

The comparative analysis of three different mini-invasive methods for upper ureteric calculi which is bigger than 12 mm.

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Abstract

Objective: To compare the differences of clinical effect and complications of Percutaneous Nephrostolithotomy (PCNL), Ureteroscopic Pneumatic Lithotripsy (UPL) and Ureteroscopic Holmium Laser Lithotripsy (UHLL) in the treatment of upper ureteric calculi which is bigger than 12 mm.

Methods: Totally 196 patients with upper ureteric calculi which is bigger than 12 mm in our hospital were selected as research object from May 1, 2012 to April 30, 2012, and divided into PCNL group (66 cases), UPL group (65 cases) and UHLL group (65 cases) according to the operation method. The condition of operation, postoperative complications, stone expulsion rate and recurrence rate between the three groups were compared.

Results: The operation time of PCNL group was significantly less than that in UPL group and UHLL group (40.9 ± 12.5 vs. 55.1 ± 13.2 vs. 50.7 ± 10.1 , $P < 0.05$); the hospital stays were significantly longer than that in UPL group and UHLL group (4.7 ± 1.3 vs. 3.2 ± 0.6 vs. 2.8 ± 0.4 , $P < 0.05$); the decline of intraoperative hemoglobin was significantly larger than that in UPL group and UHLL group (2.9 ± 0.7 vs. 1.3 ± 0.5 vs. 1.2 ± 0.7 , $P < 0.05$); the successful lithotriptic rates of PCNL group, UPL group and UHLL group were 100.00% (66/66), 89.23% (58/65), 92.31% (60/65) respectively. The stone expulsion rate of PCNL group was significantly higher than that of UPL group and UHLL group ($P < 0.05$). There was no significant difference in total incidence of complications between three groups ($P > 0.05$).

Conclusion: Three methods for upper ureteric calculi which is bigger than 12 mm are well effective. Comparing with UPL and UHLL, PCNL has the advantage of short operation time and hospital stays, as well as better effect on lithotripsy and expulsion, which is recommended adopting in clinical.

Keywords: Mini-invasive, PCNL, UPL, UHLL, Upper ureteric, Calculi.

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Introduction

Urological calculi is one of common diseases, frequently-occurring diseases in urology, which can be divided into upper urinary tract calculi and lower urinary tract calculi. Upper ureteric calculi are a kind of particular upper urinary tract calculi [1]. Irregularly shaped calculi, a long interval of incarceration and inflammatory tissues encapsulation may occur in calculi which are bigger than 12 mm [2]. The conservative treatment of big-diameter calculi in upper urinary tract often has the difficulty to achieve excellent curative effect. The treatment of minimally invasive surgery is also relatively difficult. In the past, the treatment of open surgery had been adopted widely [3,4]. In recent years, it has inclined to laparoscopic minimal invasive treatment for complex upper urinary tract calculi over 12 mm with the development of urological minimal invasive equipment and minimal invasive surgical technique [5]. At present, the common minimally invasive surgeries in the treatment of upper urinary tract calculi clinically are as follows: PCNL (Percutaneous Nephrolithotomy), UPL (Ureteroscopic Pneumatic

Lithotripsy), and UHLL (Ureteroscopic Holmium Laser Lithotripsy).

PCNL usually under straight sight fragments the stones *via* percutaneous channel not ureter, with the advantages of further dealing with kidney stones [6]. Generally, UPL under the ureteroscope takes the advantage of lithotripter to cause the fragmentation of the upper ureteric calculi without heat injury of ureteral mucosa [7]. While UHLL adopts the holmium laser to fragments the stones, it would hardly produce oddments [8]. Clinically, the three surgical methods have different operative characteristics with well efficacy almost, and exists the differences of efficacy at certain extent [9,10].

With regard to the selection of the above surgical techniques, there are different controversies in clinical [11,12]. Therefore the research collected 196 patients with upper ureteric calculi over 12 mm who were treated by PCNL, UPL and UHLL in our hospital from May 1, 2012 to April 30, 2012. The difference of each clinical efficacy, complication and recurrence rate were compared and analysed. The valuable

information about the treatment of calculi which is bigger than 12 mm is provided. Now the report is as follows.

