

# Surgical management of benign prostatic hyperplasia: current evidence

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## SUMMARY

Benign prostatic hyperplasia (BPH) is one of the most common male urological disorders. The surgical management of BPH is evolving at a rapid rate, with several new procedures available that challenge transurethral resection of the prostate as the standard treatment in the surgical management of small to medium sized glands. The new procedures aim to achieve results comparable to transurethral resection of the prostate while minimizing morbidity and cost. In this Review, we discuss some of the current surgical options for the treatment of BPH that seem popular in the literature.

**KEYWORDS** benign prostatic hyperplasia, bipolar transurethral resection, holmium laser enucleation of the prostate, photoselective vaporization of the prostate, minimally invasive prostate surgery

## REVIEW CRITERIA

A PubMed search was conducted using the keywords “benign prostatic hyperplasia” and “minimally invasive surgery”. Additionally, searches involving the specific procedures (e.g. “holmium laser enucleation of prostate” or “HoLEP”) and “benign prostatic hyperplasia” were also performed. Relevant English articles were retrieved and reviewed. Additional articles referenced in these papers were also retrieved for review. We did not apply any date limits. The search was performed in May 2008.

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## Learning objectives

Upon completion of this activity, participants should be able to:

- 1 Describe the prevalence of benign prostatic hyperplasia (BPH) in men.
- 2 List the most common complications associated with transurethral resection of the prostate (TURP).
- 3 Compare TURP with transurethral incision of the prostate (TUIP).
- 4 Describe the holmium laser transurethral incision with enucleation (HoLEP) procedure for BPH.
- 5 Compare outcomes of HoLEP with TURP.

## Competing interests

MM Elhilali has declared associations with the following companies: Laserscope and Lumenis. See the article online for full details of the relationships. A Baazeem, the Locum Journal Editor N Siva and the CME questions author D Lie declared no competing interests.

## INTRODUCTION

Benign prostatic hyperplasia (BPH) is a common urological disorder. One population-based study, published in 2001, suggests that it might affect up to 8.4% of men aged 40–49 years and 33.5% of those aged 60–70 years (Box 1).<sup>1</sup> In the 20th century, open surgical management of BPH became popular. A relatively high-morbidity and expensive procedure, open prostatectomy was gradually replaced by transurethral resection of the prostate (TURP) as the standard surgical treatment of small to medium sized BPH. High success rates, lower costs and shorter recovery times after TURP were among the factors contributing to the gradual replacement of open prostatectomy; however, TURP is associated with considerable complications, including the need

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Received 7 July 2008 Accepted 15 August 2008

www.nature.com/clinicalpractice  
doi:10.1038/ncpuro1214

for blood transfusions in 2.0–4.8% of patients and the occurrence of transurethral resection (TUR) syndrome in 0–1.1% of patients.<sup>2</sup> Eight-year follow-up data on a large cohort of 23,123 men who underwent TURP showed a cumulative incidence of repeat endourological interventions of 14.7%.<sup>3</sup> The incidence of TUR syndrome increases with a gland size greater than 45 g and resection times longer than 90 min.<sup>4</sup>

Over the past 15 years, numerous alternative procedures have been introduced with the goal of achieving comparable results to TURP, while minimizing morbidity and cost. Many of these alternative procedures have not fulfilled these objectives, while a few maintain the potential to replace TURP owing to the promising results from several methodologically sound, prospective, randomized controlled trials. In this Review, we examine the most commonly discussed surgical procedures, among the current literature, that are used to treat BPH, with special emphasis on original research.

### TRANSURETHRAL INCISION OF THE PROSTATE

Transurethral incision of the prostate (TUIP) involves making an incision at the 5 and 7 o'clock positions from distal to the corresponding ureteral orifice to the level of the verumontanum on the ipsilateral side, extending the depth of the incision to the surgical capsule. This procedure is usually performed in patients with small prostates (<40 g). Several randomized trials<sup>5–7</sup> have compared TUIP with TURP, with comparative results. TUIP has a shorter procedure time and is associated with a lower risk of retrograde ejaculation, while some studies indicate that TURP is associated with a slight improvement in urinary symptoms.

A randomized trial by Aho and colleagues<sup>8</sup> compared outpatient holmium laser TUIP with holmium laser enucleation of the prostate (HoLEP) in men with prostates smaller than 40 g.<sup>8</sup> TUIP was associated with a shorter procedure time and a lower risk of retrograde ejaculation, whereas HoLEP was associated with better postoperative urodynamic findings, smaller postoperative prostate size on transrectal ultrasonography (TRUS) and a higher incidence of transient stress urinary incontinence.

