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Original Article

Retrograde ureteral catheterization under local anesthesia for emergency drainage in patients with infection and hydronephrosis secondary to ureteral calculi: Experience from a tertiary care hospital

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Abstract

Objectives: The aim is to evaluate the safety and efficacy of retrograde ureteral catheterization under local anesthesia in patients with urinary tract infections complicated by hydronephrosis caused by ureteral stone obstruction. **Materials and Methods:** From October 2020 to September 2021, a retrospective analysis of patients' medical records was performed. Records of past history, physical examination, laboratory tests, and imaging investigations were reviewed. Retrograde ureteric stent (RUS) was performed under local anesthesia using cystoscopes and guided by portable fluoroscopy. Real-time fluoroscopy was used to verify the double-J stent position and confirm a smooth process. The postoperative recovery and length of admission were also recorded. **Results:** A total of 14 patients with ureteral stone obstruction with infective hydronephrosis received 15 total emergency RUS procedures (one bilateral). Intraoperative findings, operation times, and infection signs were recorded and analyzed. All patients met systemic infection criteria, with a mean body temperature of 38.7°C ± 1.7°C. Leukocytosis was noted in 8 (57.1%) patients. Elevated C-reactive protein (8.5 ± 6.3 mg/L) and procalcitonin (24.1 ± 22.0 ng/mL) were found in 13 (92.9%) and 9 (64.3%) patients, respectively. Mean stone size was 8.5 ± 6.3 mm, mostly localized to the upper ureter (upper: 12; middle: 0; lower: 3). Mean operation time was 14.1 ± 4.3 min. After emergency drainage, all patients improved and were discharged after infection was controlled. The average length of admission was 6.2 ± 2.2 days. **Conclusion:** RUS under local anesthesia is safe and effective for treating infective hydronephrosis due to ureteral stone obstruction. A randomized controlled trial with a large sample remains necessary to validate these findings.

Keywords: *Retrograde ureteral catheterization, Ureteral stent, Urolithiasis*

Introduction

Urinary tract stone is a common disease noted worldwide in modern society, with an increasing prevalence in recent years (5%–15% in different areas). Despite adequate treatment, the lifelong recurrent rate remains high (approximately 50%) [1,2]. Rise of metabolic syndrome, global warming, and highly availability of advanced medical imaging techniques that help in the detection of stones, leading to increased prevalence [3,4]. Renal colic and hematuria are the most common symptom of acute ureteral stone obstruction. Urinary tract infections and acute renal insufficiency are the most commonly reported major complications secondary to urinary tract stone obstruction. In prolonged severe sepsis or ignored obstruction, permanent renal function deterioration or mortality can develop [5,6].

The management of sepsis secondary to ureteral calculi obstruction should consist of three important steps: adequate fluid resuscitation, broad-spectrum empiric antibiotics, and surgical drainage of the main infection source [7-9]. Immediate drainage of an obstructed and infected urinary tract is associated with lower overall mortality [10]. Currently, two techniques are widely used for emergency decompression: retrograde ureteric stent (RUS) and percutaneous nephrostomy (PCN). Both methods have advantages and disadvantages, and which is the most effective remains controversial [11,12]. The safety

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and efficacy of both approaches have been well established, with similar efficacy reported for both techniques. However, some reports suggest that RUS is inferior to PCN due to the risk of exacerbating infection during bladder irrigation, inadequate drainage, and higher cost [13]. Another argument suggests that PCN is a better option than RUS because PCN can be performed under local anesthesia and minimal bladder irrigation to avoid spreading infection [14]. However, some patients are not suitable for or are not willing to submit to PCN, which makes RUS the only option. This study reports the safety and effectiveness of RUS performed under local anesthesia with minimal fluid irrigation for the treatment of ureteral stone obstruction with infective hydronephrosis.