Materials and Methods

General information

196 patients with upper ureteric calculi over 12 mm who come to our hospital were selected as research object from May 1, 2012 to April 30, 2012, of which 124 males and 72 females. All of patients were informed consent. The ethical committee of Central Hospital in Jin Hua city Zhe Jiang Province approved this study (approval no.JH20120042). The average age is 40.5 ± 7.7 y, ranging from 22 to 58 y. 36 cases are complicated with underlying diseases of hypertension, diabetes, coronary and so on. The average largest diameter of calculi is 17.2 ± 3.6 mm, ranging from 12.0 to 24.3 mm. The average stay time of calculi within the body is 24.6 ± 4.3 w, ranging from 13 to 27 w. 196 patients are registered and numbered respectively according to the order of admission, and divided into the group of PCNL (66 cases), the group of UPC (65 cases) and the group of UHLL (65 cases) according to the operation methods. There were no significant difference of general information such as gender, age, underlying diseases and the largest diameter of calculi etc. in patients among three groups ($P > 0.05$). Inclusion criteria include as follows: the acceptance of endoscopic calculus operation for the first time with ≥ 12 mm calculi, no psychiatric disorders, malignant tumor and other severe underlying diseases, having better compliance and cooperation, and acceptance of postoperative follow-up.

Surgical techniques

All cases of three groups are treated by combined spinal-epidural and continuous epidural anesthesia. The operations are performed by the same doctor or with the assistance of the doctor's guidance. The surgeries were completed by using equipment like Germany Olympus ureteroscopic, Swiss EMS pneumatic lithotripsy system, American Lumenis holmium laser system and so on.

Patients with PCNL were placed in lithotomy position. Ureteral catheter was inserted conversely into the upper ureter after anesthetizing successfully. Change the posture to prone position after inserting catheters. Through B-ultrasonic examination, the position of stones was measured precisely. Puncture points were 11th intercostal space, lines of shoulder blades near to spine. Puncture with an 18 gauge puncture needle of kidney and place zebra urological guidewire. Fascia was expanded to F16 catheter through fascia dilators progressively. Place Germany Olympus ureteroscopic, and ensure that each channel of ureter is smooth. Lithotripsy and wash were performed directly. The stone of which the diameter is less than extraction of stone channel was ejected directly. The wide fragments of calculi were pulled out. The URL position was turned into lithotomy position. Germany Olympus ureteroscopic was placed after anesthetizing successfully. Ureteral catheter was inserted conversely. The stones were

localized under the ureteroscopy vision, place Swiss EMS pneumatic lithotripsy trigger. Lithotripsy and wash were performed. The tiny fragments of stone were ejected directly. The wide fragments of calculi were pulled out. The UHLL position and the establishment method of working aisle are similar with URL group. Germany Olympus ureteroscopic is placed after anesthetizing successfully. Lithotripsy is performed by sheathing the holmium laser fiber with the help of ureteroscopic. Clear and flush the stones. Meanwhile patients combined with polyp were dealt. The patients of the three groups received DJ catheter and three cavities urinary catheter, and were given with conventional anti-infection treatment.

Observational indicators and evaluation

Operation time, hospital stays, decline of hemoglobin and bleeding volume during the operation, the successful lithotripsy rate and complication of the patients in three groups were observed and recorded. The patients of three groups were followed up for 6 months, and by the methods of clinic, phone, home visit and so on. The occurrence of complication, stone discharge rate after lithotripsy and relapse rate of stones were recorded during the follow-up.

Statistical methods

Statistical software SPSS 19.0 was used for data analysis. The measurement data were expressed as mean \pm standard deviation ($\bar{x} \pm s$). The comparisons of three groups adopted single-factor analysis of variance, comparisons between two groups were performed by SNK-q test. The enumeration data were analysed by χ^2 test. $P < 0.05$ mean that the difference had statistical significance.

Results

Comparison of 3 groups' general data

There were no significant differences in gender, age, largest diameter of stones, residence time among groups ($P > 0.05$). The results are shown in Table 1.

Comparison of 3 groups' operation conditions

There was no connecting open surgery in three groups. The operation time of PCNL group was significantly shorter than that of UPL group and UHLL group ($P < 0.05$). The hospital stays of PCNL group was significantly longer than that of UPL group and UHLL group ($P < 0.05$). Decline of intraoperative hemoglobin of PCNL group was significantly larger than that of UPL group and UHLL group ($P < 0.05$). The successful lithotripsy rate of PCNL group was significantly higher than that of UPL group and UHLL group ($P < 0.05$). There were no significant differences of these indicators between UPL group and UHLL group ($P > 0.05$). The results are shown in Table 2.

