

# Management of greenlight laser plus transurethral resection of prostate for elderly men

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## Abstract

The study is aiming to evaluate the treatment safety and efficacy of greenlight laser photovaporization of the prostate (PVP) combined with transurethral electrovaporization resection (TUVP) for elderly ( $\geq 70$  years) men with lower urinary tract symptoms due to benign prostatic hyperplasia (BPH/LUTS) with a large prostate volume ( $\geq 80$  mL). One hundred twelve BPH/LUTS patients treated with PVP were divided into 2 groups according to prostate volume (PV), the outcomes of the 2 groups were assessed at 12 months after the operation. Patients in the  $PV \geq 80$  group ( $n=51$ ) had a higher level of maximum detrusor pressure (Pdet.max) than those in the  $PV < 80$  group ( $n=61$ ) ( $97.14 \pm 36.68$  vs  $70.70 \pm 32.55$ ,  $P < .001$ ). Pdet.max level of the 2 groups was significantly decreased at the end of follow-up. International Prostate Symptom Score questionnaires (IPSS) score, maximum flow rate (Qmax), and residual urine volume (PVR) were significantly improved in comparison to the preoperative status ( $P < .001$ ). PVP combined with TUVP can significantly improve outcomes (IPSS, Qmax, PVR) and is a safe and effective technique for elderly BPH/LUTS patients with a large prostate volume.

**Abbreviations:** BMI = body mass index, BOO = bladder outlet obstruction, BPH = benign prostatic hyperplasia, BPH/LUTS = lower urinary tract symptoms due to benign prostatic hyperplasia, DM = diabetes mellitus, DRE = digital rectal examination, DU = detrusor underactivity, HTN = hypertension, IPSS = International Prostate Symptom Score Questionnaires, MCC = maximum capacity of the bladder, OAB = overactive bladder, Pdet.max = maximum detrusor pressure, PSA = prostate specific antigen, PV = prostate volume, PVP = greenlight laser photovaporization of the prostate, PVR = residual urine volume, Qmax = maximum flow rate, TURP = transurethral resection of the prostate, TUVP = transurethral electrovaporization resection.

**Keywords:** laser therapy, lower urinary tract symptoms, prostatic hyperplasia

## 1. Introduction

Lower urinary tract symptoms (LUTS) are a common clinical disease entity with a significant impact on health-related quality of life in adult men worldwide.<sup>[1]</sup> LUTS is associated with multifactorial etiology including: bladder outlet obstruction (BOO), overactive bladder (OAB), detrusor underactivity (DU), neurogenic bladder dysfunction, and others.<sup>[2]</sup> However, LUTS is the most commonly correlated with an increasing incidence of BOO, which often results from age-related benign prostatic hyperplasia (BPH).<sup>[3,4]</sup>

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ZHZ and FL contributed equally to this study.

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The treatment of lower urinary tract symptoms due to benign prostatic hyperplasia (BPH/LUTS) has been established with oral medication ( $\alpha$ -receptor blockers and 5- $\alpha$  reductase inhibitors) as the first-line approach.<sup>[5,6]</sup> Transurethral resection of the prostate (TURP) has been applied as standard surgical treatment for more than half a century. However, the postsurgical complications, such as bleeding, transurethral resection (TUR) syndrome, and incontinence makes it a high-risk surgery for elderly BPH/LUTS patients and those with a large prostate volume (PV).<sup>[7]</sup> Greenlight laser photovaporization of the prostate (PVP) uses a sidelight and non-contact system at a wavelength of 532 nm, which can be selectively absorbed by hemoglobin in prostate tissues, resulting in efficient vaporization and coagulation. PVP is an alternative to TURP with the characteristics of efficacy, reliability, and safety, especially for elderly and high-risk BPH/LUTS patients.<sup>[8,9]</sup> A large number of studies have proven that the BPH/LUTS patients treated by PVP are improved similarly as TURP with fewer complications.<sup>[10,11]</sup> However, due to the low vaporization efficiency and long surgical time, PVP is considered to be limited in the treatment of large prostates.

In the present study, we performed this study aiming to investigate the short-term efficacy outcomes of PVP combined with transurethral Electroevaporization resection(TUVP) for elderly (age  $\geq 70$  years) BPH/LUTS patients with  $PV \geq 80$  mL in mainland China, and to help assist in clinical decision-making about BPH/LUTS treatment.

