

Original Article

Reflections on ureteral rupture caused by extracorporeal shockwave lithotripsy of ureteral calculi: one case report

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Abstract: Urinary calculi is a common type of urinary disease in southern China. Extracorporeal shockwave lithotripsy (ESWL) is still being widely performed at county-level hospitals in China. Ureteral rupture caused by ESWL is very rare. Here we report one case of ureteral rupture caused by ESWL from May 2014 to December 2015. One 25-year-old male patient suffered from Ureteral rupture caused by ESWL has fully recovered after remove the ureteral calculi and indwelling right renal pelvis two double-J catheters for long term, through approximately 1.5 years of the three surgical treatment. In summary, ESWL is a safe, effective, inexpensive treatment for upper urinary calculi in most cases. But once serious complications such as rupture of the ureter occurs, treatment must be very patient, indwelling right renal pelvis and two double-J catheters for long term is the only treatment plan.

Keywords: Ureteral calculus, extracorporeal shockwave lithotripsy, postoperative complications, ureteral rupture

Introduction

Urinary calculi are a common type of urinary disease in southern China. Clinically, primary urinary calculi are rare. Urinary calculi are generally formed when the discharge of kidney calculi is obstructed in a narrow segment of the ureter [1-3]. The peak age of onset for urinary calculi is between 20 and 50 years. The high-risk group for urinary calculi is composed of young and middle-aged adults. Urinary calculi are 2-3 times more likely to occur in men than in women. So far, the use of combined treatments, such as percutaneous nephroscopy or ureteroscopic lithotripsy, has been gradually popularized in the treatment of complicated urinary calculi. However, extracorporeal shockwave lithotripsy (ESWL) is still being widely performed at county-level hospitals in China. The advantage of ESWL is that it does not require incisions for most patients with urinary calculi [4-6]. However, ESWL can lead to serious complications if performed improperly [7-9].

Between May 2014 and January 2016, one patient with ureteral rupture caused by extracorporeal shockwave lithotripsy (ESWL) that

had been performed to treat his urinary calculus was admitted to Renmin Hospital of Wuhan University. This patient had undergone ESWL twice within a short period of time at a county-level hospital. This patient was transferred to department of urology at Renmin Hospital of Wuhan University, after he had suffered from postoperative ureteral rupture. The analysis of this patient is reported as follows.

The patient was a 25-year-old male. After having suffered from recurrent swelling and pain in the right lumbar region for three months and experiencing worsening symptoms for one week, the patient sought medical attention in the department of urology at a local hospital (Renmin Hospital of Chibi County, Xianning, Hubei Province) on May 25, 2014. The patient was subjected to urinary computed tomography (CT) examination at the hospital. The result showed that there was a right upper ureteral calculus with a size of approximately 1.2*0.6 cm. The patient then underwent ESWL twice (May 5, 2014 and May 12, 2014) in the department of urology at the same hospital. The results of lithotripsy and calculus expulsion were unsatisfactory. The patient was hospital-



Figure 1. CTU images of the patient at the time of first admission showed that the calculus (approximately 1.0*0.6 cm in size) was located in the upper segment of the right ureter where ureteral rupture occurred and perirenal effusion was formed (in an area of approximately 11*7 cm).

ized for one week after ESWL, during which time he received anti-inflammatory and hemostatic treatments for his symptoms. On May 24, 2014, approximately 10 days after being discharged from the hospital, the patient started to experience swelling and pain in the right lumbar region accompanied by a high fever (up to 39°C). The patient was immediately transferred to Renmin Hospital of Wuhan University for emergency treatment. The patient had been healthy previously. An examination of the patient showed that he had a body temperature of 39.0°C, a pulse of 90 beats/min, and a blood pressure of 110/70 mmHg. The patient was visibly in pain and in an active position. A cardiopulmonary examination showed no significant abnormalities. The patient had a flat and soft abdomen, and no intestinal slow waves or peristaltic waves were observed. Negative shifting dullness was confirmed in an abdominal examination. There was no palpable liver or spleen in the subcostal region. An examination of percussion pain in the right costovertebral angle showed a positive result. An examination of tenderness in the right pelvic-ureteric junction also showed a positive

