Comparative Study of the Efficacy and Safety of Plasmakinetic Enucleation of the Prostate in Different Stages Versus Plasmakinetic Resection of the Prostate for Benign Prostate Hyperplasia

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Research Article

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Abstract

Purpose: To evaluate the clinical curative effect and safety of plasmakinetic enucleation of the prostate (PKEP) in different stages versus plasmakinetic resection of the prostate (PKRP) in the treatment for benign prostate hyperplasia (BPH).

Methods: Clinical data of 171 hospitalized patients who suffered from BPH undergoing PKEP or PKRP were collected. All patients were separated into PKEP1 group (n = 44, between July 2018 to June 2019), PKRP group (n = 72, between July 2018 to June 2020), and PKEP2 group (n = 55, between July 2019 to June 2020). General preoperative clinical data, perioperative and postoperative results, and complications were recorded and analyzed among the 3 groups.

Results: The hemoglobin change in the PKEP1 and PKEP2 were more slightly than that in the PKRP ($P > 0.05$). Compared with PKRP, more prostate weight was removed in PKEP1 and PKEP2 ($P < 0.05$). The operation time of PKEP2 was reduced significantly ($P < 0.05$), compared with PKEP1 and PKRP. We further found the ratio of operation time to prostate volume($\text{çrsç} = 0.630$, $P < 0.001$), and the ratio of operation time to enucleation weight($\text{çrsç} = 0.540$, $P < 0.001$) were both decreased with the increase of the number of surgical cases. Compared with preoperative results, postoperative 3-month IPSS, QOL and RUV decreased, while Qmax increased in the 3 groups ($P < 0.05$).

Conclusion: In terms of surgical safety and efficacy, skilled PKEP was comparable with PKRP, in addition it is superior to PKRP in operation time and enucleation weight.

1. Introduction

Benign prostate hyperplasia (BPH) is common among men, affecting about 50% of those in their 50s and more than 70% of those in their 70s with an annual incidence of 3.44%[1, 2], which seriously decreases the quality of the patients' life. Nowadays, transurethral resection of the prostate (TURP) is still considered the gold-standard surgical option for treatment of BPH[3, 4]. It also has defects such as requiring mannitol or glucose solution as washing liquid, once the venous plexus is damaged, it can cause the occurrence of transurethral resection syndrome (TURS)[5, 6]. The plasmakinetic resection of the prostate (PKRP) could avoid TURS through physiologic saline used as an irrigant[7]. The present study has suggested that PKRP can achieve the same efficacy of TURP for the treatment of BPH. Even the incidence of some other complications such as acute epididymitis and postoperative re-bleeding in PKRP was lower than TURP[8]. While plasmakinetic enucleation of the prostate (PKEP) used the same equipment and irrigant as PKRP has received increasing attention because of its high safety, low risk of bleeding, fewer postoperative complications, and it was considered suitable for patients whose prostate size is more than 80 ml, avoiding limitation of volume and time of the hyperplastic glands[9].

Our department has carried out PKRP for nearly 20 years, with satisfactory curative effect, high safety and few complications. In order to gradually adapt to the change of surgical methods for prostatectomy and improve the surgical methods, we tried to carry out PKEP surgery without introducing new equipment. As we all know, the development of a new surgical method has a fixed learning curve. We have carried out the

operation for 2 years and divided it into two periods according to the first year and the second year, to discuss whether the second year will be more optimized through the accumulation of one year's surgical experience, and both of them are compared with conventional PKRP.

2. Patients And Methods

2.1 General clinical data and group

The BPH patients' general clinical data who underwent either PKEP or PKRP between July 2018 to June 2020 in our department were reviewed retrospectively. According to the date and method of operation, they were divided into 3 groups: ① PKEP1, between July 2018 to June 2019; ② PKRP, between July 2018 to June 2020; ③ PKEP2, between July 2019 to June 2020. Data from patients' age, prostate size, prostate-specific antigen (PSA), International Prostate Symptom Score (IPSS), quality of life(QOL), maximum urinary flow rates (Qmax) and residual urine volume (RUV) were collected and analyzed before the operation.

2.2 Inclusion and exclusion

Inclusion criteria were: ① patients with confirmed BPH who underwent PKEP or PKRP surgery; ② medical records involved preoperative examination, intraoperative and postoperative 3-month follow-up data were complete; ③ the patients had clear indication for surgery, no contraindication for surgery, and informed consent was obtained from patients and their families before the operation.

Exclusion criteria were: ① patients suffering from various malignant tumors such as prostate cancer, bladder cancer, urethral cancer and other cancers requiring surgery or further treatment; ② patients lose contact or have poor compliance; ③ history of prostate surgery; ④ postoperative pathological report was malignant tumor patients (such as prostate cancer, prostate sarcoma, prostate lymphoma, etc.).

