Universe Scientific Publishing

ORIGINAL ARTICLE

Clinical analysis of ureteroscopic holmium laser lithotripsy for the treatment of nephrolithiasis

Xue Yansi, Xu Lei, Xu Xiaojun, Wang Dukun, Wang Guocheng, Chen Yi*

Jiangsu Taixing People's Hospital, Taixing, Jiangsu Province, China

Abstract: The objective of the study is to evaluate the clinical value of ureteroscopic holmium laser lithotripsy for the treatment of nephrolithiasis. Clinical data of 44 patients treated for renal stones with polyscope modular flexible ureteroscopic holmium laser lithotripsy from May 2014 to April 2015 were retrospectively analysed. Following the operation, F4.7 D-J stents were routinely indwelled for 4 weeks and catheterization for 1–3 days. A plain kidney, ureter, and bladder (KUB) X-ray was performed on postoperative days two. A total of four success cases were determined following the first treatment. The remaining 40 cases were first placed with double-J stent and the surgery was performed one week later. A stone size between 0.8–4.0 cm in diameter was defined, the operation time for the treatment was 80–180 minutes, patients were discharged within 3-5 days, and the double-J stent was removed within 1–3 months. Thirty-nine patients were found to be completely stone-free at approximately three months postoperatively. However, five patients were shown to have 11.1% of residual stones after treatment. No blood transfusion, septic shock, ureteral injury, and other complications were reported. Flexible ureteroscopic holmium laser lithotripsy is safe and effective for the treatment of nephrolithiasis. This approach could be a valuable choice for the treatment of patients with renal stones.

Keywords: Ureteroscopic holmium laser lithotripsy; Renal stone

Introduction

Urinary stones are one of the most common urological diseases. In recent years, despite with the adjustment of diet, the incidence of urinary tract stones has risen considerably[1]. Nevertheless, the treatment of renal stones using the "conventional" techniques, such as extracorporeal shock-wave lithotripsy (ESWL), ureteroscopic, percutaneous nephrolithotomy (PCNL), and open surgery in the past have had a profound impact with the ability to cause severe bleeding which could lead to death. With the continued advancements of technology, ureteroscopic holmium laser lithotripsy has evolved as the most minimally invasive approach for the treatment of urinary and renal stones[2,3]. In May 2014 to April 2015, the flexible ureteroscope was applied by our hospital to treat a total of 44 patients with renal stones. Herein, the analyses were reported.

Copyright © 2016 Xue YS, et al.
doi: 10.18686/aem.v5i2.74
This is an Open Access article distributed under the terms of the Creative Commons Attribution-Non Commercial 4.0 International License (http://creativecommons.org/ licenses/by-nc/4.0/), permitting all non-commercial use, distribution, and reproduction in any medium, provided the original work is properly cited.

Materials and Methods

General Information

A group of 44 nephrolithiasis patients presenting with lower back pain, gross hematuria, and physical examination associated with ureteral stones were admitted after ultrasound, X-ray, and computed tomography (CT) scan. The patient cohort presented with 31 males and 13 females, aged from 28–76 years with a mean age of 45 years, respectively (With upper urinary tract calculi in 7 patients, bilateral stones in 3, staghorn calculi, solitary kidney, and horseshoe kidney in 1, respectively). Twenty-one patients presented with the stones sized > 2 cm in diameter and 23 patients with the stone sized < 2 cm. Medical history of patients have revealed failure of ESWL therapy in 9, hypertension in 5, 2 patients with diabetes, and 3 patients with open surgery. All patients underwent preoperative urine culture sensitivity test.

Instruments

The instruments used included F8/9.8 Wolf® semi-rigid ureteroscope, super-smooth guidewire, COOK® ureteral access sheath (F12/14), polyscope modular flexible ureteroscope, ureteral double-J stent, Lumenis® 60W holmium laser, and 200 um fiber laser.