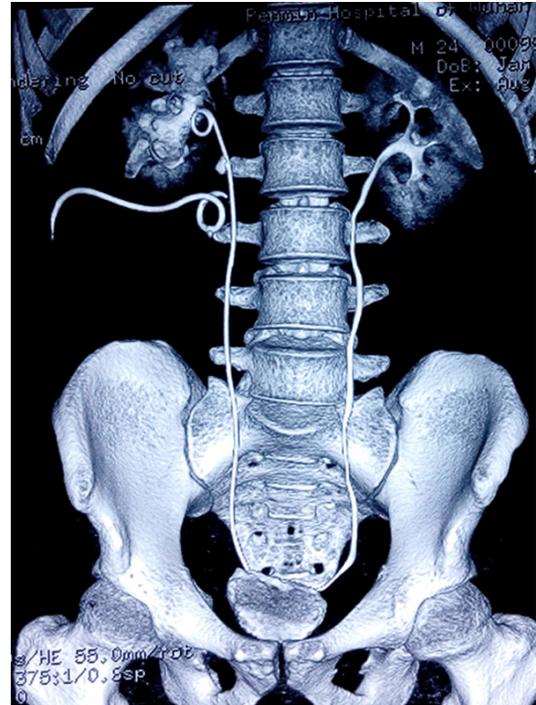


Figure 2. After the first operation, which involved right ureter stent placement and right perirenal nephrostomy, it could be observed that both catheters were successfully placed, and a calculus (approximately 1.0*0.6 cm in size) was located in the upper segment of the right ureter at approximately the second lumbar transverse process.

result. The spiral three dimensional CT reconstruction in urological system (CTU) examination performed in the department of urology at Renmin Hospital of Wuhan University confirmed the presence of a calculus with a size of approximately 1.0*0.6 cm in the upper right ureter and edema in the right perirenal space (**Figure 1**), which was mainly located in the lower pole of the right kidney in an area of approximately 11*7 cm. The results of routine blood tests showed the following: a leukocyte concentration of $18.5 \times 10^9/L$ and a neutrophil percentage of 89%. The results of a routine urinalysis showed the following: a urine leukocyte concentration of 829/ μl and a red blood cell concentration of 75/ μl . After having received symptomatic treatments, such as anti-inflammatory treatments, for approximately two weeks, the patient underwent right perirenal nephrostomy and right ureteral stent placement under general anesthesia on June 11, 2014. One F6 double-J catheter was indwelt in the ureter, and one catheter was indwelt in the right perirenal space during the operation (**Figure 2**). The

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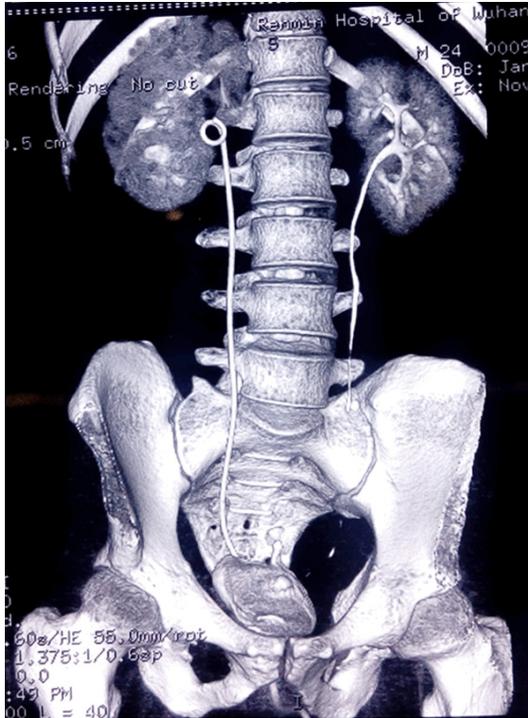


Figure 3. CTU images of the patient obtained after the second operation showed that the calculus had been removed and that the F6 double-J catheters were successfully placed.

