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Long-term outcome after flexible ureteroscopy with holmium laser for simultaneous treatment of a single renal cyst and ipsilateral renal stones

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Abstract

Objective: To assess the long-term outcome of simultaneous treatment of a single renal cyst and ipsilateral stones with transurethral flexible ureteroscopy (FURS) lithotripsy and internal cyst drainage.

Methods: Patients who underwent simultaneous treatment with FURS lithotripsy and internal cyst drainage in our institution between July 2014 and September 2017 were enrolled. The cyst wall was identified endoscopically and a 1–3-cm window was created in the wall using a holmium laser. The proximal end of a double-J stent was placed in the cystic cavity to facilitate internal drainage.

Results: Thirteen patients underwent simultaneous treatment. No intraoperative complications with Clavien grading score >2 were noted in any patients. Mean stone burden and cyst diameter were 1.6 (range: 0.9–2.5) cm and 5.8 (range: 3.0–7.1) cm, respectively. Stone-free rates after single and complementary procedures were 84.6% and 92.3%, respectively. During the mean 33.1-month follow-up period (range: 17–54 months), seven patients (53.8%) achieved full resolution of renal cysts, five patients (38.5%) maintained >50% size reduction, and one patient (7.6%) experienced recurrence at 18 months postoperatively.

Conclusions: FURS with a holmium laser may constitute a safe and effective alternative procedure for simultaneous treatment of a single renal cyst and ipsilateral stones.

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Introduction

Both nephrolithiasis and cysts are common diseases of the kidney, the incidences of which increase with age in the general population.[1–5] Fortunately, most renal cysts are asymptomatic and do not require any intervention. However, patients with renal stones accompanied by renal cysts are more likely to experience recurrence of renal calculi and exhibit an increased risk of developing cysts with increasing age.[6] Simultaneous treatment of renal cysts and ipsilateral stones may reduce recovery time and medical expenditures. Therefore, surgeons seek to treat both entities simultaneously, although the ipsilateral coexistence of these conditions is uncommon.[7,8]

The laparoscopic approach for renal cyst unroofing has become the first-choice treatment given its satisfactory efficacy and safety;[9] however, this approach imposes a high risk of postoperative urine leakage in patients with peripelvic renal cysts because it causes damage to the collecting system.[10] Moreover, it is extremely challenging for surgeons to manage multiple renal stones without the assistance of percutaneous nephrolithotomy (PCNL) or flexible ureteroscopy (FURS).[11,12] Several reports have suggested that percutaneous ureteroscopy with laser unroofing or a plasma column electrode is less invasive than laparoscopy for treatment of simple renal cysts.[13–16] However, this approach has not been widely applied because of the possibility of serious postoperative complications, such as urinary leakage or massive hemorrhage requiring angio-embolization;[17,18] renal cysts and ipsilateral stones occasionally cannot be managed simultaneously through a single tract because their locations are suboptimal.[14]

Recently, the technological developments of flexible ureteroscopy and laser lithotripsy systems have enabled urologists to use a ureteroscope with a holmium laser for treatment of renal cysts through a natural orifice, thus achieving satisfactory efficiency and safety via internal drainage.[18–20] To the best of our knowledge, few studies have explored the feasibility of simultaneous treatment of renal cysts and ipsilateral renal stones by flexible ureteroscopy.[8] Therefore, we sought to assess the long-term outcome of FURS using a holmium laser for simultaneous treatment of a single renal cyst accompanied by ipsilateral renal stones.

Materials and methods

Patients

This study included consecutive patients with a single renal cyst and ipsilateral renal stones who underwent treatment with transurethral flexible ureteroscopic lithotripsy and internal cyst drainage in our hospital during the period from July 2014 to September 2017. Inclusion criteria were as follows: (1) the presence of renal stones (diameter <2.5 cm) and a single ipsilateral renal cyst (diameter >3 cm and/or compressing the renal pelvis or calyx) and (2) lack of ureteral stricture. We excluded patients who had a suspected malignant

