Research Article

Emergency Ureteroscopy for Obstructive Anuria Caused by Ureteric Stones

Abstract

Objective: This study details our experiences of the efficiency and safety of emergency ureteroscopy as a treatment of ureteral stones presented in cases of acute renal failure.

Introduction: Acute Renal Failure (ARF) is a syndrome characterised by a rapid decline in the glomerular filtration rate and retention of nitrogenous waste products such as Blood Urea Nitrogen (BUN) and creatinine. Clinically, ARF is separated into 3 major categories: pre-renal, intrinsic, and post-renal. Post-renal ARF is most frequently caused by an obstruction of the urinary tract. Ureteral calculi are one of the most frequent causes of obstruction of the urinary tract. The emergency approach, within 24-48 hours of presentation to the emergency room, is both productive and cost-efficient. This study was presented as a moderated poster in EAU Urology in January 2024 and as a non-moderated poster in SIU in October 2023.

Patients and Methods: This retrospective study was conducted between May-December 2013. 4200 cases presented with anuria or oliguria, 743 of which were diagnosed as post-renal ARF. 389 patients (266 men and 123 women) with post-renal ARF with ureteric stones underwent emergency ureteroscopy and were included in the study. 70 patients (18%) had bilateral uteral stones, 148 patients (38%) had stones in the right ureter only, and in 171 (44%) in the left. There were 263 (57.3%) calculi in the pelvic ureter, 84 (18.3%) in the iliac ureter, and 112 (24.4%) in the lumbar ureter. Stone size ranged from 6-27 mm with a mean of 7.8 ± 7.9mm, as measured on pre-operative radiography of plain KUB, ultrasonography, and non-contrast spiral C.T, recorded as the maximal diameter.

Results: 432 of 459 procedures (95.1%) resulted in a total removal of stones. Failure to retrieve the stones was reported in 27 procedures (5.9%), including a failure to retrieve the stones because of severely impacted distal stones in 8 procedures (1.7%). These cases were managed with a nephrostomy tube, followed by an elective URS one week later, and were subsequently reported as stone-free. The hospital stay ranged from 1-14 days with a mean of 2.4 ± 1.7 days. The success rates for removing stones from the lower ureter, mid-ureter, and upper ureter were 93.5%, 82.1%, and 77.7% respectively (p value=.000). This procedure failed in 16 cases (3.4%) where the stone size was ≤1cm, and 11 cases (2.3%) where the stone size was >1cm (p-value 0.004). A higher failure rate was reported with pneumatic lithotripsy (10.6%) than laser (6.8%) (p-value 0.012). The mode of extraction also affected the success of the procedure, with a higher failure rate reported in procedures with the basket (7.3%) than those with forceps (1.7%) (p-value 0.029).

Conclusions: This study examined the efficacy of various methods of ureteroscopy management of ureteral stones in emergency situations. Emergency URS appears to be an efficient treatment modality for obstructive ureteral stones, especially distal ones. It is safe and effective, as well as providing immediate relief from pain and stone fragmentation. However, this procedure requires specific technical expertise and dedicated facilities, and more extensive studies with these features in place would be required to corroborate our findings.

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Introduction

Acute Renal Failure (ARF) is a critical condition marked by a rapid decline in kidney function, leading to the accumulation of nitrogenous waste products such as Blood Urea Nitrogen (BUN) and creatinine. This condition can be distressing for both patients and their families. ARF is classified into three main types: pre-renal, intrinsic, and post-renal. Post-renal ARF often results from urinary tract obstructions, with ureteral stones being a common cause. Greater awareness and improved management of urinary tract stone disease are essential, as it affects 2-3% of cases [1] and has significant consequences for patients. Obstructive ureteral calculi are a leading cause of severe colic pain, necessitating rapid evaluation and treatment. Calculus anuria is considered a medical emergency and can arise due to bilateral ureteric impaction or unilateral ureteric obstruction in a solitary or only functioning kidney [2]. Calculus anuria leads to increased intra-pelvic pressure and potential renal damage. The extent of renal function impairment depends on factors such as the unilateral or bilateral nature of the obstruction, its acute or chronic presentation, and whether it is partial or