2.3 Collection of observation indicators

Intraoperative and postoperative observation indicators involved operation time; hemoglobin change; excision glandular tissue weight; postoperative bladder irrigation time; postoperative catheterization period; postoperative hospitalization day. Data on postoperative complications in the 3 groups were recorded, such as capsule perforation, re-catheterization, febrile urinary tract infection(UTI), bleeding requiring surgery, urinary incontinence (UI), urethral stricture, bladder injury, rectal injury, and blood transfusion. Follow-up data from IPSS, QOL, Qmax and RUV were collected and analyzed 3 months after the operation.

2.4 Operation equipment and method

All the operations were performed by the same experienced senior surgeon. Patients were placed in the lithotomy position and received epidural anesthesia for surgery. The procedures were the same as previously reported[10]. PKEP and PKRP were both performed with the Gyrus bipolar PlasmaKinetic system (Gyrus Medical Ltd, Cardiff, UK), the power of bipolar cutting was 160 W, and the power of electrocoagulation was 80 W. A 22Fr continuous flow resectoscope (Karl Storz, GmbH, Tuttlingen, Germany) was used. After surgery, a 20Fr 3-chamber air bag catheter was inserted into the bladder and connected to physical saline irrigation.

2.5 Statistical Analysis

All statistical analyses were conducted using SPSS 17.0. The analysis of variance was used to analyze continuous variables. Fisher's exact method was used to compare the categorical variables. The spearman correlation test was used to analyze the continuous variable: ratio of operation time to prostate volume and ratio of operation time to enucleation weight. The absolute value of correlation coefficient $|rs|$ was calculated. $P < 0.05$ was considered statistically significant.

3. Results

3.1 General preoperative clinical data in the 3 groups

As shown in Table 1, the general preoperative clinical data of patients in the 3 groups were similar. There were no statistically significant differences among the 3 groups in average age, prostate size, PSA value, IPSS, QOL, Qmax, and RUV ($P > 0.05$).

Table 1
General preoperative clinical data in the 3 groups.

	PKEP1	PKRP	PKEP2	F value	Pvalue
Age(year)	71.1 ± 7.6	71.7 ± 6.5	70.9 ± 6.6	0.270	0.764
Prostate size (mL)	61.95 ± 21.13	59.03 ± 16.77	62.15 ± 17.04	0.588	0.556
PSA (ng/mL)	3.75 ± 2.18	3.48 ± 2.13	3.83 ± 2.90	0.369	0.692
IPSS	20.9 ± 4.4	20.0 ± 4.6	19.8 ± 3.1	1.065	0.347
QOL	4.52 ± 0.93	4.32 ± 0.77	4.56 ± 0.63	1.820	0.165
Qmax (mL/s)	9.6 ± 2.5	9.1 ± 2.1	9.2 ± 1.8	0.713	0.491
RUV (mL)	90.0 ± 125.7	86.6 ± 124.5	85.2 ± 115.9	0.019	0.981
PSA = prostate-specific antigen; IPSS = International Prostate Symptom Score; QOL = quality of life; Qmax = maximum urinary flow rates; RUV = residual urine volume.					

3.2 Perioperative and postoperative results in the 3 groups

During the surgery, the PKEP and PKRP were successfully performed in almost all cases. As shown in Table 2, hemoglobin decreased in all groups after operation, but there was no statistical difference among the 3 groups ($P > 0.05$). Further, pairwise comparison showed that hemoglobin change in the PKEP1 (14.9 ± 5.6 g/L) and PKEP2 (14.3 ± 7.8 g/L) were more than that in the PKRP (12.4 ± 5.4 g/L), and there was a statistical difference between the PKEP1 and PKRP ($P < 0.05$). Compared with PKRP (31.6 ± 12.6 g, $P < 0.05$), more prostate weight was removed in the PKEP1 (41.4 ± 15.0 g) and PKEP2 (42.1 ± 11.7 g). Bladder irrigation time, catheterization period, and postoperative hospitalization day were similar among the 3 groups ($P > 0.05$).

The average operation time of the PKEP2 (63.7 ± 18.5 min) was significantly reduced ($P < 0.05$), compared with the PKEP1 (75.0 ± 24.7 min) and PKRP (77.2 ± 20.4 min). We further study the learning curve of PKEP. A total

of 99 patients underwent PKEP surgery. The relationship between prostate volume, or enucleation weight and increased number of surgical cases referred to the scatter plot in Fig. 1. The ratio of operation time to prostate volume($r_s = 0.630$, $P < 0.001$), and the ratio of operation time to enucleation weight($r_s = 0.540$, $P < 0.001$) were both decreased with the increase of the number of surgical cases.

