Flexible ureteroscope with ultrasound guidance for treatment of parapelvic renal cysts: A complementary approach to locate the cystic wall

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Abstract

Background

The main treatment of parapelvic cysts is flexible ureteroscope currently. Considering the intraoperative localization of the cyst may fail with flexible ureteroscope, we tend to use an innovative method by ultrasound-guided for easily locating cystic wall during flexible ureteroscopic surgery

Methods

We retrospectively reviewed 17 consecutive cases of parapelvic renal cysts treated by ultrasound-guided flexible ureteroscope between March 2017 and May 2020. The differences of simple flexible ureteroscopic technique and ultrasound-guided flexible ureteroscopic technique were compared. The surgical procedures, postoperative complications, results and patients' follow-ups were evaluated.

Results

The cysts wall were seen clearly in 10 patients with ureteroscopic vision. Another 7 patients changed to ultrasound-guided flexible ureteroscopic surgery since it was difficult to identify the cyst wall. Mean operative time were 25.9 ± 8.7 minutes and 37.1 ± 10.1 minutes for conventional and modified technique respectively ($P = 0.004$), of which 17.6 ± 5.8 minutes and 26.5 ± 8.4 minutes to search the cysts, respectively ($P = 0.002$), and the mean time of the incising were 7.1 ± 4.9 minutes and 12.1 ± 5.6 minutes, respectively ($P = 0.000$). All of the patients were followed-up 12 months, there were no serious complications and recurrence observed.

Conclusions

We demonstrated that it is feasible and safe to treat parapelvic renal cyst by ultrasound-guided flexible ureteroscopic incision and drainage. The less sample size and further studies were the limitations of our study.

Introduction

Parapelvic renal cysts are the special type of renal cystic disease. The prevalence of parapelvic renal cysts is 1–3% among all cases of renal cystic [disease](#) [1], and their diameter increases with aging, especially in the 50–70 year-old individuals. Other studies reported the occurrence rate is equally common in males and females [2]. Parapelvic renal cysts easily become symptomatic caused by compression of the renal collecting system or the renal pedicle vessels, which may result in pyelocaliceal junction obstruction, flank pain, infection, and complicated stone formation in some cases. Diagnosing a parapelvic renal cyst by Computed tomography (CT) scan and enhancement have an accuracy rate of 80–

95% [3]. Meanwhile, CT-scan criteria is used for differentiating benign cysts (Type I-II) from malignant cysts (Type III-IV) according to Bosniak classification [4].

Several techniques are used to treatment parapelvic renal cysts disease. Currently available management options for parapelvic cysts include from percutaneous nephroscopic ablation and laparoscopic cyst decortication to flexible ureteroscope [5]. In comparison with the other options, the flexible ureteroscope approach has the advantage of minimally invasive nature, low complication rate and a short hospital stay [6]. Since 2009, Basiri et al. reported the first intra-renal cyst incision and drainage [7]. The clinical feasibility of flexible ureteroscopic management for parapelvic renal cyst have been confirmed in a larger number of patients, but few studies have investigated the localization of parapelvic cysts during endoscopic surgery. As far as we know, more challenging procedures may be performed if the parapelvic cyst wall is not found during surgery, especially if the cyst wall does not normally bulge into the collection system or the tissue thickness between the collection system and the cyst.

To locate an endoscopic cyst and thereby decrease complicated surgical interventions when our initial attempt to find the cyst wall by direct observation failed, we tended to perform a study using ultrasound-guided flexible ureteroscope in the treatment of parapelvic cyst. We describe the process of localizing parapelvic cysts in dealing and summarize our initial clinical experience.

Methods

Patient selection and evaluation

From March 2017 to May 2020, 17 patients with parapelvic renal cysts were admitted to Handan First Hospital. This study retrospectively analyzed clinical data from ultrasound-guided flexible ureteroscope in the treatment of parapelvic cyst procedures. The informed consent was obtained throughout the process. All of the patients received Imaging evaluations included plain films of the kidneys, ureters and bladder (KUB), renal ultrasonography and CT scanning and computed tomography urography (CTU) to define the collecting system anatomy.

The standard of inclusion criteria and exclusion criteria was followed

The inclusion criteria were as follows: (1) patients with a Bosniak classification of CT imaging were grade I and II;(2) presence of parapelvic cyst larger than 3 cm in size; (3) urinary obstruction and hydronephrosis caused by parapelvic cyst compressing the renal calyx or renal pelvis;(4) flank pain, hemorrhage and some other complications caused by parapelvic cyst;(5) secondary renal calculi larger than 5 mm in size.

