Long-term outcomes of bipolar transurethral enucleation and resection of the prostate on patients with benign prostatic obstruction: a 10-year follow-up

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Objective. We aimed to explore the long-term outcomes of bipolar transurethral enucleation and resection of the prostate (B-TUERP) in patients with benign prostatic hyperplasia (BPH).
Methods. A total of 1195 patients with BPH who underwent B-TUERP from July 2006 to June 2010 were enrolled in this retrospective study. Preoperative data, particularly urodynamic study (UDS) parameters, were collected by questionnaire and examination. Postoperative follow-up was performed at 3, 6, 12, 36, 60 and 120 months, respectively. Demographic, perioperative and functional data were analysed. International Prostate Symptom Score, quality of life and overactive bladder syndrome score (OABSS) were used to assess the functional scores. Predictors of postoperative urgency incontinence were identified by univariate analysis.
Results. Long-term outcomes of functional score were significantly better than the preoperative values. All UDS variables, including maximum urinary flow rate, postvoid residual urine volume, compliance, maximum cystometric capacity (MCC), bladder outlet obstruction index, prostatic urethral pressure and detrusor pressure at maximum urinary flow rate, were all significantly improved. No one required reoperation due to recurrent BPH. The postoperative rate of transient urinary incontinence was 31.7%, while the long-term incontinence rate was 0%. Retrograde ejaculation occurred in 44.3% patients who remained sexually active after operation. Patients who had transient urge incontinence were older with preoperative higher OABSS, prostate-specific antigen (PSA) and detrusor overactivity rate and lower MCC.
Conclusion. B-TUERP is a safe, successful and highly effective treatment for BPH at 10-year follow-up. Increased age, OABSS, PSA level and detrusor overactivity rate are potential predictors for urge incontinence after B-TUERP.

Key words: benign prostatic hyperplasia, bipolar, enucleation, outcome, resection

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INTRODUCTION

Benign prostatic hyperplasia (BPH) is a common disease in elderly men[1]. Dihydrotestosterone accumulation within the gland serves as hormonal mediator for the hyperplasia, which probably occurs partially because of decreased catabolism of the molecule and in part due to enhanced intracellular binding of the molecule. The process can be accelerated by estrogen, which further enhances the androgen receptor level in the gland, allowing for androgen-mediated growth even if androgen production declines in advanced age[2]. Benign prostatic obstruction/lower urinary tract symptoms (BPO/LUTS) are a type of manifestations of BPH. The main clinical symptoms of BPH are micturition frequency, micturition urgency, weak micturition and nocturia, resulting in some complications such as hematuria, bladder stones and urinary tract infections, which seriously affect the quality of life of elderly patients[3-5].

Currently, transurethral resection of prostate (TURP) is the standard for the surgical treatment of BPO/LUTS (ref.[6]). However, there are still many complications, such as TUR/TURP syndrome, intraoperative, postoperative bleeding and others[7]. Therefore, holmium laser enucleation of the prostate (HoLEP) (ref.[8]), bipolar transurethral enucleation and resection of prostate (B-TUERP) (ref.[9]) and thulium laser enucleation of the prostate (ThuLEP) (ref.[10]) have been recommended. In our hospital, B-TUERP has been routinely used to treat BPH for more than 15 years[11], with satisfactory postoperative urinary function at 5-year follow-up[12]. Therefore, we aimed to explore the long-term outcomes of B-TUERP on patients with BPO at 10-year follow-up, especially the changes of the urodynamic study (UDS) parameters.

SUBJECTS AND METHODS

Subjects

This study was approved by the Ethics committee of the Zhujiang Hospital of Southern Medical University. All patients signed informed consent. A total of 1195 patients with BPO who underwent B-TUERP in the Zhujiang Hospital of Southern Medical University from July 2006 to June 2010 were enrolled in this retrospective study. Inclusion criteria: (1) Male patients over 50 years

old; (2) patients with BPH confirmed by urologists; (3) patients without surgical contraindications or coagulation disorders; (4) patients who were followed up for 10 years. Exclusion criteria: (1) patients with a history of prostate and urethral surgery; (2) patients with pelvic tumor and surgical history; (3) patients with prostate cancer and bladder cancer confirmed by postoperative pathology; (4) patients with neurogenic bladder dysfunction; (5) patients with nervous system diseases.

