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Original Article

Combined laparoscopic ureterolithotomy and flexible ureteroscopy for removing large upper ureteral stones with ipsilateral concurrent renal stones in selected patients

Liwei Xu, Zhenghui Wang, Youyun Zhang, Chi Zhang, Shicheng Yu

Department of Urology, Sir Run Run Shaw Hospital, School of Medicine, Zhejiang University, Hangzhou, China

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Abstract: Objectives: The objective of this study is to report our experience of combined laparoscopic ureterolithotomy (LU) and flexible ureteroscopy for removing large upper ureteral stones with ipsilateral concurrent renal stones in selected patients and evaluated its advantages and potential. Methods: This retrospective study included 31 patients who underwent combined LU and flexible ureteroscopy for removing large upper ureteral stones and ipsilateral concurrent renal stones in our department from January 2014 to April 2017. For each patient, detailed medical history, demographics, and stone characteristics were collected. Procedure-related parameters, including stone-free rate, operation time, hospital stay after surgery, duration of drainage, mean estimated blood loss, visual analog scale (VAS) score, and complication rate, were evaluated. Results: The mean size of ureteral stones was 20.13±4.01 mm. The mean number of stones removed per patient was 4 (range: 2-7). All the procedures were completed laparoscopically with no open conversions. The total SFR was 90.3%, and the SFR of ureteral stones was 100%. The operation time was 110.4±26.5 minutes. Median hospital stay after surgery was 4 (range: 3-6) days, and the median duration of drainage was 4 (range: 3-5) days. The mean estimated blood loss was 16.5±9.1 mL. The mean VAS scores obtained at 24 and 48 hours after surgery were 2.53±0.91 and 1.08±0.45, respectively. No intraoperative complications were noted. The complication rate was 29.0%. Prolonged urine leakage was not detected. No ureteral strictures were detected in patients at follow-up visits 12 months after surgery. Conclusion: As a safe and minimally-invasive procedure, combined LU and flexible ureteroscopy is suitable for removing large upper ureteral stones along with ipsilateral concurrent renal stones. It provided high SFRs and low complication rates in these patients.

Keywords: Laparoscopic ureterolithotomy, flexible ureteroscopy, ureteral stone, renal stone

Introduction

Management of ureteral calculi has changed in recent decades, but the treatment objective of clearance with minimal invasion has remained the same. Extracorporeal shockwave lithotripsy (SWL) and ureteroscopic lithotripsy (URS) are common treatments for ureteral calculi. However, treatment of large upper ureteral stones is still a controversial and challenging aspect of endourology today. Large ureteral stones respond less well to SWL and URS, exemplified by their low stone-free rates of 35.7% and 62.5% respectively when removing large upper ureteral stones [1]. Laparoscopic ureterolithotomy (LU) is therefore recommended as the first-line treatment for patients with large stones (diameter > 15 mm) in the upper ureter or for patients who wish to remove their stones in a single procedure [2, 3]. The stone-free rate (SFR) of LU in most reported cases is almost 100%, with a low conversion rate to open procedure [3, 4].

Although LU has unique advantages for patients with large upper ureteral stones, it also has some drawbacks. The presence of multiple renal stones presents a very difficult situation, and the appearance of stone migration often means failure of LU. Multiple stones have been

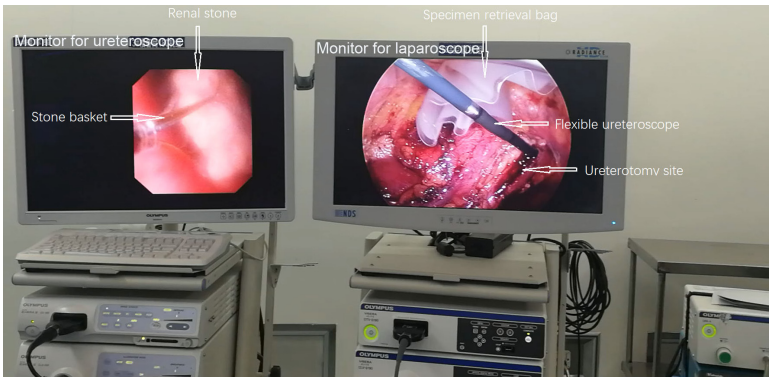

Figure 1. A flexible ureteroscope was inserted into the ureter under the guidance of a laparoscope and renal stones were removed using a nitinol stone basket.

