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Original Article

Comparison of plasmakinetic enucleation of the prostate with holmium laser enucleation of the prostate in the treatment of benign prostate hyperplasia

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Abstract: Objective: To compare the safety and efficacy of plasmakinetic enucleation of the prostate (PKEP) with holmium laser enucleation of the prostate (HoLEP) in the treatment of benign prostate hyperplasia (BPH). Patients and methods: Retrospective analyses were performed on 360 cases of BPH, 180 treated by PKEP and 180 treated by HoLEP at our institution between January 2008 and January 2011. The safety and efficacy of the two approaches were assessed based on the peri- and postoperative outcome data during a 24-month follow-up. Significant findings: Operation time (87.6±32.3 vs. 74.9±25.0 min) and take-out tissue time (30.9±15.7 vs. 15.1±7.9 min) were significantly longer in the PKEP group than those in the HoLEP group (P<0.01). There were significant reductions of the hemoglobin level and bladder irrigation time in the HoLEP group. Enucleating time, serum sodium level, resected weight and catheter time were comparable between the two groups. Both groups displayed marked improvements in international prostate symptom score (IPSS), postvoid residual urine (PVR), maximum urinary flow rate (Qmax), and quality of life score (QoL), compared to baseline levels. However, no significant difference in these outcome parameters was noted between the two groups. Additionally, the two groups showed a similar complication rate after surgery. Conclusions: Both PKEP and HoLEP are effective and safe in the treatment of BPH. HoLEP is associated with less risk of hemorrhage and reduced operation time and bladder irrigation time.

Keywords: Benign prostatic hyperplasia, laser therapy, prostatectomy, retrospective analysis

Introduction

In aging men, benign prostate hyperplasia (BPH) and related lower urinary tract symptoms are common problems, affecting daily activity and quality of life. Transurethral resection of the prostate (TURP) is considered the gold standard for the surgical treatment of BPH [1]. As morbidity after TURP is significant [2, 3], there has been a continuous decline in TURP surgery and an increase in the use of new treatment techniques for lower urinary tract symptoms presenting with BPH. Enucleation surgery is more respected than resection surgery nowadays, and transurethral enucleation is reported to be superior to resection in treating BPH [4]. Plasmakinetic enucleation of the prostate (PKEP) and holmium laser enucleation of the prostate (HoLEP) are two of the most respected techniques of enucleation surgery. PKEP has recently shown fewer complications and comparable results to the standard TURP [5]. HoLEP has been shown to be as effective as TURP in the management of bladder outlet obstruction (BOO) and has less perioperative morbidity than TURP [6, 7]. These new techniques appear to be candidates to replace traditional TURP as the gold standard for the surgical treatment of BPH. Few studies have compared PKEP with HoLEP. In this study, we conducted a retrospective study to compare PKEP with HoLEP in terms of its efficacy and safety within a 24-month follow-up.

Patients and methods

We retrospectively reviewed 360 patients with BPH who were treated by PKEP or HoLEP at our institution between Jan 2008 and Jan 2011. All patients were previously treated with conserva-

tive medical therapy which did not result in satisfactory improvement. They all had obvious indications for the surgical treatment of BPH. Any patient with a previous history of prostatic or urethral surgery, neurovesical dysfunction, bladder stone, prostate or bladder cancer, severe pulmonary disease or heart disease was excluded from the study. This study was approved by the Ethics Committee of Jiaotong University (Shanghai, China).

Before surgery, we collected the baseline characteristics of the patients, which consisted of urological history, presence of concurrent diseases, prostate volume, international prostate symptom score (IPSS), post void residual urine (PVR volume), quality of life score (QoL), and maximum urinary flow rate (Qmax). Measurement of the PSA level, serum sodium, and hemoglobin was performed and recorded preoperatively. Operation time, resected prostatic weight, serum sodium decrease, hemoglobin decrease and early complications were recorded. The bladder irrigation time, catheterization time and hospitalization duration were also recorded. Follow-up was assessed at 1, 6, 12 and 24 months after surgery. The assessments consisted of the IPSS, QoL score, Qmax, and PVR.

HoLEP was performed using a 550-μm end firing laser fiber, a 100 W Versapulse Holmium Laser (Lumenis Inc., Tel Aviv, Israel) and a 27 F continuous-flow resectoscope, with a modified bridge to hold the laser fiber (Karl Storz, Tuttlingen, Germany). The power settings were 60-100 W at 1.5-2 J/s and 40-50 Hz. Transurethral morcellation was conducted through a 26 F nephroscope, using a mechanical morcellator (Versacut Morcellation, Lumenis Inc., Tel Aviv, Israel).