Surgical procedures

As we described in previous reports[9,13], the B-TUERP procedure was performed with saline irrigation and bipolar electrodes, using the Gyrus Plasmakinetic device (Gyrus Medical). The default setting was set at 160 W for cutting and 100 W for coagulation. In brief, the glands of the mid lobes and bilateral lobes were enucleated off the surgical capsule using the resectoscope tip combined with the loop, which was just as the surgeon's finger did during performing open prostatectomy. The detached adenoma was extended anatomically in a retrograde fashion from the prostate apex towards the bladder neck, with the preservation of the bladder neck and the verumontanum. When only the lower half of the mid lobe and bilateral lobes were attached to the bladder neck, the enucleated prostatic adenomas were rapidly resected into fragments with the loop electrode. The fragments were finally retrieved by the Ellik evacuator.

Data collection

All patients completed the preoperative questionnaires, including International Prostate Symptom Score (IPSS), quality of life (QOL) scores, and Overactive Bladder Symptom Score (OABSS). Moreover, preoperative examinations were performed, including frequency-volume chart evaluation, digital rectal examination, serum prostate-specific antigen (PSA), urinalysis, transrectal ultrasonography (TRUS) and UDS (MMS UD-2000, Medical Measurement System). UDS was performed following the recommendations of the International Continence Society[14]. The perioperative parameters included operative time, intraoperative blood loss, serum sodium and haemoglobin changes, catheterisation time and length of hospital stay.

Clinical parameters

Urodynamic values, including maximum cystometric capacity (MCC), compliance during the filling phase and maximum urethral closure pressure (MUCP), were recorded as parameters of storage function. The maximum urinary flow rate (Qmax), detrusor pressure at Qmax (PdetQmax), postvoid residual urine (PVR) volume, prostatic urethra pressure (PUP) and the bladder outlet obstruction index (BOOI, defined as PdetQmax-2Qmax) were measured as voiding function parameters[15].

Follow-up

Postoperative follow-up was performed at 3, 6, 12, 36, 60 and 120 months, respectively. Postoperative outcomes included IPSS, QOL, OABSS, frequency-volume chart, TRUS measurements of prostate volume (PV), PSA levels and UDS assessments at each visit on follow-up. Postoperative complications, involving the occurrence of incontinence, retrograde ejaculation, urethral stricture, bladder neck contracture and reoperation due to recurrent BPO, were retrospectively recorded. The comparison of preoperative values between urge incontinence and no-urge incontinence groups, such as OABSS, PSA, MCC and detrusor overactivity (DO) rate, was also taken to analyse the predictors of urge incontinence after B-TUERP.

Statistical analysis

Data analysis was performed with the Statistical Package for the Social Sciences (SPSS for Windows, release 19.0, SPSS). Data were expressed as means ± standard deviation (SD). Statistical significance was considered when $P<0.05$. The levels of IPSS, QOL, OABSS, PV, PVR, PSA and UDS data after operation were compared with the preoperative values using the paired *t* test. The independent *t* test was used to compare the preoperative values for groups based on urge incontinence (except for DO rates, which were assessed using the Chi-square test).

RESULTS

Perioperative data

Out of 1195 patients who underwent B-TUERP in the Zhujiang Hospital of the Southern Medical University from July 2006 to June 2010, 118 patients with BPH com-

Table 1. The exclusion causes of patients in 10 years postoperatively.

Exclusion causes	Patients number
Death	322
Loss of contact	363
Unwillingness to follow up	194
Bladder cancer underwent radical cystectomy	6
Incidental prostate cancer	13
Severe stroke	47
Severe Parkinson's disease	18
Lack of subjective or objective parameters	114
Follow-up of ten years finally	118
Total	1195

Table 2. Patient characteristics.

Item	Mean ±SD (Range)
Number of patients	1195
Age (years)	62.35±6.77
Operative time (min)	75.92±34.81
Estimate blood loss (mL)	115.11±20.83
Catheterization time (day)	3.63±1.09
Hospital stays (day)	7.27±2.08
Preoperative Na (mmol/L)	140.19±3.93
Postoperative Na (mmol/L)	137.74±6.46
Preoperative hemoglobin (g/mL)	138.59±14.39
Postoperative hemoglobin (g/mL)	132.35±12.39

Table 3. Changes in subjective and objective parameters from baseline to 10-year follow-up.