Figure 2. Stones removed from the renal pelvis or calyces.

detected in 20-25% of patients with urolithiasis. Moreover, 25% of patients with ureteral stones have synchronous kidney stones [5]. Percutaneous nephrolithotomy (PNL) may be considered for patients with multiple stones. However, PNL is a procedure with an inherently high risk of surgical complications and is not acceptable for some patients and surgeons. A flexible ureteroscope can bend with multiple degrees of freedom and reach different renal calyces. Combining flexible ureteroscopy with LU may help in overcoming disadvantages of LU alone, and this combination was studied for its advantages and potential in selected patients with large upper ureteral stones and ipsilateral concurrent renal stones.

Materials and methods

This retrospective study included 31 patients who underwent combined LU and flexible ureteroscopy for removing large upper ureteral stones and ipsilateral concurrent renal stones in our department from January 2014 to April 2017. The study was approved by the local ethics committee of the hospital, and informed consent was obtained from each patient included in the study. Patients with a radiopaque upper ureteral stone with a diameter > 15 mm (located at the level of the third or fourth lumbar vertebra), small renal stone burden (fewer than ten renal stones), and ipsilateral concurrent renal stones were included in the study. Patients with a solitary kidney, bilateral upper urinary tract obstruction, nonfunctional renal unit, distal ureteral stone, ipsilateral ureter surgical history, active urinary infection, urinary tract abnormalities, or patients with serious underlying diseases were excluded from the study. Five patients had previous failed treatments with SWL. The treatment method was chosen based on the preferences of surgeons and patients after discussing the advantages and disadvantages of optional procedures, such as SWL, URS, flexible ureteroscopy (fURS), and PNL.

For each patient, detailed medical history, demographics, and stone characteristics were collected. Stone size was determined with preoperative KUB by measuring the longest axis. Renal stone burden was assessed by CT scan. Urinary infection was controlled by administering selected antibiotics before the surgical intervention based on culture and sensitivity. Procedure-related parameters, including stone-free rate, operation time, hospital stay after surgery, duration of drainage, mean estimated blood loss, visual analog scale (VAS) score [6], and complication rate, were determined. Complications were classified by the Modified Clavien Grading System [7]. SFR was defined as the absence of residual stones (fragments of > 3 mm in diameter) on KUB abdominal plain film examination and ultrasonography performed a month post-surgery. The VAS scores were evaluated at 24 and 48 hours after surgery. All patients underwent ultrasonography and/or CT scan three months post-surgery to check for ureteral stricture. All patients were re-evaluated six and 12 months after surgery.

Surgical techniques

LU was performed using a classical three-port transperitoneal approach [8]. Patients were po-

Table 1. Patient demographics and stone characteristics

Variables	Values
Median age (years)	56 (26-73)
Male/Female	19/12
Stone side (left/right)	10/21
Ureteral stone size (mm)	20.13±4.01
Median renal stone number	4 (2-7)
Median BMI (kg/m^2)	21.51±2.11

sitioned in a 70° lateral decubitus position. After establishing the pneumoperitoneum (CO_2 pneumoperitoneum was maintained at 12 mm Hg), a 10-mm camera port was introduced at the umbilicus level in the ipsilateral abdominal wall. Next, two work ports were placed. The colon was mobilized to explore the ureter, and the ureteral stone was identified rapidly near the dilated proximal ureter, along the bulge of the ureter. A longitudinal incision was made over the conspicuous bulge on the ureter by using a cold knife, and the ureteral stone was extracted carefully with a grasper.

After the ureteral stone was removed, a flexible ureteroscope (Olympus Corporation, Tokyo, Japan) was inserted into the ureter through the lower work port and ureterotomy site. Stones in the renal pelvis or calyces were removed using a nitinol stone basket (Cook Medical, Bloomington, USA). (**Figures 1** and **2**) Holmium laser lithotripsy was performed in patients with large renal stones. The laparoscopic suction device was placed below the ureterotomy site to aspirate irrigation fluid from the operative field. A 6 Fr ureteral stent was inserted laparoscopically in an antegrade manner, and the ureteral incision was closed using a 4-0 Vicryl suture and interrupted sutures. A drainage tube was inserted routinely near the ureter and was removed after confirming the absence of urinary leakage (< 50 mL). The ureteral stents were removed four weeks after surgery.

Results

The patient demographics and stone characteristics are listed in **Table 1**. The mean size of ureteral stones was 20.13±4.01 mm. The mean number of stones removed per patient was 4 (range: 2-7).