Surgical procedures

Surgical procedure was performed with the patient under general anaesthesia and endotracheal intubation. Firstly, the dorsal lithotomy position was determined. Then, the super-smooth guidewire was smoothly positioned and inserted in the ureter up to the kidney. Ureteric dilatation was performed by the use of two semi-rigid ureteroscopes. The impaction of the stones to the ureteral mucosa was confirmed once entering the renal pelvis. The guidewire was gently inserted in an attempt to provide passage to the distal side of the stone, and the fragmented stones were crushed into powder. In patients whom the guidewire could not be passed beyond the stones before the procedure, F12/14 ureteral access sheath was used for allowing a larger fragment extraction and better irrigation flow. Ureteral double-J stent was applied if the ureteral access sheath could not be placed in patients with a tight ureter or ureteral stricture during the passage. The polyscope modular flexible ureteroscope was introduced into the renal pelvis. Once the particular calyx was identified and the calculus was found, holmium laser lithotripsy was then inserted. 200 µm core size fiber with the energy level settings of 1J/10–15Hz (10–15W) was applied. After complete fragmentation, the process was stopped when a very small stone fragments were obtained. A F4.7 double-J ureteral stent was routinely left in all patients after the surgery, and the stent was removed 4–8 weeks postoperatively. Nevertheless, the charterer was removed after 1–3 days. The patient's stones specimens were collected for evaluation. Patients with urine infection were adequately treated with appropriate antibiotics.

Clinical Assessment

All patients were followed up 1–2 weeks after surgery and residual stone fragments were assessed after stent removal. Treatment was considered successful when stone-free status was defined (no residual fragments observed or the presence of clinically insignificant residual fragments ≤ 4 mm) and asymptomatic [4].

Results

Of all the four successful cases after the first treatment (without the placement of ureteral double-J stent), two patients were successfully placed with ureteral sheath while the other two had ureteroscopic inserted but access sheath could not be passed over guidewire into the ureter. Apart from that, the entire 40 success cases were observed with the double-J tube placement following by flexible ureteroscopic holmium laser lithotripsy for renal stones after 1 week. The

stone size was ranged from 0.8–4.0cm. Operation time was approximately 80 to 180 minutes. The patients were discharged 3 to 5 days after surgery and double-J stents were removed 1 to 3 months postoperatively. Stone-free status was observed 3 months later. Of all the 44 cases, 39 patients had stone-free and five had residual stones. One of the patients who underwent a second surgery showed no kidney stone residual left. One had abnormal renal pelvis and ureter. Among all renal stones location, eighth in the kidney, 16 in upper calyx, and 13 in the lower calyx. One patient underwent a laparoscopic surgery. There were no blood transfusions, complications of septic shock, and ureteral injuries were examined from all the patients underwent the second treatment.

Discussion

In recent years, flexible ureteroscopy has been the most widely used approach for the treatment of renal stones due to a limitation of the rigid ureteroscopy used for the urinary tract calculi treatment. The combination of polyscope modular flexible ureteroscope with holmium laser was used in this present study. This flexible ureteroscopes has the same upwards and downwards deflection of 180° in order to improve the ability to navigate the entire pelvicaliceal system. With the rapid advances in technology, miniaturization of flexible ureteroscopes and corresponding working devices enabled active 2-way deflection with secondary passive deflection at the shaft, thus increasing endoscope manoeuvrability and clinical applicability for treating renal stones effectively.

Patient Selection

Preoperative evaluation: Based on the imaging data obtained, a full assessment of the size and location of stones, ureter and renal pelvis condition were evaluated. The visualisations of the ureteroscope in the pelvicalyceal system for the stone formation were also accessed to determine the impact of the renal pelvis and lower calyx ureter[4]. Studies have shown that the angle between the pelvis and the lower calyx was < 90°. The height of lower calyx is > 3 cm and diameter is < 4 mm. Stones residual were difficult to remove when the lower calyx is distorted. The bend angle decreases when the holmium laser fiber was inserted, thus, a flexible ureteroscope treatment of lower calyx stones should be listed as one of the challenges in the treatment. Some thought that flexible ureteroscope might replace percutaneous nephrolithotomy treatment in the future. In my opinion, the flexible ureteroscope may not be applicable for all the treatment of renal stones. The problems should be take into account following the treatment: 1. select ureteral and renal pelvic stones first, followed by the calyx or diverticulum stones, followed by the final choice of multiple and complex stones; 2, the number of stones, patient with single stones should be selected first; 3, stone location, choose the upper and mid calyx; 4, stone size, first select patients stones with the diameter of about 2.0 cm; 5, hydronephrosis, first select patients with mild or no hydrocephalus.