Parameter	Preoperative	3-month	6-month	1-year	3-year	5-year	10-year
Number of patients	1195	1156	1083	974	823	620	118
IPSS	22.94±2.47	6.01±4.77	5.62±4.67	5.54±4.77	5.52±4.69	5.33±4.40	5.69±4.67
QOL	4.47±0.71	1.14±1.05	1.25±1.08	1.18±1.11	1.36±1.08	1.65±0.98	1.74±1.14
OABSS	8.56±3.10	3.13±2.42	2.90±2.21	2.65±2.31	2.79±2.26	2.67±2.40	2.82±2.31
FV chart							
Daytime frequency	8.52±1.13	5.76±1.26	6.02±1.46	5.78±1.57	5.63±1.14	5.97±1.11	5.56±1.07
Nocturia	2.65±1.03	0.88±0.65	0.68±0.63	0.82±0.77	0.67±0.87	0.68±0.57	0.58±0.60
PV (mL) by TRUS	61.03±21.80	16.26±6.57	16.30±6.77	17.37±7.02	17.48±6.87	18.02±6.54	18.26±6.99
Serum PSA (ng/mL)	4.31 ± 1.87	0.87 ± 0.75	0.85±0.80	0.90 ± 0.90	1.11±1.03	1.14±1.51	1.37±1.61
Urodynamic Study							
Q max (mL/s)	8.13 ± 2.50	24.57±12.46	24.21±12.66	23.33±10.21	21.05±10.99	20.55±9.69	19.57±9.75
PVR (mL)	60.20 ±57.68	15.21±15.26	10.80±13.00	10.90±12.05	10.50± 20.56	10.60±14.90	11.80±12.30
Compliance (mL/cmH_2O)	12.45±4.80	23.64±10.68	25.88±11.42	26.01±11.22	25.59±10.99	24.96± 11.67	26.59±11.58
MCC (mL)	225.05±74.30	323.30±95.23	369.66±95.07	370.40±105.54	378.88±109.22	372.47±107.66	383.30±100.08
BOOI	62.19±13.66	4.04 ± 6.84	4.30±7.23	4.24±7.67	4.39±10.03	4.22±9.22	4.54±9.93
PdetQ max (cmH_2O)	62.01±4.80	46.68±12.66	43.66±12.66	39.74±11.56	35.88±10.77	32.88±4.74	33.74±11.88
PUP (cmH_2O)	22.64±6.74	14.25±6.88	13.05±7.01	13.33±7.44	14.16±8.21	14.75±7.83	14.26±7.36
MUCP (cmH_2O)	84.27±9.77	70.66±16.32	73.21±20.11	73.11±19.66	74.46±18.87	75.73±17.99	76.82±18.22

IPSS, International Prostate Symptom Score; QOL, quality of life; OABSS, Overactive Bladder Symptom Score; FV chart, frequency-volume chart; PV, prostate volume; TRUS, transrectal ultrasonography; Qmax, maximal urinary flow rate; PVR, post-void residual urine volume; MCC, maximal cystometric capacity; BOOI, bladder outlet obstruction index; PdetQmax, detrusor pressure at Qmax; PUP, prostatic urethra pressure; MUCP, maximum urethral closure pressure. Statistical significance at $P<0.05$ is between baseline and the data of follow-up in 10 years.

Table 4. Postoperative complications and grades by Clavien-Dindo classification.

Complication	Patients number	Percentage (%)	Clavien-Dindo Classification
Transient incontinence	367	31.75	II
Urge incontinence	298	25.78	II
Stress urinary incontinence	69	5.97	II
Long-term incontinence	0	0	II
Retrograde ejaculation	327/739	44.25	II
Reoperation due to recurrent BPO	0	0	III
Urethral stricture	29	2.51	III
Bladder neck contracture	10	0.87	III

Table 5. Comparison of preoperative values for groups based on postoperative urge incontinence.