## 2. Materials and methods

### 2.1. Study design and patients

A total of 112 BPH/LUTS patients treated with PVP were enrolled in our study from January 2014 to October 2015. The inclusion

criteria were as follows: patients with LUTS (International Prostate Symptom Score [IPSS] > 16), age  $\geq$  70 years old, maximum flow rate (Qmax) < 15 mL/s, and prostate volume > 30 mL. The exclusion criteria included: neurogenic bladder with a clear etiology, urethral stricture, prostate cancer, or severe systemic disease. All patients were divided into 2 groups according to PV (PV < 80 and PV  $\geq$  80 mL). The present study was carried out at Tianjin Union Medical Center and was approved by the Institutional Ethics and Research Committee.

Information about high-risk habits and concomitant diseases was collected after admission, including smoking, drinking, hypertension (HTN), diabetes mellitus (DM), and a history of myocardial infarction or stroke. All patients were evaluated with standard processes such as physical examination, body mass index (BMI), digital rectal examination (DRE), urine analysis, IPSS questionnaires, serum prostate specific antigen (tPSA), abdominal ultrasound measurement of prostate volume (PV), and residual urine volume (PVR). Patients also underwent a urodynamic measurement to obtain information about maximum detrusor pressure (Pdet.max), maximum urinary flow rate (Qmax), and maximum capacity of the bladder (MCC). The following formulae were applied to calculate the corresponding parameters: BMI = weight (kg)/(height (m))<sup>2</sup>, PSA density (PSAD) = tPSA/PV, PV/PVR = 0.52  $\times$  length  $\times$  width  $\times$  height, bladder compliance (BC) =  $\Delta V/\Delta P$ .

## 2.2. Surgical technique

The large PV patients received PVP combined with TUVP, while cases with PV < 80 mL underwent PVP only. PVP was performed according to the standardized surgery procedure as previously described.<sup>[12,13]</sup> The GreenLight HPS Laser System (American Medical System Incorporation, Minnetonka, MN) was used, and a summary of the laser parameters was shown in Supplement Table 1, <http://links.lww.com/MD/C397>. In PV < 80 mL group, the enlarged prostate gland tissues were vaporized and resected to the depth of surgical capsule, followed by a PVP coagulation procedure to reduce postoperative hematuria. The PVP operational energy for vaporization and coagulation was adjusted within 80–120 W/20–30 W for patients in both groups. PVP operations were completed under irrigation with 0.9% saline. In PV  $\geq$  80 mL group, TUVP was performed first to remove most of prostate hyperplastic tissue in same way of conventional TURP. The electrovaporization power was set at 230 to 260 W, and the coagulation was 50 to 70 W with the irrigation of Mannitol. Then PVP was used to vaporize the remaining tissue and coagulate the bleeding. Simultaneous suprapubic cystostomy was performed for all patients with detrusor underactivity as previously described.<sup>[12]</sup> A 3-way Foley catheter was inserted without irrigation after the operation. All surgeries were performed by well-trained urologists in our center.

## 2.3. Follow-up and assessment

Patients were followed for 12 months and they were also asked to return if urinary-related symptoms appeared. The IPSS questionnaire was completed at the last visit of the follow-up period and PVR was re-evaluated by abdominal ultrasound. The urinary flow rate was investigated to analyze the Qmax. Pdet.max was also re-assessed at the end of follow-up. Patients with a bladder fistula were examined and evaluated after closing the fistula.

## 2.4. Statistics

All data were given as mean  $\pm$  standard deviation (SD) or percentage.  $\chi^2$  tests and Fisher exact tests were used to compare

the proportion parameters. Student's *t* test was applied for the quantitative variables while a paired *t* test was performed to assess the perioperative and postoperative variables. A *P* value of < .05 was defined as statistically significant. All statistics were analyzed by using the SPSS (22.0 version) software package.

## 3. Results

A total of 112 patients were included in our study with an average age of 76.5 (70–86) years old. The preoperative prostate volume and tPSA of all patients was 77.11  $\pm$  37.27 mL and 5.93  $\pm$  4.51 ng/mL, respectively. Based on prostate volume, 51 cases were categorized into the PV  $\geq$  80 group, while 61 cases were in the PV < 80 group. The mean prostate size of patients in both groups was 51.10  $\pm$  12.58 mL and 108.22  $\pm$  32.88 mL, respectively. As shown in Figure 1A, there was no significant difference between the 2 groups for habits (smoking and drinking) or common concomitant diseases (HTN, DM, myocardial infarction, and stroke). Figure 1B displayed a summary of the baseline clinical characteristics of both groups. No significant difference was observed between the 2 cohorts except for tPSA and PV.

