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Research Article

Clinical Analysis on the Safety and Efficacy of Ultra-perc combined with 30 cm Short FURS in the Treatment of Multiple Nephrolithiasis in Children

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Abstract: ***Objective:*** To evaluate the safety and efficacy of ultra-percutaneous nephrotic access combined with 30 cm FURS in the treatment of multiple nephrolithiasis in children. ***Methods:*** From October 2016 to March 2018, 30 children with multiple nephrolithiasis (age range 2 to 10 years old) were admitted to our hospital with ultra-perc combined with 30 cm FURS holmium laser lithotripsy The patients' operation time, hospitalization time, stone freel rate, blood loss before and after surgery, C-reactive protein, leukocyte, platelet and other stress factors, creatinine, urea nitrogen and other indicators of renal function, Renal scintigraphy was used to evaluation the injury of renal parenchymal. ***Results:*** The use of ultra-perc combined with 30 cm FURS, the first lithotomy was 93%, 2 patients were staged surgery, staging clearance rate of 100% (30/30) operation time 20 to 50 minutes, the average 35 minutes, average postoperative hospital stay 2 days, postoperative hemoglobin decreased no significant change. No transfusion in children, before and after surgery creatinine, urea nitrogen and CRP leukocytes, platelet and other grades were no significant differences, in Renal scintigraphy renal parenchymal injury was not obvious. Follow-up from 6 months to 1 year, no long-term complications in all children. ***Conclusion:*** Ultra-percutaneous nephrotic access combined with 30 cm FURS in the treatment of multiple nephrolithiasis in children is safe and effective.

Keywords: Ultra-percutaneous nephrotic, 30 cm FURS, Pediatric, Multiple kidney stones

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1 Introduction

Kidney stone in infant is a common disease in pediatric urology. Its incidence is about 0.1-5.5%[1]. Children kidney stone is often associated with congenital malformation or metabolic factors. Stones larger than 0.5cm are difficult to be discharged spontaneously and have high recurrence rate[2]. Complete removal of kidney stones in children is necessary. In particular, multiple kidney stones prone to give rise to residual stones after surgery, which increase the difficulty of operation. Establishment of multiple channels in percutaneous nephrolithotomy is required, which will be more invasive for children. Ureters of children are thinner and shorter than that of adults, and success rate of transurethral ureteroscopic lithotripsy is very low. We used ultra micro percutaneous renal channel (F7) combined with short flexible ureteroscope for treatment of multiple kidney stones in children. The method was safe, effective and highly operative, as reported as follows:

2 Materials and methods

2.1 Data of patients

From August 2016 to April 2018, 30 children with multiple kidney stones were hospitalized in our hospital. Of which, there were 17 males and 13 females; included 14 with stones on left side, 10 with stones on right side and 6 on both sides. The average age of patients was 6 years (2–10 years old), and diameter of stone was 1.2 ± 0.4cm. In this group, 6 cases received treatment due to crying of discomfort, 4 cases due to gross hematuria and 10 cases were due to urinary tract infection and fever. There were no obvious symptoms in 10 cases.

Preoperative examination included: routine blood and urine, electrolyte, renal function, coagulation, routine biochemistry, C-reactive protein and other laboratory tests. Based on the condition of each patient, urinary ultrasound, renal ureter CT imaging, rapid intravenous pyelography or renal static imaging was selected for examination. Patients with leukocytosis in urine were tested for urine culture + drug sensitivity. Sensitive antibiotics were selected to control urination urge. Operation date was selected after urine routine check restored to normal.

Inclusion criteria of patients: 1. Pediatric patients (age<12 years old); 2. Patients with multiple kidney stones; 3. With exception of congenital malformations, those who required other operations e.g. patient with kidney stone combined with ureteropelvic junction stenosis requiring laparoscopic operation, and patient with kidney stone combined with ureteral end stenosis requiring laparoscopic ureteral bladder transplantation; 4. Patients with well controlled urinary tract infection or with no significant bleeding urinary tract infection; 5. Good general condition, no serious cardiopulmonary disease and coagulation abnormalities.

