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ORIGINAL ARTICLE

Photoselective green-light laser vaporisation *vs.* TURP for BPH: meta-analysis

Hui Ding[1,*], Wan Du[2,*], Ze-Ping Lu[1], Zhen-Xing Zhai[1], Han-Zhang Wang[3] and Zhi-Ping Wang[1]

This study sought to evaluate the efficacy and safety of photoselective vaporisation (PVP) *vs.* transurethral resection of the prostate (TURP) for patients with benign prostatic hyperplasia (BPH). Eligible studies were identified from electronic databases (Cochrane Library, PubMed and EMBASE). The database search, quality assessment and data extraction were performed independently by two reviewers. Efficacy (primary outcomes: maximum urinary flow rate (Q_{max}), international prostate symptom score (IPSS), postvoid residual urine (PVR) and quality of life (QoL); secondary outcomes: operative time, hospital time and catheter removal time) and safety (complications, such as transfusion and capsular perforation) were explored by using Review Manager 5.0. Six randomized controlled trials (RCTs) and five case-controlled studies of 1398 patients met the inclusion criteria. A meta-analysis of the extractable data showed that there were no differences in IPSS, Q_{max}, QoL or PVR between PVP and TURP (mean difference (MD): prostate sizes <70 ml, Q_{max} at 24 months, MD=0.01, P=0.97; IPSS at 12 months, MD=0.18, P=0.64; QoL at 12 months, MD=−0.00, P=0.96; PVR at 12 months, MD=0.52, P=0.43; prostate sizes >70 ml, Q_{max} at 6 months, MD=−3.46, P=0.33; IPSS at 6 months, MD=3.11, P=0.36; PVR at 6 months, MD=25.50, P=0.39). PVP was associated with a shorter hospital time and catheter removal time than TURP, whereas PVP resulted in a longer operative time than TURP. For prostate sizes <70 ml, there were fewer transfusions, capsular perforations, incidences of TUR syndrome and clot retentions following PVP compared with TURP. These results indicate that PVP is as effective and safe as TURP for BPH at the mid-term patient follow-up, in particular for prostate sizes <70 ml. Due to the different energy settings available for green-light laser sources and the higher efficiency and performance of higher-quality lasers, large-sample, long-term RCTs are required to verify whether different energy settings affect outcomes.
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INTRODUCTION

Benign prostatic hyperplasia (BPH) is a major cause of lower urinary tract symptoms (LUTSs) in men, especially in individuals over the age of 50 years.[1] LUTS secondary to BPH is typically characterized as voiding symptoms, such as weak stream, hesitancy, intermittency and incomplete emptying, storage symptoms, such as urgency, frequency and nocturia, and postmicturition symptoms.[2,3] Currently, the main treatment options for BPH include pharmacological therapy, such as α-adrenergic blockers and 5α-reductase inhibitors, or surgery, such as transurethral resection of the prostate (TURP), transurethral incision of the prostate and open simple prostatectomy.[4] Although TURP is the current 'gold standard' treatment for moderate-to-severe LUTS secondary to BPH,[5,6] the procedure has some limitations. Several studies[7,8] have demonstrated that the rate of complications following TURP, including transfusions, infections, urethral strictures, sexual dysfunction, urinary incontinence, urinary retention and the development of transurethral resection (TUR) syndrome, is almost 20%.

In recent years, photoselective vaporisation of the prostate (PVP) has become a promising alternative to TURP.[9–13] PVP uses a high-powered potassium-titanyl-phosphate laser or a lithium triborate laser that emits light at a wavelength of 532 nm, which is in the green portion of the light spectrum.[9,10,14] Because this wavelength is absorbed strongly by haemoglobin but not by water when it is applied to vascularized prostatic tissue, the laser light is absorbed instantly by the blood, which is then quickly vaporized and removed, thus creating a prostate cavity with minimal blood loss, postoperative discomfort and hospital stay.[15,16] However, to date, there has been no systematic review and meta-analysis of randomized controlled trials (RCTs) and non-RCTs to determine the effectiveness and safety of PVP *vs.* TURP for BPH. Therefore, this meta-analysis was designed to provide more reliable evidence of the efficacy and safety of PVP *vs.* TURP for patients with BPH.

