MEDICAL SCIENCE MONITOR

CLINICAL RESEARCH

e-ISSN 1643-3750
© Med Sci Monit, 2020; 26: e921272
DOI: 10.12659/MSM.921272

Received: 2019.11.08
Accepted: 2019.12.27
Available online: 2020.02.29
Published: 2020.04.27

Comparative Study of the Effectiveness and Safety of Transurethral Bipolar Plasmakinetic Enucleation of the Prostate and Transurethral Bipolar Plasmakinetic Resection of the Prostate for Massive Benign Prostate Hyperplasia (>80 ml)

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Statistical Analysis C
Data Interpretation D
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Source of support: This study was supported by the National Natural Science Foundation of China (NSFC81372736)

Background: The aim of this study was to compare the clinical safety and effectiveness of transurethral bipolar plasmakinetic enucleation of the prostate (PKEP) *vs.* transurethral bipolar plasmakinetic resection of the prostate (PKRP) in the treatment of benign prostate hyperplasia (BPH) more than 80 ml.

Material/Methods: From June 2015 to February 2019, 179 BPH patients with prostate volume greater than 80 ml were enrolled and separated into a PKEP (n=81) group and a PKRP group (n=98). The patients in the 2 groups were followed up for 6 months. We collected and analyzed data from the international Prostate Symptom Score (IPSS), residual urine volume (RUV), quality of life (QOL), maximum urine flow rate (Qmax), and international erectile function index (ILEF-5). The clinical data collected during and after the operation and surgical complications were compared between the 2 groups.

Results: The PKEP group had significantly shorter operation time, bladder flushing time, indwelling catheter time, and hospitalization time, and has less intraoperative blood loss, intraoperative blood transfusion, postoperative secondary hemorrhage, bladder neck contracture, capsule perforation, and retrograde ejaculation ($P<0.05$). Compared with the PKRP group, the postoperative IPSS and QOL scores were significantly lower in the PKEP group ($P<0.05$), while the excision glandular tissue weight and Qmax were significantly improved ($P<0.05$). There were no significant differences in ILEF-5 scores, RUV, urethral stricture, urinary incontinence, or erectile dysfunction between the 2 groups ($p>0.05$).

Conclusions: PKEP treatment of BPH with a large volume (>80 ml) has the advantages of complete gland resection, good surgical effect, improved surgical safety, and reduced intraoperative and postoperative complications.

MeSH Keywords: **Postoperative Complications • Prostate • Prostatic Hyperplasia • Safety • Transurethral Resection of Prostate • Treatment Outcome**

Full-text PDF: https://www.medscimonit.com/abstract/index/idArt/921272

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Background

More than 50% of elderly men have benign prostate hyperplasia (BPH). The main clinical manifestations of BPH are frequent urination, urgency, progressive dysuria, and urinary incontinence, which seriously affect the physical and mental health of older men [1,2]. Transurethral resection of the prostate (TURP) is the preferred method for treatment of BPH, while PKRP is the preferred method for TURP [3–6]. However, PKRP has some disadvantages, such as risk of intraoperative hemorrhage, postoperative residual glands, sexual dysfunction, and long surgical washing time [3–5].

In recent years, with the improvement of medical devices and technology, PKEP has rapidly developed. PKEP has received increasing attention from urologists because of its high safety, low risk of bleeding, clearer visual field, fewer postoperative complications, and fast recovery [6–9]. PKEP is one of the recommended treatment methods for BPH. It is considered to be more suitable for the anatomical structure of the prostate, and it is suitable for patients whose prostate volume is more than 80 ml, avoiding limitation of volume and time of the hyperplastic glands [6–9]. However, PKEP still has some complications, such as long learning curve, risk of capsule perforation, urinary incontinence, and urethral stricture. Therefore, we collected the clinical data of 179 patients with massive BPH (>80 ml) in our center to compare the efficacy of PKEP *vs.* PKRP in the treatment of BPH >80 ml and to compare the effects on sexual function.