### BIPOLAR TECHNIQUES

In conventional (monopolar) TURP, electrical current passes through the patient from the active electrode (connected to the resectoscope

**Box 1** Indications for surgical intervention for benign prostatic hyperplasia.

- Botherome, moderate to severe lower urinary tract symptoms refractory to pharmacological treatment
- Refractory urinary retention
- Recurrent urinary tract infections
- Recurrent or persistent gross hematuria
- Urinary bladder stones
- Renal insufficiency secondary to benign prostatic hyperplasia

loop) to a grounding pad attached to the patient; this has potential risks, such as skin burns, excessive heating of deep tissues, nerve damage,<sup>9</sup> inadvertent nerve stimulation (e.g. obturator reflex) and cardiac pacemaker malfunction.<sup>10</sup> Additionally, conventional TURP requires non-hemolytic, hypo-osmolar irrigation fluids (e.g. glycine), which, if absorbed in high volumes, may lead to TUR syndrome. In an attempt to address some of these disadvantages, bipolar technology was proposed as an alternative treatment for BPH.

### Bipolar transurethral vaporization of the prostate

Bipolar transurethral vaporization of the prostate (TUVP) works by running electricity between an active and a passive electrode, which results in a vapor (plasma) layer at the interface of the tissue.<sup>11</sup> The high energy contained within this plasma layer is released locally into the tissue on contact, and causes tissue vaporization. Normal saline is usually used as an irrigant, which should help eliminate the risk of TUR syndrome. Additionally, the risk of thermal injury to surrounding tissue is reduced,<sup>11</sup> and there is also decreased risk of skin burns and interference with cardiac pacemakers.

Several studies have compared bipolar TUVP with conventional TURP, including four randomized trials published in English.<sup>12–15</sup> Only one of these studies showed a significantly shorter procedure time for bipolar TUVP compared with TURP.<sup>15</sup> In one study,<sup>12</sup> the postoperative decrease in serum hemoglobin levels and transfusion requirements were both greater after TURP, whereas the reduction in hemoglobin levels 24 h after the procedure was not significant

in two other studies.<sup>13,14</sup> In one of these two studies, however, a significantly higher number of patients required manual clot evacuation after TURP compared with TUVF (19% vs 0%).<sup>14</sup> Among studies that commented on postoperative serum sodium levels, none reported statistically significant differences between the two techniques;<sup>12–14</sup> Dunsmuir *et al.*<sup>14</sup> found a transient difference between the procedures, which corrected itself 24 h after surgery. One randomized study showed a significantly shorter catheterization time with TUVF,<sup>15</sup> but otherwise there does not seem to be a difference between the two techniques in terms of catheterization time and length of hospital stay.<sup>12–14</sup> Dunsmuir *et al.*<sup>14</sup> reported that a significantly larger number of patients required recatheterization after bipolar TUVF compared with TURP.<sup>14</sup> Three of these randomized trials did not show a difference between TURP and bipolar TUVF in terms of postoperative International Prostate Symptom Score (IPSS), quality of life (QOL) score, postvoid residual (PVR) urine volume or maximum urinary flow rate ( $Q_{max}$ ) after a mean follow-up duration of 3–12 months.<sup>12–14</sup> Results from the fourth study reported 1-year and 3-year follow-up data.<sup>15,16</sup> Although this cohort's postoperative IPSS and  $Q_{max}$  values improved from baseline, improvement in IPSS was substantial in the bipolar TUVF group at early follow-up.<sup>15</sup> Interestingly, at 2 and 3 years' follow-up, IPSS and  $Q_{max}$  values were significantly better in the patients who underwent TURP, despite both groups having similar preoperative prostate volumes and IPSS and  $Q_{max}$  values.<sup>16</sup> Moreover, significantly more patients in the TUVF group compared with the TURP group required secondary TURP after the first year (12% vs 6.6%). These long-term results raise questions about the efficacy of bipolar TUVF.

### **Bipolar transurethral resection of the prostate**

Bipolar TURP has similar benefits to bipolar TUVF, in addition to its capability of providing resected tissue that can be submitted for histopathological assessment. Bipolar TUVF is technically similar to conventional TURP, which implies a short learning curve for training surgeons. In bipolar TURP, resectoscope loops of varying shapes are used, but the general concept is essentially the same as that of conventional TURP. Electricity runs between an active and a passive electrode, converting the irrigation

solution (i.e. normal saline) into a plasma layer which disintegrates tissue on contact.<sup>17</sup> Several devices have been assessed, some of which have been modified or withdrawn. A review of the technical differences between these devices has been reported by Rassweiler and colleagues.<sup>18</sup>