2.2 Surgical procedure

General anesthesia was applied in operation. First, artificial hydronephrosis was established. Ureteral catheter was inserted into lithotomy site of the affected side under ureteroscopy vision, and it was fixed and connected with air bag catheter for pressure washing. The patient was then placed into prone position with abdomen raised by pads. Under the guidance of ultrasound, target renal calices were punctured with puncture needle. The target renal calices were punctured according to the location of kidney stones. Special guide wire was inserted along puncture needle and the puncture needle was then withdrawn. Skin was cut open with a sharp knife, and needle channel was progressively expanded with a fascial expander until F8 and working sheath was inserted. Combined type of flexible ureteroscope (30 cm short flexible ureteroscope) was placed through the working sheath. After determination of the location of kidney stones, the stones were fragmented by holmium laser lithotripsy system, or taken out using stone basket. Ureteral stent and catheter were retained after operation.

3 Results

All patients were successfully treated with the phase I channel establishment and lithotripsy. On the second day after operation, urogram of the patients were reexamined for lithotripsy condition. CT or ultrasound was used for postoperative reexamination in patients with negative stone before operation. There were 2 cases with residual kidney stones requiring second operation. Fragmentation condition was satisfactory for the remaining patients. Rate of stone removal was 28/30 (93%). Catheter and stent were removed on the third day after operation.

There were 23 cases where target middle calyx was selected, 4 cases with upper calyx selected, and 3 cases with lower calyx selected for establishment of percutaneous renal channel. All patients were not given blood transfusion. There were 3 cases of postoperative fever (38–38.7℃), dismissed after prescription of nonsteroidal antipyretics. There were 5 cases of pain, relieved after prescription of pain killer. There were no significant differences in renal function, C-reactive protein, leukocyte and platelet before and after operation. Postoperative renal static imaging showed no obvious renal parenchymal injury. The average hospital stay was 3 days. All patients were followed up for 6 months to 1 year. During the follow-up, ultrasound and routine urine examination were performed. CT imaging of kidney and ureter was performed when necessary. The average follow-up time was 9 months (6–12 months). No long-term complications occurred.

4 Discussions

Incidence of renal calculi in children is lower than that of adults, but it has been gradually increasing in recent years. Renal calculi in children are mostly related to infection, metabolic factors and congenital malformation. Therefore, children have more complex kidney stones[3]. Complex kidney stones include cast stones, multiple stones, or kidney stones with congenital malformation. Complex kidney stones often require surgical intervention[4]. According to Dsai M[5], complete removal of multiple or cast kidney stones in children is necessary in order to control recurrence effectively.

At present, minimally invasive methods for renal calculi include extracorporeal shock wave lithotripsy, percutaneous nephrolithotripsy and retrograde ureteroscope lithotripsy. Extracorporeal lithotripsy is mainly for ureteral calculi of small sizes; its effect is not satisfactory for complex kidney stones. Tan AH et al.[6] reported that complete clearance rate of multiple kidney stones using extracorporeal lithotripsy was only 20%–58%. Application of ESWL in very young children has many limitations. Repeated lithotripsy is required if stone volume is large and renal function can be affected. Exposure to X-ray may also lead to long-term effects in infants such as damage in reproductive organs, hypertension and so on[7]. Since the introduction of percutaneous nephroscopy in 1976, the technology has been very established and it has become the gold standard for treatment of complex kidney stones[8]. In 1985, Woodside first used percutaneous nephroscopy to treat kidney stone in children. However, kidneys of children are smaller than of adults and there was no device dedicated for children. Damage due to adult instrument was obvious because of the larger diameter. Finer surgical instruments are the proposition to ensure surgical safety. Bilen CY et al.[9] reported that the use of F20 channel significantly increased blood transfusion rate compared with F14, with no improvement of stone clearance rate. Meanwhile, another study[10] found that the use of adult instrument in children under 7 years old would significantly increase surgical complications. The main complication of percutaneous nephroscopy is bleeding. Because blood volume in infant is significantly lesser than that of adults, bleeding has very large effect in infants. For example, infection caused by declined immunity after hemorrhage, and slow recovery after operation. Rodrigues reported that 11–14% of children who underwent percutaneous nephroscopy would require blood transfusion, in which severe cases might lead to nephrectomy[11]. Bleeding complications usually occur during the course of channel expansion. The best way to prevent bleeding is to use fine instruments that introduce small damage[12]. The study by Mishra and colleagues[13] confirmed that the smaller the diameter of channel, the more significant the reduction in bleeding and hospital stay. Therefore, it is safer for children to undergo operation using ultra micro channel percutaneous nephroscopy. Because diameter of channel is small, damage to renal parenchyma is small. In this study, postoperative results of renal static imaging showed no obvious sign of renal damage in the children, confirmed that small channel poses certain advantages.

