Original Article

# Large impacted upper ureteral calculi: A comparative study between retrograde ureterolithotripsy and percutaneous antegrade ureterolithotripsy in the modified lateral position

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## Abstract

**Context:** The treatment for patients with large impacted proximal ureteral stone remains controversial, especially at institutions with limited resources.

**Aim:** The aim of this study is to compare and to evaluate the outcome and complications of two main treatment procedures for impacted proximal ureteral calculi, retrograde ureterolithotripsy (URS), and percutaneous antegrade ureterolithotripsy (Perc-URS).

**Settings and Design:** Our inclusion criteria were solitary, radiopaque calculi, >15 mm in size in a functioning renal unit. Only those patients in whom the attempt at passing a guidewire or catheter beyond the calculus failed were included in this study.

**Patients and Methods:** Between January 2007 and July 2011, a total of 52 patients (13 women and 39 men) with large impacted upper-ureteral calculi >15 mm and meeting the inclusion criteria were selected. Of these, Perc-URS was done in 22 patients (group 1) while retrograde ureteroscopy was performed in 30 patients (group 2). We analyzed operative time, incidence of complications during and after surgery, the number of postoperative recovery days, median total costs associated per patient per procedure, and the stone-free rate immediately after 5 days and after 1 month.

**Statistical Analysis Used:** Bivariate analysis used the Student *t*-test and the Mann-Whitney test to compare two means and Chi-square and Fisher's exact tests to compare two percentages. The significance level was set at 0.05.

**Results:** The mean age was 42.3 years (range 22-69). The mean stone sizes (mm) were 34 ± 1.2 and 29.3 ± 1.8 mm in group 1 and 2, respectively. In the Perc-URS group, 21 patients (95.45%) had complete calculus clearance through a single tract in one session of percutaneous surgery, whereas in the URS group, only 20 patients (66.7%) had complete stone clearance ($P = 0.007$). The mean operative time was higher in the Perc-URS group compared to group 2 (66.5 ± 21.7 vs. 52.13 ± 17.3 min, respectively; $P = 0.013$). Complications encountered in group 1 included transient postoperative fever (2 pts) and simple urine outflow (2 pts). Ten patients (33%) of group 2 experienced failure: Migration to the kidney (3 pts), ureteral perforation (2 pts), tortuosity of the ureter (2 pts), and epithelial polyps (2 patients). Group 1 patients had an average visual analog (VAS) pain score of 47 mm compared with 31 mm in group 2 patients. The mean hospital stay (days) in group 1 was higher than the group 2 (2.27 ± 0.8 vs. 1.67 ± 0.6, respectively; $P = 0.01$). The mean analgesia requirement for group 1 (paracetamol chlorhydrate + codeine 12 ± 3 g) was significantly more compared with group B (6.8 ± 2 g) ($P < 0.01$). The difference in average blood loss between the two groups was not statistically significant. Total costs was slightly higher in group 1 but the difference was not statistically significant between the two groups (15000 vs. 13400 MDH respectively; $P > 0.05$). After 1 month, the stone free-rate remained higher in group 1 (95.5% vs. 66.7%, respectively; $P = 0.012$).

**Conclusions:** In our series, Perc-URS is a safe and efficient treatment option for proximal ureteral stone, especially when the stone size is superior to 15 mm with the presence of moderate or severe hydronephrosis.

**Key Words:** Endoscopy, percutaneous nephroscopy, ureteral stone, ureterolithotripsy

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## INTRODUCTION

Large impacted upper ureteral calculus defined as a stone is located above the lower border of the fourth lumbar vertebra, remaining fixed at the same site for at least six weeks. Moreover, it is associated with hydronephrosis or/and prevents contrast medium from passing below the calculus on intravenous urography (IVU).[1-4] Moreover, there is inability to pass a guidewire or catheter beyond the stone at initial attempts [Figure 1]. The treatment for patients with large impacted proximal ureteral stone remains controversial; the surgical options for the treatment of proximal ureteral stones include extracorporeal shockwave lithotripsy (SWL), ureteroscopy, PCNL and rarely laparoscopic or open surgery.[3] Every technique has its own limitations. The aim of this retrospective study is to compare and to evaluate the outcome and complications of two main treatments procedures for impacted proximal ureteral calculi, retrograde ureterolithotripsy (URS), and percutaneous antegrade ureterolithotripsy (Perc-URS).

## PATIENTS AND METHODS

### Patients

From January 2007 to January 2011, we retrospectively reviewed the medical records of patients with large impacted upper ureteral calculi. All patients were evaluated by CT-scan before operation. Our inclusion criteria were solitary, radiopaque calculi, >15 mm in size in a functioning renal unit. Only those patients for whom the attempts failed to pass a guidewire or catheter beyond the calculus are included in this study. The patients were split into two groups: Group 1 ($n$ = 22) and group 2 ($n$ = 30) for antegrade and retrograde approach, respectively. Patients with a solitary kidney, ureteral stricture, ureteropelvic junction obstruction, bilateral obstruction, or simultaneous lower associated calculus were excluded. The stone size assessed by measuring its largest dimension in the plain abdominal film. Patients' selection was non-randomized. Both the options of retrograde and antegrade ureteroscopy were explained to the patients.