Materials and Methods

From October 2020 to September 2021, a retrospective analysis of patients' medical records was performed at Taipei Tzu Chi Hospital to identify patients with ureteral stone obstruction with infective hydronephrosis who received emergency RUS. We only enrolled those patients who presented to the emergency department and underwent RUS within 24 h of diagnosis. The patients' history and medical exams were carefully reviewed. Records of past history, physical examination, laboratory tests, and imaging investigations were reviewed. Abdominal X-ray, renal sonography (RS), and abdominal to pelvis computed tomography (CT) were performed in all patients as part of a complete evaluation before the operation. Stone characteristics were measured according to imaging studies. Stone size was recorded based on the maximum diameter measured on CT. Stone location was defined as the upper, middle, or lower ureter depending on the relative locations of the iliac vessels and sacroiliac joint. The degree of hydronephrosis was classified as mild, moderate or severe based on RS outcomes using the following definition, which was the same as our previous report [15]. Mild hydronephrosis refers to dilatation of the renal pelvis and some calyces; moderate hydronephrosis refers to marked dilatation of the calyces; and severe hydronephrosis refers to all the above with narrowing parenchyma [15]. Complete blood count, differential count, bio-chemical studies of renal and liver function, prothrombin time, and activated partial thromboplastin time were all evaluated at the emergency department. The severity of the infection was measured according to serum procalcitonin (PCT) and C-reactive protein (CRP) levels. Blood bacteria cultures were also obtained before the administration of antibiotic therapy. Urine cultures were collected both before and after the RUS. Complete informed consent was obtained before the procedure.

The patients were sent to the operating room after primary acute resuscitation and the initial broad-spectrum antibiotics. RUS was performed under local anesthesia by the same surgeon (Dr. Wu) using 30° and 70° cystoscopes and guided by portable fluoroscopy. The patient was placed into the lithotomy position and received local anesthesia in the form of a urethral injection of Lido jelly (2% lidocaine HCl). After entering the bladder and identifying the ureteral orifices, a hydrophilic guidewire was placed into the ureter orifice under direct visualization. Portable fluoroscopy was used to verify that the guidewire passed beyond the stone obstruction and reached the renal pelvis. One double-J stent (DBJ) was set along the wire. Real-time fluoroscopy was used to verify the DBJ position and confirm a smooth process. At the end of the operation, a 14-Fr indwelling Foley catheter was placed in each patient. During the procedure, gravity was used in place of pressurized bladder irrigation, pressure was maintained below 50 cmH_2O, and minimal fluid was used to prevent infection spread.

Postoperative recovery outcomes were recorded. The patients' vital signs and laboratory investigations were used as major indicators of infection control. The total length of admission was also analyzed. Descriptive statistics analysis was performed using SPSS (IBM Corp. Released 2013. IBM SPSS Statistics for Windows, Version 22.0. Armonk, NY, USA).

This study had been approved by the Ethics Committee of Buddhist Tzu Chi General Hospital, Taipei, Taiwan (approval number: 11-X-026). Informed consent was waived by the Ethics Committee of Buddhist Tzu Chi General Hospital, Taipei, Taiwan, because the chart review involved routine treatment and the study was conducted retrospectively.

Results

A total of 14 patients were enrolled in this study, including 8 men and 6 women, with a mean age of 65.4 ± 14.8 years (range: 40–87 years). Among them, 3 (21.4%) patients had a history of diabetes; 10 (71.4%) had hypertension; 2 (14.3%) had previously experienced stroke; 4 (28.6%) had heart disease; and 1 (7.1%) had chronic obstructive pulmonary disease. All patients met the criteria for systemic inflammatory response syndrome, and 10 had fever >38°C, with a mean body temperature at presentation to the emergency department of 38.7°C ± 1.7°C (range: 35.6°C–41.3°C). Other symptoms of sepsis, such as chills and consciousness changes, were noted in 8 (57.1%) and 7 (50%) patients, respectively. Detailed baseline data are presented in Table 1.

Leukocytosis is a commonly identified sepsis symptom, detected in sepsis, 8 (57.1%) patients. Acute kidney injury (AKI) was detected in 6 (42.9%) patients, defined as an absolute increase in serum creatinine >0.3 mg/dL. No patients in our study experienced thrombocytopenia. Elevated CRP (8.5 ± 6.3 mg/L) and PCT (24.1 ± 22.0 ng/mL) were detected in 13 (92.9%) and 9 (64.3%) patients, respectively. Positive urine and blood cultures were noted in 10 (71.4%) and 9 (61.3%) patients, respectively. Negative cultures were noted in 4 (28.6%) patients. *Escherichia coli* was the most commonly detected species (five patients), followed by *Klebsiella pneumoniae* (two patients), whereas *Proteus mirabilis*, *Morganella morganii*, and *Staphylococcus aureus* were detected in one patient each.

A total of 15 RUS were performed (one patient had simultaneous bilateral ureteral stone obstructions). Of these 15 events, 6 were right ureter stones, and 9 were left ureter stones. The average stone size was 8.5 ± 6.3 mm, and most were localized to the upper ureter (upper: 12; middle: 0; lower:

3). Hydronephrosis was mostly mild (mild: 11; moderate: 4; severe 0). Twelve cases presented with fat stranding around the affected kidneys. After retrograde catheterization, pus drainage from the ureteral orifice was noted in 11 (73.3%) patients. The mean operation time was 14.1 ± 4.3 minutes. Details regarding laboratory investigations and stone characteristics are summarized in Table 2.