All the procedures were completed laparoscopically with no open conversions. Treatment outcomes are summarized in **Table 2**. The total SFR was 90.3%, and the SFR of ureteral stones was 100%. There were residual renal stones in two patients. One patient agreed to postponed SWL. Another patient had a residual stone in a lower calyx but did not want further treatment. In one patient, a small stone was detected post-surgically in the perirenal fat tissue, which may have been washed out of the renal pelvis during surgery. The operation time was 110.4±26.5 minutes. The operation duration was prolonged by flexible ureteroscopy. In three cases, holmium laser lithotripsy was performed because of the large renal stone size. Median hospital stay after surgery was 4 (range: 3-6) days, and the median duration of drainage was 4 (range: 3-5) days. Mean estimated blood loss was 16.5±9.1 mL, and no blood transfusions were needed. The mean VAS scores obtained at 24 and 48 hours after surgery were 2.53±0.91 and 1.08±0.45, respectively.

Complications were classified according to the Modified Clavien Grading System and are summarized in **Table 3**. No intraoperative complications were noted. The complication rate was 29.0%. Except for one patient with residual renal stones who required SWL (grade III), there were no major complications (grade III-V). Prolonged urine leakage was not detected. No ureteral strictures were detected in patients at follow-up visits 12 months after surgery.

Discussion

Various minimally-invasive options have become available for treatment of ureteral stones, including SWL, URS, LU and PNL. Each treatment modality has different efficacy rates, additional operational requirements, and complications. Urologists are responsible for choosing the least invasive and most effective method for patients with ureteral stones. Determination of the best technique is dependent on stone characteristics, anatomical details, patient status, and surgeon's preference. Most ureteral stones can be managed by SWL and URS. However, ureteral stones > 1 cm in diameter may require multiple sessions of SWL, which is associated with a low success rate [9]. SWL is not effective for removing large ureteral stones because large stones are usually wrapped around or adhered to ureteral polyps, which limits the space required for stone dila-

Table 2. Treatment outcomes

Variables	Values
Stone-free status, n (%)	28 (93.5)
Operation time (min)	110.4±26.5
Median hospital stay after the surgery (days)	4 (3-6)
Median duration of drainage (days)	4 (3-5)
Mean estimated blood loss (mL)	16.5±9.1
VAS score	
24 hours	2.53±0.91
48 hours	1.08±0.45
Auxiliary procedure rate, n (%)	1 (3.2)

Table 3. Complications

Grade I	5
Grade II	3 (fever)
Grade III	1
Grade IV	0
Grade V	0
Grade III-V, n (%)	0 (0)
Total, n (%)	9 (29.0)

tion during fragmentation [10, 11]. URS is also prone to a greater degree of failure in large proximal ureter stones. The reported URS success rate for removing upper ureteral stones of > 15 mm in diameter is 66.7-75.8% [12-14]. Low success rates are mostly associated with ureteral conditions such as edema, polyps, and strictures caused by large, impacted stones [10]. With the advent of fURS used in conjunction with holmium laser lithotripsy, many upper ureteral stones can be managed. The minimally-invasive fURS procedure is associated with a stone-free rate of 77-85% after removing proximal ureteral stones (diameter > 10 mm). These percentages decrease with an increase in the size of the stones [15]. Rates of fURS retreatment in patients with large proximal ureteral stones are 20-42% [16]. Furthermore, stone size is statistically correlated with postoperative ureteral stricture formation in patients undergoing ureteroscopic treatment for ureteral calculus removal [17]. PNL may be an appropriate modality for large upper ureteral stones, but it may also cause severe complications, such as bleeding and sepsis. Because of the overall complication rate of up to 83% [18], PNL may not be preferred by some urologists or patients.