HoLEP mainly included two parts: enucleation and morcellation. We inspect the urethra, prostate and bladder. The enucleation was begun by making an incision at the proximal part of the verumontanum from the 5 to the 7 o'clock position to establish a cleavage plane at the apical region, which was identified as a smooth plane with clear vessels. The laser fiber was inserted into the cleavage plane. We typically used a two-lobe technique to enucleate one lateral lobe along the prostate capsule. We enucleated the median and remaining lateral lobes as a single unit and placed it into the bladder. The three-lobe technique is suited for a large gland with a large median lobe. The gland of the mid lobe was dissected from the prostate capsule in a retrograde fashion toward the bladder neck by the laser fiber and was enucleated and placed into the bladder. We subsequently enucleate the left lateral lobe followed by the right lateral lobe or vice versa. After the enucleation procedure, we placed the morcellation device into the bladder to break-up and remove the resected tissue.

PKEP was conducted using the ScanMed Plasmakinetic Super Pulse System (ScanMed, ZhuHai, China). All of the procedures were performed using a Karl Storz 27 F continuous-flow resectoscope (Karl Storz, Tuttlingen, Germany). The generator for PKEP was set at 160 W for cutting and 80 W for coagulation.

We performed PKEP using a previously described technique that is well known in our country [8, 9]. The enucleation procedure of PKEP is similar to HoLEP. Some differences, the prostate lobes were subtotally enucleated with a narrow pedicle attached to the bladder neck in the 6 o'clock position. We resected the adenoma rapidly in pieces by the loop electrode and removed the resected tissue by Ellik.

Each procedure was performed by one surgeon (Z.W.), who was quite skilled in HoLEP and PKEP and who had performed more than 500 of these surgeries. We used general anesthesia or epidural anesthesia, and all the patients were in the lithotomy position during surgery. The irrigation fluid used was 3 L of normal saline (0.9%), and all the irrigation bags were hung 60 cm above the operating table. All the patients were treated peri-operatively with the appropriate antibiotics. We inserted an irrigating catheter after surgery, and bladder irrigation was used as necessary until the hematuria had settled sufficiently to remove the catheter.

All the measurement data were statistically analyzed with the two-tailed Student's t-test and presented as the mean ± standard deviation (SD). The differences were considered statistically significant at $P<0.05$.

Results

Baseline characteristics including age and preoperative prostate volume were not significant-

Table 1. Baseline characteristics and perioperative data

Parameter	PKEP	HoLEP	*P*
Age, year	74.0±8.6	74.3±7.5	0.77
Preoperative prostate volume, mL	56.6±26.7	60.3±22.6	0.15
Operative duration, min	87.6±32.3	74.9±25.0	<0.01
Enucleation time, min	56.7±24.5	59.8±20.0	0.18
Take-out tissue time, min	30.9±15.7	15.1±7.9	<0.01
Resected weight, g	47.6±23.5	50.9±19.6	0.14
Serum sodium decrease, mmol/L	3.0±1.4	2.9±1.0	0.17
Hemoglobin decrease, g/dL	1.4±0.7	1.2±0.5	0.02
Bladder irrigation time, h	25.8±11.5	23.4±9.5	0.03
Catheter time, h	71.2±21.5	68.0±18.8	0.13
Hospital stay, d	3.3±1.1	3.2±1.0	0.62
No. of α-blockers used	86	82	0.28
No. of 5α-reductase used	32	28	0.76

ly different between the PKEP and HoLEP groups (**Table 1**). Perioperative data were also shown in **Table 1**. Operation time (87.6±32.3 vs. 74.9±25.0 min) and take-out tissue time (30.9±15.7 vs. 15.1±7.9 min) were significantly longer in the PKEP group than that in the HoLEP group ($P<0.01$). There were significant reductions of the hemoglobin level and bladder irrigation time in the HoLEP group. Enucleation time, serum sodium level, resected weight and catheter time were comparable between the two groups.

Table 2 showed time course of outcome measures during follow-up. Compared to baseline levels, both the groups showed marked improvements in IPSS, QoL, Qmax and PVR from 1 month after surgery. However, there was no significant difference in these parameters between the two groups.