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Comparison of 3 groups' postoperative complications

There were no deaths in 3 groups in the perioperative period. Procedure-related complications include ureteral injury, pyelic laceration, postoperative hematuria and so on. All complications were successfully controlled after proper treatment. Ureteral stricture was founded in UPL group at the 5 w after operation when DJ catheters were pulled out, but

without any major complications. The total complication rates in PCNL group, UPL group and UHLL group were 16.67% (11/65), 9.23% (6/65), and 12.76% (8/65) respectively. There were no significant differences of incidence of complication among three groups (P>0.05). The results are shown in Table 3.

Table 1. Comparison of 3 groups' general data ($\bar{x} \pm s$, n (%)).

Group		PCNL group (66)	UPL group (65)	UHLL group (65)	f/ χ^2	P
Gender (n)	Male	42 (63.64%)	39 (60.00%)	43 (66.15%)	0.54	0.77
	Female	24 (36.36%)	26 (40.00%)	22 (33.85%)		
Complicated with underlying diseases (n)		18 (28.13%)	13 (20.63%)	15 (24.59%)	0.96	0.62
Age (y)		40.9 \pm 8.4	39.2 \pm 6.6	42.0 \pm 7.4	2.30	0.10
Largest diameter of stones (mm)		16.7 \pm 4.1	18 \pm 5.4	17.4 \pm 3.2	1.48	0.23
Residence time (w)		25.9 \pm 4.7	24.5 \pm 5.0	24.2 \pm 3.7	2.67	0.07

Table 2. Comparison of operation time, hospital stays, decline of hemoglobin during the operation in 3 groups ($\bar{x} \pm s$, n (%)).

Group		PCNL group (66)	UPL group (65)	UHLL group (65)	f/ χ^2	P
Operation time (min)		40.9 \pm 12.5	55.1 \pm 13.2 ^a	50.7 \pm 10.1 ^a	24.03	0.00
Hospital stays (d)		4.7 \pm 1.3	3.2 \pm 0.6 ^a	2.8 \pm 0.4 ^a	88.80	0.00
Decline of hemoglobin (g/L)		2.9 \pm 0.7	1.3 \pm 0.5 ^a	1.2 \pm 0.7 ^a	145.59	0.00
Successful lithotripsy rate (%)		66 (100.00%)	58 (89.23%) ^a	60 (92.31%) ^a	7.03	0.03

Note: ^ameans comparing with PCNL group, P<0.05

Table 3. Comparison of 3 groups' complications (n (%)).

Group		PCNL group (66)	UPL group (65)	UHLL group (65)	χ^2	P
Ureteral injury		0 (0.00%)	1 (1.54%)	1 (1.54%)	1.65	0.44
Pyelic laceration		1 (1.52%)	0 (0.00%)	0 (0.00%)		
Postoperative hematuria		5 (7.58%)	3 (4.62%)	3 (4.62%)		
Infection		1 (1.52%)	0 (0.00%)	1 (1.54%)		
Fever		3 (4.55%)	1 (1.54%)	2 (3.08%)		
Renal colic		1 (1.52%)	0 (0.00%)	1 (1.54%)		
Ureteral stricture		0 (0.00%)	1 (1.54%)	0 (0.00%)		
Total		11 (16.67%)	6 (9.23%)	8 (12.76%)		

Comparison of 3 groups' stone discharge rate and the postoperative recurrence rate

6 months of follow-ups were performed after operation. PCNL group, UPL group, UHLL group have 1, 12, 9 cases respectively without stones expulsion clearly, the stone discharge rates were 98.48% (65/66), 81.54% (53/65), 86.15% (56/65) respectively, there were significant differences among three groups ($\chi^2=10.11$, P=0.01). There into, PCNL group was

significant higher than UPL group ($\chi^2=10.52$, P=0.00) and UHLL group ($\chi^2=7.06$, P=0.01). PCNL group, UPL group and UHLL group have 2, 4, 3 cases respectively with stone recurrence. The recurrence rates of each group were 3.03% (2/65), 6.15% (4/65), 1.56% (1/65) respectively, there were no significant differences of recurrence rate among three groups (P>0.05).