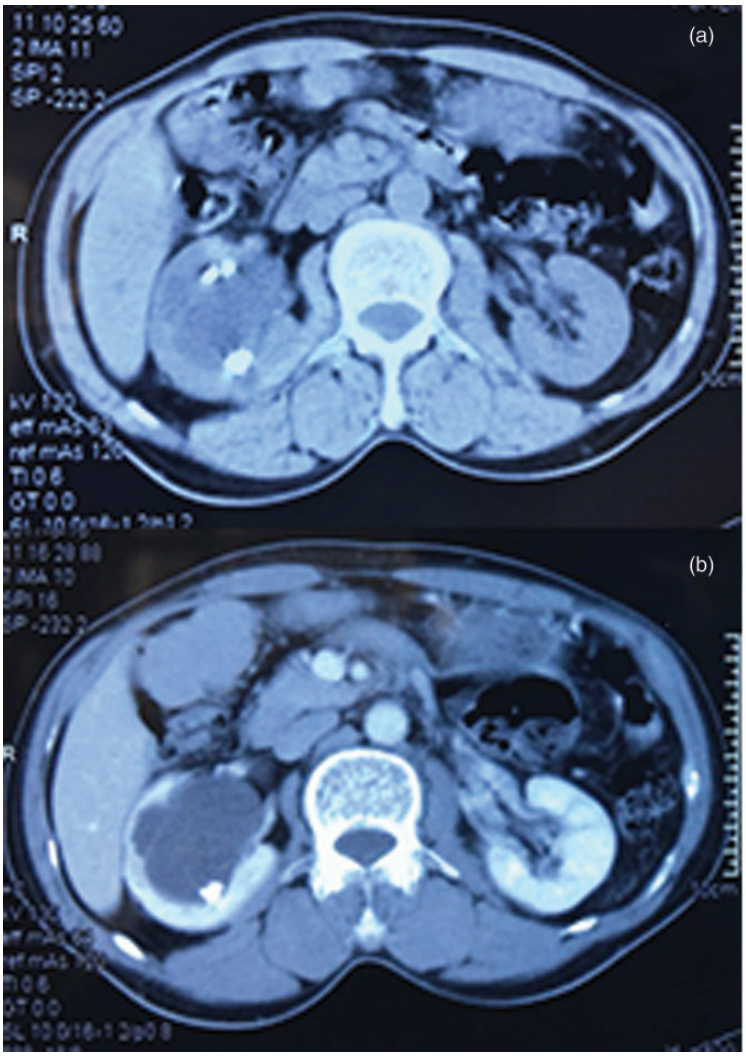

Figure 1. Nonenhanced computed tomography (CT) (a) and enhanced CT (b) scans showed multiple renal stones and a large parenchymal cyst in the middle of the right kidney.

cyst, based on contrast-enhanced computed tomography (CT) findings.

The renal cyst and ipsilateral renal calculi were confirmed by preoperative contrast-enhanced CT with three-dimensional reconstruction in all patients (Figure 1). The stone burden was assessed based on the maximum diameter of the stone on CT; if multiple stones were noted, the stone burden was measured as the sum of the longest axes of all stones.

Routine urinalysis, urine culture, blood routine examination, serum creatinine measurement, and X-rays of kidney, ureter, and bladder were performed preoperatively. Appropriate antibiotic prophylaxis was administered preoperatively and intraoperatively, in accordance with the results of the

patient's urine culture; prophylactic antibiotic treatment including quinolones or cephalosporins was administered preoperatively and intra-operatively to patients with negative urine culture results.

All patients were informed of the risks of surgery and of alternative treatment methods, including the laparoscopic unroofing procedure, PCNL and simultaneous intrarenal cyst marsupialization, and multisession surgery. All patients selected their preferred treatment option before they signed informed consent to undergo surgery. Additionally, written informed consent to analyze and publish the patients' clinical data, on the condition of anonymity, was routinely obtained on the day of admission. This study was approved by the Ethics Committee of Xiangya Hospital of Central South University (protocol number: 201806887).