[1]Institute of Urology, Key Laboratory of Urological Diseases in Gansu Province, Gansu Nephro-Urological Clinical Center, The Second Hospital of Lanzhou University, Lanzhou 730000, China and [2]Otolaryngological Department, The Second Hospital of Lanzhou University, Lanzhou 730000, China and [3]The Medical College of Shandong University, Jinan 250000, China
* These authors contributed equally to this work.
Correspondence: Dr ZP Wang (erywzp@lzu.edu.cn)
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MATERIALS AND METHODS

Selection of studies

We searched the electronic databases as follows: PubMed (1966–2011), EMBASE (1974–2011), the Cochrane Library (2011, issue 4), ISI—Science Citation Index (1955–2011) and the Chinese biomedicine literature database (1978–2011). We also searched the references of included studies to identify additional, potentially relevant studies. We combined Medical Subject Headings terms with text words to obtain the relevant RCTs. The following medical-subject heading terms and keywords were used to identify relevant studies: 'ablation techniques' AND ('lasers' OR 'photoselective vaporization' OR 'greenlight' OR 'PVP') AND ('transurethral resection of prostate' OR 'TURP') AND ('prostatic hyperplasia' OR 'benign prostatic hyperplasia' OR 'BPH'). The searches were not restricted by publication year or language. RCTs and non-RCTs studies were included if they met the criteria of comparing the efficacy and safety of PVP *vs.* TURP for BPH. All titles and abstracts retrieved *via* electronic searches were screened independently by two reviewers.

Types of outcome measures

Our primary outcomes were maximum urinary flow rate (Q_{max}), international prostate symptom score (IPSS), postvoid residual urine (PVR) and quality of life (QoL). Secondary outcomes were operative time, hospital time, catheter removal time and complications, such as transfusion and capsular perforation, among others. The relevant data were extracted independently by two reviewers. The methodological quality of the included RCT studies, which included assessment of sequence generation, allocation concealment, blinding, incomplete outcome data, selective reporting of outcomes and other possible sources of bias, was assessed using the Cochrane Collaboration's tool.[17] The non-RCT studies were assessed using a modification of the Newcastle–Ottawa Scale.[18] Scores of 5–9 were defined as high-quality scores, and a score <5 was defined as low quality. The quality assessment was performed independently by two reviewers. Disagreements were resolved in consultation with the third reviewer.

Statistical analysis

We analysed the data using Review Manager (version 5.0) and extracted and pooled the data to generate summary estimates. According to the Cochrane Collaboration's guideline,[17] we combined data for meta-analysis of dichotomous outcomes using the Mantel-Haenszel relative risk (RR) method, and for continuous outcomes, we used the inverse variance mean difference (MD) method and 95% confidence intervals (95% CIs). We also used the χ^2 test and I^2 test to assess heterogeneity between trials and the I^2 test to assess the extent of inconsistency. Data were pooled using the random-effects model. Where data were available and sufficient, subgroup analyses were performed to explore possible heterogeneity by grouping the trials into an RCT group and a non-RCT group. Subgroup analyses were performed to explore the influence of the size of the prostate.

RESULTS

Two hundred and four potential studies were identified from the above electronic databases. Following study assessment, we identified 11 trials[10–12,19–26] including six RCTs and five prospective case-controlled studies (CCSs) that met our including criteria (**Table 1**). Two trials of 128 patients were not available because we were unable to obtain the data for inclusion in this meta-analysis.[27,28]

Study characteristics

There were 1398 patients involved in the 11 trials: 808 received PVP treatment and 590 received TURP treatment. The prostate sizes in nine studies were <70 ml, and in two studies, the prostate sizes were >70 ml. In **Table 1**, we show the characteristics of the 11 studies included in this meta-analysis. Baseline information was comparable between the PVP and TURP groups.

Quality assessment showed that five CCSs were of high quality. Although only two RCTs[10,12] were adequate in sequence generation and incomplete outcome data but inadequate in allocation concealment and blinding and three RCTs[11,19,20] were adequate in sequence generation, allocation concealment and incomplete outcome data but inadequate in blinding, they were regarded as high quality because of the limitation of ethics factor and the characteristics of the surgery studies. One RCT[22] reported only randomisation but inadequate allocation concealment, blinding and incomplete outcome data and was regarded as low quality.