After emergency drainage, all patients showed progressive improvement and were discharged after the infection was controlled. Vital signs and laboratory investigation results before discharge are summarized in Table 3. The average length of admission was 6.2 ± 2.2 days, and only 5 (35.7%) patients required short-term intensive care, lasting fewer than 3 days. Continuous oral antibiotics were prescribed for 1 week after discharge. Further stone management approaches were recommended to be discussed during clinical follow-up with the patients and their primary care providers.

The first clinical follow-up was usually scheduled 1 week after discharge. The average interval between hospital admissions is 17.6 ± 1.9 days. Extracorporeal shock wave lithotripsy (ESWL) and ureteroscopic lithotripsy (URSL) are the most common stone management, each with 6 (42.9%) patients treated. Only one patient each (7.1%) had been treated with percutaneous nephrostomy lithotripsy (PCNL) or retrograde intrarenal surgery (RIRS). In those who had received ESWL, URSL, and PCNL, the DBJ would be removed 2 weeks postoperatively after being checked for no residual stone by abdominal X-ray during clinical follow-up. We extended DBJ placement in the patient undergoing RIRS to 1 month to complete the stone passage. No stent encrustation was noted in our study. All patients were asked to follow up 1 month after DBJ removal, and no special events or complications were recorded.

Discussion

In the present study, we showed that RUS performed under local anesthesia is a safe and effective procedure for treating infective hydronephrosis caused by ureteral stone obstruction. This procedure provides excellent decompression performance and infection control, offering better patient comfort and easier catheter care.

Ureteral calculi obstructions accompany with infection may cause serious complications such as pyelonephritis, AKI, and even death. Emergent and effective drainage is crucial in the treatment of these conditions and has a relationship with better outcomes [10]. RUS internal drainage and PCN percutaneous drainage are the most common interventions for ureteral stone-induced sepsis and infective hydronephrosis. Many studies attempt to compare the differences between the two procedures. To our knowledge, Pearle *et al*. [16] reported the first report more than 20 years ago. They found that RUC and PCN were equally effective in both obstruction and infection control caused by ureteral stones. Another study by Mokhmalji *et al*. [13] demonstrated that PCN is better than RUS. They report that PCN can provide better success rates, shorter operative time, reduced use of anesthesia drugs and X-ray exposure, and most importantly, better quality of life. To date, PCN is still considered to provide better stone passage and quality of life compared to RUS [11].

Table 1: Patient's underlying diseases and baseline data before treatment

Index	Value, *n* (%)
Age (years), mean±SD	65.4±14.8
Sex (male: female)	8:6
BMI (kg/m^2), mean±SD	26.6±4.6
Diabetes	3 (21.4)
Hypertension	10 (71.4)
CVA	2 (14.3)
Heart disease	4 (28.6)
CKD	0 (0)
COPD	1 (7.1)
BT (°C), mean±SD	38.7±1.7
Fever	10 (71.4)
MAP (mmHg), mean±SD	89.6±23.3
Chills	8 (57.1)
Consciousness change	7 (50)
AKI	6 (42.9)

AKI: Acute kidney injury, BMI: Body mass index, BT: Body temperature, CKD: Chronic kidney disease, COPD: Chronic obstructive pulmonary disease, CVA: Cerebrovascular accident, MAP: Mean arterial pressure, SD: Standard deviation

Table 2: Laboratory investigation results and stone characteristics

Index	Value
WBC (10^3/µL), mean±SD	18.2±23
CRP (mg/L), mean±SD	8.5±6.3
PCT (ng/mL), mean±SD	24.1±22.0
CRE (mg/dL), mean±SD	1.4±0.6
Positive urine culture, *n* (%)	10 (71.4)
Positive blood culture, *n* (%)	9 (64.3)
Stone characteristics	15 events
Side (right: left), *n*	6:9
Size (mm), mean±SD	8.5±5.3
Location (upper: middle: lower)	12:0:3
Hydronephrosis (mild: moderate: severe)	11:4:0
Fat stranding, *n* (%)	12 (80)
Pus from UO, *n* (%)	11 (73.3)
Operation time (min), mean±SD	14.1±4.3