Surgical procedure

All patients underwent the surgical procedure under general anesthesia in the lithotomy position. A 9.8-Fr semirigid ureteroscope (Karl Storz, Tuttlingen, Germany) was inserted into the ureter and reached the renal pelvis under the guidance of a catheter. If the ureteroscope failed to reach the renal pelvis because of a narrow ureter, a 6-Fr double-J stent (KYB, Shenzhen, China) was placed for 1 month to facilitate passage of the ureteroscope during a subsequent surgery. If the ureteroscope successfully passed the ureter and reached the renal pelvis, the catheter was replaced by a hydrophilic guide wire (Cook Medical, Bloomington, IN, USA), and a ureter access sheath (UAS) (KYB, China) was placed with the guide wire. After successful placement of the UAS, an 8.5-Fr flexible ureteroscope (Olympus, Tokyo, Japan) was inserted to find stones. Lithotripsy was performed with a holmium: yttrium-aluminum-garnet (Ho:YAG) laser using a 200-μm fiber with an energy range of 12–20 W at a frequency of 14–20 Hz. A nitinol basket (Cook Medical) was used to relocate stones and retrieve stone fragments.

Typically, the renal cyst wall protruded into the collecting system, and its semitransparent membrane appeared light blue. When difficulty was encountered in distinguishing the thick cyst wall, methylene blue was injected into the cyst through a puncture needle under ultrasonic guidance, in an attempt to change the color of the cyst wall to blue or black (i.e., for increased contrast). If methylene blue injection was unsuccessful in producing sufficient contrast, the cyst wall was carefully punctured with the needle and the methylene blue was permitted to leak out from the target wall of the cyst. Subsequently, the planned incision location in the cyst wall was routinely rechecked by ultrasound. The cyst wall was incised with the Ho:YAG laser (8 W; 20 Hz) to create a 1–3-cm diameter window, thereby connecting the renal cyst and collecting system. The cyst interior was inspected to avoid misdiagnosis of cystic renal cell carcinoma. A 6-Fr double-J stent (KYB) was routinely placed, with the proximal end in the cystic cavity for internal drainage, and removed 3 months later.

The procedure was completed with the placement of a Foley urethral catheter. The operative time was calculated from ureteroscope insertion to urethral catheter placement. All procedures were performed by a single surgeon who had >15 years of experience and had performed >3500 FURS procedures. The surgical course is shown in Figure 2.

Follow-up

All patients underwent noncontrast CT of the urinary system at 1 month postoperatively. Ultrasonography of the urinary

