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Adjuvant U100-plus laser cystolithotripsy is therapeutically effective and safe for benign prostate hyperplasia patients with complicating bladder lithiasis: a prospective, randomized, controlled study

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Abstract: Our objective is to evaluate the effect and safety of transurethral resection of prostate (TURP) and U100 laser lithotripsy for benign prostate hyperplasia patients with complicating bladder lithiasis. 79 cases with bladder outflow obstruction (BOO) secondary to benign prostate hyperplasia (BPH) complicating bladder lithiasis were collected. Based on the different ways of bladder lithiasis lithotripsy, the patients were randomized into two groups: the punch lithotrite group (43 cases) and the U100 laser group (42 cases). All patients were assessed perioperatively and followed at one month postoperatively. The preoperative and postoperative parameters included international prostate symptom score (IPSS), maximum urinary flow rates (Qmax), postvoid residual urine (PVRU) volume, patient baseline characteristics, perioperative data, and postoperative outcomes. In the two groups, the IPSS scores and the maximum flow rate (MFR) showed significant differences when compared to the preoperative data ($P < 0.05$). The stone-free rate (97.2%) in the U100 laser group was significantly higher than that in the punch group (62.8%), with a statistical difference ($P<0.05$). For stones < 1.5 cm, the time of lithotripsy and stone-free rate in the U100 laser group was not statistically different as compared with those in the punch group. For stones >2.5 cm, the lithotripsy efficiency and the stone-free rate in the U100 laser group increased significantly with a statistical difference when compared with those in the punch group. In conclusion, the therapeutic effects of the two lithotripsy approaches showed no difference for calculi with a diameter <1.5cm. While for calculi with a diameter >2.5cm, the U100 laser lithotripsy was recommended. We have shown that the U100 laser lithotripsy, when combined with TURP, is an effective and safe treatment for BPH with bladder lithiasis.

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Keywords: BPH, bladder calculus, TURP, U100-plus laser

1. Introduction

Benign prostate hyperplasia is a common disease for the aged male. Vesical calculus is one of the major complications of BPH and arises from an obstruction at the bladder outlet (considered a major risk factor for the development of bladder calculi) [1, 2]. As various approaches of simultaneous transurethral cystolithotripsy and prostatectomy have been used, we hope to discover one kind of efficient and safe intracavity lithotripsy technique to deal with this disease. U100-plus laser is a type of cystolithotripsy that is safer than holmium laser and rarely injures soft tissues [3]. We collected 79 cases of patients with BPH and vesical calculus, treated with either the transurethral resection of prostate (TURP) and U100-plus laser lithotripsy technique or punch lithotrite lithotripsy method in our hospital from May, 2007 to May, 2009 in order to compare the safety and effectiveness of U100-plus laser and transurethral resection of prostate for benign prostate hyperplasia (BPH) with vesical calculus.

2. Materials and Methods

2.1 General Information

From May, 2007 to May, 2009, 79 patients with vesical calculus with BPH were treated in our hospital,

aging 61 to 86 years, with a mean age of 75.01 ± 6.12 years. Among them, 16 were with coronary heart diseases or arrhythmia. In the 16 cases, 3 were with coronary stents, 8 with cerebral infarction, and 2 with renal insufficiency. 42 patients had single calculus and 37 multiple calculi. With preoperative B-ultrasound, KUB plain film, and cystoscopy, the diagnosis of BPH and vesical calculus was confirmed. There were no surgical contraindications. The detailed records of the patients' international prostate symptom score (IPSS) scores one month before and after the operation were kept, including the maximum urinary flow rate (MRF), the size of the vesical calculus (for single stone, the maximum diameter measured by transurethral endoscope was used; and for multiple stones, the sum of the maximum diameters of each stone by endoscopic resection was used), lithotripsy time, surgical findings (no residual stones or residual stones < 3mm for the successful operation; change for other surgical approaches for unsuccessful operation), weight of the removed prostate, and complications during the operation and after one month.

2.2 Patient groups

Group patients with BPH and vesical calculus were treated with the transurethral punch lithotripsy and TURP treatment in the same period. Based on the different ways of vesical calculus lithotripsy, the patients were divided into two groups in random: Group A with the TURP and Punch lithotripsy (43 cases), and Group B with the U100-plus laser lithotripsy and TURP (36 cases).

2.3 Surgical protocol

Surgical proceduresepidural anesthesia was performed in 79 patients to take the lithotomy position. In Group A, an Olympus F26 punch lithotrite was placed in the urethra of each patient for lithotripsy; while in Group B, an F21 cystoscope was placed in the urethra. Then a U100-plus laser fiber was pushed in through the sheath to break up the stones, one by one, under a monitor control, and Elick was used to flush out the stone debris. After the success of stone lithotripsy, F26 Olympus resectoscope was used to electrically resect every leave of prostate hyperplasia in sequence, and an attention was paid to protect the prostate capsule and the external sphincter. After flushing out the chopped prostate tissue, the indwelled F22 three-chamber catheter was used to wash the bladder continuously for 1-3 days, with catheter indwelling 3-5 days. One month after the surgery, every check index was reexamined in outpatient.