Material and Methods

Clinical case inclusion and exclusion

We collected clinical data on 179 BPH patients with prostate volume greater than 80 ml admitted to our hospital from June 2015 to February 2019. We randomly assigned the 179 BPH patients into a PKEP (n=81) and a PKRP group (n=98). Inclusion criteria were: 1) The patient has symptoms such as frequent urination, urgency, urinary incontinence, progressive dysuria, and nocturia; 2) All patients had complete B-ultrasound, prostate-specific antigen (PSA), urodynamic test, and digital rectal examination to confirm the diagnosis of BPH; 3) Patients with PSA elevation, abnormal rectal digital exam results, and the possibility of canceration indicated by MRI were all given ultrasound-guided prostate biopsy, and the pathological results were BPH; 4) Preoperative B-ultrasonic diagnosis of prostate volume greater than 80 ml (prostate volume=upper and lower diameter×left and right diameter×front and rear diameter×0.546, weight=volume×1.05, 3 diameter lines of prostate are subject to B-ultrasonic measurement); 5) The patients had clear indication for surgery (according to the European guidelines for urology diagnosis and treatment), no contraindication for surgery, and informed consent was obtained from patients and their families before the operation; 6) Age 55–78 years old; and 7) Patients had complete medical records and follow-up data. Exclusion criteria were: 1) Prostate cancer; 2) Prostate volume less than 80 ml; 3) Combined with severe urinary tract infection, urethral stricture, neurogenic cystitis, chronic cystitis, or overactive bladder; 4) Surgical contraindications; 5) Incomplete medical records or a follow-up period of less than 6 months; 6) Also had severe dysfunction of heart, liver, kidney, or other organs; 7) Mental illness; and 8) History of prostate surgery.

Operation method

PKEP or PKRP was performed in all patients under epidural anesthesia. The procedures were the same as previously reported [1,6,10,11]. PKEP and PKRP were performed with an Olympus plasma electric cutting mirror, the power of electrocoagulation was 80 W, and the power of bipolar cutting was 160 W. All the operations were performed by the same senior surgeon. After PKEP and PKRP surgery, a F20 3-chamber air bag catheter was placed and the bladder was flushed continuously.

Collection of observation indicators

Data from RUV, IPSS, QOL, Qmax, and ILEF-5 were collected and analyzed before and 6 months after the operation. We collected data on the surgical conditions of the 2 groups, including operation time, intraoperative bleeding volume (intraoperative bleeding volume (mL)=hemoglobin concentration in flushing solution (g/L)×flushing solution (L)/hemoglobin concentration of patients before operation (g/L)×1000), bladder washing time, indwelling catheter time, excision glandular tissue weight, hospitalization time, and hemoglobin and hematocrit changes. Data on complications in the 2 groups were recorded, such as death, blood transfusion, rectal injury, bladder injury, capsule perforation, secondary bleeding, urethral stricture, urinary incontinence (UI), bladder contracture, retrograde ejaculation, and erectile dysfunction (ED). Sexual dysfunction was assessed by retrograde ejaculation and ED, and IIEF-5 was used to evaluate the occurrence of ED. IIEF-5 scores lower than 21 indicate ED.

Statistical processing

BSPSS 20.0 software was used for data analysis. Data are shown as x±s and the *t* test was used. The K-S single-sample test was used to calculate the normal distribution of continuous variables before doing further comparisons. The chi-square test was used to compare 2 groups. $P<0.05$ was regarded as a statistically significant difference. Multivariate logistic regression analysis was used to assess the statistical significance of results, with $P<0.05$ set as the level of significance.

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Table 1. Comparison of general preoperative clinical data between the 2 groups.