Since the safety and efficacy of bipolar TURP was first reported,<sup>19,20</sup> at least 11 randomized trials have assessed its use (Table 1).<sup>21–31</sup> In most of these studies, preoperative prostate volume was around 40–55 ml. Resection time was comparable between bipolar TURP and TUVF in most studies.<sup>22–24,26,27,29–31</sup> Interestingly, the largest two studies showed opposing results on which technique resulted in better resection times;<sup>21,25</sup> the group that reported shorter resection times with bipolar TURP, however, did not comment on the weight of the resected tissue, nor did they perform postoperative TRUS or PSA assessment. A hybrid technique that uses bipolar TUVF for the median and lateral lobes and bipolar TURP for apical tissue resection and histopathological specimen extraction was also reported to be faster than monopolar TURP.<sup>28</sup> None of these studies showed a difference in the weight of the resected tissue between the two techniques, including the study that showed a shorter resection time with monopolar TURP.<sup>22,23,25–27</sup>

Intraoperative blood loss is usually assessed either by immediate (within 24 h) postoperative measurement of hemoglobin or hematocrit levels<sup>22–26,29,30</sup> or by other methods or techniques.<sup>27,31</sup> Two studies have reported that the bipolar technique resulted in significantly less blood loss than monopolar TURP.<sup>29,31</sup> In a third study, while intraoperative blood loss was not assessed, the number of patients requiring blood transfusions was significantly higher in the monopolar TURP group than in the bipolar TURP group.<sup>21</sup> Additionally, five randomized, prospective studies<sup>22,25–27,30</sup> reported that there was a less significant decline in serum sodium levels after bipolar TURP. Eight studies<sup>21,23,24,27–30</sup> found significantly shorter postoperative catheterization times and five studies revealed significantly shorter hospital stays with bipolar TURPs compared with monopolar TURP (Table 1).

Although postoperative improvements in IPSS and QOL at 3 years were comparable between monopolar and bipolar TURP in all studies,<sup>32</sup> two studies reported significant improvements in  $Q_{max}$  1 year after bipolar TURP.<sup>21,28</sup> Nevertheless,

**Table 1** Prospective, randomized trials that compare monopolar TURP with bipolar TURP.

Procedure (resectoscope size) and study year	Patients (n)	Prostate volume (ml)	Surgery time (min)	Resected weight (g)	Follow-up duration (months)	Baseline IPSS <sup>a</sup> /QOL <sup>a</sup>	Baseline Q <sub>max</sub> (ml/s)	Catheter time (h)	Hospital stay (h)
Monopolar (26 Fr) <sup>24</sup> (2008)	26	48	31.7	NR	12	20/3.6	8.7	31.9	50.6
Bipolar (27 Fr) <sup>24</sup> (2008)	27	49	39.1	NR	12	21/3	7	23 ( <i>P</i> <0.001)	48
Monopolar (26 Fr) <sup>21</sup> (2007)	120	42	57	NR	12	24/3	9.2 <sup>c</sup>	108	120
Bipolar (27 Fr) <sup>21</sup> (2007)	120	43	36 ( <i>P</i> <0.001)	NR	12	23/3	10.9 <sup>d</sup>	72 ( <i>P</i> <0.001)	72 ( <i>P</i> <0.001)
Monopolar (26 Fr) <sup>22</sup> (2007)	52	54.8	58	30.6	12	24.6/NR	6.5	NR	NR
Bipolar (26 Fr) <sup>22</sup> (2007)	48	56.5	59	29.8	12	22.6/NR	6.8	NR	NR
Monopolar (26 Fr) <sup>25</sup> (2007)	120	NA	44	21.3	Perioperative only	NR/NR	NR	108	122.4
Bipolar (24 Fr) <sup>25</sup> (2007)	118	NA	56 ( <i>P</i> =0.001)	21	Perioperative only	NR/NR	NR	96	117.6
Monopolar (26 Fr) <sup>23</sup> (2006)	35	47.5	53	24	9	24.3/3.9	6.3	100	107
Bipolar (26 Fr) <sup>23</sup> (2006)	35	51.6	49	20	9	24.18/4.2	7.1	72 ( <i>P</i> <0.05)	78.2 ( <i>P</i> <0.05)
Monopolar (25 Fr) <sup>30</sup> (2006)	30	49	52	NR	12	17.3/NR	7.3	75	NR
Bipolar (27 Fr) <sup>30</sup> (2006)	27	47	55	NR	12	17.6/NR	6.9	47 ( <i>P</i> <0.01)	NR
Monopolar (24 Fr) <sup>31</sup> (2006)	51	52.26	57.88	NR	<1	23.73/NR	6.4	42.4	NR
Bipolar (24 Fr) <sup>31</sup> (2006)	52	51.3	49.99	NR	<1	23.3/NR	5.9	18.44 ( <i>P</i> <0.05)	NR
Monopolar (26 Fr) <sup>26</sup> (2006)	24	41.4	52.9	31.9	13.9	23.2/4.7	8.3	74.4	NR
Bipolar (27 Fr) <sup>26</sup> (2006)	24	49.4	52.9	36.6	14.5	24.1/4.4	8.5	74.4	NR
Monopolar (25.5 Fr) <sup>27</sup> (2005)	30	27.9 <sup>b</sup>	36.9	27.6	3	21.6/4.4	5.1	81.84	93.1
Bipolar (25.6 Fr) <sup>27</sup> (2007)	30	24.1 <sup>b</sup>	39.3	24	3	20.5/4.6	5.8	60.5 ( <i>P</i> =0.022)	72.5 ( <i>P</i> =0.019)
Monopolar (26 Fr) <sup>28</sup> (2005)	50	54	57.8	NR	18.3	20.4/NR	8.3 <sup>e</sup>	91.2	"Significantly less" with hybrid technique
Bipolar (27 Fr) <sup>28</sup> (2005)	51	50.1	40.3 ( <i>P</i> <0.01)	NR	18.3	21.3/NR	7.8 <sup>f</sup>	55.2 ( <i>P</i> <0.05)	"Significantly less" with hybrid technique
Monopolar <sup>29</sup> (2004)	59	48.9	55	NR	3	21.6/4	10.9	76.8	91.2
Bipolar <sup>29</sup> (2004)	58	45.8	46	NR	3	20.9/3.7	10.4	64.8 ( <i>P</i> <0.05)	76.8 ( <i>P</i> <0.05)