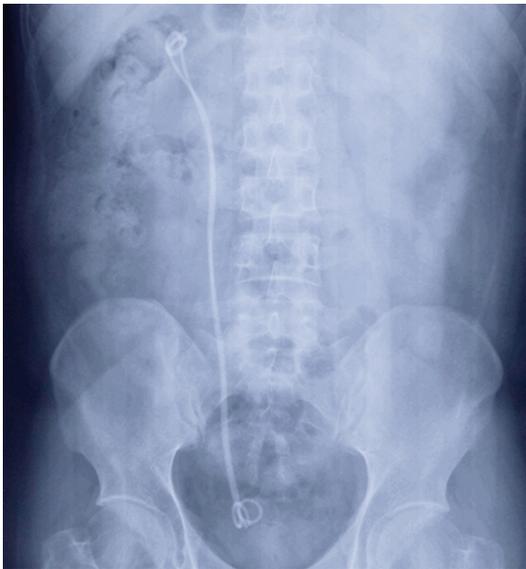


Figure 4. Two F6 double-J catheters were placed, and one catheter was indwelt in the right renal pelvis during the third operation. No catheter in the right renal pelvis could be observed in this photograph, as it had already been removed.

patient was discharged from the hospital after receiving routine postoperative anti-inflam-

matory and hemostatic treatments for one week. Afterwards, approximately 1,000-1,500 ml of urine was drained by the catheter in the right perirenal space, and approximately 1,000-1,500 ml of urine was urinated through urethra every day. The patient was readmitted to the department of urology at Renmin Hospital of Wuhan University two months after the first discharge. This time, the patient underwent open ureterolithotomy. The following was observed during the operation: severe tissue adhesions were present near the lower pole of the right kidney and the upper segment of the right ureter. There was an approximately 1 cm-long ulcer with obvious inflammatory edema on the right ureter. In addition, the ulcer was covered by purulent secretions. A calculus with a size of approximately 1.0*0.6 cm was located near the ulcer. The calculus was removed as a whole. However, the area of the ureter where the ulcer was located could not be sutured because of the occurrence of edema and suppuration. Therefore, one F6 double-J catheter was indwelt in the ureter, and one drainage catheter was indwelt in the right perirenal space. The original catheter in the right perirenal space was removed, after which the incision was sutured, and the operation was completed. One week after the operation, the drainage catheter in the right perirenal space was removed, and the patient was subjected to CTU examination once again (Figure 3). Afterwards, the patient received anti-inflammatory and hemostatic treatments for his symptoms. The patient was discharged from the hospital approximately two weeks after the operation. However, approximately one month after being discharged, the patient started to experience urine leakage from the original wound in the right lumbar region accompanied by a high fever (up to 38.8°C). Therefore, the patient again sought medical attention at the department of urology at Renmin Hospital of Wuhan University. An examination showed that the wound in the right lumbar region was infected. The results of routine blood tests showed the following: a leukocyte concentration of $11.5 \times 10^9/\mu\text{l}$ and a neutrophil percentage of 87%. The results of a routine urinalysis showed the following: a urine leukocyte concentration of 35,340/ μl and a red blood cell concentration of 812/ μl . The patient underwent debridement and suturing again, and a catheter was again indwelt in the right renal pelvis. In addition, the original double-J catheter was removed. It was observed

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that the top end of the double-J catheter was covered by purulent secretions, which blocked the inlet of the double-J catheter. Two new F6 double-J catheters were indwelt in the ureter. The patient was discharged approximately one week after his condition improved.