However, the included studies had several limitations. Of the 11 PVP RCTs and CCSs identified, two used a low-powered 60-W

Table 1 Baseline characteristics of the studies included

Study	*Design*	*No. of patients*	*Age (year)*	*Prostate volume (ml)*	*KTP or lithium triborate*	*IPSS*	*Q_{max} (ml s^{-1})*	*PVR (ml)*
		PVP/TURP				*PVP/TURP*		
Shingleton *et al.*[19,20]	RCT	50/50	68.2/67.4	32.2/29.6	60 W	None	8.0/6.9	None
Horasanli *et al.*[22]	RCT	39/37	69.2/68.3	86.1/88	80 W	18.9/20.2	8.6/9.2	183/176.9
Bouchier-Hayes *et al.*[11]	RCT	60/59	65.06/66.36	38.78/33.36	80 W	25.28/25.41	8.81/8.86	129.2/111.3
Al-Ansari *et al.*[10]	RCT	60/60	66.3/67.1	61.8/60.3	120 W	27.2/27.9	6.9/6.4	53.2/57
Capitan *et al.*[12]	RCT	50/50	69.8/67.7	51.29/53.10	120 W	23.74/23.52	8.03/3.88	None
Bachman *et al.*[21]	CCS	64/37	71.0/68.7	65.1/48.9	80 W	18.1/17.3	6.9/6.9	146.1/120.7
Ruszat *et al.*[23]	CCS	113/75	62.3/61.7 (<70)	56.3/45.3	80 W	20/19	8.5/9.8	203/104
		91/40	75.0/74.0 (70–80)	64.8/54.2	80 W	18.6/16.0	7.3/9.2	215/124
		65/12	84.3/82.4 (>80)	69.3/44.9	80 W	14.1/15.5	7.1/7.6	200/231
Tugcu *et al.*[24]	CCS	112/98	67.5/66.3	49.1/47.7	80 W	17.9/17.7	6.9/7.2	107.9/100.3
Nomura *et al.*[25]	CCS	78/51	72.0/70.5	50.5/42.8	80–100 W	None	7.0/7.0	288/292
Tasci *et al.*[26]	CCS	40/41	71.8/70.1	108.4/104.2	None	22.5/22.2	6.3/6.5	116.5/110.7

Abbreviations: CCS, case-controlled study; IPSS, international prostate symptom score; KTP, potassium-titanyl-phosphate; PVP, photoselective vaporisation of the prostate; PVR, postvoid residual urine; Q_{max}, maximum urinary flow rate; RCT, randomized controlled trial; TURP, transurethral resection of the prostate.

laser,[19,20] six used a medium-powered 80-W machine (one of which enrolled only patients with large (70–100 ml) prostates[22]) and two studies[10,12] evaluated a high-powered 120-W laser machine. Three trials[10,12,25] did not report IPSS, Q_{max} or QoL data as the mean±s.d. We contacted the authors to obtain these data but nothing was provided. Therefore, these data were not included in this meta-analysis.

Efficacy

Maximum urinary flow rate. Data from six available studies of 666 patients described Q_{max} for PVP *vs.* TURP. We performed a meta-analysis using a random-effects model. The results of the pooled meta-analysis showed that there were no significant differences between PVP and TURP (prostate sizes <70 ml: Q_{max} at 24 months, MD=0.01, 95% CI: −0.45–0.47, P=0.97; prostate sizes >70 ml: Q_{max} at 6 months, MD=−3.46, 95% CI: −10.48–3.56, P=0.33; **Table 2**).

IPSS. Data from five available studies of 557 patients showed IPSS for PVP *vs.* TURP. The results of the pooled meta-analysis showed that there were no differences between PVP and TURP (prostate sizes <70 ml: IPSS at 12 months, MD=−0.18, 95% CI: −0.95–0.58, P=0.64; prostate sizes >70 ml: Q_{max} at 6 months, MD=3.11, 95% CI: −3.54–9.77, P=0.36; **Table 2**).

QoL. Data from three available studies of 413 patients revealed QoL for PVP *vs.* TURP. There were no significant heterogeneities revealed by the pooled analysis. The results of pooled meta-analysis showed that there were no differences evident between PVP and TURP other than QoL at 6 months (prostate sizes <70 ml: QoL at 12 months, MD=−0.00, 95% CI: −0.08–0.08, P=0.96; **Table 2**).