Three urodynamic parameters, including Pdet.max, MCC, and BC, are shown in Figure 2. Patients in the PV  $\geq$  80 group had higher levels of Pdet.max than those in the PV < 80 group (70.70  $\pm$  32.55 vs 97.14  $\pm$  36.68, *P* < .001). In addition, more cases with Pdet.max < 50 cm H<sub>2</sub>O were observed in the PV < 80 group compared with the larger PV group (21.3% vs 7.8%, *P* = .048). There was no significant difference in the proportions of patients with MCC > 400 mL/MCC < 100 mL in both groups, and the BC (BC < 20/BC > 40) differences also did not reach the significance level.

All patients were treated with PVP or PVP+TUVP. The average surgery time of the 2 groups was 49.8  $\pm$  15.6 minutes (PV < 80) and 62.4  $\pm$  17.3 minutes (PV  $\geq$  80), respectively (*P* < .001). The mean postoperative hospitalization time of the PV < 80 group was 3.9  $\pm$  1.9 days in comparison to the 4.5  $\pm$  2.7 days in the large PV group (*P* = .197). The surgical complications of the 2 groups were shown in Table 1. Patients who developed intraoperative and postoperative complications were treated with the appropriate management, and 2 patients in the large PV group required retreatment. Of those, one patient with PV > 150 mL and 1 patient with severe heart disease underwent the designed-reoperation 1 week later.

A total of 93 patients in the present study were successfully followed up for 12 months with 42 cases in the PV  $\geq$  80 group and 51 in the PV < 80 group. Qmax, tPSA, IPSS score, Pdet.max and PVR were assessed in both groups (Fig. 3). The postoperative parameters of Qmax, IPSS score and PVR were significantly improved in comparison to the preoperative status in each group (*P* < .001). The IPSS-voiding and IPSS-storage were improved in both groups, and the QoL score were also significantly decreased in PV < 80 mL (4.6  $\pm$  1.4 vs 1.4  $\pm$  1.1) and PV  $\geq$  80 mL (4.2  $\pm$  1.3 vs 1.2  $\pm$  1.2) groups. In addition, Pdet.max was also found obviously decreased between the 2 groups at the end of follow-up (*P* < .001).

## 4. Discussion

A number of studies have shown that PVP can be used as a safe and effective alternative treatment to TURP for LUTS related to BPH.<sup>[14–16]</sup> A European multicenter randomized controlled trial<sup>[17]</sup> demonstrated that PVP could produce similar functional outcomes to TURP at 12 months' follow-up, which is consistent

