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Intraluminal Lithotripsy with Rigid Ureteroscopy for Proximal and Distal Ureteral Stones: Results of a Single Center in Cameroon

Cyril Kamadjou[1,2*], Divine Enoru Eyongeta[3], Edouard Herve Moby[2], Jerry Kuitche[1], Fru Angwafor[4]

[1]Medical and Surgical Center of Urology, Douala, Cameroon
[2]Faculty of Medicine and Pharmaceutical Sciences, Department of Surgery and Specialties, University of Douala, Douala, Cameroon
[3]Department of Surgery, Faculty of Health Sciences, University of Buea, Buea, Cameroon
[4]Coordinator Urology Residency Program, Faculty of Medicine and Biomedical Sciences, University of Yaoundé, Yaoundé, Cameroon
Email: *cyrkamadjou@yahoo.fr

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Abstract

Aim: To evaluate the efficacy and safety of intraluminal lithotripsy with a pneumatic lithotripter (EMS, Switzerland) and laser Holmium YAG in retrograde rigid ureteroscopy for proximal and distal ureteric calculi. **Materials and Methods:** This was a retrospective study carried out from January 2015 to December 2019 including 175 patients with ureteric calculi who presented with ureteric colic at a mini-invasive surgical urological center in Douala, Cameroon. All the patients underwent retrograde ureteroscopy with a 7F rigid ureteroscope, and fragmentation was done with either a pneumatic lithotripter or a laser holmium YAG. Six patients who had urinary tract infection benefited from double J stent placement before retrograde ureteroscopy. The study variables included age, clinical symptoms, size and location of the stone, the type of lithotripsy, operating time, and the results of lithotripsy. **Results:** We included a total of 175 patients with a mean age of 40.95 ± 12.50 years. Seventy-six (43.43%) of our participants were females and all patients had at least one calculus confirmed by a CT scan. Stone sizes ranged from 5 - 26 mm (median of 12 mm). Fifteen (8.57%) stones were located in the upper ureter (pyeloureteric junction), 64 in the middle ureter, 20 in the iliac ureter, 43 in the pelvic ureter, and 33 at the vesico-ureteric orifice. The success rate was 100% for stones located in the iliac ureter, pelvic ureter and the ureteric orifice. For those in the middle and upper ureter, the success rate was 92.18% and 60%, respectively. **Conclusion:** Rigid ureteroscopy is an excellent treatment modality for ureteral calculi, especially those located at the distal part of

the ureter. The procedure is associated with a shorter operation time and a shorter post-operative hospitalization period, in addition to its safety and effectiveness compared to open surgery.

Keywords

Calculi, Rigid Ureteroscopy, Pneumatic Lithoclast, Laser Holmium, Double J Stent

1. Introduction

Although ureteroscopy (URS) was developed as an extension of cystoscopy, it has rapidly evolved and found application in the diagnosis and treatment of disorders of the upper urinary tract [1]. Its use dates as far back as the 1970s when Lyon *et al.* used it to diagnose and manage ureteral tumours, calculi, and obstructions [2]. Ureteroscopes could be rigid or flexible, and both can be used complementarily to gain access to the entire upper urinary tract [3]. Rigid ureteroscopes are easier to use, provide excellent image transmission, allow excellent control of working instruments, provide larger working channels, and are best suited for the lower ureter, particularly the part below the level of the iliac vessels [4]. Although flexible ureteroscopes are better suited for use in the upper ureter and intrarenal collecting system, they are more difficult to use in the lower ureter because of their tendency to buckle into the bladder [4].

The most common indication for URS continues to be the treatment of urinary calculi [4] [5]. Other indications include the diagnosis and treatment of filling defects observed in excretory computer tomographic urography, lateralizing essential hematuria, foreign bodies, and upper urinary tract neoplasms and fistulas [6]. An active urinary tract infection is the commonest contraindication to URS, and this diagnosis usually leads to the deferral of URS until after the infection has been fully treated (by placing a double J ureteral stent to establish urinary drainage on the affected side and administering the appropriate antibiotics) and its resolution confirmed [5].