PVR. Data from five available studies of 570 patients revealed PVR for PVP *vs.* TURP. The results of the pooled meta-analysis showed that there were no differences between PVP and TURP other than PVR at 3 months (prostate sizes <70 ml: PVR at 12 months, MD=0.52, 95% CI: −0.77–1.81, P=0.43; prostate sizes >70 ml: Q_{max} at 6 months, MD=25.50, 95% CI: −32.49–83.49, P=0.39; **Table 2**).

Operative time. Data from seven available studies of 1084 patients showed operative time for PVP *vs.* TURP. The results of the pooled meta-analysis showed that the operative time was longer for PVP compared with TURP (prostate sizes <70 ml: MD=12.27, 95% CI:

Table 2 Results of the meta-analysis on the efficacy of PVP compared with TURP

Parameters	N*	*Sample size (I/C)*	*Heterogeneity*	*Pooled MD (95% CI)*	*Z test*
PS<70 ml					
Q_{max}					
3 months	4	280/229	χ^2=3.54, P=0.32, I^2=15%	−0.24 (−1.27, 0.80)	Z=0.45, P=0.66
6 months	4	265/215	χ^2=4.61, P=0.20, I^2=35%	0.12 (−1.26, 1.50)	Z=0.17, P=0.87
12 months	3	197/169	χ^2=0.99, P=0.61, I^2=0%	0.06 (−0.37, 0.49)	Z=0.27, P=0.79
24 months	2	128/111	χ^2=0.11, P=0.75, I^2=0%	0.01 (−0.45, 0.47)	Z=0.04, P=0.97
IPSS					
3 months	3	214/181	χ^2=0.29, P=0.87, I^2=0%	0.25 (−0.24, 0.75)	Z=1.01, P=0.31
6 months	3	219/167	χ^2=0.35, P=0.84, I^2=0%	0.23 (−0.12, 0.59)	Z=1.30, P=0.19
12 months	2	154/134	χ^2=1.07, P=0.30, I^2=7%	−0.18 (−0.95, 0.58)	Z=0.47, P=0.64
QoL					
3 months	3	232/181	χ^2=2.94, P=0.23, I^2=32%	−0.05 (−0.26, 0.16)	Z=0.48, P=0.63
6 months	3	219/167	χ^2=0.54, P=0.76, I^2=0%	−0.09 (−0.16, −0.03)	Z=2.73, P=0.006
12 months	2	154/134	χ^2=0.20, P=0.65, I^2=0%	−0.00 (−0.08, 0.08)	Z=0.05, P=0.96
PVR					
3 months	3	232/181	χ^2=0.64, P=0.73, I^2=0%	−4.71 (−7.30, −2.12)	Z=3.57, P=0.0004
6 months	3	219/167	χ^2=0.74, P=0.69, I^2=0%	0.49 (−1.10, 2.08)	Z=0.61, P=0.54
12 months	2	154/134	χ^2=0.15, P=0.70, I^2=0%	0.52 (−0.77, 1.81)	Z=0.78, P=0.43
OT	5	555/372	χ^2=23.92, P=0.0005, I^2=75%	12.27 (7.37, 17.18)	Z=4.90, P<0.00001
HT	5	551/361	χ^2=118.70, P<0.00001, I^2=95%	−1.52 (−2.17, −0.88)	Z=4.62, P<0.00001
CR	6	601/411	χ^2=39.62, P<0.00001, I^2=82%	−1.15 (−1.43, −0.88)	Z=8.17, P<0.00001
PS>70 ml					
Q_{max}					
3 months	2	79/78	χ^2=11.67, P=0.0006, I^2=91%	−2.49 (−10.99, 6.01)	Z=0.57, P=0.57
6 months	2	79/77	χ^2=9.95, P=0.002, I^2=90%	−3.46 (−10.48, 3.56)	Z=0.97, P=0.33
IPSS					
3 months	2	79/78	χ^2=11.45, P=0.0007, I^2=91%	2.33 (−2.65, 7.31)	Z=0.92, P=0.36
6 months	2	79/77	χ^2=18.13, P<0.00001, I^2=94%	3.11 (−3.54, 9.77)	Z=0.92, P=0.36
PVR					
3 months	2	79/78	χ^2=52.33, P<0.00001, I^2=98%	27.28 (−23.19, 77.74)	Z=1.06, P=0.29
6 months	2	79/77	χ^2=31.84, P<0.00001, I^2=97%	25.50 (−32.49, 83.49)	Z=0.86, P=0.39
OT	2	79/78	χ^2=5.86, P=0.02, I^2=83%	42.45 (30.41, 54.49)	Z=6.91, P<0.00001
HT	2	79/78	χ^2=8.64, P=0.003, I^2=88%	−2.42 (−3.10, −1.73)	Z=6.94, P<0.00001
CR	2	79/78	χ^2=0.18, P=0.67, I^2=0%	−2.10 (−2.18, −2.03)	Z=54.35, P<0.00001