<sup>a</sup>No significant difference in the improvement of the parameter between the two procedures. <sup>b</sup>Transition zone volume. <sup>c</sup>Postoperative Q<sub>max</sub> was 18.5. <sup>d</sup>Postoperative Q<sub>max</sub> was 19.5, the difference between <sup>c</sup> and <sup>d</sup> was significant (*P*<0.001). <sup>e</sup>64.3% improvement in Q<sub>max</sub> at 12 months. <sup>f</sup>103.6% improvement in Q<sub>max</sub> at 12 months, the difference between <sup>e</sup> and <sup>f</sup> was significant (*P*<0.05). Abbreviations: IPSS, International Prostate Symptom Score; Q<sub>max</sub>, maximum urinary flow rate; QOL, quality of life; TURP, transurethral resection of the prostate.

the clinical significance of these differences may be questioned (Table 1). Postoperative urine storage symptoms varied between the two techniques; the rate of postoperative urinary storage symptoms was higher after bipolar TURP in one study,<sup>28</sup> whereas it was higher after monopolar TURP in two other studies.<sup>21,27</sup> Urethral stricture rates were significantly higher with bipolar TURP in one study,<sup>28</sup> and they were high in another study,<sup>22</sup> but this was not statistically significant (3 patients vs 1 patient, *P*>0.05). The

high ablative energy used, in addition to a larger resectoscope size (27 Fr vs 26 Fr), were proposed causes for this difference in stricture rates.<sup>28</sup> Ho *et al.*<sup>22</sup> used a 26 Fr resectoscope for both bipolar TURP and TUVP procedures, and excluded any leakage of current along the instrument's sheath as a potential cause. Another study also reported substantial urethral injury rates during the insertion of a 27 Fr resectoscope, in addition to significantly higher meatal stricture rates with the bipolar technique.<sup>21</sup>

### Bipolar enucleation of the prostate

Neill and colleagues<sup>33</sup> compared HoLEP and bipolar enucleation of the prostate in a randomized controlled trial. Specimen weight, postoperative catheterization time, hospital stay and the postoperative improvement in IPSS and  $Q_{\max}$  at 1 year follow-up were comparable for both HoLEP and bipolar enucleation of the prostate, whereas operative and postoperative recovery time, as well as the need for postoperative bladder irrigation, were all lower with HoLEP.

### LASER PROCEDURES

Several laser techniques have been assessed for the treatment of BPH, including visual laser ablation of the prostate (VLAP), interstitial laser coagulation of the prostate, holmium laser resection of the prostate (HoLRP) and holmium laser ablation of the prostate (HoLAP).<sup>34–36</sup> In this Review, however, we will focus on a few techniques that have been more thoroughly investigated and show the most promise for the treatment of BPH, including HoLEP, photoselective vaporization of the prostate (PVP) and thulium laser resection of the prostate (TmLRP).