Parameter	PKRP (N=98)	PKEP (N=81)	P value
Age, years	66.91±7.67	67.64±6.12	0.652
Prostate volume	112.84±25.96	117.84±29.26	0.341
Hypertension n (%)	41 (42)	38 (46)	0.243
Diabetes mellitus n (%)	30 (31)	28 (34)	0.541
Coronary heart disease n (%)	25 (26)	23 (28)	0.732
PSA	2.07±0.61	2.11±0.58	0.352
IPSS	22.19±5.06	21.81±5.87	0.221
QOL	5.36±1.45	5.41±1.51	0.819
ILEF-5	17.53±3.71	17.01±4.07	0.147
RUV	91.04±14.76	90.57±15.25	0.375
Qmax (ml/s)	8.04±3.76	7.83±4.25	0.475
Hemoglobin (g/L)	131.47±17.05	133.35±16.74	0.375
Hematocrit (%)	38.25±3.78	37.82±4.19	0.524

PSA – prostate-specific antigen; IPSS – International Prostate Symptom Score; QOL – Quality of life; ILEF-5 – International Erectile Function Index; RUV – residual urine volume; Qmax – maximum urine flow rate.

Table 2. Comparison of surgical conditions between the 2 groups.

Parameter	PKRP (N=98)	PKEP (N=81)	P value
Operation time (min)	105.78±24.56	70.18±21.37	<0.001
Intraoperative bleeding volume (ml)	87.63±18.25	58.83±17.05	<0.001
Bladder flushing time (d)	3.05±0.83	1.24±0.59	0.008
Indwelling catheter time (d)	3.27±1.42	2.27±1.19	0.005
Excision glandular tissue weight (g)	67.58±25.29	92.16±27.07	<0.001
Hospital stay (d)	7.68±1.85	5.53±1.67	<0.001
Hemoglobin (g/L)	109.67±14.74	121.07±17.74	<0.001
Hematocrit (%)	32.04±3.58	35.43±3.95	<0.001

Results

Comparison of general preoperative clinical data in the 2 groups

As shown in Table 1, the IPSS, age, prostate volume, PSA, QOL, hemoglobin, Qmax, and associated diseases of the 2 groups were similar, and the differences were not statistically significant (P>0.05).

Comparison of operation-related indexes in the 2 groups

As shown in Table 2, patients in the PKEP group had operative time (105.78±24.56 *vs.* 70.18±21.37, P<0.001), intraoperative blood loss (87.63±18.25 *vs.* 58.83±17.05, P<0.001), and bladder irrigation time (3.05±0.83). *vs.* 1.24±0.59, P=0.008), indwelling catheter time (3.05±0.83 *vs.* 2.27±1.19, P=0.005), hospital stay (7.68±1.85 *vs.* 5.53±1.67, p<0.05), which were notably lower than in the PKRP group. The PKRP group had significantly higher glandular tissue weight (67.58±25.29 *vs.* 92.16±27.07, P<0.001), postoperative hemoglobin (109.67±14.74 *vs.* 121.07±17.74, P<0.001), and hematocrit (32.04±3.58 *vs.* 35.43±3.95, P<0.001).

Comparison of related indicators before and after treatment in the 2 groups of patients

As shown in Table 3, the IPSS score, QOL score, RUV, and IIEF-5 score in both groups decreased significantly (P<0.05), while Qmax increased significantly (P<0.05). There was no significant difference in IIEF-5 score (15.43±4.71 *vs.* 15.21±4.53, P>0.05) and RUV (16.74±7.47 *vs.* 17.14±7.01, P>0.05) in the 2 groups. Compared with the PKRP group, IPSS scores (6.37±1.5

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Table 3. Comparison of relevant indexes between the 2 groups before and after treatment.

Parameter	PKRP (N=98)		PKEP (N=81)	
	Preoperative	Postoperative	Preoperative	Postoperative
IPSS	22.19±5.06	6.37±1.51*	21.81±5.87	5.21±1.23*,**
QOL	5.36±1.45	2.21±0.47*	5.41±1.51	1.32±0.36*,**
RUV	91.04±14.76	16.74±7.47*	90.57±15.25	17.14±7.01*
ILEF-5	17.53±4.01	15.43±4.71*	17.01±4.27	15.21±4.53*
Qmax (ml/s)	8.04±3.76	15.54±5.13*	7.83±4.25	17.14±6.31*,**

PSA – prostate-specific antigen; IPSS – International Prostate Symptom Score; QOL – Quality of life; ILEF-5 – International Erectile Function Index; RUV – residual urine volume; Qmax – maximum urine flow rate. * Compared with preoperative, P<0.05; ** compared with PKRP group, P<0.05.