LU is suggested as the first-line treatment for patients with large stones (diameter > 15 mm) in the proximal ureter because the stone-free rate of LU in most reported cases is almost 100%, and there is a low conversion rate to open procedure [3, 4]. LU has the highest SFR compared to SWL, and URS for proximal ureteral calculi and has a particular advantage in those who have previously failed treatment with SWL or URS [19]. In this study, the SFR of ureteral stones was 100%, and five patients had undergone at least one failed SWL. For treatment of large upper ureteral stones, LU provided significantly higher success and lower retreatment rates compared with fURS [7]. However, dealing with stone migration to the kidney and concurrent renal stones is very difficult in LU. Migrated or concurrent renal stones must be treated by additional SWL or PNL. Sun et al. [20] treated ipsilateral renal and ureteral calculi by combining retroperitoneal laparoscopic surgery with tubeless mini-percutaneous nephrolithotomy. With the concerns of bleeding and urinary leakage, we do not think PNL is the perfect partner for LU. Advances in flexible equipment may help in overcoming the limitations associated with LU. Sahin et al. [21]. used a flexible cystoscope to extract concomitant renal stones in LU. They achieved complete stone clearance in all patients. However, in our experience several years ago, we found the flexible cystoscope to be too large for the ureter, and it was difficult to introduce the scope into the small renal calyces. The problem was solved with the advent of the flexible ureteroscope. It is more slender and easier to bend. Large upper ureteral stones and ipsilateral concurrent renal stones were treated with combined LU and flexible ureteroscopy. To our knowledge, this is the largest study to date, all the ureteral stones were removed successfully, and the total SFR was 90.3%. All procedures were completed laparoscopically with no open conversions. The complication rate was 29.0%. With the exception of one patient with residual renal stones requiring SWL (grade III), there were no major complications (grade III-V). Prolonged urine leakage was not detected, and there were no ureteral strictures observed 12 months after the surgery.

LU can be a fairly difficult procedure, although the learning curve is short [22, 23]. The debate remains about whether transperitoneal or retroperitoneal access is better. One commonly held opinion is that neither approach has a

clear advantage over the other, and the choice of treatment is dependent on surgeon preference. In our department, most LU procedures have been performed using the transperitoneal approach, which can provide better working space and obvious anatomical landmarks. Bove et al. [22] suggested that urologists in training for laparoscopy perform LU using a transperitoneal route which could provide larger working space and clear anatomic landmarks. To prevent urinary leakage and ureteral stricture, the ureteral incision should be made with a cold knife in the dilated ureteral wall, above the stone and along the ureteral axis. Placing a ureteral stent is necessary, though it may be challenging for beginners. Various techniques were developed to insert a ureteral stent during or before LU. We inserted a ureteral stent in an antegrade manner through the ureterotomy site laparoscopically. The upper curve of the stent was placed in the renal pelvis with forceps. The guidewire of a central venous catheter, which was 45 mm long and could be inserted into the abdominal cavity, was used with the ureteral stent through a work port. The flexible ureteroscope can also identify and correct stent malpositioning during LU [24]. In the presence of a ureteral stent, loose suturing of the ureteral incision is recommended. Periureteral drainage was also placed, and urinary catheters should be indwelling for 5-6 days. There was no prolonged urine leakage, urinoma, or delayed ureteral stricture in any patient during the present study.

In patients with large upper ureteral stones, moderate or severe hydronephrosis is common. The slender, flexible ureteroscope can be easily inserted into the dilated proximal ureter and renal pelvis through the ureteral incision. Because of the shorter operating distance, there are fewer blind spots compared with normal transurethral access. Placing a specimen retrieval bag near the ureterotomy site to collect stones can reduce the number of times the ureteroscope must pass through the work port. In three cases, holmium laser lithotripsy was performed because of the large size of renal stones. The renal stones were broken into large fragments and the fragments were extracted using a nitinol stone basket instead of pulverizing the stones. Necessary caution was taken to ensure that small stone fragments did not enter the abdominal cavity during fragmentation. Using two monitoring systems, two screens placed side by side, and a laparoscope, the flexible ureteroscope was guided by the grasper, prevented renal stone migration, and inserted an aspirator below the ureteral incision to aspirate irrigation fluid and small stone fragments.

The most important limitation of our study is its retrospective nature and that it was done in a single center. With a lack of comparison, these results are not representative. Our purpose was to introduce an innovative combined technique to treat selected patients with large upper ureteral stones and ipsilateral concurrent renal stones. Although our results are satisfactory, SWL and URS are still recommended as primary methods for treatment of ureteral calculi, and PNL is an alternative. Considering the techniques and experience, together with the patients' conditions, the choice of treatment depends on the preferences of surgeons and patients. Moreover, additional data should be obtained by performing long-term follow-up, and additional studies should be performed to compare different treatment methods.

Conclusion

As a safe and minimally-invasive procedure, combined LU and flexible ureteroscopy is suitable for removing large upper ureteral stones along with ipsilateral concurrent renal stones. It provided high SFRs and low complication rates in these patients.

Disclosure of conflict of interest

None.

Address correspondence to: Shicheng Yu, Department of Urology, Sir Run Run Shaw Hospital, School of Medicine, Zhejiang University, Hangzhou 310016, China. E-mail: 3314011@zju.edu.cn

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