### Holmium laser enucleation of the prostate

HoLEP uses the resectoscope in a similar way to when a surgeon performs an open prostatectomy; that is, the surgeon uses his finger to separate the adenoma from the surgical capsule and achieve a truly anatomical enucleation, as described by Gillig and colleagues.<sup>37</sup> In HoLEP, the adenoma is pushed into the bladder by the resectoscope and removed using a tissue morcellator. Normal saline is used as the irrigant to lessen the risk of TUR syndrome. HoLEP is the most extensively studied laser technique for the treatment of BPH.

#### *HoLEP versus monopolar TURP*

At least six randomized trials from four different investigator groups have compared HoLEP with monopolar TURP (Table 2).<sup>38–45</sup> One group used the mushroom technique (resection of devascularized lobes with electrocautery, using hypotonic irrigants, while still attached to the capsule by a thin pedicle) instead of a tissue morcellator.<sup>39,42</sup> Mean prostate size in both studies ranged from 53.5 g to 77.8 g; patients in the HoLEP group had significantly larger glands than patients in the monopolar TURP group.<sup>40,43</sup> In all trials,

procedure length was significantly shorter in the TURP group. Specimen weight after HoLEP was significantly larger than after TURP in two trials,<sup>43,45</sup> but was larger after TURP in another trial.<sup>41</sup> In yet another trial, procedure time was comparable between both techniques.<sup>42</sup> Gupta and colleagues<sup>41</sup> attributed the small specimen weight in the HoLEP and TUVP groups to the substantial vaporization effect and the relatively small prostate sizes in the study. In another trial, Tan and colleagues<sup>45</sup> compared the efficiency of the two techniques by assessing the mass of specimen removed per minute of energy source used; HoLEP was significantly more efficient than TURP, despite the longer surgery time during the HoLEP procedure. Although blood loss was significantly lower during HoLEP than TURP in two studies, the clinical significance of these findings is questionable.<sup>41,42</sup> The reduction of serum sodium levels was similar in both techniques.<sup>41,42</sup> Early postoperative dysuria was more frequent in patients after HoLEP in two studies.<sup>41,43</sup> Few other differences in complication rates were reported between the two techniques. Catheterization time and hospital stay were consistently shorter in the HoLEP groups.<sup>41–43,45</sup> The differences in IPSS, QOL,  $Q_{\max}$  and changes in sexual function were generally comparable between the two techniques.<sup>38–45</sup>

#### *HoLEP versus open prostatectomy*

Two randomized trials compared HoLEP with open prostatectomy in patients with a mean prostate size of 113–124 ml.<sup>46,47</sup> Although the weight of the removed specimen was significantly higher with open prostatectomy in both trials,<sup>46,47</sup> this difference disappeared with correction for estimated tissue loss to vaporization.<sup>47</sup> Procedure time was significantly shorter for open prostatectomy compared with HoLEP, and HoLEP was associated with less blood loss and transfusion requirements as well as shorter catheterization and hospitalization times.<sup>46,47</sup> Transient dysuria was reported during the early postoperative period more commonly in patients who underwent HoLEP than in those who underwent open prostatectomy.<sup>47</sup> The two procedures were comparable in terms of IPSS,  $Q_{\max}$  and PVR urine volume, in addition to the incidence of long-term complications (up to 5 years).<sup>47,48</sup> HoLEP was also found to provide significant net cost savings compared with open prostatectomy for patients with large prostates (>70 g).<sup>49</sup>