Abbreviations: C, control; CI, confidence interval; CR, catheter removal time; HT, hospital time; I, intervention; IPSS, international prostate symptom score; MD, mean difference; N, number of included studies; OT, operative time; PS, prostate size; PVP, photoselective vaporisation of the prostate; PVR, postvoid residual urine; Q_{max}, maximum urinary flow rate; QoL, quality of life; TURP, transurethral resection of the prostate.

7.37–17.18, $P<0.00001$; prostate sizes >70 ml: MD=42.45, 95% CI: 30.41–54.49, $P<0.00001$; **Table 2**).

Hospital time. Data from seven available studies of 1069 patients described hospital time for PVP *vs.* TURP. The results of the pooled meta-analysis showed that hospital time was shorter following PVP compared with TURP (prostate sizes <70 ml: MD=−1.52, 95% CI: −2.17 to −0.88, $P<0.00001$; prostate sizes >70 ml: MD=−2.42, 95% CI: −3.10 to −1.73, $P<0.00001$; **Table 2**).

Catheter removal time. Data from eight available studies of 1088 patients described catheter removal time for PVP *vs.* TURP. The results of the pooled meta-analysis showed that catheter removal time was shorter following PVP compared with TURP (prostate sizes <70 ml: MD=−1.15, 95% CI: −1.43 to −0.88, $P<0.00001$; prostate sizes >70 ml: MD=−2.10, 95% CI: −2.18 to −2.03, $P<0.00001$; **Table 2**).

Complication rate

Ten studies reported complications including blood transfusion, capsular perforation, incidences of TUR syndrome, clot retention, urinary retention, urinary tract infection, reintervention, retrograde ejaculation, urethral stricture, urinary incontinence, bladder neck contracture and dysuria. For prostate sizes <70 ml, the results of the pooled meta-analyses showed that there were fewer transfusions (RR=0.10, 95% CI: 0.03–0.28, $P<0.0001$), capsular perforations (RR=0.08, 95% CI: 0.02–0.29, $P=0.0001$), incidences of TUR syndrome (RR=0.16, 95% CI: 0.04–0.75, $P=0.02$), clot retentions (RR=0.13, 95% CI: 0.05–0.31, $P<0.00001$) and more dysuria (RR=1.78, 95% CI: 1.03–3.08, $P=0.04$) following PVP compared with TURP, whereas there was no obvious difference in urinary retention, urinary tract infection, reintervention, retrograde ejaculation, urethral stricture, urinary incontinence, bladder neck contracture or dysuria between PVP and TURP. For prostate sizes >70 ml, the results of pooled meta-analysis showed no differences (**Table 3**).

DISCUSSION

To our knowledge, this study is the first meta-analysis of RCTs and CCSs comparing PVP with TURP for BPH. One former systematic review has reviewed PVP *vs.* TURP for BPH.[29] However, due to the lack of sufficient comparative studies, the authors depicted only results without statistics in their study; thus, their conclusions could not provide reliable evidence to urologists or readers.

For our systematic review and meta-analysis, we generated a precise and detailed retrieval strategy. By doing so, we expected to include all of the studies related to BPH for a comparison between PVP and TURP and hoped to reduce confounds and biases and ultimately draw a scientifically and statistically robust conclusion. It is well known that RCTs are considered the gold standard trial design for evaluating and comparing interventions by reducing bias to a minimum. However, only three of six RCTs obtained complete data including Q_{max}, IPSS, PVR and QoL, and in one RCT, the prostate volume reported was larger than 70 ml reported in previous studies.[22] To provide more effective evidence for urologists and patients, we also assessed another five CCSs.

On the basis of long-term efficacy results from RCTs, TURP remains the current 'gold standard' treatment for moderate-to-severe LUTS secondary to BPH.[8] In our study, meta-analyses of Q_{max}, IPSS and QoL of RCTs and of RCTs combined with CCSs both suggested that PVP was as efficacious as TURP. Although both procedures had the same efficacy, long-term follow-up after 24 months will be required.

