literature do not provide enough evidence-based information to draw sound conclusions in the comparison between KTP laser vaporisation and HoLEP. Surely, initial expenses are a common burden for both techniques, but it would seem that an impact on costs could also derive from the different use and price of fibres. During KTP laser vaporisation, disposable fibres are used for each procedure and the number of joules per fibre is limited, whereas during HoLEP, the same fibre can be used up to 20 times. Furthermore, KTP and LBO laser vaporisation is still under development, and improvements regarding overall quality of the fibres are awaited to improve the deterioration reported.

The learning curve of a surgical technique depends on several factors, such as surgical skills, the complexity of the procedure, and the intensity and availability of adequate teaching and mentoring. It definitely has to be kept in mind that any kind of urologic laser is a very powerful and potentially dangerous tool that has to be handled with care. It should be strictly avoided to describe any surgical technique that uses laser energy within the prostatic urethra as a simple and easy-to-learn procedure. Certainly, HoLEP is a demanding surgical procedure, but if it could be taught like TURP (ie, in practically any urology department), with constant supervision, the learning curve could be shorter. KTP for direct vaporisation is a potentially easier technique to master.

This review has documented the need for better quality data to increase the levels of evidence for both KTP laser vaporisation and HoLEP. Nevertheless, based on current evidence, HoLEP seems to offer the most favourable combination of symptom and objective improvement for most prostate sizes, coupled with the best durability in terms of a low reoperation rate. Updated long-term results from high-volume centres are eagerly awaited to assess durability of KTP laser vaporisation for all prostate sizes treated, as data are currently discrepant.

Multicentric, multiarm randomised studies with at least 3-yr follow-up would be necessary to standardise indications and specific guidelines for each technique in order to inform each patient in an objective and complete manner.

4. Conclusions

In the last 2 yr, evidence from case-control and cohort studies has documented safety, low perimorbidity, and efficacy of KTP laser vaporisation and HoLEP. Although the relatively long learning curve seems to have limited the wide spread of HoLEP, randomised controlled trials have proven its durability at long-term follow-up for most prostate sizes. Longer term, quality data from randomised studies are still needed to assess the results published for KTP. Probably, the perfect alternative to TURP and OP does not yet exist, but the objective of future studies must be to determine which procedure is best for each patient.

Author contributions: Richard Naspro had full access to all the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis.

Study concept and design: Naspro.
Acquisition of data: Naspro.
Analysis and interpretation of data: Naspro, Bachmann, Gilling, Kuntz, Madersbacher, Montorsi, Reich, Stief, Vavassori.
Drafting of the manuscript: Naspro, Bachmann, Gilling, Kuntz, Madersbacher, Montorsi, Reich, Stief, Vavassori.
Critical revision of the manuscript for important intellectual content: Naspro, Bachmann, Gilling, Kuntz, Madersbacher, Montorsi, Reich, Stief, Vavassori.
Statistical analysis: Naspro.
Obtaining funding: None.
Administrative, technical, or material support: None.
Supervision: Naspro, Bachmann, Gilling, Kuntz, Madersbacher, Montorsi, Reich, Stief, Vavassori.
Other (specify): None.

Financial disclosures: I certify that all conflicts of interest, including specific financial interests and relationships and affiliations relevant to the subject matter or materials discussed in the manuscript (eg, employment/affiliation, grants or funding, consultancies, honoraria, stock ownership or options, expert testimony, royalties, or patents filed, received, or pending), are the following: Alexander Bachmann is a consultant for American Medical Systems, Olympus, Astrazeneca, Orionpharma. Peter Gilling is a consultant for Lumenis. Rainer Kuntz is a consultant for Lumenis and Karl Storz. Francesco Montorsi is a paid consultant for American Medical Systems. Richard Naspro received speaker honoraria from Lumenis. Oliver Reich received speaker honoraria for American Medical Systems, Dornier, and Olympus. Ivano Vavassori is a consultant for Lumenis Italy. Stephan Madersbacher and Christian Stief have nothing to disclose.

Funding/Support and role of the sponsor: None.

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Editorial Comment on: A Review of the Recent Evidence (2006–2008) for 532-nm Photoselective Laser Vaporisation and Holmium Laser Enucleation of the Prostate

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What can we expect from a review of the literature by the pioneers of these procedures? At first glance, this article is just a reconfirmation that both laser techniques ‘‘have the potential to become alternatives to open prostatectomy and transurethral resection of the prostate’’ [1]. The review, however, shows more. Only two monocentric randomized controlled trials (RCTs) for the 80-W potassium-titanyl-phosphate (KTP) laser and four monocentric RCTs for holmium laser enucleation of the prostate (HoLEP) reveal a lower transfusion rate, a shorter catheter time, and a shorter hospital stay. In case of the KTP laser vaporization, however, the functional short term results were already better for transurethral resection of the prostate (TURP) [2]. In the same study, the retreatment rate was 17.9% when treating larger glands. Additionally, the authors state that postoperative storage symptoms and urge incontinence are often reported after laser treatment (up to 25.7% after KTP, 30% following HoLEP) and are generally higher than after standard TURP [1,3]. The applied laser energy may be beneficial with respect to hemostasis, but a significant number of patients have to pay the price of postoperative urgency. This factor is not mentioned in the manufacturers’ brochures or Web sites. Based on this experience, one will have to wait for a detailed analysis of the recent data for the lithium triborate (LBO) laser, which uses even higher power. It still seems to be hard work to vaporize 80 g of tissue!

Based on personal experience [4], there is no doubt that laser enucleation of the prostate is a difficult procedure. The endoscopic anatomy is different from TURP, and the technique of tissue morcellation has to be learned. TURP is not a simple procedure, but currently, there are no established training concepts for HoLEP, at least that are comparable to TURP. This issue represents the main reason why HoLEP has not gained wider acceptance. How should we proceed? In my personal view, laser vaporization should be limited to the selective cases of bleeding disorders; otherwise mono- or bipolar TURP presents well-established, cost-effective techniques, at least for midsized glands [3,5]. For larger glands, HoLEP represents an interesting but technically demanding alternative. Nevertheless, I agree with the authors that multicentric randomized studies are required to determine the roles of both laser-assisted techniques.

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DOI: 10.1016/j.eururo.2009.03.071

DOI of original article: 10.1016/j.eururo.2009.03.070