Apart from URS, there exist other non-invasive techniques used in treating patients with renal and ureteric calculi such as extracorporeal shockwave lithotripsy (ESWL), percutaneous nephrolithotomy (PCNL), laparoscopy, and robotic surgery [3]. Where non-invasive or minimally invasive methods are either unavailable or fail, invasive procedures (including open surgery) can be employed. The American Urological Association (AUA) recommends watchful waiting for patients with uncomplicated ureteral stones ≤ 10 mm, URS for patients with stones in the middle or distal parts of the ureter who require intervention and for patients with suspected cystine or uric acid ureteral stones in whom medical expulsive therapy (MET) as a treatment modality for adult patients with ureteralstones fails [3]. In the case of adult patients with renal stones, the AUA recommends ESWL or URS for symptomatic patients with a total

non-lower pole renal stone burden < 20 mm, PCNL for symptomatic patients with a total renal stone burden > 20 mm [3].

Ureteroscopy is generally a safe procedure with minimal complications. The complications of URS range from minor complications like mild urinary tract infection, hematuria, double J stent discomfort, and temporal elevation of creatinine level to more severe complications such as severe urosepsis, submucosal or extra-ureteral stone migration, ureteral perforation, ureteral stricture, and ureteral avulsion [7] [8]. The overall stone-free success rates for URS in the treatment of ureteral calculi ranges from 91% - 93%.

2. Methods and Materials

We conducted a retrospective study over a period of five years (from January 2015 to December 2019) at the Centre medico-chirugicale d'urologie, which is located in Bali, Douala. This is a medical center that specializes in minimally-invasive surgery and the surgical management of urological pathologies using innovative techniques. The study included 175 patients with ureteric calculi who all presented with ureteric colic. The calculi were located at the upper ureter, middle ureter, iliac ureter, pelvic ureter, and the vesico-ureteric orifice. Ureteroscopy was performed using a rigid ureteroscope (7F) under loco-regional anesthesia. Two types of lithotripsy were used to fragment the stones; these were the pneumatic lithoclast (EMS, Switzerland) used in 32 patients and the laser holmium YAG, with a power of 30 W, used in 132 patients. The calculi could not be reached in 11 patients because of the migration of the stone to the renal pelvis or the narrowness of the ureter. Urine analysis and urine culture were carried out in all patients prior to the procedure to exclude any urinary tract infection. Thereafter, a second generation cephalosporin was administered to all of them as a prophylactic antibiotic (**Figure 1**).

The procedure involved placing patients in the lithotomy position and advancing

(A) (B) (C)

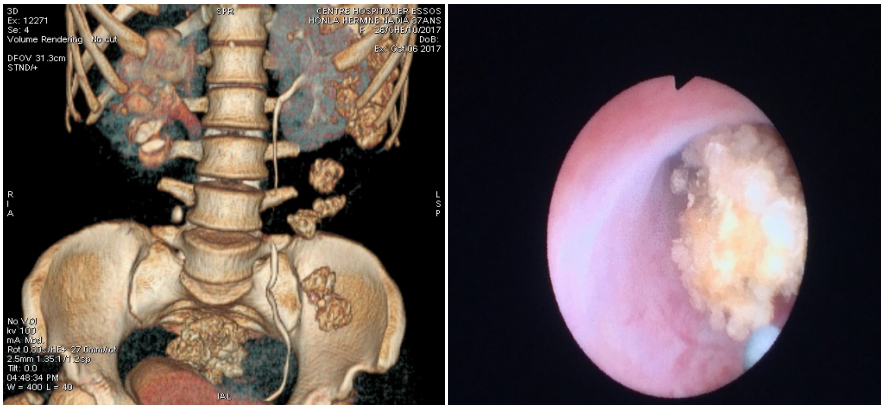
Figure 1. Endoscopy (Ureteroscopy) unit (A), Pneumatic lithoclast (B), and Laser holmium YAG (C) used to manage the patients.

a guidewire (Guidewire 0.035) controlled by an image intensifier through a 19F cystoscope that was previously inserted up to the level of the ureteric orifice. The guidewire was advanced to the level of the stone, then carefully beyond the stone into the kidney cavity. The ureteroscope was then introduced beside the wire until it reached the stone. A pneumatic lithotripter or laser holmium YAG was used to fragment the stone and a basket was used to extract the fragmented calculi.