Table 4. Comparison of postoperative complications and changes in sexual function in the 2 groups [n (%)].

Parameter	PKRP (N=98)		PKEP (N=81)		P value
Death	0		0		–
Rectal injury	0		0		–
Bladder injury	0		0		–
Transurethral resection syndrome	0		0		–
Intraoperative blood transfusion	8	(8.2%)	3	(3.7%)	<0.001
Secondary bleeding after operation	6	(6.2%)	2	(2.4%)	<0.001
Capsule perforation	7	(7.1%)	3	(3.7%)	<0.001
Urethral stricture	2	(2.0%)	2	(2.4%)	0.671
Urinary incontinence	1	(1.0%)	1	(1.2)	0.328
Contracture of bladder neck	5	(5.1%)	1	(1.2)	<0.001
Retrograde ejaculation	57	(58.16%)	35	(43.21)	<0.001
Erectile dysfunction	44	(44.89%)	37	(45.68%)	0.167

vs. 5.21±1.23, P<0.05) and QOL scores (2.21±0.47 *vs.* 1.32±0.36, P<0.05) were remarkably lower in the PKEP group, while Qmax was significantly higher (15.54±5.13 *vs.* 17.14±6.31, P<0.05).

Postoperative complications and changes in sexual function in the 2 groups

As shown in Table 4, there were no deaths, rectal injury, bladder injury, or electrosurgical syndrome in either group. There was no significant difference in UI, urethral stricture, or ED between the 2 groups (P>0.05). The PKEP group was notably lower than the PKRP group in intraoperative blood transfusion (8.2% *vs.* 3.7%, p<0.001), postoperative secondary bleeding (6.2% *vs.* 2.4%, p<0.001), bladder neck contracture (5.1% *vs.* 1.2%, p<0.001), capsule perforation (7.1% *vs.* 3.7%, p<0.001), and retrograde ejaculation (58.16% *vs.* 43.21%, p<0.001).

Discussion

The criterion standard for BPH surgery is TURP, but because BPH patients are older and generally in poor physical condition, the difficulty of surgery is increased. In addition, TURP itself has certain defects, and once the venous plexus is damaged, it can cause intraoperative massive hemorrhage and the occurrence of transurethral resection syndrome (TURS) [12,13]. Under the same conditions, the operation time of TURP is closely related to the size of the prostate gland, and the larger the gland, the more time it takes. Because TURS easily occurs in traditional TURP, the operation time is usually less than 90 min, which limits the operation indication of large glands (>80 ml) [14–16]. PKRP is based on the local control loop formed by high radio frequency electricity through normal saline. The plasma sphere with high heat energy is formed between the running electrode of the electric cutting ring and the circuit electrode carried by itself. The hyperplastic tissue is

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vaporized and removed immediately after entering. The use of PKRP reduces the occurrence of TURP, avoids the time limit, and can remove more gland tissue. It can still be performed on prostates larger than 80 ml [17,18].