**Table 2** Prospective, randomized trials that compare monopolar TURP to various laser procedures.

Procedure and study year	Patients (n)	Prostate volume (ml)	Surgery time (min)	Resected weight (g)	Follow-up duration (months)	Baseline IPSS/QOL <sup>a</sup>	Baseline Q <sub>max</sub> (ml/s)	Catheter time (h)	Hospital stay (h)
TURP <sup>39</sup> (2007)	100	49.9	73.8	37.2	36	21.4/NA	5.9	43.4	85.8
HoLEP <sup>39</sup> (2007)	100	53.5	94.6 ( <i>P</i> <0.0001)	32.6	36	22.1/NA	4.9	27.6 ( <i>P</i> <0.0001)	53.3 ( <i>P</i> <0.0001)
TURP <sup>40</sup> (2006)	60	58.2	NR	NR	24	21.6/4.5	NR	NR	NR
HoLEP <sup>40</sup> (2006)	60	73.3 ( <i>P</i> <0.05)	NR	NR	24	21.1/4.4	NR	NR	NR
TURP <sup>41</sup> (2006)	50	59.8	64.1	24.8	12	23.3/NA	4.5	45.7	NR
HoLEP <sup>41</sup> (2006)	50	57.9	75.4 ( <i>P</i> <0.001)	17.2 ( <i>P</i> <0.004)	12	23.4/NA	5.15	28.6 ( <i>P</i> <0.001)	NR
TURP <sup>44</sup> (2006)	48	56.2	57	NR	12	21.9/4.7	7.8	57.78	85.8
HoLEP <sup>44</sup> (2006)	52	60.3	74 ( <i>P</i> <0.05)	NR	12	21.6/4.6	8.2	31 ( <i>P</i> <0.001)	59 ( <i>P</i> <0.001)
TURP <sup>38</sup> (2006)	30	70	33.1	57	24	23.7/4.7	8.3	44.9	49.9
HoLEP <sup>38</sup> (2006)	30	77.8	62.1 ( <i>P</i> <0.001)	74 ( <i>P</i> <0.05)	24	26/4.8	8.4	17.7 ( <i>P</i> <0.01)	27.6 ( <i>P</i> <0.001)
TURP <sup>43</sup> (2004)	48	56.2	57	25.4	12	21.9/4.7	7.8	57.78	85.8
HoLEP <sup>43</sup> (2004)	52	70.3 ( <i>P</i> <0.05)	74 ( <i>P</i> <0.05)	36.08 ( <i>P</i> <0.05)	12	21.6/4.6	8.2	31 ( <i>P</i> <0.001)	59 ( <i>P</i> <0.001)
TURP <sup>58</sup> (2008)	37	88	51	NR	6	20.2/NA <sup>c</sup>	9.2 <sup>c</sup>	57.78	85.8
PVP <sup>58</sup> (2008)	39	86.1	87 ( <i>P</i> =0.03)	NR	6	18.9/NA <sup>d</sup>	8.6 <sup>d</sup>	31 ( <i>P</i> <0.001)	59 ( <i>P</i> <0.001)
TURP <sup>56</sup> (2006)	50	33.5	34.11	NR	12	25.41/5.06	8.88	44.72	85.7
PVP <sup>56</sup> (2006)	60	39.4	30.4	NR	12	25.27/4.75	8.80	13.1 ( <i>P</i> <0.0005)	26.4 ( <i>P</i> <0.00000001)
TURP <sup>65</sup> (2008)	48	59.2	50.4	38.8	12	20.8/4.5	8.3	87.4	161.1
TmLRP <sup>65</sup> (2008)	52	55.1	46.3	21.2 ( <i>P</i> =0.0001)	12	21.9/4.7	8	45.7 ( <i>P</i> <0.0001)	115.1 ( <i>P</i> <0.0001)

<sup>a</sup>No significant difference in the improvement of the parameter between the two procedures. <sup>b</sup>Significantly better with HoLEP until 2 years. <sup>c</sup>Postoperative Q<sub>max</sub> was 6.4. <sup>d</sup>Postoperative Q<sub>max</sub> was 13.1, the difference between <sup>c</sup> and <sup>d</sup> was significant (*P*=0.01). <sup>e</sup>Postoperative Q<sub>max</sub> was 20.7. <sup>f</sup>Postoperative Q<sub>max</sub> was 13.3, the difference between <sup>e</sup> and <sup>f</sup> was significant (*P*=0.02). Abbreviations: HoLEP, holmium laser enucleation of the prostate; IPSS, International Prostate Symptom Score; PVP, photoselective vaporization of the prostate; Q<sub>max</sub>, maximum urinary flow rate; QOL, quality of life; TmLRP, thulium laser resection of the prostate; TURP, transurethral resection of the prostate.

HoLEP has also been reported to be safe and effective for the treatment of patients with urinary retention,<sup>50,51</sup> patients who are critically ill,<sup>52</sup> and those with bleeding disorders or who are receiving anticoagulants.<sup>53</sup> Moreover, HoLEP can be used to simultaneously treat BPH with bladder or upper urinary tract stones.<sup>54,55</sup>

#### Photoselective vaporization of the prostate

PVP is performed with the potassium titanyl phosphate (KTP) laser, which is selectively absorbed by hemoglobin, resulting in vaporization of intracellular water in the tissue. The procedure can be performed using normal saline for irrigation. Most published data uses the 80 W KTP laser system. There is also a new, high-performance system that allows an output power of 120 W, with the aim of increasing vaporization efficiency. Outcome data from this new device is still scarce.