The exclusion criteria were as follows:(1) patients with a Bosniak classification of CT imaging were grade III and IV;(2) suspicion of severe urinary tract infection;(3) ureteral stricture;(4) history of cardiopulmonary insufficiency

Surgical technique

A 6Fr Double-J stent (Laekna, Shanghai, China) was placed two weeks before surgery for the dilation of ureter. Urine test and urinary culture were routinely done, antibiotics treatment was administered to the patients with urinary tract infection findings before surgical treatment. The patient was placed in the lithotomy position and the pre-placed 6Fr Double-J stenting was removed after general anesthesia. Operator cannulated the ureteral orifice with a hydrophilic guidewire (Cook® Medical, Bloomington, IN, USA) into the renal pelvis. Confirming guidewire placement in the renal pelvis by ultrasound, then the rigid ureteroscope (Richard Wolf, Germany) was used to examine the relevant ureter routinely. A ureteral access sheath (Cook® Medical, Bloomington, IN, USA) was inserted into the ureteropelvic junction to facilitate flexible ureteroscopy. The operator surveyed the renal pelvis and calyces sequentially with using flexible ureteroscope (Olympus, Tokyo, Japan) to locate parapelvic cysts wall. In addition, handling the renal stones first if the cyst combined with calculus, the renal stones were fragmented to less than 3 mm with holmium laser (Raykeen, Shanghai, China). The large fragments were removed by a stone basket (Bard, Georgia, USA) to prevent the fragments entering the cystic cavity after the wall was opened.

Generally, the parapelvic cyst appeared transparent with blue areas in ureteroscope vision when we tried to search the cyst wall by direct visualization initially. To avoiding renal pedicle injury, the renal calyces were chosen as the best incision point, and then renal pelvis was the second choice. The holmium laser was used to cut the cyst wall about 2 cm to enable communication with the collecting system.

If the typical blue wall was not found, searching a suspicious wall which protruded into the renal pelvis, the flexible ureteroscope was guided close to the suspicious wall in real time by using ultrasound (SIUI, Guangzhou, China). Before the holmium laser was triggered for drainage, the operator Confirmed that the flexible ureteroscope was pushing against the cyst wall under the ultrasound imaging (Video 1). The incision was performed on an appropriate drainage site and the typical smoking sign was observed in ultrasound (Figure 1). For drainage, the proximal double-J stent was coiled in the cyst cavity which was removed 1-3 months later.

All patients were followed-up 3, 6 and 12 months later in our outpatient department. Ultrasonography or CT examinations were used to detect the recurrence of parapelvic cyst and residual stones, patients with cyst shrinks to half of its original size by imaging examination on 6 months were considered as effective therapy. In addition, clinically insignificant residual stone was defined as less than 4 mm in largest diameter.

Statistical analysis

SPSS 26.0 software was used to [analyse](#) the extracted data. T-test was used for comparing quantitative value and χ^2 test was used for qualitative values. $p < 0.05$ was defined as a statistically significant difference.

Results

A total of 17 patients with parapelvic renal cysts, composed of 8 males and 9 females, received endoscopic management by flexible ureteroscopy. All operations were conducted successfully and no patients were received open management in surgery. The mean patient age was 52.8 ± 15.1 years (range 45-79 years). There were 6 cases of simple parapelvic cysts and 11 cases of parapelvic cysts with ipsilateral renal calculi. The mean size of cyst and stone were 53.6 ± 7.8 mm (range 40-65 mm) and 10.1 ± 1.7 mm (range 8-12 mm) on preoperative CT scan, respectively (Table 1).

During marsupialization, 10 patients underwent endoscopic management by simple flexible ureteroscopy, 7 patients transformed to ultrasound-guided flexible ureteroscopy because of locating the cyst wall difficultly. The mean operative times of simple flexible ureteroscopy and ultrasound-guided flexible ureteroscopy were 25.9 ± 8.7 minutes and 37.1 ± 10.1 minutes, respectively. No severe postoperative complications (such as massive hemorrhage or renal perforation). Postoperative fever ($\geq 38.5^\circ\text{C}$) occurred in 2 cases, backache in 4 cases, the clinical symptoms were alleviated 3-5 days after surgery. The follow-up for 12 months showed 12 cysts became undetectable, while 5 cysts decreased in size by at least half (Table 2).