PKEP is an improved surgery for PKRP. PKEP can retrogradely and bluntly strip the prostate gland along the surgical envelope interface, and can maximally remove the gland, basically achieving the effect of open surgical anatomical enucleation. It has the characteristics of complete gland resection, short operation time, less bleeding, and fewer complications [6,19,20]. In this study, compared with before surgery, IPSS, QOL, and RUV in both groups were decreased significantly ($P<0.05$), while Qmax was significantly increased ($P<0.05$). The QOL, IPSS, and Qmax in the PKEP group were notably better ($P<0.05$) than in the PKRP group. In addition, in contrast with the PKRP group, the quality of surgically removed glands in the PKEP group was notably increased ($p<0.05$). These outcomes indicate that PKEP optimally combines the thoroughness of open surgical resection of the gland and the minimal invasiveness of PKRP. It can effectively ameliorate the symptoms of BPH shortly after surgery, especially for patients with a large prostate. We found that, compared with open prostatectomy and PKRP, PKEP can significantly reduce intraoperative bleeding and shorten the operation time [6,19–22]. In contrast with the PKRP group, we found that for prostates larger than 80 ml, the operation time and intraoperative bleeding volume of the PKEP group were conspicuously better ($P<0.05$), and the postoperative hemoglobin and hematocrit were notably increased ($P<0.05$). The results show that PKEP can directly stop bleeding of the capsule, block the glandular blood supply, and then cut and crush the gland, which not only effectively prevents bleeding, but also improves the cutting efficiency and shortens the operation time. We found that the bladder washing time, indwelling catheter time, and hospitalization time in the PKEP group were remarkably better than in the PKRP group. The main reason for this result is that PKEP dissects the hyperplastic glands along the surgical envelope, there is little necrotic tissue falling off after surgery, the time of wound repair is short, there is less blood in the urine after surgery, the time of bladder washing and indwelling catheter are shorter, and the patient recovers quickly.

PKEP has the advantages of complete glandular resection, clear anatomy, and good hemostasis, which greatly reduces the risks of postoperative bleeding, capsule perforation, and TURS [19–22]. In this study, we found no deaths, rectal injury, bladder injury, or TURS in either group. The PKEP group had significantly less intraoperative blood transfusion, postoperative secondary bleeding, bladder neck contracture, and capsule perforation than in the PKRP group. PKEP has the advantages of light thermal damage, hemostasis of the capsule, and "capsule protection" (when cutting to the prostate capsule, there is a significant sense of difficulty in cutting), which results in less intraoperative bleeding, the surgical field is clearer, the rate of capsule perforation is low, and the operation efficiency and safety are significantly higher than in the PKRP group. At present, there is still controversy about the incidence of UI after PKEP. Some published studies reported a high incidence of UI after PKEP, while others report the opposite [23,24]. At present, with the improvement of urologists' awareness of UI and urinary control protection after PKEP, the incidence of UI after PKEP is significantly declining. In this study, we found that there was no significant difference in UI between the PKRP group and PKEP group for prostates larger than 80 ml.

Studies have indicated that BPH patients have some decrease in sexual function after TURP, and the incidence of ED is about 10–35% [3,25,26]. In the present study, we found that the postoperative ILEF-5 scores in both groups were conspicuously lower after surgery, but there was no significant difference in the postoperative ILEF-5 score and the incidence of ED between the 2 groups. In addition, in contrast to previous reports, we found that the incidence of ED in both groups was significantly higher [3,25,26]. This may be because prostate glands with a volume larger than 80 ml have more severe compression of the erectile nerve outside the capsule, which leads to chronic ischemia of the erectile nerve and affects the erectile function of BPH patients. BPH patients rarely experienced retrograde ejaculation before surgery. After the operation, the bladder neck could not be completely closed, the post-urethral resistance was significantly reduced, and the incidence of retrograde ejaculation was higher [27,28]. In this study, we found that the incidence of retrograde ejaculation was significantly increased in both groups, but the incidence of retrograde ejaculation was remarkably lower in the PKEP group. This may be because both operations change the bladder neck integrity and affect its normal closure function. However, in the PKEP group, the prostate was resected along the prostate capsule, the intraoperative blood loss was small, and the visual field was clearer. The operation itself completely protected the bladder neck, so the incidence of retrograde ejaculation was significantly lower than in the PKRP group.

Conclusions

PKEP and PKRP are both safe and effective methods for the treatment of BPH more than 80 ml, but PKEP has the advantages of complete gland resection, precise surgery, shorter operation time, less bleeding, high safety during operation, and fewer postoperative complications.

Conflicts of interest

None.

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