#### PVP versus TURP

Two randomized trials have compared PVP with TURP (Table 2). In the first trial, Bouchier-Hayes<sup>56</sup> assessed 110 patients with mean preoperative prostate sizes of 33.5 ml in the TURP group and 39.4 ml in the PVP group. Procedure time, postoperative IPSS, QOL and Q<sub>max</sub> and sexual function outcomes were similar for both procedures; however, PVP showed significantly better results in terms of blood loss, catheterization time and hospital stay. Cost analysis suggested that PVP was also cheaper overall than TURP. A nonrandomized prospective trial showed similarly favorable results for PVP.<sup>57</sup> The second randomized trial compared PVP and TURP in patients with prostates larger than 70 ml.<sup>58</sup> Catheterization time and hospital stay were significantly shorter after PVP than after TURP. Additionally, significantly fewer patients in the PVP group required transfusions;

however, TURP was associated with a significantly shorter operative time, a lower incidence of early acute urinary retention and reintervention requirements, a substantial reduction in serum PSA level and TRUS prostate volume, as well as improvements in  $Q_{\max}$ , PVR urine volume and IPSS at 6 months. Nonetheless, a nonrandomized prospective trial that compared TURP with PVP in patients with prostates larger than 70 ml showed more favorable results for PVP, including significantly smaller reductions in serum hematocrit and sodium levels and shorter catheterization times and hospital stays in patients who underwent this procedure.<sup>59</sup> Postoperative IPSS, QOL,  $Q_{\max}$  and PVR urine volume and long-term complications were similar between the two groups for up to 2 years, whereas the operative time was significantly shorter and the decline in PSA was significantly more pronounced for TURP.

#### *PVP versus open prostatectomy*

As with HoLEP, PVP showed promising results when compared with open prostatectomy in a randomized controlled trial that included patients with prostate volumes greater than 80 ml.<sup>60</sup> Despite longer procedure times, PVP was associated with less blood loss and shorter catheterization times and hospital stays. For up to 12 months, postoperative IPSS, QOL and five-item International Index of Erectile Function values,  $Q_{\max}$ , PVR urine volume and complications were comparable between PVP, open prostatectomy, except for a significantly higher transfusion rate with open prostatectomy. The reduction in TRUS prostate size was significantly greater in the open prostatectomy group. As with HoLEP, PVP is safe and efficacious in patients with urinary retention,<sup>61</sup> those who are critically ill,<sup>62</sup> and patients receiving anticoagulation treatment.<sup>63</sup> A 2006 study suggests that PVP is more cost-effective than TURP and several minimally invasive BPH treatments.<sup>64</sup> Unfortunately, HoLEP and bipolar TURP were not included in the comparison.

#### **Thulium laser resection of the prostate**

The thulium laser has recently been introduced for use in the management of BPH. The laser can be used in continuous wave or pulse modes. In the only randomized, prospective trial to have compared thulium laser prostate resection (TmLRP) with monopolar TURP, Xia *et al.*<sup>65</sup> assessed 100 patients for 12 months postoperatively

(Table 2).<sup>65</sup> Estimated specimen weight was similar for the new laser and monopolar TURP techniques after correction for the vaporization effect. Serum hemoglobin and sodium levels, catheterization time and hospital stay were substantially reduced after TmLRP. Both techniques had comparable IPSS, QOL and  $Q_{\max}$  outcomes, as well as similar complication rates.

#### **LAPAROSCOPIC SIMPLE PROSTATECTOMY**

Laparoscopic simple prostatectomy, via either the transvesical or the preperitoneal approach, has been assessed in patients with BPH.<sup>66,67</sup> Retrospective studies comparing this technique with open prostatectomy showed similar improvement parameters and complication rates as well as reduced blood loss, catheterization time and hospital stays and longer operation times with the laparoscopic approach.<sup>68,69</sup> Blood loss and catheterization time, however, were considerably higher than those reported for transurethral procedures. These findings, in addition to the steep learning curve and with high costs, may reduce interest in this laparoscopic approach.

#### **ROBOTIC SIMPLE PROSTATECTOMY**

Robotic simple prostatectomy has also been assessed in patients with BPH.<sup>70</sup> In seven patients, the mean procedure time, blood loss, catheterization time, drain time and hospital stay were 195 min, 381.6 ml, 7.5 days, 3.5 days and 1.33 days, respectively. The average cost was \$12,093.

#### **DISCUSSION**

In recent years, most patients with symptomatic BPH are started on pharmacological therapy. This treatment option has resulted in patients presenting at an older age with more comorbidities and larger prostates than usual after unsuccessful pharmacological therapy.<sup>71</sup> These factors, coupled with the relatively high morbidity associated with the traditional options of intervention for BPH (i.e. open prostatectomy and TURP), have triggered the development of new treatment options for patients who do not respond to drug-based therapy or present with refractory urinary retention.