complete. Experimental studies have demonstrated that significant renal function changes can occur within the first 24 hours of complete Unilateral (UUO) or Bilateral Ureteral Obstruction (BUO). Early intervention is crucial to prevent chronic renal failure [3]. The primary objective in managing acute upper urinary tract obstruction is to restore urinary drainage. The chosen intervention—whether immediate or delayed, endoscopic, percutaneous, open, or laparoscopic—depends on diagnostic findings. When feasible, definitive treatment should be provided alongside urinary drainage. In cases of renal failure, infection, or complete obstruction, urgent decompression of the obstructed tract is the priority [4]. In well-equipped facilities, immediate and definitive treatment for patients with calculus anuria is preferred over temporary diversion. Ureteroscopy (URS) combined with intracorporeal lithotripsy is the preferred approach for most obstructive lower and middle ureteral calculi [5]. Despite the increasing interest in URS, limited data exist on its emergency use for obstructive anuria caused by ureteral stones. Emergency procedures within 24-48 hours have been shown to be effective and cost-efficient, and this approach is currently under review in AUA and EUA guidelines [6]. Teichman highlighted the role of temporary procedures, such as nephrostomy or double-J stenting, in managing obstructive anuria and noted a growing preference for non-urgent pathways in urgent stone conditions [7]. This study presents our experiences in evaluating the safety of emergency URS procedures.

Materials and Methods

This retrospective study was conducted from May to December 2013 and included 4,200 patients with anuria or oliguria, 743 of whom were diagnosed with post-renal Acute Renal Failure (ARF). A total of 389 patients (266 men and 123 women) with ureteric stones underwent emergency ureteroscopy. Anuria was the chief complaint in 227 patients (58.3%), while 162 (41.6%) presented with oliguria. Loin pain was reported by 170 patients (37%), and 60 patients (13%) experienced haematuria. Serum creatinine levels ranged from 1.8 to 26 mg/dL (mean: 6.45 ± 4.1 mg/dL), while serum potassium levels ranged from 5 to 7.6 mmol/L (mean: 6.2 ± 0.36 mmol/L). Urine cultures were collected from 162 patients (41.6%), and all patients underwent renal ultrasonography and KUB imaging to detect hydronephrosis and stone locations. Non-contrast CT scans were performed on 310 patients (67.5%) with non-opaque stones. In this study, bilateral ureteral stones were found in 70 patients (18%). Right ureteral stones were present in 148 patients (38%), while left ureteral stones were identified in 171 patients (44%).

Improvement Evaluation

Improvement was classified into three categories based on specific criteria:

- **Evident improvement**: Defined as meeting one or more of the following criteria:Serum creatinine returned to normal based on the patient's age and gender.
- Creatinine clearance increased by 20 mL/min or more.
- Complete weaning from dialysis.

Equivocal improvement: Defined as meeting one or both of the following criteria:

- Serum creatinine decreased but remained above the normal range for the patient's age and gender.
- The number of weekly dialysis sessions decreased.

No improvement: Patients who did not meet the criteria for evident or equivocal improvement were classified under this category.

Data Collection and Treatment Outcomes

Data collected included patient demographics, stone characteristics, type of treatment, and post-operative outcomes and complications.

Treatment failure: Defined as stones remaining in situ, residual stone fragments <3 mm, or failed access.

Treatment success: Defined as the complete absence of stones and fragments.

Impacted stones: Defined by the inability to pass a guidewire or catheter on initial attempts.

Stone-free status: Defined as the complete absence of calculi at the last follow-up.

Of the total calculi, 263 (57.3%) were in the pelvic ureter, 84 (18.3%) in the iliac ureter, and 112 (24.4%) in the lumbar ureter. Stone sizes ranged from 6 to 27 mm, with a mean size of 7.8 ± 7.9 mm, measured using plain KUB, ultrasonography, and non-contrast spiral CT. Refer to Table 1 for more details. A total of 84 patients (21.5%) underwent preoperative haemodialysis. Metabolic acidosis was found in 23 patients with a pH of less than 7.2 (27.3%), while 47 patients (55.9%) had severe hyperkalaemia (serum potassium >7 mmol/L). Additionally, 14 patients (16%) presented with volume overload, leading to respiratory and circulatory issues. Ureteroscopy was performed in this group after correcting electrolyte and acid-base imbalances. Ureteroscopy was conducted under

Table 1:

Variables	
Laterality: Right: Left: Bilateral:	148(38%) 171(44%) 70(18%)
Stone location: Pelvic: Iliac: Lumbar:	263(57.3%) 84(18.3%) 112(24.4%)
Size of stone: ≤1cm: >1cm:	369(80.4%) 90(19.6%)
Opacity: Radio-opaque: Radio-lucent:	149(32.4%) 310(67.5%)
Recurrence: Denovo: Recurrent:	110(28.2%) 279(71.7%)
Multiplicity: Single: Multiple:	 331(72.1%) 128(27.9%)

spinal anaesthesia, with preoperative antibiotics administered. A semi-rigid ureteroscope (sizes 8.5–10 CH or 9.5–11.5 CH) was guided by fluoroscopy. In 275 cases (59.9%), a ureteral catheter was placed and removed within 48 hours, while a double-J stent was inserted in 184 cases (40.1%). The operative time ranged from 25 to 80 minutes, with an average of 45 ± 28.5 minutes. Post-treatment monitoring included urine culture, serum creatinine levels, and electrolyte assessments. Radiologic follow-up involved a plain abdominal film on the first postoperative day to evaluate the initial stone-free rate and stent position, along with a non-contrast CT for cases with radiolucent stones or suspected residual fragments. Another plain abdominal film was performed before removing the double-J stent, typically after 15 to 30 days. Postoperative patient monitoring included vital signs, urine output, fluid balance, and the management of any complications until normalization. Patients were discharged once they had stable vital signs, spontaneous diuresis, effective pain control, independent mobility, and no significant complications. Follow-up appointments were scheduled every two weeks for the first two months, then every two months for a year, or as needed, particularly for patients with residual stones or those requiring secondary procedures. The study analysed patient characteristics and outcomes using IBM SPSS Statistics version 19 software (IBM Corp., Armonk, NY, USA). Outcomes were compared based on stone locations, gender, ureteroscopy types, and stent use, utilizing Pearson's chi-square test for categorical variables and analysis of variance (ANOVA) for continuous variables. Statistical significance was set at $p < 0.05$. Since not all patients had complete data, analyses were performed on available data.

Results

Ureteroscopy Procedure

URS (Ureteroscopy) was performed under spinal anaesthesia with a semi-rigid ureteroscope and fluoroscopic guidance. Ureteral dilation was needed in 43 cases (9.4%). Stone extraction was achieved mechanically in 144 procedures (31%) using graspers and in 74 (16.1%) with a basket. Pneumatic lithotripsy was used in 123 cases (26.8%), while laser lithotripsy with Ho:YAG was performed in 118 (25.7%). The overall stone-free rate was 95.1% (432 of 459 procedures), with 27 failures (5.9%). Of these, 8 cases (1.7%) involved severely impacted distal stones managed with a nephrostomy tube followed by elective URS. Other failures included 7 cases (1.5%) of stone migration, effectively treated with double-J stenting and either ESWL or alkalization therapy. Stone fragmentation failed in 3 cases (0.6%), and minor ureteral perforations occurred in 9 (2%), all treated conservatively. Hospital stays ranged from 1-14 days, averaging 2.4 ± 1.7 days. All patients experienced obstructive diuresis on the first day, with urine volumes between 3,200-7,600 mL over 24 hours, decreasing to a normal range of 1,500-3,000 mL daily within seven days. Renal function returned to normal in 63.0% of patients within three days and in 75.4% within seven days. One patient showed significant improvement in renal function at the 12-week follow-up. Hyperkalaemia resolved by the third day post-operation. Seven patients had mild fevers (37.2-37.5°C) on the first post-operative day, normalizing by day three. One patient had a higher fever of 38.8°C, which resolved by day four after treatment with ceftriaxone sodium. Regarding delayed complications, two patients (0.2%) developed ureteral strictures. One had stenosis post-ureter lithotripsy, managed with balloon dilatation and a double J stent for four weeks. The other underwent endoscopic ureterostomy and had a ureteral stent placed for six weeks, both with uneventful follow-ups.