Discussion

Renal cyst is a common cyst disease and it occur 5% of the cysts in the general population, most of them do not require any treatment [8]. Parapelvic renal cysts are rare entities of renal cysts which adjacent to the collecting system and the vessels of renal hilum. The ratio of men to women is similar, most patients are older than 50 and the age is directly related to the increase of cyst diameter [9]. However, parapelvic cysts may cause clinical symptoms earlier than simple renal cysts and are more frequently associated with pain, hematuria, infection, hypertension, hydronephrosis and stone formation [10,11,12]. Thus earlier surgical intervention is required than simple renal cysts.

To date, some studies have reported flexible ureteroscopic treatment of this disease and have been proven to be feasible and safe in patients which was selected. Comparing with percutaneous resection or ablation, the work access sites associated with percutaneous nephrostomy (PCN) inevitably cause renal injury, such as severe perinephritis, retroperitoneal abscess and secondary ureteropelvic junction obstruction. The complications often emerge with ranging from 29% to 83% [13,14]. Comparing with the laparoscopic unroofing, the latter has a high risk of injury to the renal cortex and renal pedicle since the parapelvic cysts are usually surrounded by renal parenchyma [7,15]. The retrograde approach may be less invasive for entirely endophytic cysts. flexible ureteroscopic technique has lowered the risk of serious complications [16].

The location of the renal cyst wall is a crucial step of marsupialization for treatment of parapelvic cysts. Liaconis et al reported that in ureteroscope vision, the light blue color of cystic wall was helpful for location of cyst [17]. We also found that some case of typical cystic in our study, however, these features were not discovered if the cyst wall was relatively thick. Another study by Zhixian Wang et al reported methylene blue injection via percutaneous renal cyst puncture to identify the parapelvic cyst, this method

successfully located the cystic wall in their research [18]. But in previous studies [15], we found that the blue cyst wall which was injected with methylene blue was also identified difficulty if the typical capsular wall was not found during surgery. The cystic wall has the same color as other parts of the renal pelvis because of relatively thick, it is a challenging for the operator to locate the cystic wall and to choose the area for incision.

The primary aim of this study was to present a method for locating cystic wall during routine flexible ureteroscopy failed to search for parapelvic cysts. Intraoperative ultrasound has been used increasingly in recent years. Ultrasound has the advantages of real-time monitoring of cysts and guided flexible ureteroscope, which can help us to find cystic wall and adjust the incision direction. Kang N et al have reported the experience of flexible ureteroscope combined ultrasound to help search for parapelvic cysts, the holmium laser can be presented linear high-echo and cysts can be presented low-echo under ultrasound image [19]. Meanwhile, the adjacent relationship between flexible ureteroscope and cyst can be showed under ultrasound image, to choose the best area for incision and inner drainage. In our study, more than half cysts could be found under ureteroscopic vision, as we demonstrated successfully in 10 patients in this study. In cases where the cyst wall had the same color as other parts of the renal pelvis, the ultrasound had been employed. We found this technique can eliminate the methylene blue injection via percutaneous renal cyst puncture and reduce the patient's pain without prolonging the operation time.

During a mean follow-up period of 14 months (range 12-18 months) with ultrasound and CT showed no cyst recurrence. [The results suggest](#) that our techniques prevent further compression on the collecting system and promote complete drainage of cystic fluid. We provide an alternative method which can be selected for patients with parapelvic cysts.

Our research has limitations of small patient sample, since the parapelvic cysts are not relatively common. Meanwhile the inherent defects of retrospective study and lack of long-term follow-up led to flaws in the study. The number of patients who required ultrasound-guided flexible ureteroscopy was not many. In this situation, designing and conducting a randomized controlled trial was difficult, we chose to perform a retrospective research instead, which could explain there was no control group.

Conclusion

Ultrasound guidance as a modified method for the treatment of parapelvic cysts by flexible ureteroscopy. According to our research results, this procedure is a feasible, safe, and effective approach to parapelvic cysts. Further studies with large samples and longer follow-ups need to be assessed for long-term efficacy.

Abbreviations

No: number; CT: Computed tomography; PCN: percutaneous nephrostomy; KUB: plain films of the kidneys, ureters and bladder; min: Minute; mm: Millimeter; SD: Standard deviation

Declarations

Acknowledgements

None.

Authors' contributions

KWY conceived and designed the study, NM and XFT contributed to acquisition of data and revision of the paper, WZL and ZML contributed to analysis and interpretation of data, MTG and BX contributed to design, acquisition, analysis, interpretation of data and revising the paper critically. All authors approved the final version of the paper.