After ureteroscopic manipulation, the double J stent that was placed in some patients before retrograde ureteroscopy was left in place for 10 days to prevent edematous inflammation of the ureteral mucosa. Most of the patients had a double J stent placed following the procedure, which was left in place for 10 - 60 days depending on the presence or absence of ureteral trauma. The decision to place or not to place the double J stent depended on the location of the stone (the more distal the stone, the less likely it was to place a stent), and the state of the ureteral mucosa following fragmentation (difficult fragmentation with associated ureteral inflammation favors stent placement).

We collected data on patients' ages, genders, clinical profiles, relevant medical history, sizes of the calculi, localization of the calculi as confirmed by imaging, and outcome of lithotripsy. All the study participants had at least one ureteric stone. The imaging method used for confirmation of the stones before URS in all patients was the CT scan, and X-rays were also performed following the procedure to confirm stone clearance. Patients were considered stone-free if no stone was visible on imaging following URS. Failure was defined as inability to remove the identified calculi due to either the migration of the calculi towards the kidney or the narrowness of the ureter (**Figure 2**, **Figure 3**).

Continuous data were collected and presented as mean values and standard deviations (for normally distributed data) and medians with interquartile ranges (for skewed data). On the other hand, categorical data were presented as frequencies and percentages.



(A) (B)

Figure 2. CT Scan imaging of a right ureteric stone (A) and an endoscopic view of a ureteric calculi (B).

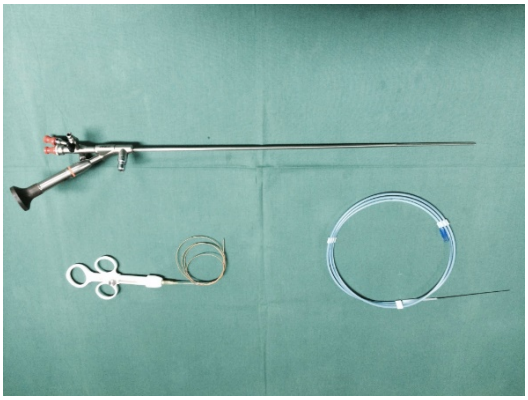


Figure 3. Ureteroscopy set with rigid ureteroscope, basket and guidewire.

3. Results

Of the 175 patients treated, 99 (56.57%) were males and 76 (43.43%) were females. The mean age of these patients was 40.95 ± 12.50 years. Of the 175 patients, 164 (93.72%) underwent intraluminal lithotripsy with a pneumatic lithotripter (32 patients) and a laser holmium (132 patients). The stone could not be reached by URS in 11 (6.29%) patients. Drainage using a Double J stent preceded URS in 6 patients because they had renal colic with urinary tract infection at presentation as confirmed by urine culture.

The stone sizes ranged 5 - 26 mm, with a mean size of 12.11 ± 4.38. Concerning the exact locations of the stones, 20 (11.43%) were located in the iliac ureter, 64 (36.57%) were located in the lumber ureter, 43 (24.57%) were located in the pelvic ureter, 15 (8.57%) were located in the Pyeloureteric junction, and 33 (18.86%) were located at the vesico-ureteric orifice. As concerns the laterality of the stones, they were located on the right side of the body in 85 (48.57%) patients and on the left side of the body in 90 (51.43%) patients. The patients were hospitalized for 1 - 7 days, with a mean duration of 1.18 ± 0.67 days. A total of 156 (89.14%) of the 175 patients were hospitalized for one day, 14 (8.00%) were hospitalized for two days, 2 (1.14%) were hospitalized for three days, 1 (0.57%) patient was hospitalized for four days, 1 (0.57%) patient was hospitalized for five days 0 (0%) patient was hospitalized for six days, and 1 (0.57%) patient was hospitalized for seven days. The duration of the surgery ranged from 20 - 130 minutes, with a mean duration of 58.64 ± 22.57 minutes. Of the 175 patients, double J stents were placed in 132 (75.43%) post-operatively and in 6 (3.43%) preoperatively. The time lapse till the removal of the double J stent ranged from 0 - 60 days, with a median time lapse of 10 (IQR: 0 - 13) days.

A dormia basket was used for stone extraction in 45 (25.71%) of the 175 patients while these forceps were not used in 130 (74.29%) patients. A total of 6 (3.43%) of the 175 patients experienced complications. Out of these 6, 2 (33.33%) experienced septic shock, 2 (33.33%) experienced fever, and 2 (33.33%) experienced perforation at some point in the urinary tract.

The profiles of the 175 patients involved in this study are presented in Table 1.