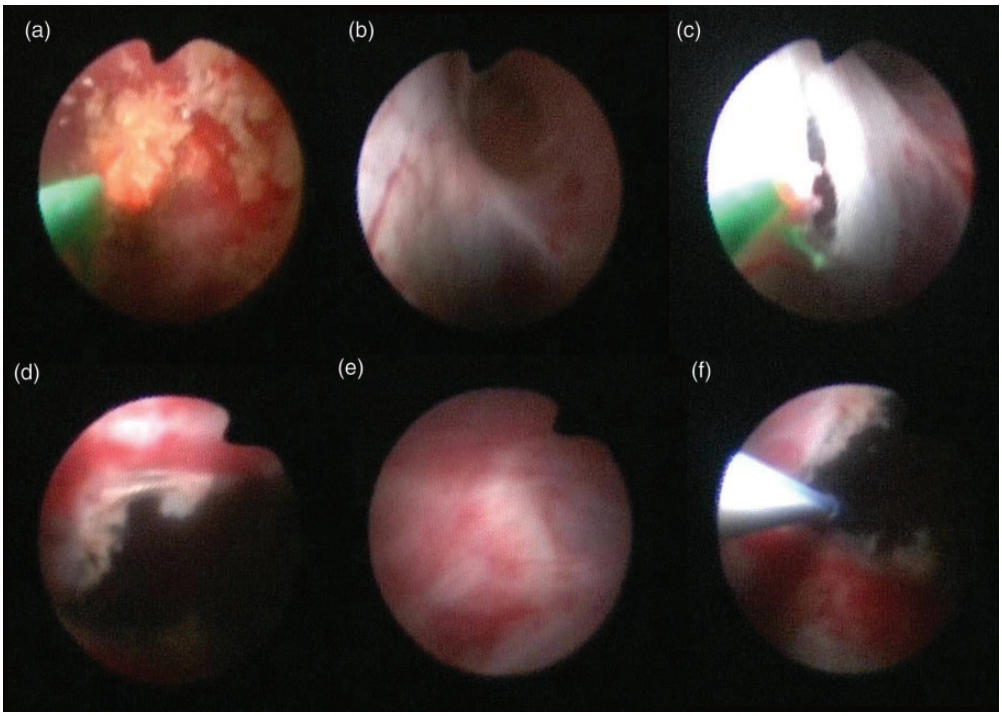

Figure 2. The surgical course of flexible ureteroscopy lithotripsy and cyst drainage. (a) Lithotripsy was performed using a holmium:yttrium-aluminum-garnet (Ho:YAG) laser. (b) The wall of the parapelvic cyst was semitransparent with a light blue color and protruded into the collecting system. (c) The parapelvic cyst was excised using a Ho:YAG laser. (d) An approximately 2-cm window was created in the cyst. (e) The interior of the cyst was inspected by ureteroscopy. (f) The proximal end of a 6-Fr double-J stent was placed in the cystic cavity.

system was performed at 3 and 6 months postoperatively, then every 6 months thereafter. CT of the urinary system was also performed for patients who met the following criteria: (1) cyst recurrence or hydronephrosis; (2) suspicion of cyst malignancy. The stone-free rate (SFR) was defined as residual stone fragmentation <2 mm in diameter at 1 month postoperatively, as determined by CT.

Results

Patient and clinical characteristics

The detailed demographic and clinical data are described in Table 1. Renal cyst and ipsilateral renal stones were found incidentally on abdominal imaging performed for nonurological indications in four asymptomatic patients. Among the remaining 10 symptomatic patients, five exhibited lumbago, three exhibited flank pain, one exhibited intermittent gross hematuria, and one had a history of repeated urinary infection with fever, frequency, and/or urgency. There were nine single peripelvic cysts and five single parenchymal cysts; the mean cyst diameter was 5.8 (range: 3.0–7.1) cm. In total, cysts in 11 (78.5%) and three (21.5%) patients were defined as Bosniak I and Bosniak II cysts, respectively.[21] The mean stone burden was 1.6 (range: 0.9–2.5) cm.

Perioperative events

One patient with a 6-cm parenchymal cyst and a 1.5-cm ipsilateral renal stone only underwent lithotripsy with the holmium laser because of failure to identify the cyst endoscopically; this patient did not show any residual fragments. The parenchymal cyst was successfully treated in our institution by using the laparoscopic unroofing procedure, approximately 2 months later. The remaining 13 patients simultaneously underwent lithotripsy treatment and internal cyst drainage; summary data regarding perioperative and follow-up outcomes are shown in Table 2. One patient had a fever of 38.7°C at 4 hours postoperatively; the fever was controlled by administration of proper antibiotics on the second day postoperatively. No intraoperative complications with Clavien grading score >2, such as significant blood loss, collecting system damage, or septic shock, were observed in any patient.

Table 1. Patient characteristics.

Parameter	Value
Sex (male/female), n	9/5
Age (range), years	52.9 (34–71)
BMI (range), kg/m^2	23.7 (19.3–26.6)
Laterality (right/left), n	8/6
Mean stone burden (range), cm	1.6 (0.9–2.5)
Stone location, n	
Upper calyx	1
Middle calyx	4
Lower calyx	4
Pelvis	3
Multiple	3
Mild-to-moderate hydronephrosis	4
Mean cyst diameter (range), cm	5.8 (3.0–7.1)
Cyst location, n	
Peripelvic	9
Parenchymal	5
Bosniak classification, n	
I	11
II	3
Comorbidities, n	
Hypertension	4
Diabetes mellitus	2

Postoperative outcome

The SFR of patients who underwent a single procedure was 84.6% (11/13) (Table 2). One patient (7.6%) underwent a complementary FURS procedure because of a 7-mm residual fragment in the low calyx, as determined by noncontrast CT at the 1-month follow-up; one asymptomatic

Table 2. Perioperative and follow-up outcomes.