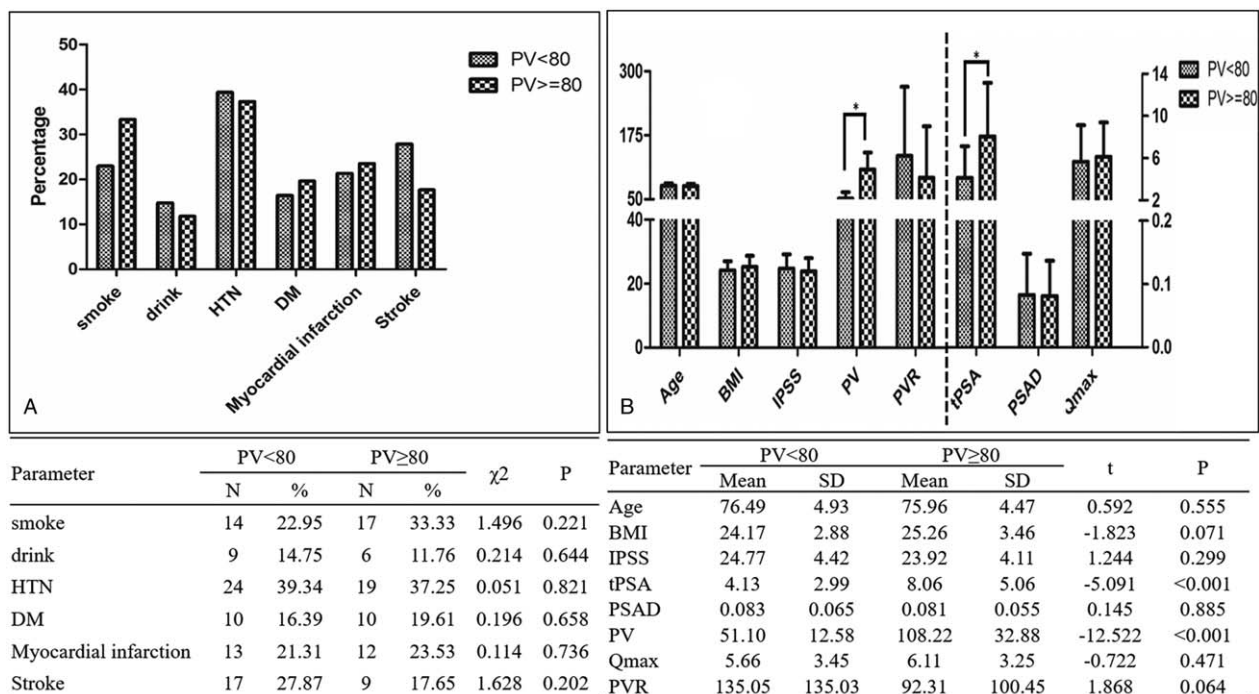


Figure 1. The medical history and baseline clinical characteristics in both groups.

with Bouchie-Hayes' study of 120 patients.<sup>[18]</sup> Al-Ansari and his colleagues<sup>[19]</sup> compared green light HPS 120 W laser vaporization to TURP for the treatment of BPH over 3 years and demonstrated that PVP produced dramatic improvements in Qmax, IPSS, and PVR with fewer intraoperative or postoperative complications. Ruszat et al<sup>[20]</sup> investigated 396 BPH/LUTS patients and found that cases treated with TURP were more likely to develop bleeding, capsular perforation, and early postoperative clot retention than the PVP group, and they

concluded that PVP was more favorable in terms of perioperative safety. Additionally, another study found that HPS-PVP was an effective, long-term treatment option for BPH, with sustained efficacy of 76.1% at 5-year follow-up.<sup>[21]</sup> Consequently, it seems to be wise for older and high-risk BPH/LUTS men to receive a less invasive PVP operation.

Comorbid diseases can make it dangerous to perform an operation. In the present study, HTN was the most prevalent comorbidity with BPH/LUTS (43/112, 38.4%), while the

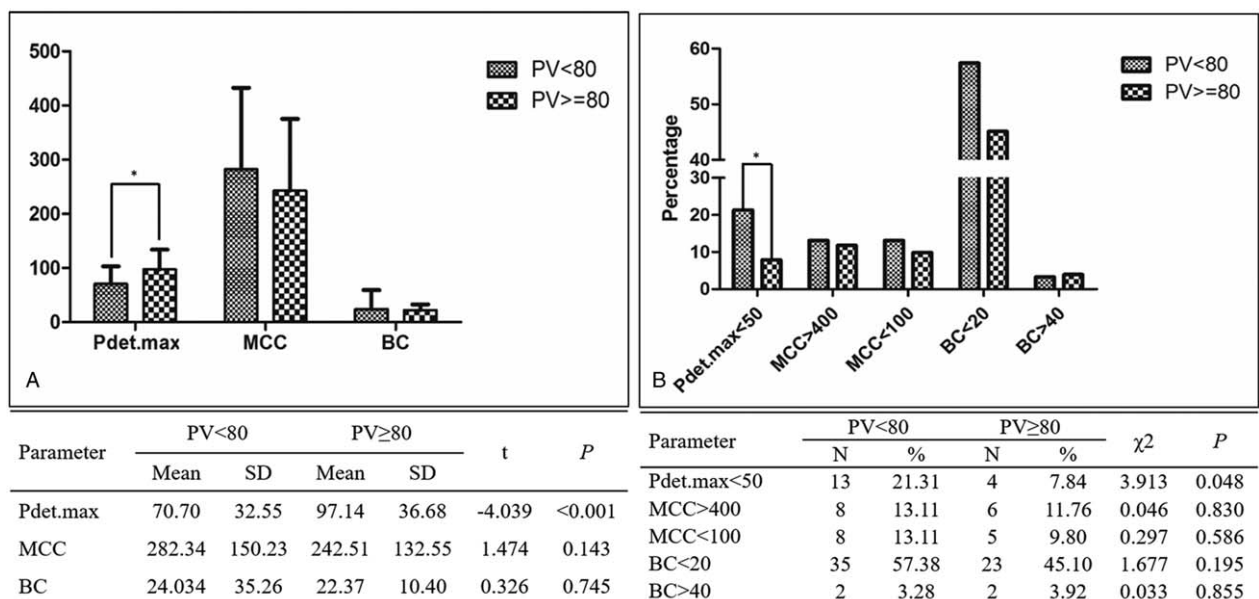


Figure 2. The urodynamic comparison between the 2 PV groups. PV=prostate volume.