Currently, there is sufficient data to suggest that HoLEP has replaced open prostatectomy as the standard surgical treatment of BPH. HoLEP is associated with lower morbidity rates and is more cost-effective than open prostatectomy, with comparable long-term results. Thus, it would seem that the only role for open prostatectomy

at present is when there is no access to HoLEP. Unlike most of the other available options, the benefits of HoLEP have been shown to be independent of prostate size.<sup>72</sup>

The two main criticisms of HoLEP are its high costs and a steep training curve. Despite the considerable initial costs of the holmium laser equipment, it can also be used in the treatment of stones, urethral and ureteral strictures and superficial bladder tumors.<sup>73</sup> Furthermore, holmium laser fibers can be sterilized and reused, unlike KTP fibers, which are single use; as a result, the cost of holmium laser fibers is 5% of the cost of KTP fibers per patient.<sup>36</sup> The learning curve of HoLEP for use in patients with small to medium sized prostates is estimated to be 20–30 cases.<sup>36,74</sup> In a prospective assessment, Shah *et al.*<sup>75</sup> reported that an endourologist who is not familiar with the procedure can achieve outcomes comparable to experts with experience of about 50 cases.<sup>75</sup>

PVP is emerging as a popular treatment modality for BPH, particularly in patients with small-sized and medium-sized prostates. The procedure has a relatively short learning curve and, like HoLEP, can be used in patients with significant comorbidities and those on anti-coagulation therapy. Further evidence that supports the durability of PVP results is anticipated. Five-year follow-up results reported by Malek and colleagues,<sup>76</sup> although positive, represent only 14 of their original 94 patients.<sup>76</sup> Long-term evidence on the applicability of PVP to patients with large prostates is presently not available. There are concerns that this treatment modality may require that more patients have to be reoperated upon in light of the limited degree of reduction in PSA and TRUS volumes. Prominent median lobes might also pose a large challenge with this technique because the laser beam leaves the side-firing fiber at a 70° angle, increasing the potential risk of bladder injury. Another concern, among others, is that ablative methods do not leave tissue for histopathological assessment. Incidental detection of prostate cancer on transurethraly resected specimens is usually 5.2–7.4%, and has even been reported as high as 19%.<sup>25,77,78</sup> Although the KTP laser is not used for stone treatment, it has been assessed for the treatment of urethral strictures.<sup>79</sup>

Bipolar TURP also seems to be a promising option for treating small to medium sized prostates, pending long-term results. The technique has not yet been tested on large prostates in

prospective, randomized controlled studies. Bipolar TURP is also proposed as a safe way of providing training in transurethral resection techniques for urology residents.<sup>80</sup> Bipolar resection devices can also be applied to removing bladder tumors without the risk of perforation owing to the obturator reflex.<sup>81</sup>

Conventional and robotic laparoscopic prostatectomies remain as new methods of treating BPH that are under investigation. In our opinion, these procedures represent an exploration of the limits of these technologies' application. TUIP can be performed as an outpatient procedure, but is reserved for small prostates (<40 g). Minimally invasive treatment options for BPH, such as transurethral microwave thermotherapy, transurethral needle ablation, high-intensity focused ultrasonography and water-induced thermotherapy, have not been discussed here owing to space limitations, but have been recently reviewed thoroughly.<sup>82</sup> In general, the durability, quality of clinical response and cost effectiveness of these options are variable and, when taken together with a lack of correction for the possible sham effect of the procedure in some studies, render their long-term outcomes questionable. Some of the more durable options are associated with increased morbidity and patient discomfort.

## CONCLUSIONS

As more data accumulate, the roles of the different surgical treatment options for BPH are becoming better defined. The role of some procedures (e.g. open prostatectomy) in the management of BPH is diminishing, while the use of other modalities is increasing. Hopefully, with the aid of innovative technologies, urologists will continue to improve outcomes and minimize patient discomfort and morbidity when managing this common disorder.

## KEY POINTS

- Open prostatectomy is being replaced by minimally invasive surgical techniques
- Monopolar transurethral resection of the prostate is being challenged by new technologies
- New technology for the treatment of BPH is associated with fewer complications and shorter hospital stays compared with transurethral resection of the prostate
- Laser prostatectomy is cost effective

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**Acknowledgments**

Désirée Lie, University of California, Irvine, CA, is the author of and is solely responsible for the content of the learning objectives, questions and answers of the Medscape-accredited continuing medical education activity associated with this article.

**Competing interests**

MM Elhilali has declared associations with the following companies: Laserscope and Lumenis. See the article online for full details of the relationships. A Baazeem declared no competing interests.