2.4 Statistical Analysis

Software SPSS11.0 was applied to process the statistics. Data was performed using analysis of t-test and $\chi 2$ test, and $P < 0.05$ was considered as statistical significance.

3. Results

3.1. Comparison of general data and baseline data

The diameter of stones in 79 patients was between 0.8 cm and 4.2 cm. The prostate tissues resected were 10 ~ 121 g, with a mean of 28.47 ± 1.84 g. The overall stone-free rate of the operation was 78.48%. 43 cases were operated with punch lithotripsy in the Group A, and 36 cases were performed with U100-plus laser lithotripsy in the Group B. The baseline data of the two groups showed no difference in age, preoperative IPSS, and preoperative maximum urinary flow rate ($P > 0.05$, Table 1). No difference was found in the constituent ratio of the sizes of vesical calculus between the 2 groups ($P > 0.05$, Table 2).

Table 1 Clinical data of Group A and Group B

Group	Case	Age（year）	NOS	Sum of largest stones in diameter.（cm）	Preoperative IPSS (scores)	Preoperative MFR (mL/s)
Group A	43	75.23±6.11	1-5	3.7	28.44±4.22	6.92±2.60
Group B	36	74.75±6.21	1-8	4.6	27.22±4.14	6.29±2.83
p		0.878			0.201	0.963

Note: NOS is the number of stones; SOLS is the sum of the largest stones in diameter.

Table 2 The stone size proportion ratio of Group A and Group B

Group	Diameter of stone（cm）		
	1.5	1.5-2.5	>2.5
Group A	9	19	15
Group B	8	12	16
p	0.589		

3.2. Comparison of the situation of operations between Group A and Group B

There is no significant difference was discovered (P > 0.05) in SFR, WRP, OIB&U, IPSS, MFR, US, O&P CCA between the two groups (Table 3).

3.3. Comparison of the stone-free rate and the lithotripsy time between the two groups

In Group A, the stone-free rate with different diameters, showed a significant difference (P <0.05). In Group B, no significant difference was discovered (P > 0.05). For the lithotripsy time of different size stones, there was a significant difference between the two groups (P < 0.05) (Table 4). In addition, there were 16 failure cases in Group A, with a single stone diameter of 2.4cm-3.5cm .

Table 3 Comparison of the situation of operations between Group A and Group B

Group	SFR (%)	WRP (g)	OIB&U (%)	IPSS(s)	MFR (mL/s)	UR (%)	O&PCCA
Group A	62.8	29.02±17.42	4.7	7.90±2.79	20.9±4.36	14.6	0
Group B	97.2	27.81±19.71	0	7.33±3.44	21.33±4.67	11.1	0
p	0.000	0.771	0.190	0.416	0.226	0.646	

Note: SFR is the stone-free rate of lithotripsy; WRP is weight of resected prosdate; OIB&U indicates the operational injury of bladder & urethra; IPSS(s) is the international prostate symptom scores one month after operation; MFR is the maximum flow rate one month after operation; US stands urethral stricture one month after operation; O&P CCA stands the operational & post-operational cordis and cerebral accidents.

Table 4 Comparison of stone-free rate and lithotripsy time between Group A and Group B

Group	Diameter (<1.5 cm)		Diameter (1.5-2.5 cm)		Diameter (>2.5 cm)	
	SFA (%)	CT (min)	SFA (%)	CT (min)	SFA (%)	CT (min)
Group A	100	7.55±2.19	63.2	27.83±12.18	33.3	58.60±27.01
Group B	100	8.50±2.78	100	20.17±8.47	93.8	31.20±16.51
p	-	0.445	0.017	0.087	0.000	0.013

Note: SF is the stone-free rate; CT is the crushing time.

4. Discussion

BPH is a common disease for the aged male, and vesical calculus is one of the major complications of BPH. Vesical calculus is caused by the obstruction of the bladder outlet, which is further considered a major risk factor for the development of bladder calculi as 2% of patients undergoing TURP will have coexistent bladder stones [1, 2]. Bladder stones is considered an absolute indication for surgical management of BPH, and the management of bladder lithiasis should be always accompanied by surgical treatment of BPH [4, 5]. Various approaches of simultaneous transurethral cystolithotripsy and prostatectomy have been used. Current approaches of cystolithotripsy include extracorporeal shock wave lithotripsy, transurethral cystolithotripsy, percutaneous cystolithotomy, and open surgery. Open suprapubic cystolithotomy has maximized the stone clearance rates, especially for large calculi, but suprapubic cystolithotomy does more injury to patients and has a slow recovery and a higher surgery risk for elderly patients [2, 6]. As most BPH patients are the aged, they have more underlying diseases, with a high perioperative risk. The treatment of these patients has

been completely shifted to various minimally invasive treatments with various endoscopic technologies. Transurethral stone disintegration can be achieved using the mechanical stone crusher, ultrasonography, ballistic lithotripsy, pneumatic and elec-trohydraulic lithotripsy, combined ultrasound / pneumatic lithotripsy, and laser energy [7-10]. Laser has led to successful disintegration of large stones with minimal mucosal injury and hematuria compared with mechanical lithotripsy [8]. These methods and equipments have their own advantages and disadvantages. One advantage is the simultaneous transurethral cystolithotripsy with holmium laser enucleation of the prostate. While the main shortage is the tissue damages caused by Holmium laser [9, 10]. Therefore, we have been looking for a kind of efficient and safe intracavity lithotripsy equipment.