Parameter	Urgency incontinence (n=298)	No urgency incontinence (n=858)	*P*
Age (yrs)	64.38±6.93	61.65±5.32	0.017
OABSS	9.73±3.42	8.24±2.81	0.004
PV(mL)	60. 3222.64	63. 03±21.12	0.513
PSA (ng/mL)	4.47±1.74	4.06±2.89	0.006
Qmax (mL/s)	7.92±3.53	8.70±2.57	0.879
PVR (mL)	58.57±63. 20	67.28±61.40	0.350
MCC (mL)	215. 19±32. 87	248.67±68. 58	0.008
DO (%)	38.26	5.71	0.000
BOOI	61.25±15. 53	63.13±11. 42	0.354
PdetQmax(cmH_2O)	60. 72±4. 83	64. 11±2.16	0.551
MUCP(cmH_2O)	85.09±5.87	79.71±10.59	0.257

OABSS, Overactive Bladder Symptom Score; PV, prostate volume; PSA, prostate-specific antigen; Qmax, maximal urinary flow rate; PVR, post-void residual urine volume; MCC, maximal cystometric capacity; DO, detrusor overactivity; BOOI, bladder outlet obstruction index; PdetQmax, detrusor pressure at Qmax; MUCP, maximum urethral closure.

pleted the 10-year protocol (Table 1). Perioperative data are shown in Table 2. The patients were aged 62.35±6.77 years. The operating time was 75.92±34.81 min, the intraoperative blood loss was 115.11±20.83 mL, the catheterisation time was 3.63±1.09 days and the hospital stay was 7.27±2.08 days. The values of haemoglobin and serum sodium were both decreased from preoperative 138.59±14.39 g/mL and 140.19±3.93 mmol/L to postoperative 132.35±12.39 g/mL and 137.74±6.46 mmol/L, respectively (P<0.05).

Follow-up data

The baseline data and corresponding follow-up data of the 118 patients were presented in Table 3. At 3-month, 3-year and 10-year follow-up, average IPSS value was 6.01, 5.52 and 5.69, average QOL value was 1.14, 1.36 and 1.74, and average OABSS was 3.13, 2.79 and 2.82, respectively. Compared with the preoperative values, the average IPSS and QOL scores were improved 4.0-fold and 2.6-fold at 10-year follow-up, respectively (P<0.05). The percentage reductions in the PV and PSA values were 73.36% and 79.81% at 3-month follow-up, respectively. Moreover, the PV and PSA values still remained at low levels (18.26 mL and 1.37 ng/mL, respectively) until 10-year follow-up. The values of PV, PSA, IPSS, QOL and OABSS were significantly improved compared with the preoperative baseline (P<0.001). The values for Qmax and compliance were at high levels (19.57 mL/s and 26.59 mL/cmH_2O, respectively), and PdetQmax and PUP were still at low levels (33.74 and 14.26 cmH_2O, respectively) at 10-year follow-up. All UDS variables (Qmax, PVR, MCC, MUCP, BOOI, PUP and compliance) were significantly improved at 3-month follow-up, even at 10-year follow-up.

Complications

Incontinence and retrograde ejaculation were the most notable complications (Table 4). The incidence rate of transient incontinence was 31.75%, including 298 cases of urge incontinence and 69 cases of stress urinary incontinence. The patients who experienced transient urge incontinence were significantly older than those who did not experience (64.4 vs. 61.7 years, P=0.017) with higher OABSS (9.73 vs. 8.24, P=0.004), higher PSA level (4.47 vs. 4.06 ng/mL, P=0.006), lower MCC (215 vs. 249 mL, P=0.008) and higher DO rate (38.3 vs. 5.71% P=0.000) (Table 5). The long-term incontinence rate was 0%, and the recovery time was 2.45±1.69 months. The incidence rate of retrograde ejaculation in patients who remained sexually active after operation was 44.3% (327/739). And 30% of the patients with retrograde ejaculation had recovered to different degrees at 3-month follow-up. Urethral stricture and bladder neck contracture developed in 2.51% and 0.87% of patients, respectively. In all survivors, none required reoperation due to recurrent obstruction caused by BPH during 10-year follow-up.

DISCUSSION

BPO/LUTS is performed to relieve the bladder outlet obstruction and improve the micturition symptoms as well as the QOL. Although TURP has been considered as the "gold standard" for median size BPH (30–80 mL) (ref.[6]), several alternative surgical procedures have also been reported, such as HoLEP (ref.[8,16]) and B-TUERP (ref.[9,17]). Open prostatectomy involves peeling prostatic adenoma off the surgical capsule completely, and it has been proven to have satisfactory outcomes with better symptom scores and improved voiding parameters. However, its higher degree of invasiveness and morbidity also discouraged many urologists[18]. Due to the fear of prostate capsule perforation, although the trauma is small, transurethral resection of the prostate usually leads to residual prostate adenoma and high postoperative recurrence rate[19].