Parameter	Value
Operative time, mean (range), minutes	56.7 (37–75)
Hospital stay, mean (range), days	2.6 (1.5–5)
Postoperative complication	
Fever (>38°C), n (%)	1 (7.6%)
Stone free rate after one procedure, n (%)	11/13 (84.6%)
Stone-free rate after multiple procedures, n (%)	12/13 (92.3%)
Stone composition, n (%)	
Calcium-based	12/13 (92.4%)
Uric acid	1/13 (7.6%)
No detection of renal cysts (>50% reduction of original diameter), n (%)	
1 month postoperatively	5/13 (38.5%)
3 months postoperatively	6/13 (46.2%)
6 months postoperatively	7/13 (53.8%)
12 months postoperatively	7/13 (53.8%)
18 months postoperatively	7/13 (53.8%)

patient (7.6%) with a 5-mm stable stone in the lower calyx was advised to undergo close follow-up monitoring. Stone analysis showed mixed calcium oxalate and calcium phosphate stones in seven patients (53.8%), calcium oxalate stones in three patients (25.0%), calcium phosphate stones in two patients (15.3%), and uric acid stones in one patient (7.6%).

At 1 month postoperatively, the resolution of renal cysts was observed in five patients (38.5%) (Figure 3a); all remaining patients showed >50% reduction relative to the original diameter (Figure 3b, c). During subsequent follow-up periods (Table 2), renal cyst resolution was confirmed in six patients (46.2%) at 3 months postoperatively and seven patients (53.8%) at 6 months postoperatively; none of those patients experienced recurrence during the mean 32.3-month follow-up period (range: 17–48 months). Among the six patients with residual cysts at 6 months postoperatively, five (38.5%) maintained noticeable relief without recurrence during the mean 37.2-month follow-up period (range: 21–54 months) (Figure 3d). However, one patient (7.6%) with a peripheral renal cyst experienced cyst recurrence (enlargement to the preoperative diameter of 6.8 cm) at approximately 18 months postoperatively; the patient was successfully treated by using the laparoscopic unroofing procedure in our institution. Additionally, during the

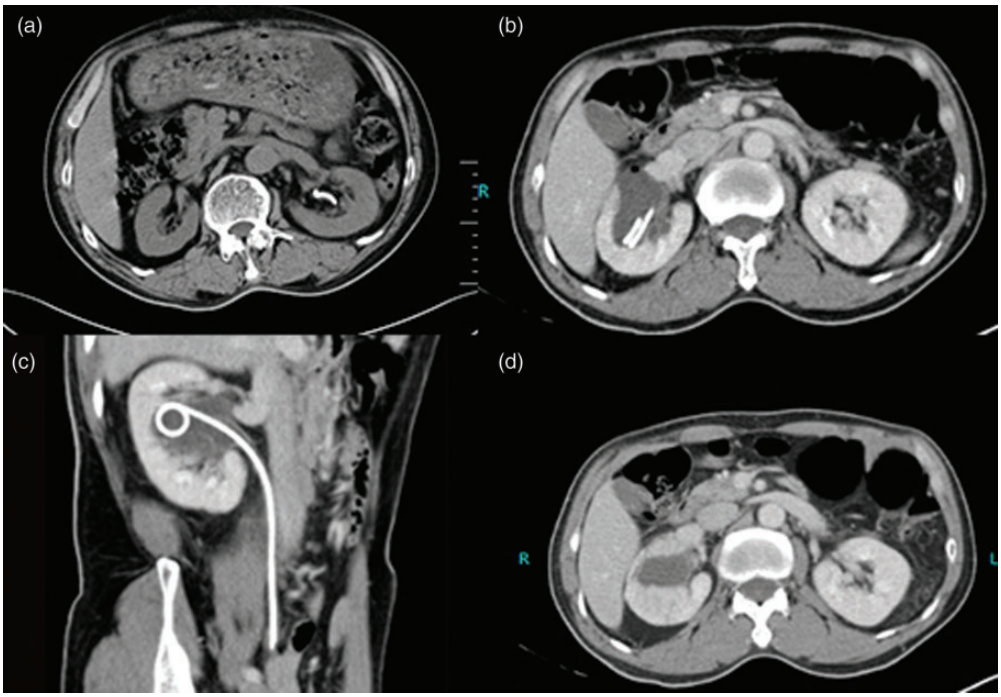

Figure 3. Follow-up results of simultaneous treatment with lithotripsy and internal cyst drainage. (a) Computed tomography (CT) at 1 month postoperatively showed the disappearance of the cyst and calculi, and the presence of the double-J stent in the pelvis of the left kidney. (b, c) CT at 1 month postoperatively showed cyst regression, calculi clearance, and the proximal end of the double-J stent in the cystic cavity of the right kidney. (d) CT at 12 months postoperatively showed noticeable relief of the cyst without recurrence of calculi in the right kidney.

follow-up period, urinary stone recurrence and urologic neoplasms were not observed in any patient.