Table 1. Patients' profiles.

VARIABLE	MALE, 99 (56.57%) N° (%)	FEMALE, 76 (43.43%) N° (%)	TOTAL, 175 N° (%)
Mean age (SD)	41.59 (12.99)	40.12 (11.86)	40.95 (12.50)
Initial presentation			
Colic only	84 (84.85)	61 (80.26)	145 (82.86)
Colic + haematuria	13 (13.13)	7 (9.21)	20 (11.43)
Colic + sepsis	1 (1.01)	5 (6.58)	6 (3.43)
Colic + LUTS	1 (1.01)	3 (3.95)	4 (2.29)
Median size of stone (range), mm	12 (5 - 26)	10.5 (5 - 24)	12 (5 - 26)
Localization of stone			
upper ureter (pyeloureteric junction)	10 (10.10)	5 (6.58)	15 (8.57)
lumbar ureter,	39 (39.39)	25 (32.89)	64 (36.57)
iliac ureter,	11 (11.11)	9 (11.84)	20 (11.43)
pelvic ureter,	27 (27.27)	16 (21.05)	43 (24.57)
vesico-ureteric orifice	12 (12.12)	21 (27.63)	33 (18.86)
Laterality of the affected ureter			
Right	52 (52.53)	33 (43.42)	85 (48.57)
Left	47 (47.47)	43 (56.58)	90 (51.43)
Culprit germs causing UTI pre-op			
Pseudomonas	0	1 (1.32)	1 (0.57)
Klebsiela	0	1 (1.32))	1 (0.57)
E. coli	1 (1.01)	2 (2.63)	3 (1.71)
Proteus sp	0	1 ((1.32)	1 (0.57
Number of clients with double J stent pre-op	1 (1.01)	5 (6.58)	6 (3.43)
Number of clients with double J stent post-op	80 (80.81)	52 (68.42)	132 (75.43)
Calculi fragmentation method			
Laser lithotripsy	73 (73.74)	59 (77.63)	132 (75.43)
Pneumatic lithotripsy	20 (20.20)	12 (15.79)	32 (18.29)
No fragmentation	6 (6.06)	5 (6.58)	11 (6.29)
Outcome of URS			
success	93 (93.94)	71 (93.42)	164 (93.71)
failure	6 (6.06)	5 (6.58)	11 (6.29)
Reason's for URS failure			
Migration of the stone	3 (50.0)	1 (20.0)	4 (36.36)
Narrow ureters	3 (50.0)	4 (80.0)	7 (63.64)
Post-URS complication n (%)			
No complication	97 (97.98)	72 (94.74)	169 (96.57)
Septic shock	1 (1.01)	1 (1.32)	2 (1.14)
Fever	0 (0.0)	2 (2.64)	2 (1.14)
Ureteral perforation	1 (1.01)	1 (1.32)	2 (1.14)

Continued

Duration of hospitalization median (range)	1 (1 - 7)	1 (1 - 6)	1 (1 - 7)
Duration of URS procedure in minutes, median (range)	60 (20 - 130)	60 (20 - 120)	60 (20 - 130)

LUTS = lower urinary tract symptoms.

Success Rate Following URS According to Stone Size, Location, and Fragmentation Method

In general, 164 (93.71%) patients were stone-free following URS and fragmentation. All 132 patients who underwent laser lithropsy and 32 patients who underwent pneumatic lithotripsy were stone-free following the procedure. Nine (60%) stones were successfully removed from the upper ureter (pyeloureteric junction), 59 (92.19%) from the lumbar ureter, 20 (100%) from the iliac ureter, 43 (100%) from the pelvic ureter, and 33 (100%) from the vesico-ureteric orifice. All of the 72 stones measuring 5 - 10 mm were successfully removed. Of the 69 patients with stones measuring 11 - 15 mm, 65 (92.20%) became stone-free after URS. Of the 29 stones measuring 16 - 20 mm, 23 were successfully removed, giving a success rate of 79.31%. Of the 5 stones measuring greater than 20 mm, 4 (30.0%) were successfully removed by URS (**Table 2**).