Complications related to surgery within 24 months were summarized in **Table 3**. Two patients needed recatheterization because of urine retention after catheter removal in the PKEP group, whereas none of the patients in the HoLEP group required re-catheterization. No transfusions were required in either group. Some degree of stress incontinence was present in both groups (8 in the PKEP and 9 in the HoLEP group), but these patients all recovered within 6 months. During the follow-up, no patient needed repeated surgery because of recurrence. Six patients had urethral strictures at 3-8 weeks after surgery in the PKEP group and 4 patients at 4-9 weeks after surgery in the HoLEP group. Two patients presented BNCs at 8 and 10 weeks after surgery in the PKEP group and 1 patient at 9 weeks after surgery in the HoLEP group. Retrograde ejaculation was encountered in 15 patients in the PKEP group and in 14 patients in the HoLEP group. The overall complication rate was similar between the two groups.

Discussion

TURP has been considered the gold standard surgical therapy for patients with BPH for many years; however, it may cause morbidity, such as bleeding, TUR syndrome and increased recurrence rate. Many new endoscopic technologies have been introduced to treat BPH [10]. Bipolar technology and laser technology have been introduced and reported to have clear efficacies and low complication rates [11-14]. In addition to equipment upgrades, surgical technology has also improved. Enucleation surgery has been introduced as an anatomical removal of the prostate like open surgery. In many aspects, enucleation surgery is proved to be superior to resection to treat BPH [15-17]. First, enucleation surgery results in more hemostasis. During enucleation, the blood vessel is only cut once, and then, bleeding is stopped. During resection, loop is used to cut tissues back and forth until the root of the blood vessel is cut, which increases the risk of bleeding, especially in large prostates. There is less bleeding and clearer visibility in enucleation surgery. The risk of bleeding was lower than that of open surgery. Enucleation is performed along the capsule of the prostate, which clarifies the anatomical structure and brings less capsular perforation. Second, enucleation surgery leads to rapid complete tissue removal and more resected tissue. PSA levels decrease more after enucleation surgery than after resection surgery. Enucleation surgery is unaffected by prostate size. Faced with a large prostate, the resection rate is much higher with enucleation surgery. Third, enucleation surgery was reported with fewer complications than resection surgery, including no occurrence of TUR syndrome, reduced risk of bleeding, and reduced recurrence rate. Reduced bladder irrigation and catheter times and reduced hospital stay were

Table 2. Time course of outcome measures during follow-up

Parameter	Baseline (n=360)	1 month (n=358)	6 months (n=320)	12 months (n=296)	24 months (n=280)
IPSS					
PKEP	23.1±3.2 (n=180)	11.0±2.7 (n=179)	8.11±2.0 (n=158)	6.1±1.7 (n=146)	5.0±1.7 (n=138)
HoLEP	23.0±3.6 (n=180)	11.11±2.8 (n=179)	8.3±2.7 (n=162)	6.4±2.2 (n=150)	5.1±2.0 (n=142)
P value	0.88	0.80	0.48	0.14	0.48
QoL					
PKEP	4.6±0.7 (n=180)	2.4±0.7 (n=179)	1.6±0.6 (n=158)	1.2±0.6 (n=146)	1.0±0.5 (n=138)
HoLEP	4.6±0.7 (n=180)	2.3±0.6 (n=179)	1.4±0.6 (n=162)	1.2±0.6 (n=150)	1.0±0.6 (n=142)
P value	0.52	0.15	0.06	0.65	0.58
Qmax (mL/s)					
PKEP	7.0±2.2 (n=180)	22.8±5.4 (n=179)	23.2±5.1 (n=158)	23.2±4.9 (n=146)	23.7±4.9 (n=138)
HoLEP	7.2±2.2 (n=180)	22.8±5.1 (n=179)	23.0±4.6 (n=162)	23.2±4.4 (n=150)	23.7±4.2 (n=142)
P value	0.53	0.97	0.63	0.94	0.88
PVR (mL)					
PKEP	130.8±55.5 (n=180)	23.8±8.2 (n=179)	23.0±8.4 (n=158)	21.9±8.3 (n=146)	20.2±10.0 (n=138)
HoLEP	127.7±75.0 (n=180)	23.6±10.1 (n=179)	21.8±10.4 (n=162)	21.0±10.4 (n=150)	19.8±11.9 (n=142)
P value	0.66	0.83	0.22	2.39	0.70

IPSS, international prostate symptom score; PVR, postvoid residual urine; Qmax, maximum urinary flow rate; QoL, quality of life score.