Improvement Evaluation

Evident improvement was reported in most cases. Creatinine returned to normal as per the patient's age and gender. The mean serum creatinine in the first week post-operatively was 2.6 ± 1.17 mg/dl. A more favourable outcome was achieved for patients with bilateral obstruction than those with unilateral obstruction, with mean creatinine in the early post-operative measured at 2.43 and 2.76 mg/dl respectively (p value=0.006). There were also better outcomes for those with distal ureteric stones than those with proximal ureteric stones, with serum creatinine measured at 3.61 and 4.39 mg/dl respectively (p-value=0.000). The pre-operative serum creatinine level and degree of hydronephrosis had no statistically significant values in relation to post-operative renal function (p-value >0.05).

Discussion

Acute Renal Failure (ARF) accounts for approximately 5% of hospital admissions and up to 30% of intensive care admissions [8]. It can be asymptomatic and is often detected through routine biochemical screenings. A multi-center study identified the primary causes of ARF as follows: 45% due to acute tubular necrosis, 21% pre-renal, 13% acute-on-chronic renal failure, 10% urinary tract obstruction, 6% glomerulonephritis-vasculitis, 4% acute interstitial nephritis, and 1% aeroembolism renal disease [9]. The kidneys have a unique ability to recover from significant loss of function, and most cases of ARF are reversible, although some residual defects may persist. Calculus disease can lead to ARF, requiring urgent interventions such as percutaneous nephrostomy, dialysis, and surgical treatments like ureteroscopy with lithoclast or Extracorporeal Shock Wave Lithotripsy (ESWL) to prevent chronic renal failure [10]. The management of ARF depends on its cause. Post-renal ARF, associated with urinary tract obstruction, occurs in 5-10% of cases. The recovery potential in humans varies based on the extent and duration of the obstruction, with documented recoveries even after prolonged obstruction (≥69 days) [11]. Calculus obstructive anuria is a medical emergency that can occur due to bilateral ureteric impaction or unilateral ureteric obstruction, particularly in patients with a solitary functioning kidney. Obstructing ureteral stones are the most common cause of acute urinary obstruction and require urgent evaluation and treatment [14]. Treatment typically involves relieving the obstruction, followed by definitive management of the stones [12]. Emergency definitive stone clearance is a favourable and cost-effective option that reduces patient suffering and improves productivity. Studies have shown positive stone-free rates and manageable morbidity with emergency ureteroscopy stone treatment, particularly for stones >1 cm and those located distally [12]. While minimally invasive procedures are preferred, ongoing debate exists regarding whether elective or Urgent Ureteroscopy (URS) should be prioritized. Advances in ureteroscopy technology have improved the safety of accessing urinary calculi [4]. However, limited data exist on the effectiveness of emergency URS for ureteral colic caused by stones, although treating patients within 24-48 hours of emergency room presentation is both beneficial and cost-efficient [13]. The standard approach for managing symptomatic, obstructive ureteral stones in ARF usually involves placing a nephrostomy tube or internal ureteral stent, followed by plans for stone disintegration or removal. Nephrostomy drainage may be preferred in cases of infected hydronephrosis, but both methods successfully relieve obstruction [14]. Calculus anuria increases intra-pelvic pressure and can cause significant renal damage, making prompt management essential in preventing chronic renal failure. Immediate treatment is preferable in well-equipped facilities [15]. Some studies, such as those by, performed emergency operations without temporary urinary diversion, while opted for preliminary diversion in all cases. Immediate treatment allows for effective obstruction relief in a single session. The American Urological Association reported a stone-free rate of 56% for stones <1 cm and 44% for those >1 cm in the proximal ureter, compared to 89% and 73% for those in the distal ureter [16]. In our study, males comprised 68.3% of patients and females 31.7%, similar to [34], who reported 74% male patients. The procedure had a 98.1% success rate for distal ureteric stones. Initial stone-free rates after ureteroscopy were 95.7% for stones <10 mm and 87.8% for larger stones. The duration of anuria ranged from 1-3 days, with serum creatinine normalizing within six days. [35] indicated that earlier presentations (i.e., within five days) resulted in better outcomes, while prognosis worsened for patients with more than ten days of anuria [17] found that maximum improvement in creatinine levels occurred 2-14 days after obstruction relief, highlighting the importance of timely intervention in minimizing renal damage. Open surgery was required for one patient (0.2%) due to a proximal stone complication, necessitating ureterovesical reimplantation as an urgent treatment. Sharma et al. (2003) noted that open mini-access ureter lithotomy is a reliable minimally invasive option, primarily used as salvage after failed first-line treatments, but can also be effective as a first-line treatment in selected cases. The success rate for ureterorenoscopy with lithoclast was reported at 94.1%, while studies by Mugia et al. (2006) and Park et al. (1998) indicated success rates of 87% and 87.8%, respectively. Both studies utilized ureteric occlusion balloon catheters to minimize stone migration. Drimi et al. (2006) employed a ureteric balloon catheter and Dormia basket for the same purpose. Traditionally, ureteroscopy techniques have higher complication rates (9%-11%) than shock wave lithotripsy (4%). However, advancements such as small-caliber flexible ureteroscopes and Holmium:Yttrium-Aluminum-Garnet (YAG) laser have improved stone-free rates and lowered severe complication risks, although ureteral trauma may still occur in approximately 15% of procedures [18]. In our