4. Discussion

The treatment modality adopted for the management of ureteral calculi is highly dependent on the size of the calculi. Treatment options for ureteral calculi include URS, SWL, laparoscopic ureterolithotomy, PCNL, and robotic surgery [3]. URS remains an attractive modality used to manage upper ureteral stones. We assessed the treatment outcomes of 175 patients with ureteral calculi who were treated by ureteroscopy and intraluminal lithotripsy. We described the success rate according to the initial presenting symptoms, localization of stone within the ureter, laterality of stone, stone size, and fragmentation method. The overall success rate (patients who became stone-free after URS) of 93.71% in the general population and 93.94% and 93.42%, in males and females, respectively. This was in accordance with the success rate of 89.7% reported by Fathelbab *et al.*, 85.71% reported by Ciftci *et al.*, and 84.8% reported by Tahsin *et al.* [9] [10] [11].

URS is used to locate ureteral calculi. Fragmentation and extraction of the calculi, however, is done by means of dormia baskets, lithotripters, or graspers. Instruments for intraluminal lithotripsy include ultrasound, electrohydraulic, electromechanical, pneumatic, or laser energies [4]. In our study, we used pneumatic lithotripsy to fragment the calculi in 32 of the 164 patients (18.29%) and had a 100% success rate, while laser lithotripsy was used in 132 (75.43%) patients with a 100% success rate. This result is in contrast to that reported by Abedi *et al.* [12] who achieved a stone-free rate of 65.2% with pneumatic lithotripsy, and 93.3% with laser lithotripsy, but ties with the results obtained by Travassos *et al.* of a 100% stone-free rate [13].

Table 2. Success rate following rigid ureteroscopy and intraluminal lithotripsy of ureteral calculi.

VARIABLE	Success rate following rigid ureteroscopy and lithotripsy N° (%)
Initial presentation	
Colic only	136 (93.79)
Colic + haematuria	18 (90.0)
Colic + sepsis	6 (100)
Colic + LUTS	4 (100)
Localization of stone	
upper ureter (pyeloureteric junction)	9 (60.0)
lumbar ureter,	59 (92.19)
iliac ureter,	20 (100)
pelvic ureter,	43 (100)
vesico-ureteric orifice.	33 (100)
Laterality of the affected ureter	
Right	78 (91.76)
Left	86 (95.56)
Calculi fragmentation method	
Laser lithotripsy	132 (100)
Pneumatic lithotripsy	32 (100)
Size of stones	
5 - 10 mm	72 (100)
11 - 15 mm	65 (92.20)
16 - 20 mm	23 (79.31)
>20 mm	4 (80)

In the current study, as the location of the ureteral calculi moved distally from the pyoloureteric junction towards the vesicoureteric orifice, the stone-free rate after URS increased from 60% (9 of 15) to 100% (33 of 33). This trend was similar to the overall initial success rate of 76.54%, 85.48%, 90.74% for proximal, middle, and distal ureteral stones, respectively, reported by Ciftci *et al.* in the 336 patients who underwent ureteroscopic pneumolithotripsy for ureteric stones [10].

In our study, 100% of patients with calculi measuring less than 10 mm were stone-free following URS, and this success rate decreased as the stone size increased, going as low as 80% for stones greater than 20 mm. This trend of decreasing success rate with increasing size of stones was also reported by Mursi *et al.* and Gunlusoy *et al.* [14] [15].

Although the placement of a ureteral stent is not routinely required prior to URS, it can be placed if a urinary tract infection is confirmed [3] [9]. In our study, 6 patients underwent double J stent placement before retrograde ureteroscopy since they had urinary tract infections.

Complications are commonly associated with URS, like with any surgical procedure. These complications include stent pain, residual stone fragments,

stone migration, ureteral injury, ureteral stricture, hematuria, and infection [16]. In the current study, the incidence of complications was low, with just 3.43% of the study participants developing post-URS complications (2 had septic shock, 2 experienced ureteral rupture, and 2 developed a fever). This was similar to the 4.44% complication incidence rate among patients treated with laser lithotripsy and the 12.17% among patients treated with pneumatic lithotripsy reported by Abedi *et al.* [12].

5. Conclusion

Rigid ureteroscopy is an excellent modality for the management of ureteral calculi, especially those located at the distal parts of the ureter. The procedure is associated with a shorter operation time and a shorter post-operative hospitalization period, in addition to its higher safety and efficacy compared to open surgery. We found that both pneumatic lithotripsy and laser lithotripsy were safe and effective methods of clearing ureteral stones.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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