**Table 1**  
The surgical complications of PVP in both groups.

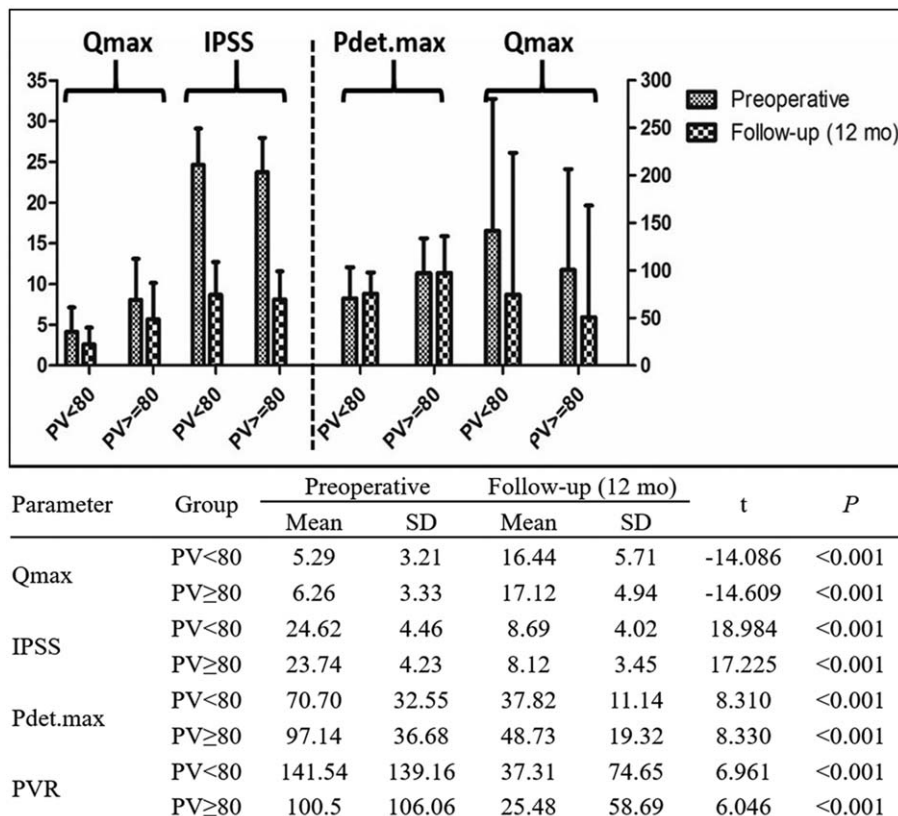
	PV < 80 (n=60)	PV ≥ 80 (n=51)
Intraoperative complications		
Bleeding and blood transfusion	0 (0%)	2 (3.92%)
Capsular perforation	0 (0%)	0 (0%)
TUR syndrome	0 (0%)	0 (0%)
Postoperative complications		
Early postoperative (<90 days)	(0%)	(0%)
Hematuria	2 (3.33%)	5 (9.80%)
Blood transfusion	0 (0%)	2 (3.92%)
Urosepsis	0 (0%)	0 (0%)
UTI	5 (8.33%)	5 (9.80%)
Urge incontinence (transient)	1 (1.67%)	3 (5.88%)
Retreatment	0 (0%)	2 (3.92%)
Embolia	0 (0%)	0 (0%)
Death	0 (0%)	0 (0%)
Long-term postoperative (12 months)		
Urethral stricture	1 (1.67%)	3 (5.88%)
Bladder neck stricture	0 (0%)	0 (0%)
Incontinence	0 (0%)	1 (1.96%)

PVP = greenlight laser photovaporization of the prostate, TUR = transurethral resection; UTI = urinary tract infection.

morbidity of DM, myocardial infarction and stroke in our study were also higher. In addition, Song et al<sup>[22]</sup> examined 155 BPH patients treated with PVP and showed that age can serve as an independent predictor of storage symptom improvement for as much as 3 years. Therefore, we investigated 112 patients, who were ≥ 70 years old, to evaluate the treatment outcome of elderly patients with a large PV.