An ideal operation is to remove the complete prostatic adenoma on the anatomic plane, reduce the perioperative morbidity with a minimally invasive technique, and provide good and durable efficacy. B-TUERP, also called plasmakinetic enucleation of the prostate, has been demonstrated to have good short-term outcomes and safety worldwide, which meets all these criteria of an ideal operation as just described[13,20,21]. Moreover, it has been reported that the efficacy of B-TUERP for symptomatic BPH is similar to that for diode laser enucleation of the prostate[22,23]. The present study indicated that the B-TUERP procedure can provide long-term benefits to patients for subjective symptoms and UDS endpoints.

In terms of perioperative concerns, B-TUERP has more advantages than standard TURP, with less perioperative morbidity, shorter catheter time and hospital stays[24]. Unlike HoLEP, B-TUERP is performed using the common Gyrus Plasmakinetic equipment as bipolar TURP, which do not require additional device and cost. Furthermore, B-TUERP procedure only requires a short learning curve for an experienced urologist[25].

Four evaluation criteria were proposed by Homma et al.[26] to evaluate the clinical efficacy during follow-up after: symptoms, QOL, function and anatomy. In the present study, the long-term clinical efficacy of B-TUERP remained excellent and durable at 10-year follow-up, with high satisfaction for most patients. Compared with the preoperative baseline, IPSS and QOL scores were improved 4.0-fold and 2.6-fold at 10-year follow-up, respectively. Moreover, the percentage of reductions in PV and PSA values were 73.4% and 79.8% at 3 months, respectively. With the relief of bladder outlet obstruction after B-TUERP, the storage symptoms such as overactive bladder (OAB) symptoms, daytime frequency and nocturia were significantly improved and maintained during the entire follow-up period. These findings indicate that detrusor dysfunction secondary to bladder outlet obstruction can be reversed by surgical deobstruction. The educible reason may be that high bladder pressure caused by BPO can result in ischaemia and partial denervation of detrusor muscle, which decreases bladder capacity and leads to detrusor overactivity[27]. These improved subjective symptoms are in accordance with the results of UDS values in this investigation, including voiding functions (Qmax, PVR, BOOI, PUP and PdetQmax) and storage functions (MCC, compliance and MUCP). Therefore, it is very important to take the lower urinary tract functional assessment by developing UDS before and after surgery[28]. This will not only reduce the unnecessary intervention for patients with detrusor hypocontractility, but also provide accurate recovery information for postoperative patients with OAB.

It is noteworthy that after 10-year follow-up, none of the survivors require reoperation because of the recurrent residual tissue, which is consistent with the result of the HoLEP trial[29]. This finding also indicates that B-TUERP is an anatomical enucleation procedure for BPO. Although different energies are used, the principle of B-TUERP is similar to that of HoLEP, because they are manipulated on the same anatomical plane[30]. In this regard, many researchers believe that the glandular tissue is removed more completely by enucleation than by TURP, which theoretically will address the more severe symptoms such as transient urinary incontinence and retrograde ejaculation[31]. However, transient urinary incontinence occurred in approximately 31.7% of patients after surgery in this study. The reasons for transient urinary incontinence are various, some are caused by urinary tract infection that require treatment with antibiotics, and some are overactive bladder that require treatment with anticholinergic agents and α-blocker. These patients were managed with symptomatic medication for a short time, and pelvic floor muscle exercise was also encouraged in this study. Of these patients, 88.28% (324/367) were recovered within 3 months and none reported urinary incontinence at 6-month follow-up. Age, OABSS, PSA, MCC and DO may be the predictors for urge incontinence after B-TUERP by comparison of preoperative values between urge incontinence and no-urge incontinence groups.

Retrograde ejaculation is a common clinical symptom in patients with BPH after endoscopic surgery, and it occurs in 44.3% of patients who remain sexually active after operation, which is lower than that TURP (ref.[32]) and HoLEP (ref.[33]). This outcome is likely the result of our technique used for preservation of the physiological curvature of the bladder-prostate junction at the 6-o'clock position and bladder neck (Fig. 1). Moreover, after the repair of prostate mucosa, 30% of patients with retrograde ejaculation were recovered to different degrees at 3-month follow-up.

Bladder neck contracture and urethral stricture are the common long-term complications at follow-up. All of these patients are treated successfully with endoscopic internal urethrotomy and/or urethral dilation. One of the patients with urethral stricture perform endoscopic dilation continuously up to 6 times.