Discussion

Although the coexistence of renal stones with ipsilateral renal cysts is uncommon, it is attractive to use a single procedure for simultaneous treatment of both entities. Thus far, several studies have reported the use of laparoscopy and percutaneous nephroscopy to simultaneously treat renal stones accompanied by cysts. Chen et al.[22] reported 15 well-selected patients who successfully underwent percutaneous nephrolithotripsy and simultaneous intrarenal cyst marsupialization; during a median follow-up period of 21 months, all patients showed calculi clearance and noticeable cyst regression, and no severe intraoperative or postoperative complications were noted. Yang et al.[23] reported a clinical case wherein a peripelvic renal cyst combined with renal calculi was successfully treated with percutaneous nephroscopy. Despite its effectiveness, percutaneous nephroscopy is suitable for a limited number of cases in which patients exhibit a solitary posterior or parapelvic medium- to large-sized renal cyst accompanied by ipsilateral calculi. Moreover, the risk of uncontrolled bleeding requiring angioembolization should be seriously considered, especially for patients with solitary kidneys. A laparoscopic approach has also been reported to simultaneously manage renal cysts combined with renal calculi. For instance, a case report by Micali et al.[6] described the feasibility of simultaneous laparoscopic treatment of renal stones accompanied by renal cysts. Additionally, Qiu et al.[12] performed simultaneous laparoscopic cyst decortication and laparoscopy-assisted PCNL in the treatment of 15 patients with renal cysts and ipsilateral stones, achieving satisfactory stone clearance and no recurrence of cysts during a median follow-up period of 22 months. Laparoscopy offers the advantage of a high initial SFR because stones are removed without residual fragments.[11] However, it carries risks of serious intraoperative and postoperative complications. Theoretically, the risk of serious bleeding within the tract may increase because the removal of perinephric fat is likely to attenuate the protective effects of Gerota's fat and fascia during laparoscopy-assisted PCNL; it is also challenging for surgeons to manage parapelvic cysts because the collecting system can easily be damaged, leading to postoperative urine leakage.[10]

Kavoussi et al.[19] published a case report describing successful treatment of a large peripelvic renal cyst by incising the cyst wall with a 3-Fr electrocautery probe under direct view of a ureteronephroscope in 1991; subsequently, the treatment of renal cysts by FURS using a holmium laser has been reported by several groups. Yu et al.[24] reported the findings in a series of 35 patients who underwent this type of treatment; during the mean follow-up period of 36 months, resolution of renal cysts was achieved in 74.3% of patients (26/35), and noticeable regression was observed in the remaining patients. Similar studies showed that FURS using a holmium laser is a feasible method to treat renal cysts in well-selected patients, and the rates of renal cyst resolution ranged from 35% to 81.4%.[18,25] In the present study, considering that patients with renal cysts and ipsilateral stones had an increased risk of obstruction, 13 patients (including four asymptomatic patients) successfully underwent simultaneous treatment with FURS lithotripsy and internal cyst drainage. Seven patients (53.8%) achieved cyst resolution; five patients (38.5%) achieved an acceptable result of a significant reduction in cyst diameter (i.e., $>50\%$) during the mean follow-up period of 37.2 months.

One patient (7.6%) exhibited recurrence at 18 months postoperatively, although the wall was incised as much as possible and any remaining partition inside the cyst was completely excised. For this patient, we reviewed the surgical records and found that the renal stone had been surrounded by granuloma and was located in the ureteropelvic junction; this location placed the patient at high risk of ureteropelvic junction obstruction (UPJO). Therefore, we hypothesized that the recurrence was closely related to poor internal drainage due to UPJO after the removal of the double-J stent.