Discussion

Ureter is divided into upper, middle, and under section. There are three strictures in the whole Ureter. It is easy to be impacted to the strictures of ureter when kidney stones are excreted down through the urine, large diameter stones (more than 10 mm) are stranded easily in the upper ureter, which results in hydronephrosis, renal damage [13]. The research showed that over 80% of ureteral calculi were caused by kidney, which include kidney stones or landing fragments of stones after extracorporeal shock wave [14,15]. Upper ureteric calculi occur in young adults, which is common in patients aged 20-40 [16]. There are two main factors as follows which cause upper ureteric calculi [17,18]: (1) Crystal volume increased in the urine. In special cases, the increasing metabolism of crystals in body leads to increasing crystals in the urine. The crystals can further, form precipitation and stones at last. Besides, partial metabolic disorders can also produce stone. For example, excretion of uric acid is increased by purine metabolism disorder, which is liable to cause uric acid calculi. (2) The change of urine's physicochemical environment. The crystals tend to form the stones when the abnormal changes of urine's physicochemical environment as PH and the solute types.

The conventional treatments of upper ureteric calculi include symptomatic treatment, Chinese medicine treatment and lithotripsy. Symptomatic treatment process the methods of local injection with analgesics, hot compress or indomethacin suppository anal applying; calculi discharge with Chinese medicine is quite limited, which is applicable for patients whose stones is <1 cm in diameter, elliptical, smooth and no hydronephrosis on pyelography [19]. Endourological lithotripsy locates a stone mainly under endoscopic, the calculi is splintered by shock wave and laser to achieve the purpose of lithotripsy and lithodialysis, which have better curative effects on upper ureteric calculi as comparing with conservative treatment.

Because the position of the upper ureteric massive calculi is special, the calculi are liable to be impacted, accompanied by infection and renal damage. Mere symptomatic treatment and Chinese medicine treatment will often not alleviate the pain of patients. The conventional laparotomy has the shortcomings of large injury and increasing rate of infection after operation. In recent years, minimally invasive technology has become main stream. Now UPL, UHLL and PCNL are used for complex upper ureteric calculi clinically. The features of each surgery are as follows [20]: (1) PCNL establishes the channel of stone extraction by making an about 0.5 cm incision on the waist. The stones are splintered with the help of nephroscope vision. The effect of PCNL for the elimination of staghorn stone and upper ureteric calculi is preferable. (2) UPL is widely promoted in 1990s clinically. The principle is to take the advantage of the energy arising from compressed air to drive bullets pulse in shafts of lithotripter for fragmenting stones under ureter vision. There is no electric current generation during the operations. Endoscopic insertion is subjected to certain limitations for patients with ureteral stricture and

ureteral distortion. (3) UHLL mainly inserts the about 3 mm slender endoscope into kidney through urinary system. The stones are splintered by laser energy. UHLL has the characteristics of small injury, fewer complications, and quick recovery after operation.

Because of the limitation of vision and instrument operation, UPL and UHLL cannot smash stone thoroughly and need to underwent lithotripsy repeatedly, thus lengthen operation time. PCNL can be manipulated in each direction and fragment stone thoroughly to increase the stone discharge rate, which is similar with the result of research [4]. But in Tingfang's study [21], the operation time of UHLL was significant lower than UPL, which is not similar with the result of research. The reason was possibly that the patients in this research mostly were middle-aged, while patients in Tingfang's study were older, which led to the decline of operation tolerance and long hospital stays. Lijie et al. [22] study the endoscopic treatment for upper ureteric calculi over 15 mm. The result showed that reduction of hemoglobin in PCNL is slightly higher, but the operation time was shortened and the residual stone rate was lowered. It is believed that UPL has the difficulties in operation, while PCNL is recommended, which is similar with the result of research.

In conclusion, PCNL has the characteristics of short operation time and stone expulsion thoroughly as comparing with UPL and UHLL, which is worthy of further promotion clinically. However, because of few cases of patients and the short follow-up, the reliability of conclusion remains to be further confirming in this research. Long-term recurrence rate need more follow-up.

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