Ureteroscopy is a new technology developed in recent years. It allows access to kidney for lithotripsy through natural lumen of human body. However, it cannot enter renal pelvis through urinary tract in children as easily as adults because ureters of children are narrower[14]. The end of flexible ureteroscope is thin and flexible, which can enter most renal calices without causing major damage to renal parenchyma. Unlike standard ureteroscope, there is no shear force damage to renal parenchyma due to change of direction or angle during operation. Studies confirmed that ureteroscope also has a good therapeutic effect on large kidney stones[15]. This study confirmed that combination of ultra micro percutaneous renal channel with flexible ureteroscopy which combined the advantages of low damage of ultra micro channel with flexible lithotripsy of flexible ureteroscope, improved the efficiency of lithotripsy and reduced damage to renal parenchyma.

At present, there are three types of combined flexible ureteroscopes being used in clinical setting, the length of which are 70cm, 42cm and 30cm respectively. The 70cm and 42cm are generally used for adult operation. The 30cm short flexible ureteroscope (fiber length 1500mm) with 30cm or 40cm matching catheter working length is used for examination and localized treatment in adult urethra, bladder and kidney; and for examination and localized treatment of urinary system in children. Percutaneous nephrolithotomy was used due to several advantages: short length, good support, more comfortable controllability and shorter operation time than other flexible ureteroscopes. Infection is a common complication in upper urinary system calculi operation, which is related to pressure of washing fluid during operation. Due to the fact that flexible ureteroscope is thinner, washing speed and pressure are lower, gap between scope body and sheath is wider, drainage is unobstructed, and it is thus safer. In this study, incidences of fever and pain were low, and they were mild and can be relieved by drug intervention. Changes in renal function, C-reactive protein, leukocyte and platelet before and after operation were not significant. Therefore, it poses milder effect on body and has higher safety profile.

Veeratterapill et. al.[16] reported that amount of bleeding increased significantly with increase of channel thickness, with no improvement in stone clearance rate. For children with multiple stones especially scattered stones, surgery using standard ureteroscope poses a certain axial force and kidney position will shift with scope body, because children have less perirenal fat and greater kidney activities. This increases the difficulty of surgery, rendering necessity of establishment of double channels or multi-channels. Renal parenchymal damage is also aggravated. Flexible ureteroscope is slender and its flexible tip poses a mild effect on renal parenchyma, reducing the phenomenon of shifting of kidney position during operation. In addition, it can achieve multi-site lithotripsy via single-channel, which is more in line with the characteristics of minimally invasive. Bleeding is reduced. In this study, there was no blood transfusion required in the children after surgery.

In summary, ultra micro channel percutaneous short flexible ureteroscopy is safe for treatment of children with multiple kidney stones and the surgical efficacy is satisfactory. The sequence of kidney stone surgical treatment is as follows: to first treat kidney stones at middle calyx to ensure a good surgical vision and subsequently to treat kidney stones at upper calyx. Lower calyx is to be treated the last, as stone fragments will accumulate at lower calyx due to the special anatomical structure of lower calyx[17]. Fragmented kidney stones at lower calyx are not easily excreted, so stones that are not completely fragmented need to be cleaned up using kidney stone basket to avoid affected efficiency and recurrence.

The limitations of this study include, only the efficacy of surgical operation was investigated and treatment of metabolic factors were not evaluated. The number of samples is small. Patients with congenital malformation requiring endoscopic surgery combination were excluded before operation. Follow-up time was short. Sample size needs to be increased, and the study should involve multi-disciplinary study and specific indicators.

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