Compared with prior studies in which FURS with a holmium laser was used to manage renal stones of similar sizes only,[26,27] we achieved a similar SFR and mean hospital stay without increasing the rates of intraoperative and postoperative complications; however, the mean operative time of 56.7 minutes in the present study was relatively longer than that of prior studies. The mean operative time specifically for treatment of renal cysts was 19 (range: 7–32) minutes in the present study. It is understandable that an extremely short time for treatment of renal cysts was achieved, as internal renal cyst drainage and lithotripsy shared a working channel and the same holmium laser. Nonetheless, it is crucial to accurately identify the cyst wall during the procedure. Typically, renal cysts protrude into the collecting system, and the semitransparent membrane appears light blue. When the thick cyst wall cannot be easily distinguished, injection of methylene blue into the cyst may be useful to increase contrast, as performed in the present study. However, additional studies are needed to evaluate the feasibility and safety of this approach because of its use in a limited number of cases.

Given the limited number of affected patients, few studies have reported the safety of simultaneous treatment of renal cysts and ipsilateral stones by FURS using a holmium laser. In the present study, postoperative fever without hypotension was observed in a 63-year-old woman with negative urine culture, but this condition was well-controlled by antibiotic administration. We reviewed the surgical record for this patient and found that unexpected sanious discharge had emerged from the renal cyst after incision of the cyst wall. Similarly, in a study of 20 patients with simple parapelvic renal cysts that were treated by flexible ureteroscopy with a holmium laser, Mao et al.[25] reported that postoperative septic shock was noted in one patient whose cyst had contained multiple small stones; the preoperative urine culture had indicated urinary system infection caused by *Escherichia coli*. Because of the potential risk of infection and tumor due to the long-term coexistence of calculus, close attention is needed in patients whose renal cysts contain calculi.[6] Compared with laparoscopy and percutaneous nephroscopy to manage the coexistence of renal cyst and renal calculi in well-selected patients, FURS with a holmium laser showed similar efficacy, fewer postoperative complications, and shorter recovery time because of its minimally invasive nature.[6,28] However, it is challenging for surgeons to select optimal candidate patients. Based on our experience and previously published reports,[25,29] we suggest several aspects to consider in selection of ideal candidates: (1) the presence of $<$2-cm renal stones combined with a large ipsilateral single renal cyst, especially in patients with a single peripelvic cyst that can be easily identified using an endoscope; (2) creation of a $>$1-cm window connecting the renal cyst and collecting system under satisfactory direct vision, to ensure effective intrarenal drainage; (3) placement of the proximal end of a double-J stent in the interior of the cystic cavity for prolonged internal drainage to keep the channel opened, although this may increase the risk of

stent-related complications; (4) exclusion of patients with ureteral stenosis or cysts suspected of malignancy. Because the use of various sclerosants has been reported to achieve high rates of long-lasting cyst volume reduction and cyst resolution,[5,30] lithotripsy combined with injection of sclerosants into the ipsilateral renal cyst may be an alternative minimally invasive treatment, especially for cysts that cannot be clearly identified by endoscopy.

There were some limitations in the present study. First, it was limited to a small series of patients and no control group was included because of the rarity of the coexistence of a single renal cyst and ipsilateral renal stones. Additionally, we did not modify treatment in symptomatic patients, compared with that used in asymptomatic patients. Thus, there may have been a risk of overtreatment among patients who might experience greater benefit from lithotripsy alone combined with conservative treatments for a simple single renal cyst because of the increased risks associated with internal drainage using a holmium laser. Furthermore, we did not take pathological specimens during the procedure to obtain accurate pathological diagnoses; thus, further long-term follow-up of the included patients is necessary. Additional well-designed studies with long-term outcomes are needed to evaluate the efficacy and safety of FURS using a holmium laser for simultaneous treatment of renal cysts and ipsilateral stones.

Conclusions

The results suggested that transurethral flexible ureteroscopic lithotripsy and internal cyst drainage comprises an effective and safe alternative for simultaneous treatment of a single renal cyst and ipsilateral stones in well-selected patients. Because this was a single-center study with very few cases, further studies with larger sample-size and long-term results are needed to confirm the results.

Declaration of conflicting interest

The authors declare that there is no conflict of interest.

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