CRE: Serum creatinine, CRP: C-reactive protein, PCT: Serum procalcitonin, SD: Standard deviation, UO: Ureteral orifice, WBC: White blood cell

Table 3: Vital signs and laboratory investigation results before discharge

Index	Value
BT (°C), mean±SD	36.6±0.3
MAP (mmHg), mean±SD	108.8±11.7
WBC (10^3/µL), mean±SD	8.7±3.8
PCT (ng/m), mean±SD	1.59±2.53
CRE (mg/dL), mean±SD	0.94±0.37
ICU admission, *n* (%)	5 (35.7)
Total days, mean±SD	6.2±2.2

BT: Body temperature, CRE: Serum creatinine, SD: Standard deviation, ICU: intensive care unit, MAP: Mean arterial pressure, PCT: Serum procalcitonin, WBC: White blood cell

Despite the potential benefits of PCN in terms of quality of life, there are some disadvantages associated with PCN. Common adverse events after PCN include tube dysfunction, wound infection, renal bleeding, urine leakage, fistula formation, and surrounding tissue damage [17,18]. Surgical positioning is also important, especially in those patients with severe infections. Lateral or prone positioning is often required to receive PCN, which can cause unpredictable hemodynamic changes and unnecessary respiratory stress. In addition, the presence of skeletal and renal anatomical abnormalities or mild hydronephrosis can lead to PCN misplacement [19,20]. Hsu *et al*. [21] reported a review in 2016 on the long-term use of RUS or PCN. Patient-centered decision-making is the most important.

The most frequent considerations regarding RUS are the performance of fluid instillation and the use of spinal or general anesthesia in most hospitals [22]. Bladder fluid instillation can lead to the reflux of bacteria or pyrogens into the kidney and bloodstream, which could induce severe sepsis [14,23]. The risks associated with anesthesia increase significantly in cases with acute infections or sepsis [24]. Life quality is also the other consideration; patients with DBJ are more likely to have bladder irritation symptoms than PCN. However, in a life quality analysis reported by Joshi *et al*. [25] showed no significant difference in the gross impact on the health-related quality of life between these groups. Our study provided a safe and effective method that avoids these common problems. Patients received only local anesthesia at the urethra, and saline was instilled at a very low pressure using a minimal volume. Among the 14 patients who underwent 15 total procedures, the success rate was 100%, with no drainage failure and no conversions to PCN.

The symptoms and signs of systemic infections vary across individuals. Commonly used objective parameters include body temperature, white blood cell count, PCT, and CRP [26]. Among these markers, PCT is often considered the best biomarker for detecting bacterial infection and sepsis, providing useful guidance for antibiotic use and serving as a prognostic predictor [27]. In the present study, body temperature, white blood cell count, PCT, and CRP were used to evaluate the outcomes of infection control. All of these markers showed significant improvement (all $P < 0.001$) within 1 week after drainage. Urinary tract infections are commonly encountered worldwide, often caused by uropathogens, including *E. coli, Enterococcus faecalis, K. pneumoniae*, and *P. mirabilis* [28,29]. A relationship between urolithiasis and urinary tract infection has been established. Stones associated with urease-producing bacterial urinary tract infections often consist of magnesium ammonium phosphate, with or without carbonate apatite [30]. The most important urease producers are *Proteus, Klebsiella, Pseudomonas*, and *Staphylococcus* species. Our study detected some of these bacteria, which might be associated with recurrent stone formation.

The present study has some limitations. First, the patients' usual physical conditions could not be standardized, and the patient population include different ages, underlying diseases, current medications, and the presence of other urinary tract abnormalities. Second, this is a retrospective study and lacked a suitable control group or comparative data for other treatments. Data missing cannot be completely avoided. Third, the small case number made identifying potential prognostic factors predictive of treatment success difficult. A larger size, prospective, comparative study (especially comparing RUS and PCN) may be needed to overcome these limits.

Conclusion

The present study presents a safe and effective procedure for treating patients with infective hydronephrosis caused by ureteral stone obstruction. RUS under local anesthesia avoids the risks associated with general anesthesia and bladder irrigation that complicated prior RUS approaches. Drainage from natural orifices avoids the need to adjust the operation position and reduces bleeding. The ability to perform the procedure without wounding the body provides better tube care and improves patient comfort. Although more comparative studies remain necessary, we hope that RUS under local anesthesia will become the primary standard of care for such patients.

Data availability statement

The datasets generated during the current study are not publicly available, but are available from the corresponding author on reasonable request.

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Conflicts of interest

There are no conflicts of interest.

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