There are also several limitations. First, it is a retrospective single-centre study. Second, only a small percentage of patients reached the endpoint of 10-year follow-up, which may lead to biased results. More data with a larger sample size in a multicenter randomised controlled trial

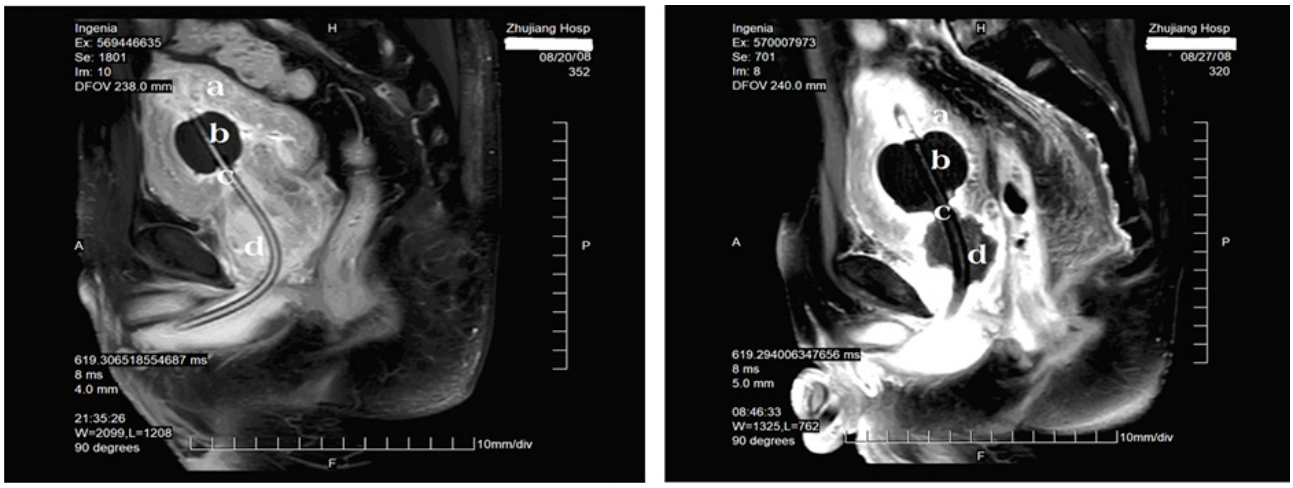

Fig. 1. MRI images of the preservation of the bladder neck before and after B-TUERP for BPO.
a. Bladder wall. **b.** The balloon of the catheter. **c.** Bladder neck. **d.** Prostate.

comparing B-TUERP with the bipolar TURP are forthcoming from an ongoing study at our institution and cooperating medical centres.

CUNCLUSION

Our present study indicate that B-TUERP is a safe, successful and highly effective treatment for symptomatic BPH with lower reoperation rates, and the clinical efficacy remains excellent and durable at 10-year follow-up. UDS value plays an important role in the preoperative judgment of surgical indications and the prediction of postoperative effect. Furthermore, age, OABSS, PSA, MCC and DO may be the important predictors for urge incontinence after B-TUERP.

ABBREVIATIONS

LUTS, Lower urinary tract symptoms; IPSS, International Prostate Symptom Score; QOL, Quality of life score; FV chart, Frequency-volume chart; Qmax, Maximum urinary flow rate; PVR, Post-void residual urine volume; TRUS, Transrectal ultrasonography; PV, Prostate volume; OABSS, Overactive bladder syndrome score; PSA, Prostate-specific antigen; UDS, Urodynamic study; PdetQmax, Detrusor pressure at the Qmax; MCC, Maximum cystometric capacity; DO, Detrusor overactivity; BOOI, Bladder outlet obstruction index; PUP, Prostatic urethral pressure; MUCP, Maximum urethral closure pressure; OAB, Overactive bladder; SUI, Stress urinary incontinence; BPO, Benign prostatic obstruction; BPH, Benign prostatic hyperplasia; TURP, Transurethral resection of prostate; B-TUERP, Bipolar transurethral enucleation and resection of the prostate; PKEP, Plasmakinetic enucleation of the prostate; ThuLEP, Thulium laser enucleation of the prostate; HoLEP, Holmium laser enucleation of the prostate; DiLEP, Diode laser enucleation of the prostate; RCT, Randomized controlled trial.

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