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Availability of data and materials

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request

Ethics approval and consent to participate

This study was approved by the ethics committee of Handan Frist Hospital, Hebei, China, The research was a retrospective study, and all data were collected from the hospital information system, and we have applied for exemption from informed consents. Because of the retrospective nature of the study, the requirement for informed consent was exempted by the ethics committee of Handan Frist Hospital. All procedures were conducted in accordance with the ethical standards of the 1964 Helsinki declaration and its later amendments.

Consent for publication

All persons who were seen in the video consent to publish itself.

Competing interests

The authors declare that they have no competing interests.

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Tables

Table 1. 17 Patients' clinical characteristics, stratified by techniques

	Overall (N = 17)	Simple Flexible Ureteroscopy (N = 10)	Ultrasound-guided Flexible Ureteroscopy (N = 7)	P Value
Age (Years) mean $\pm$ SD	52.8 $\pm$ 15.1	54.7 $\pm$ 15.8	50.3 $\pm$ 17.6	.652
Gender n (%)				.772
Male	8(47.1)	5(50.0)	3(42.9)	
Female	9(52.9)	5(50.0)	4(57.1)	
Preoperative symptoms n (%)				.748
pain	4(23.5)	3(30.0)	1(14.3)	
haematuria	2(11.8)	1(10.0)	1(14.3)	
asymptomatic	11 (64.7)	6(60.0)	5(71.4)	
Mean cyst size (mm) mean $\pm$ SD	53.6 $\pm$ 5.8	58.5 $\pm$ 3.5	53.7 $\pm$ 4.9	.141
locations of the parapelvic cysts n (%)				.155
Upper pole	7(41.2)	4(40.0)	3(42.9)	
Middle pole	2(11.8)	0(00.0)	2(28.6)	
Lower pole	8(47.1)	6(60.0)	2(28.6)	
Combine with renal stone n (%)				.115
Yes	11 (68.8)	8(80.0)	3(42.9)	
No	6 (31.2)	2(20.0)	4(57.1)	
Stone size (mm) mean $\pm$ SD	10.1 $\pm$ 1.7	14.5 $\pm$ 3.2	8.9 $\pm$ 2.6	.005

The expression of continuous variables and categorical variables were mean $\pm$ standard deviation and n (%), respectively.

Table 2. Intraoperative data, postoperative values and procedural outcomes

	Overall (N = 17)	Simple Flexible Ureteroscopy (N = 10)	Ultrasound-guided Flexible Ureteroscopy (N = 7)	P Value
Mean operative time (min) $\bar{x}$ mean $\pm$ SD	30.8 $\pm$ 8.4	25.9 $\pm$ 8.7	37.1 $\pm$ 10.1	.004
searching the renal cyst time(min) $\bar{x}$ mean $\pm$ SD	22.7 $\pm$ 5.3	17.6 $\pm$ 5.8	26.5 $\pm$ 8.4	.002
incision of the renal cyst time(min) $\bar{x}$ mean $\pm$ SD	10.8 $\pm$ 4.7	7.1 $\pm$ 4.9	12.1 $\pm$ 5.6	.000
Hospitalization time (days) $\bar{x}$ mean $\pm$ SD	3.0 $\pm$ 1.2	2.6 $\pm$ 1.5	3.4 $\pm$ 1.7	.001
Postoperative complications n (%)				.540
Fever	2 (12.5)	1 (10.0)	1 (14.3)	
Backache	4 (25.0)	1 (10.0)	3 (42.9)	
Sepsis	0(0)	0(0)	0(0)	
Follow-up of one year n (%)				.949
The disappearance rate of cyst	12 (70.6)	7 (70.0)	5 (71.4)	
The regression rate of cyst	5 (29.4)	3 (30.0)	2 (28.6)	

The expression of continuous variables and categorical variables were mean $\pm$ standard deviation and n (%), respectively.

Figures

Figure 1

Procedures of the surgery. (A); When the flexible ureteroscopy pushing the cyst wall, hyperechoic line was showed under ultrasound; (B); Typical “smoking sign” was showed under ultrasound when laser-assisted incision (C) Cyst wall was not the typical blue in endoscopy; (D) Image of parapelvic renal cyst after flexible ureteroscopic incision and drainage with holmium laser

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- [Video1demonstrationofultrasoundguidedflexibleureterscopeprocedure.BMCurology.mp4](#)