Table 2
Perioperative and postoperative results in the 3 groups.

	PKEP1	PKRP	PKEP2	F value	Pvalue
Operation time (min)	75.0 ± 24.7	77.2 ± 20.4	63.7 ± 18.5*	6.830	0.001
Hemoglobin change(g/L)	14.9 ± 5.6#	12.4 ± 5.4	14.3 ± 7.8	2.535	0.082
Enucleation weight (g)	41.4 ± 15.0	31.6 ± 12.6&	42.1 ± 11.7	12.958	0.000
Irrigation time(h)	36.7 ± 16.8	37.8 ± 16.2	35.0 ± 12.9	0.534	0.588
Catheterization period (day)	5.6 ± 0.9	6.0 ± 1.1	5.8 ± 1.2	1.321	0.269
Postoperative hospitalization day	7.9 ± 2.2	7.4 ± 1.4	7.2 ± 2.0	1.871	0.157
* $P < 0.05$ Compared PKEP2 with PKEP1 and PKRP; # $P < 0.05$ Compared PKEP1 with PKRP; & $P < 0.05$ Compared PKRP with PKEP1 and PKEP2.					

3.3 Postoperative 3-month data in the 3 groups

During the 3-month follow-up period, IPSS, QOL, Qmax, RUV data were collected and analyzed(Table 3), there was no significant difference in the 3 groups($P > 0.05$). Compared with preoperative results, postoperative IPSS, QOL and RUV decreased, while Qmax significantly increased($P < 0.05$).

Table 3
Comparison of the preoperative and postoperative 3-month data in the 3 groups.

	PKEP1 (n = 44)		PKRP (n = 72)		PKEP2 (n = 55)	
	preoperative	postoperative	preoperative	postoperative	preoperative	postoperative
IPSS	20.9 ± 4.4	9.7 ± 2.7*	20.0 ± 4.6	10.0 ± 2.6*	19.8 ± 3.1	9.4 ± 1.9*
QOL	4.52 ± 0.93	2.14 ± 0.63*	4.32 ± 0.77	2.13 ± 0.47*	4.56 ± 0.63	2.05 ± 0.49*
Qmax (mL/s)	9.6 ± 2.5	14.4 ± 2.5*	9.1 ± 2.1	14.7 ± 1.8*	9.2 ± 1.8	14.7 ± 2.3*
RUV (mL)	90.0 ± 125.7	26.4 ± 40.0*	86.6 ± 124.5	24.1 ± 20.0*	85.2 ± 115.9	23.8 ± 33.2*
IPSS = International Prostate Symptom Score; QOL = quality of life; Qmax = maximum urinary flow rates; RUV = residual urine volume. *: P < 0.05, Compared postoperative with preoperative.						

3.4 Postoperative complications in the 3 groups

There were no deaths, rectal injury, bladder injury, intraoperative blood transfusion, or TRUS in all groups. The highest incidence of complications in order were re-catheterization(n = 10), febrile UTI(n = 9), capsule perforation(n = 7), Bleeding requiring surgery(n = 2), UI(n = 2) and urethral stricture(n = 2). And there was no significant difference among the 3 groups(Table 4, $P > 0.05$).

Table 4
Postoperative complications in the 3 groups [n (%)].

	PKEP1 (n = 44)	PKRP (n = 72)	PKEP2 (n = 55)	Fisher value	P value
Capsule perforation	3(6.8%)	3(4.2%)	1(1.8%)	1.568	0.483
Re-catheterization	4(9.1%)	4(5.6%)	2(3.6%)	1.353	0.507
Febrile UTI	3(6.8%)	4(5.6%)	2(3.6%)	0.636	0.834
Bleeding requiring surgery	1(2.3%)	1(1.4%)	0	1.365	0.728
UI	1(2.3%)	0	1(1.8%)	1.904	0.334
Urethral stricture	0	1(1.4%)	1(1.8%)	0.919	1
UTI = febrile urinary tract infection; UI = Urinary incontinence.					