Afterwards, the patient never again experienced symptoms such as fever, swelling or pain in the right lumbar region or urine leakage from the wound in the right lumbar region. In addition, the two double-J catheters were replaced once every three months, and the catheter in the right renal pelvis was replaced once every month. Approximately one year after the last discharge, the patient visited the department of urology at Renmin Hospital of Wuhan University again on October 5, 2015 to have the catheter in the right renal pelvis removed **Figure 4**. Imaging tests showed no urine leakage in the right ureter. In addition, the patient also did not have symptoms such as discomfort in the right lumbar region or fevers. Three months later, on January 13, 2016, the two double-J catheters on the right side were removed as well. The patient has now fully recovered (after approximately 1.5 years of treatment).

Discussion

Mechanism of ureteral rupture caused by ESWL

Urinary calculi are the most common disease treated by urological surgery. ESWL is easily accepted by most patients because it is safe, effective, minimally invasive, and inexpensive. ESWL has become the first choice of treatment for urinary calculi at county-level medical institutions in China. The composition and structure of a calculus are important factors that affect the lithotripsy effectiveness of ESWL. Some calculi can be easily crushed, whereas others are very difficult to crush. Magnesium ammonium phosphate calculi can be crushed most easily, followed by calcium oxalate dihydrate calculi, uric acid calculi, apatite calculi, calcium oxalate monohydrate calculi and cystine calculi.

Ureteral rupture caused by ESWL is very rare, as evidenced by the limited number of reports on cases of ureteral rupture caused by ESWL published worldwide. A possible mechanism by

which ESWL causes ureteral rupture is as follows: (1) A ureteral calculus hard and thus difficult to crush. When a ureteral calculus is repeatedly crushed, the calculus will remain in a narrow segment of the ureter for a long period of time. As a result, mucosal edema occurs in some area of the ureter, which then becomes brittle. The ureteral calculus directly damages the intima of ureter. (2) After damaging the ureter, the ureteral calculus moves downward to the narrow segment of the bottom end of the ureter and becomes incarcerated. After the calculus completely obstructs the ureter, dilation of the renal pelvis and the upper segment of the ureter occurs, and hydronephrosis is formed. The ureteral pressure increases after ESWL. As a result, a tiny wound appears in the area in the upper segment of the ureter where damage has occurred. Some Chinese researchers have reported that ureteral rupture that occurs after ESWL is in fact spontaneous ureteral rupture and not significantly correlated with ESWL of ureteral calculi [8].

Clinical characteristics of ureteral rupture caused by ESWL

After ESWL, ureteral rupture is mainly manifested by lumbar-abdominal pain on the affected side that becomes aggravated after a brief remission as well as by signs of peritoneal irritation, which can be accompanied by nausea and vomiting. In addition, a small number of patients may experience hematuria and pyuria and show signs of bladder irritation, but patients will generally not show signs of hemorrhagic shock. When ureteral rupture occurs after ESWL, if the ureteral rupture is relatively small, then the ureteral rupture is often spontaneously intermittently closed, thereby relieving the symptoms caused by urine extravasation. Consequently, diagnosis and treatment may be delayed.

The patient in the present study had a calcium oxalate calculus in the upper segment of the ureter, which is very difficult to crush externally. After undergoing new ESWL twice within a short period of time, the patient started to feel pain in the right lumbar region accompanied by fever. Through examination, the patient was diagnosed with a calculus in the upper segment of the ureter and rupture of the upper segment of the ureter. The patient recovered after multiple operations. Due to timely diagno-

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sis and treatment, the patient in the present study did not face life-threatening risks. It has been reported that three patients died from multiple organ infections and sepsis due to delays in treatment of retroperitoneal infections caused by ureteral rupture-induced urine leakage after ESWL. These dreadful cases should serve as a grave warning [9].