Unlike the Holmium laser, the U100-plus laser rarely injures soft tissues [3]. The effects of cystolithotripsy are less known in literature. In this study, we compared the clinical results between the Punch lithotrite, a kind of mechanical stone crusher, and U100-plus laser lithotripsy. Punch lithotripsy is mechanical, crushing the stone with grip strength. It is cheap and durable with low supplies and powerful lithotripsy force. Of the 43 patients treated with punch lithotrite, 27 cases were successful, with the stone-free rate of 62.8%. The lithotripsy time for stones in diameters < 1.5cm was 7.55 ± 2.19 min with the stone-free rate of 100%; and for stones in diameters > 2.5cm, the lithotripsy time was 58.60 ± 27.01 min with the stone-free rate of 33.3%. The lithotripsy time and the stone-free rate were significantly correlated with the stone volume. In the lithotripsies failure cases, the diameter of a single stone was 2.4-3.5cm, with a mean of 2.91 ± 0.49 cm, which caused great difficulties in larger stones with punch lithotrite. In addition, the hardness, shape, and the surface smoothness of the stone also affected the lithotripsy effect. Mulberry-like or irregular shape, the surface un-smoothness, the crisp of stone, and round or oval, smooth, hard stones were more easily broken up. This was caused by the degree of difficulty in grasping the stone. All failed cases were successful when U100-plus laser lithotripsy was applied. Therefore, the volume of the stone could serve as a judging criterion for the lithotripsy effect with punch method. For the stones in diameter < 1.5cm, punch lithotripsy remained a highly effective method. Compared with U100-plus laser lithotripsy, punch lithotripsy showed no significant difference in the stone-free rate and the lithotripsy time. For the stones in diameter > 2.5 cm, the stone-free rate of punch lithotripsy was very low, and the surgery time long, easily leading to bladder mucosal injury and bleeding. In this study, two cases of the perforation of trigonumvesicae were in the group A. Therefore, punch lithotripsy was not recommended for the stones in diameter > 2.5cm.

U100-plus laser lithotripsy is a new type of device. The quartz optical fiber in diameter of 0.73 mm was applied to transmit the laser, and its excellent flexibility enables it to be widely used in endovascular surgery [11]. It does little injury to soft tissues and has a higher lithotripsy efficiency. U100-plus laser is not effective for cystine calculi [12], but effective for calculi made up of various components other than cysteine, resulting in a high stone-free rate. In this study, the stone-free rate of U100-plus laser lithotripsy was 98.28%. No difference in the stone-free rate of calculi with different sizes was discovered. Therefore, the effect of the volume of stones on the stone-free rate need not be taken into account in the choice of surgery types. For stones in diameter of 1.5-2.5 cm, the lithotripsy efficacy of U100-plus laser lithotripsy was similar to that of punch lithotripsy but had a higher stone-free rate. The lithotripsy time in U100-plus laser group 20.17 ± 8.47 min was shorter than that in the bunch group 27.83 ± 12.18 min, but with no significant difference. For stones > 2.5cm in diameter, the efficiency and stone-free rate in the U100-plus laser group were significantly higher than those of the bunch group. Therefore, the larger the stone volume, the more obvious advantages the U100-plus laser lithotripsy has. For > 2.5 cm stones, we recommend the U100-plus laser lithotripsy. The U100-plus laser is a non-thermal burning method and does not cut tissue [3]. The patients in the group B showed no bladder injury, nor perforation cases, and experienced a high surgical safety.

TURP is the gold standard for treating BPH [13]. In this study, vesical calculus was dealt with first and then the TURP was performed. In the two groups of patients, prostates of 29.02 ± 17.42 g and 27.81 ± 19.71 g were resected respectively and IPSS scores and MRF were reexamined one month after the operation. Compared with preoperative data, IPSS and MRP improved significantly for the patients from both two groups, indicating good surgical results were achieved. No matter what intracavity lithotripsy methods were adopted, the postoperative results showed no difference between the two groups. There were no intraoperative and postoperative cardio-cerebral vascular accident cases and deaths.

5. Conclusion

Transurethral resection of prostate combined with the intracavity cystolithotripsy for BPH with bladder stone is a safe and effective treatment. Lithotripsy time, stone-free rate, and safety of U100-plus laser are better than punch lithotripsy. In clinic, based on the stone sizes, we can choose the cost-effective lithotripsy method. For < 1.5 cm stones, the punch lithotripsy and U100-plus laser lithotripsy are both effective methods. For > 2.5 cm stones, U100-plus laser lithotripsy displays absolute advantages over the punch lithotripsy to remove lithiasis.

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