In our study, no significant difference of baseline clinical characteristics was found between the PV ≥ 80 and PV < 80 mL groups except tPSA and PV. Patients in the large PV group had a higher Pdet.max and more cases with Pdet.max < 50 cm H<sub>2</sub>O than the other group. Nevertheless, significant outcome improvement (IPSS score, Qmax, and PVR, *P* < .001) was observed in both groups with no severe adverse events that required rehospitalization or reoperation except 4 designed retreatment in the large PV group. Choi's study<sup>[23]</sup> also found that 120 W PVP was an appropriate surgery regardless of the existence of detrusor underactivity. Our findings were similar to the results of Altay's study,<sup>[24]</sup> who evaluated the voiding improvement in elderly BPH/LUTS patients with PV ≥ 80 mL. In addition, Alivizatos's study<sup>[25]</sup> compared the effectiveness and safety of PVP with open prostatectomy for large PV patients (PV ≥ 80 mL) and concluded PVP was a highly acceptable treatment. Another publication, in which all BPH/LUTS patients were divided into 3 groups (< 60, 60–100, and > 100 mL), documented that green light 120 W HPS was safe and efficacious regardless of prostate size.<sup>[26]</sup> Furthermore, Stone BV's study<sup>[27]</sup> also showed GL-XPS vapoenucleation provided durable subjective and objective improvements in men with large prostates.

The operation time of the large PV group in our cohort was significantly longer than the PV < 80 mL group, and the postoperative hospitalization time between the 2 groups was not significantly different. West and Woo<sup>[28]</sup> used a green light system to treat patients and showed that there was no prostate size-dependent complication increase or duration of hospitalization changes, which was consistent with our results. Although PVP was considered as outpatient surgery in most countries, the enrolled BPH/LUTS patients in current study were elderly and



**Figure 3.** The postoperative parameters after PVP over 12 months in the 2 groups. PVP = greenlight laser photovaporization of the prostate.

high-risky which need be managed carefully after the operation. Therefore, the hospitalization time was longer than others' studies. In addition, the operation time could be improved by GreenLight XPS 180W system. Eken's<sup>[29]</sup> study showed that the GreenLight XPS 180W laser system was as safe and effective as the HPS 120W system with a reduced operating and hospitalization time. Besides that, GreenLight HPS laser enucleation was a feasible and safe choice for BPH/LUTS patients with large prostate.<sup>[30]</sup>

Although PVP was associated with higher procedural costs during the surgery, patients treated with had less complications and shorter length of stay than those underwent TURP. In the present study, there was no significant cost difference enrolled patients, which was consistent with previous studies.<sup>[31,32]</sup>

Our experience for treatment of large PV BPH/LUTS patients was to fully assess the characteristics of each patient. Adequate energy delivery was performed to decrease the operation time in a large gland, while a lower energy power should be used to carefully vaporize the prostate closed to the surgical capsule.<sup>[20,33]</sup> For patients with a huge prostate or serious concomitant disease, designed-retreatment should be considered to reduce the incidence of perioperative complications.

There were several limitations to this study. First, retrospective nonrandomized research had its own inherent limitations. Second, the population size of presents study was relatively small. In addition, the outcome of PVP was not compared with the TURP, which was considered as the gold standard technique. At last, the follow-up period seemed to be short (1 year) for the outcome assessment of PVP.

## 5. Conclusions

Our study showed that PVP can significantly improve outcomes (IPSS, Qmax, and PVR) and is a safe and effective technique for elderly BPH/LUTS patients with a large prostate volume.

## Author contributions

**Data curation:** Yanhui Su.

**Formal analysis:** Zhihua Zhang, Yanhui Su.

**Funding acquisition:** Fei Lluo.

**Investigation:** Jian Li.

**Methodology:** Fei Luo.

**Resources:** Zhihua Zhang.

**Software:** Fei Luo.

**Validation:** Yanhui Su, Jian Li.

**Writing – original draft:** Zhihua Zhang, Fei Luo.

**Writing – review & editing:** Jian Li.

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