Preventative measures for ureteral rupture caused by ESWL

Through the analysis of the diagnosis and treatment process of the patient in the present study, we believe that the following measures may help reduce the occurrence of ureteral rupture after ESWL: (1) Physicians should strictly master the indications of the use of ESWL to treat ureteral calculi and avoid exaggerating the treatment effect to gain economic interests as well as to avoid recklessly and blindly performing lithotripsy. (2) Physicians should uphold the ESWL treatment principles and adequately perform relevant examinations and preparations prior to ESWL. (3) Physicians should make thorough enquiries about the medical history of the patient before ESWL and routinely perform urinary tract ultrasound examinations, intravenous urography, renal function tests, routine blood tests and routine urinalysis, as well as urinary CT examination or CTU examination, if necessary, to make a definite diagnosis. (4) Physicians should provide routine psychological care to the patient to alleviate the anxiety of the patient. (5) Physicians should use analgesic and sedative medications during the lithotripsy process. (6) Physicians should strictly control the lithotripsy voltage and the number of single shocks [10]. (7) Physicians should closely observe changes in the patient's condition after ESWL. (8) Lastly, patients with complicated conditions that are difficult to be diagnosed and treated at county-level hospitals should be transferred to higher-level hospitals in a timely fashion to prevent delays in treatment.

Reflections on how to treat ureteral rupture caused by ESWL

(1) If the patient can be treated within 48 h after the occurrence of ureteral rupture (no clear adhesions are formed between the ureteral rupture and the surrounding tissues during this time), then open ureterolithotomy can

be directly performed to remove the calculi, and the rupture can be sutured. In addition, double-J catheters should be indwelt during the operation. (2) If the patient is not treated within 48 h after the occurrence of ureteral rupture, such as the patient in the present study, then clear adhesions between the ureteral rupture and the surrounding tissues will be formed, and suppuration and edema will occur at the rupture site. In this case, open ureterolithotomy can still be an option used to remove the calculi. However, it is possible that the ureteral rupture will not be able to be sutured because of the occurrence of suppuration and edema, and only double-J catheters can be indwelt. Another option is to indwell a catheter in the kidney as well as double-J catheters in the ureter; after the ureteral rupture heals, ureteroscopic holmium laser lithotripsy can be performed to remove the calculi. However, the time needed for the rupture to heal is uncertain. The remaining calculi may also affect the rupture healing time. The first treatment method was used for the patient in the present study. (3) The indwelling of a catheter in the renal pelvis is superior to the indwelling of a catheter in the perirenal space. In addition, the indwelling of two double-J catheters is superior to the indwelling of one double-J catheter. For the patient in the present study, a catheter was initially indwelt in the perirenal space, and only one double-J catheter was indwelt in the ureter. This treatment method led to a serious consequence: a recurrence of urine leakage in the patient. As a result, the ureteral rupture of the patient could not easily heal. The cause for the recurrence of urine leakage is as follows: purulent secretions that formed after the occurrence of suppuration at the ureteral rupture site could easily block the catheter in the perirenal space and the one double-J catheter. During the third operation, we made a change by indwelling one catheter in the renal pelvis and two double-J catheters in the ureter. In addition, we also advised the patient to drink plenty of water, have the aforementioned three catheters replaced periodically, and undergo routine urinalysis periodically. Afterwards, the catheters were never blocked again. Our analysis suggests that the accelerated healing of the rupture might be because the catheter in the renal pelvis diverged the patient's urine above the ureteral rupture and thus reduced the pressure at the ureteral rupture site. In

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addition, the possibility of the occurrence of blockages in two double-J catheters by purulent secretions was significantly lower than that in one double-J catheter. These two factors together promoted the healing of the rupture.

In short, clinicians should perform ESWL to treat urinary calculi with the treatment principles of improving the effectiveness of ESWL, protecting renal functions, and reducing complications and the recurrence rate. A lithotripsy machine with excellent performance should be used, and adequate preparations should be made before ESWL. In addition, the indications for the use of ESWL to treat urinary calculi should be strictly mastered. ESWL should be performed by highly qualified medical professionals to reduce ESWL complications. Patients should seek medical attention within 48 h after the occurrence of ureteral rupture. If necessary, an emergency operation should be performed to remove the calculi and suture the ulcer to avoid delays in treatment, which can result in serious consequences.

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Disclosure of conflict of interest

None.

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