Table 3. Complications related to surgery within 24 months

Complications	PKEP	HoLEP	*P*
Capsular perforation	1	2	0.65
Bladder mucosal injury	0	2	0.52
Re-catheterization	2	0	0.89
Stress incontinence	8	9	0.96
Urethral stricture	6	4	0.95
Bladder-neck contracture	2	1	0.89
Retrograde ejaculation	15	14	0.78

also reported in enucleation surgery comparing to resection surgery. Besides, enucleation surgery reduces the recurrence rate [15-17].

PKEP and HoLEP are used widely in the newly developed technologies, and they are most commonly used in the enucleation surgery and have been proposed to replace traditional resection surgery. Both techniques were shown to be effective and safe for the treatment of BPH and had fewer complications compared to the standard TURP. To date, the mid or long-term results of comparing these two devices are lacking. The present study aimed to report on the 2-year follow-up results of a trial comparing PKEP with HoLEP in terms of efficacy and safety.

In the present study, both techniques displayed significant improvements in IPSS, QoL scores, Qmax and PVR compared to the baseline. The results were similar to other reported studies [18, 19]. However, no significant difference in these outcome parameters was noted between the two groups. With respect to peri-operative complications, both techniques showed significant effects and a low rate of complication, as other studies have reported [9, 20]. Particularly regarding hemostasis, no transfusions were required in either group. Some degree of stress incontinence was present in both groups (4.4% in the PKEP and 5% in the HoLEP group), but these patients all recovered within 6 months, as reported in the long-time follow-up (2% in PKEP and 7.9% in HoLEP) [5, 21]. The efficacy and safety of both techniques is obvious.

HoLEP seems to be superior to PKEP in several respects. First, the operation time in the HoLEP group was significantly shorter than in the PKEP group. The enucleation time was similar in both groups. However, the tissue take-out time was longer in the PKEP group. The specialized morcellation device for HoLEP is more efficient than the resection and suction of the enucleation tissue with Ellik in the PKEP group, especially in large prostates. The modified morcellation technique decreases surgery time [22]. Although some doctors used the specialized morcellation device for PKEP in some areas of the world, the operation time was still longer in PKEP [23]. Electrosurgery does not provide the same tissue separation and 'feel' as the

Holmium laser because of the pulsed nature of the energy [17]. Second, HoLEP appears to have a reduced risk of hemorrhage and reduced bladder irrigation time. The laser seems more hemostatic and incisive in surgery because of its physical characteristics. We found that the operation field of vision is clearer in the HoLEP group, as previously reported [23]. It uses laser energy that is more concentrated for resection, leading to deeper solidification and tissue necrosis. It produces more bubbles in the PK system, resulting in unclear vision. Ellik was used to extract the resected tissues in PKEP. This procedure causes a drastic change in bladder pressure, leading to bleeding of the blood vessel in the prostate nest cavity. HoLEP uses morcellation to break-up and remove the enucleated adenoma in a relatively constant pressure environment, with a lower risk of bleeding. We stopped the bladder irrigation until the urine color was completely clean. The bladder irrigation time was less in the HoLEP group which may be associated with less bladder spasm and less late bleeding after the laser surgery. Another advantage of HoLEP is its wide adaptability. HoLEP is not influenced by large prostate sizes, and HoLEP morcellation is effective in disrupting prostate tissue [24]. HoLEP can treat BPH presentation in combination with bladder calculi and urethral stricture. And it was reported to be safe for treating BPH patients taking anticoagulants [25-28]. Many urologists are more familiar with the PK device because it is similar to the traditional TURP device, which may enable the urologists who have never used a laser to operate more smoothly during the learning phase of enucleation surgery. The learning curve is shorter with PKEP than with HoLEP. With the tissue take-out procedure, beginners have increased opportunities to practice the resection technique in the PKRP group.

The main limitation of the present study is that it is retrospective. Future well-designed, randomized trials with an extended follow-up and larger sample sizes may be needed to better define the role of PKEP and HoLEP in treating patients with symptomatic BPH. We hypothesize that our present study provides favorable peri-operative and 2-year follow-up data for patients who underwent PKEP or HoLEP with regard to the efficacy and the safety of the surgical instrument. We believe our study will help to improve BPH surgery and increase the treatment options for men with BPH.

In conclusion, PKEP and HoLEP are effective and safe in the treatment of BPH. Compared with PKEP, HoLEP is associated with less risk of hemorrhage and reduced operation time and bladder irrigation time.

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Disclosure of conflict of interest

None.

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