study, no severe complications were reported, with minor complications (modified Clavien classification grade 1) occurring in 24 cases (5.2%), including one case of ureteric avulsion. These results align with existing literature [19]. While there is no formal classification for ureteroscopy injuries, they are typically categorized by severity. Most complications are minor and manageable without surgery, whereas major complications require intervention and can have serious consequences. To prevent ureteral injuries, refined surgical techniques are essential. In particular, forced manoeuvres should be avoided during ureteroscope introduction, and good visibility must be maintained [20]. Complications were related to stone characteristics and patient factors. Minor injuries to the ureteral mucosa can occur during the use of guidewires and instruments, leading to perforation. Ureteral perforation has a 2% incidence, often associated with longer procedures. Most perforations can be treated with an endoscopic ureteral stent, and immediate double J stenting is effective in over 80% of cases [38]. If retrograde placement of a stent is not an option, complications can be managed through percutaneous nephrostomy and antegrade stent insertion. When endoscopic or percutaneous approaches are not viable, open surgery may be necessary [21]. According to [37], minor bleeding that impaired visibility was the most common reason for repeat ureteroscopy, although it was the primary complication in only one out of 346 procedures (0.3%). Ureteral stripping is a serious complication, but its incidence has decreased with experience. Most cases were linked to the forced extraction of calculi using a Dormia basket. Open surgery is often the preferred treatment for this complication [21]. Our study included one case of ureteral avulsion managed by open surgery. Post-operative infectious complications are more likely if urinary infections are present preoperatively. Routine antibiotic prophylaxis and ureteral stenting help mitigate these risks. However, stenting may not be necessary for patients who do not require ureteral dilation, potentially reducing operative time and costs [36] The study's main limitations include its retrospective design and lack of a control group, yet it had a robust sample size. The findings support the use of emergency ureteroscopy (URS) as a primary treatment option. Future multi-institutional studies would be beneficial, and patient counselling is highly recommended.

Conclusion

This report examines the emergency ureteroscopy management of ureteral stones in patients with calculus anuria. We conducted a retrospective chart review of procedures performed on patients with obstructive anuria, focusing on stone removal without prior drainage. Patient data included demographics, medical history, and stone characteristics such as size, location, density, laterality, and associated hydronephrosis. We recorded operative details, including procedure duration, type of anaesthesia, methods of stone disintegration, retrieval techniques, stenting, and complications. Post-treatment assessments included urinalysis, urine cultures, renal function tests, and evaluations of complications and hospital stays. Follow-up imaging involved an abdominal X-ray on post-operative day one to assess the initial stone-free rate and confirm stent placement. URS was performed under spinal anaesthesia using a semi-rigid ureteroscope with fluoroscopic guidance. Ureteral dilation was required in 43 cases (9.4%). Mechanical stone extraction was successful in 144 procedures (31%), pneumatic lithotripsy was performed in 123 cases (26.8%), and laser lithotripsy was used in 118 cases (25.7%). The overall stone-free rate was 95.1% (436 out of 459 procedures). Stone retrieval failed in 27 cases (5.9%), with 8 cases involving difficulties at the ureteric orifice and the remainder due to stone migration or fragmentation issues. Minor ureteral perforations were managed conservatively, avoiding the need for open surgery. The average hospital stay was 2.4 days. In conclusion, emergency URS is a safe and effective treatment for obstructive distal ureteral stones, providing immediate pain relief. This approach requires specialized expertise and well-equipped facilities, highlighting the need for further research to validate these findings.

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