Our pooled analyses and sensitivity analyses for hospital time and catheter removal time showed that PVP results in clearly shorter times than TURP, whereas operative time is longer than that of TURP despite the existing heterogeneity in the trials. Because surgeons have different proficiencies in the techniques, we believe that the inconsistency in operative time does not affect the validity of our conclusion.

With respect to the rate of complications including blood transfusion, capsular perforation, incidences of TUR syndrome and clot retention, our results showed that there were significantly fewer incidences of complications following PVP compared with TURP. The main complication of traditional TURP is bleeding, which often

Table 3 Results of the meta-analysis on the safety of PVP compared with TURP

Complications	*N*	*Sample size (PVP/TURP)*	*Heterogeneity*	*Pooled RR (95% CI)*	*Z test*
PS<70 ml					
Transfusion	5	503/327	$\chi^2=1.00$, $P=0.91$, $I^2=0\%$	0.10 (0.03, 0.28)	$Z=4.31$, $P<0.0001$
Capsular perforation	4	505/322	$\chi^2=0.54$, $P=0.91$, $I^2=0\%$	0.08 (0.02, 0.29)	$Z=3.83$, $P=0.0001$
Urinary retention	5	320/239	$\chi^2=2.42$, $P=0.66$, $I^2=0\%$	1.06 (0.48, 2.33)	$Z=0.14$, $P=0.89$
TUR syndrome	4	425/276	$\chi^2=0.27$, $P=0.97$, $I^2=0\%$	0.16 (0.04, 0.75)	$Z=2.33$, $P=0.02$
UTI	6	619/402	$\chi^2=2.37$, $P=0.67$, $I^2=0\%$	1.15 (0.70, 1.90)	$Z=0.56$, $P=0.58$
Reintervention	4	425/276	$\chi^2=4.70$, $P=0.20$, $I^2=36$	1.71 (0.64, 4.60)	$Z=1.07$, $P=0.28$
Retrograde ejaculation	2	114/87	$\chi^2=0.75$, $P=0.39$, $I^2=0\%$	0.65 (0.12, 3.34)	$Z=0.52$, $P=0.60$
Urethral stricture	6	623/413	$\chi^2=4.91$, $P=0.43$, $I^2=0\%$	0.84 (0.43, 1.65)	$Z=0.51$, $P=0.61$
Urinary incontinence	3	178/151	$\chi^2=0.06$, $P=0.97$, $I^2=0\%$	0.87 (0.18, 4.24)	$Z=0.17$, $P=0.86$
Bladder neck contracture	6	587/424	$\chi^2=4.23$, $P=0.52$, $I^2=0\%$	1.50 (0.73, 3.09)	$Z=1.10$, $P=0.27$
Dysuria	6	629/412	$\chi^2=13.88$, $P=0.02$, $I^2=64\%$	1.78 (1.03, 3.08)	$Z=2.06$, $P=0.04$
Clot retention	5	551/361	$\chi^2=3.19$, $P=0.53$, $I^2=0\%$	0.13 (0.05, 0.31)	$Z=4.60$, $P<0.00001$
PS>70 ml					
Transfusion	2	79/77	$\chi^2=0.19$, $P=0.66$, $I^2=0\%$	0.20 (0.02, 1.76)	$Z=1.45$, $P=0.15$
Capsular perforation	2	79/77	$\chi^2=0.00$, $P=0.96$, $I^2=0\%$	0.32 (0.03, 3.05)	$Z=0.98$, $P=0.33$
UTI	2	79/77	$\chi^2=0.01$, $P=0.94$, $I^2=0\%$	1.08 (0.44, 2.64)	$Z=0.17$, $P=0.87$
Reintervention	2	79/77	$\chi^2=0.73$, $P=0.39$, $I^2=0\%$	5.46 (0.95, 31.33)	$Z=1.91$, $P=0.06$
Urethral stricture	2	79/77	$\chi^2=0.40$, $P=0.53$, $I^2=0\%$	0.47 (0.10, 2.10)	$Z=0.99$, $P=0.32$

Abbreviations: CI, confidence interval; N, number of included studies; PS, prostate size; PVP, photoselective vaporisation of the prostate; RR, risk ratio; TUR, transurethral resection; TURP, transurethral resection of the prostate; UTI, urinary tract infection.