4. Discussion

At present, TURP is still the mainstream surgical treatment for BPH, owing to its fast postoperative recovery and low mortality[11, 12]. However, the traditional monopolar TURP still triggers some complications. To reduce the complications of TURP, various minimally invasive approaches have been developed, including the improvement of surgical method, such as enucleation, and the research and development of surgical equipment, such as holmium laser, green light laser, thulium laser, etc. By dissecting along the surgical

capsule to remove more glands, endoscopic prostatic enucleation enables anatomic enucleation of entire prostate lobes in the same way that a surgeon's finger does during open prostatectomy (OP). Recently, PKEP has been reported to be an attractive, minimally invasive alternative to OP, with comparable functional results, fewer complications and requiring no additional equipment[13, 14]. PKEP, the Gyrus bipolar PlasmaKinetic System combined with transurethral enucleation of the prostate, is an improved surgery for PKRP. The efficacy and safety of PKEP has been demonstrated by urologists, it has the characteristics of complete gland resection, short operation time, less bleeding, and fewer complications[9, 15], even in treating large prostates[10, 16].

Our results showed that the 2 surgical methods, PKEP and PKRP could effectively solve the clinical symptoms caused by BPH, and had significant improvement in IPSS, QOL, and Qmax, and decrease in RUV. There were no significant differences among the 3 groups in postoperative 3-month IPSS, QOL, Qmax and RUV. And the irrigation time, catheterization period, postoperative hospitalization day, were not comparable in the 3 groups. In both the PKEP1 and PKEP2 groups, the hemoglobin change was higher than that in PKRP, but there was no statistical difference between PKEP2 and PKRP. Compared with the results of other researchers, the hemoglobin change in our PKEP group was less, such as the first PRT comparing PKEP with TURP conducted by Zhao[10], they reported a 15.5 ± 1.7 g/L hemoglobin decrease in the PKEP group. In addition, we found that compared with the PKEP1 group, the hemoglobin change in the PKEP2 was less, which was associated with an increase in the number of cases performed and a greater skill level. Like most other studies, the quality of surgically removed glands in the PKEP group was more, and that's the biggest advantage of enucleation. 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 can effectively ameliorate the symptoms of BPH shortly after surgery, especially for patients with a large prostate.

In terms of operation time, PKEP1 had little comparative advantage with PKRP, but PKEP2 was shorter than PKRP significantly. One possible explanation is that after making a circular incision with a cutting loop, the tip of the resectoscope sheath was used to dissect the prostatic lobes in a retrograde fashion and to establish the tissue planes off the capsule. During these steps, no vaporisation bubbles were generated at the point of contact, and clear vision was provided. The other explanation could be that the subtotally enucleated and devascularised lobes were then resected in a nearly bloodless field, without needing to stop frequently to check the position. In addition, the operation time of the PKEP2 group was significantly shorter than that of the PKEP1. Due to the difference in prostate volume of each patient, it is impossible to directly compare the changes in operation time with the increase in the number of cases undergoing surgery. Therefore, we calculated the ratio of operation time to prostate volume and resection mass respectively, and used the difference of ratio to represent the change of operation time with the increase of operation cases. We finally concluded that as the number of cases increased, the duration of surgery decreased.

Although the incidence of overall postoperative complications was not comparable in the 3 groups, there were 2 cases in the PKEP and 0 cases in the PKRP group in terms of UI. It was consistent with the results reported by Luo[17] that the incidence of transient incontinence after PKEP was higher than PKRP. UI is a common major complication of endoscopic prostatic enucleation, the incidence of UI after Holmium laser

enucleation of the prostate (HoLEP) and PKEP has been reported to be 1.3–40.7%[18, 19] and 3.5–18.9%[20], respectively. Studies have found that a large prostate volume(≥ 90 mL) and age ≥ 70 years was significantly associated with UI[20, 21]. More meticulous and gentle enucleation can be done during surgery to reduce postoperative incontinence. Furthermore, some selected patients can be treated by conventional PKRP.

5. Conclusions

Our single-center results indicated that PKEP and PKRP were both safe and effective for the surgical treatment option of BPH. And PKEP requires an accumulation of surgical cases. In terms of operation time and enucleation weight, skilled PKEP is superior to PKRP. Future well-designed, randomized trials with extended follow-up and larger sample size may be needed to better delineate the role of PKEP in treating patients with different volume prostate.

Declarations

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None.

Authors' contributions

Peng Gu and Minhao Zhang wrote the main manuscript text. Xiaoliang He collected the clinical data. All authors reviewed the manuscript.

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Availability of data and materials

The datasets used and/or analyzed during the current study available from the corresponding author on reasonable request.

Ethics approval and consent to participate

This study was permitted by the Ethics Committee at the Wuxi Xishan People's (xs2018ky007). All procedures performed in studies involving human participants were in accordance with the ethical standards of the

institutional and/or national research committee (include name of committee + reference number) and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Consent for publication

Not applicable.

Competing interests

The authors declare that they have no competing interests.

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Figures

Figure 1

Scatter plot of prostate volume and enucleation weight associated with increased number of surgical cases.