Preoperative selection between indwelling double-J stents and sheath

Presently, double-J stents were advocates to be placed in ureter for 1–2 weeks preoperatively. If ureter conditions are good, ureteric dilatation was performed using ureteroscopes. In contrast, in cases of ureteral stenosis or distortion, double-J stent was placed, followed by stage two treatment. Doctors should make the decision according to their own specific situations (equipment, technical proficiency, *etc.*). When carrying out the flexible ureteroscope, blind expansion of the stents should be avoided as this may cause ureteral injury. If ureteroscopic insertion is difficult, ureteral stenosis needs to be determined prior to the treatment. Ureteral double-J stent could be placed in case of mild stenosis. However, more suitable treatment need to be considered if failure for the expansion of the severe stenosis. The placement of ureteric sheath was to ensure the flushing rate, flushing fluid directly out of the body to maintain clear vision, reduced renal pelvic pressure, reduces ureteroscope rotational resistance, and reduced mucosal damage.

Laser lithotripsy technique

The power of the laser could be adjusted according to the size of stone. Although harder stones could be fragmented with the increase of energy dispersion, the stones were easily splashed. Therefore, reducing the laser energy could reduce the axial impact. For < 3 cm stone, < 30 W low-power with high-frequency were commonly used for the fragmentation of the distal side of the stone[4]. Powder was formed while fragmented slowly on the surface of the gravel. This process might affect the operation therefore, water pressure was increased for adequate drainage. Blind pursue the "powder" for the fragmentation of larger stones should be avoided as this could prolong the operation time and increased the chances of postoperative infection. The power of the laser could be increased for the larger stones and "drilling method" can be used to fragment the stones into smaller pieces. The smaller fragments may by crushed one by one and the residual stones should be removed thoroughly.

Flexible ureteroscope with other devices

Combined approach of flexible ureteroscope laser lithotripsy with laparoscopic pyelolithotomy and percutaneous nephrolithotomy could improve the surgical success rate and reduce the residual stones. The placement of flexible ureteroscope into the ureter and renal pelvis have proved to be minimally invasive, safe, and highly effective for the treatment of ureter and renal stones. As compared to flexible ureteroscope, the other available treatment techniques, such as ESWL and PCNL, were difficult to perform and have poor therapeutic effects[5]. The management of nephrolithiasis in patients with the characteristics of gravel, multiple renal calculi, bleeding tendency, obesity, anomalous kidneys (horseshoe kidney, ectopic kidney, and kidney transplant), pregnant women, and other special patients imparts a special challenge to the treating urologist. Application of holmium lithotripter technology was less efficient for the renal stones treatment due to the relatively small and low power, thus, prolonging the operation time. The flexibility of the ureteroscope is still not fully reaching the clinical needs. Hence, the surgeon should move gently during the surgery. Nevertheless, the replacement of a ureteric access sheath by fluoroscopy with visual and tactile cues avoided ureteral bleeding or perforation.

In short, development of the flexible ureteroscopic technology has emerged as a new therapeutic tool to deal with the urinary tract calculi. Concurrently, successful introduction of the holmium laser as a flexible intracorporeal lithotripter with a high safety margin lead to an increased interest in the treatment of nephrolithiasis in the near future.

Reference

1. Guo WS, Yang B, Guan YZ, Yang DB, Wang ZZ, *et al*. Application of flexible ureteroscope in diagnosis and treatment of upper urinary tract disease. Chin J Endoscopy 2011; 17(4): 417–419.
2. Gui L. Clinical application of flexible ureteroscope data analysis in 1000 cases. J Min Invasive Urol 2013; 2(2): 81–83.
3. Na YQ, Ye ZQ, Sun YH. 2014 version of the Chinese guidelines for diagnosis and treatment of urologic diseases. Beijing: People's Medical Publishing House; 2014. p. 141–142.
4. Dasgupta P, Cynk MS, Bultitude MF, Tiptaft RC, Glass JM. Flexible ureteroscopy: Prospective analysis of the Guy's experience. Ann R Coll Surg Engl 2004; 86(5): 367–370. doi: 10.1308/147870804768.
5. Aminsharifi A, Hadian P, Boveiri K. Laparoscopic anatrophic nephrolithotomy for management of complete staghorn renal stone: Clinical efficacy and intermediate-term functional outcome. J Endourol 2013; 27(5): 573–578. doi: 10.1089/end.2012.0591.