requires a transfusion. The US Department of Health and Human Services reported that the official estimation of transfusion rate is 13%,[13] and a recent meta-analysis reported that the transfusion rate ranged from 0.4%[30] to 7.1%.[31] Clot retention may occur as a consequence of the procedure and as a result of premature termination of the procedure and the consequent inadequate relief of the obstruction.[13] Hahn[32] reported that the risk of TUR syndrome during the procedure is approximately 2%. Our meta-analysis showed that the transfusion rate, capsular perforation, incidence of TUR syndrome and clot retention was 0.4%, 0.2%, 0% and 0.7%, respectively, which is less than the above study[13,30–32] in prostate sizes of <70 ml. The treatment of symptomatic BPH causes an important effect on male sexual function, with an incidence of ejaculatory dysfunction at approximately 33.6%.[33] However, we did not find any difference in ejaculatory dysfunction between the procedures. For prostate sizes >70 ml, we also did not find any difference between PVP and TURP.

Currently, four studies have analysed the costs associated with PVP and TURP that did not include the cost of the laser machine or TURP instruments. The results indicated that the actual costs of PVP are lower than those of TURP (PVP *vs.* TURP: Stovsky *et al.*,[4] $3876.84 *vs.* $5135.27; Bouchier-Hayes,[34] $2975.08 *vs.* $3790.86; Secretariat Medical Advisory,[35] $1184 *vs.* $3887; Goh and Gonzalez[36] $4266 *vs.* $5097). The likely primary reason underlying this difference is that PVP induces less morbidity and is associated with shorter hospital time than TURP.

Although PVP was associated with less morbidity and was as efficacious as TURP, this approach had some disadvantages. An important disadvantage of laser prostatectomy is the lack of tissue obtained during the operation, which precludes the identification of incidental prostate cancer. Therefore, it is important to evaluate patients carefully with both digital rectal examinations and prostate-specific antigen measurements and by using transrectal ultrasonography and biopsies where cancer is suspected.[37,38]

Our meta-analysis also had several limitations. First, one RCT reported using 60-W-laser procedures and two RCTs reported using 120-W-laser procedures, both of which were included in our study, and one RCT[10] reported IPSS, Q_{max} and QoL data in the form of boxplots or bar charts, and this information could not be extracted for meta-analysis of different green-light laser wattages. Heinrich *et al.*[14] reported that in an *ex vivo* model, the 120-W lithium triborate (LBO) laser offered a significantly higher tissue ablation capacity compared with the conventional 80-W potassium-titanyl-phosphate laser. Subsequently, Malek *et al.*[39] demonstrated in dogs that the GreenLight XPS 180-W 532-nm lithium triborate PVP laser with the MoXy fibre resulted in a significantly higher vaporisation rate and speed with a deeper haemostatic coagulation zone but a favourable tissue interaction and a healing equal to that of an HPS 120-W laser PVP. These data indicate the requirement for more clinical RCTs comparing higher wattage with lower wattage to verify these findings. Second, the lack of relevant data on the time to recovery of erectile function, on International Index of Erectile Function scores, on patients with or without anticoagulant therapy and on monopolar or bipolar TURP precludes further evaluation on these endpoints. Third, because of the small sample size and the limited methodological quality of the studies included, more analyses of higher-quality, large-sample, long-term RCTs where outcomes are described in detail are required.

CONCLUSIONS

The results of this meta-analysis suggested that PVP induced less morbidity, was lower in cost and was as efficacious as TURP for BPH and that PVP was an alternate option for BPH at the mid-term patient follow-up, especially for prostate sizes of <70 ml. Because of the different energy settings of green-light laser sources, more analyses of higher-quality, large-sample, long-term RCTs are required to verify the effects of different energy settings.

AUTHOR CONTRIBUTIONS

HD, WD, ZPL and ZPW conceived of the study, participated in its design and coordinated and drafted the manuscript. HD, WD, ZPL, ZXZ, HZW and ZPW collected the data. HD, WD, ZPL and ZXZ performed the statistical analyses. HD, WD, ZPL and ZPW participated in critical revision of the manuscript. All authors read and approved the final manuscript.

COMPETING FINANCIAL INTERESTS

The authors have no financial or commercial interests related to this study.

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