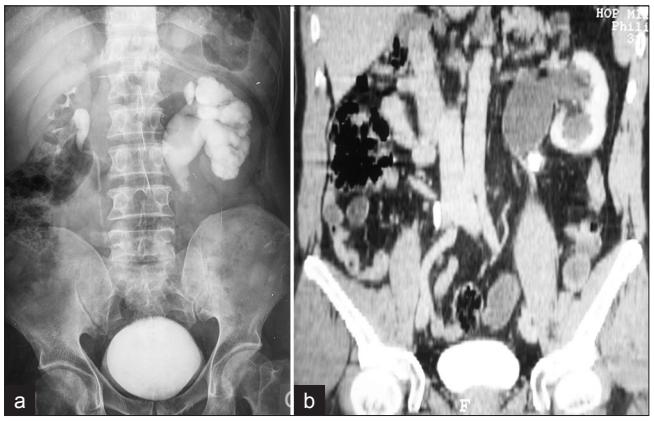


**Figure 1:** a) Intravenous pyelogram and b) CT scan showing impaction of a stone with no visible contrast media below the calculus associated to severe hydronephrosis

### Antegrade ureterolithotripsy

The details of our antegrade endoscopic procedure previously reported.[5] Briefly, Perc-URS is performed under general anesthesia and the patient is placed in the lateral modified position, with all pressure points padded. Initially, the thorax is tied up with Elastoplasts band in the lateral position perpendicular to the operating table. The patient's homolateral arm is folded over his chest to provide working space for the surgical team, so access is gained to percutaneous nephrostomy tract with a larger field for the nephroscope movements. The contralateral arm is fully extended and held at 90° making room to accommodate the fluoroscope. Secondly, the pelvis is placed in an oblique position by placing a rolled towel under the homolateral buttock. Finally, the lower limbs are split and bent in the lowest position, just like the homolateral leg in the standard position of rigid ureteroscopy, allowing more freedom for rigid-ureteroscope maneuverability. From the beginning, the anesthetized patient were placed in this position, which was maintained throughout the whole procedure. Therefore, the same set of drapes were used for retrograde and percutaneous approach. Initial placement of a retrograde ureteral catheter, tract formation, stone fragmentation, and retrieval accomplished with the patient in the same position. At the beginning of the procedure a 7 F ureteral catheter inserted below the calculus. In the case of blocked retrograde contrast media passage, a blind Chiba-needle puncture was performed for antegrade pelvicalyceal system opacification.

Percutaneous access was performed under fluoroscopic guidance with the X-ray beam perpendicular to the tract. Thus, the operator's hands are outside the fluoroscopic field. Our preference was an upper pole puncture as this approach provides a direct tract down the renal pelvis and the ureter.

Upper-pole puncture was preferred because it provided the most reliable access down to the ureter and therefore a straight tract

to the stone. In some patients' anatomy where pelvicaliceal system was found favorable, the middle posterior calyx was chosen for puncture. After puncture of the targeted higher calyx under fluoroscopy, a guidewire coiled into the collecting system (Radiofocus; Terumo wire). No attempt to lower the guidewire down the ureter was carried out. After dilation to 10 or 12 F, a second "working" PTFE guidewire was inserted in the collecting system. The hydrophilic guidewire was left as a safety guidewire. The tract dilation was performed with the "one-shot" technique.[6] The central rod of Alken metallic dilators advanced over the working-guidewire. Then, directly an Amplatz dilator of 24 F with its corresponding sheath advanced over the metallic rod into the calyx entry. A 20.8 Frigid nephroscope (Richard-Wolf) (or 18 F without its sheath) was used for nephroscopy. After location of the stone, the Amplatz sheath was inserted near the stone, or even in the first part of the ureter, to prevent stone fragments from migrating in the kidney, in large hydronephrosis it may be tedious to search for them. Stone fragmentation was performed using ultrasound or ballistic lithotripsy. After complete stone clearance, and exploration of all the pelvicaliceal system a guidewire was advanced through the ureteral catheter and coiled in the renal pelvis. At the end of the procedure, the Amplatz sheath was removed. The pattern of ureteral stent or nephrostomy tube drainage in the post-operative period left to the discretion of the surgeon.

### Retrograde ureteroscopy

Ureteroscopic lithotripsy was conducted using an 8/9.8 F semi-rigid tapered ureteroscope (Richard Wolf) with the patient under spinal anesthesia. The working channel in this ureteroscope was a generous 5 F working channel for improved therapeutic access. A hydrophilic guidewire was inserted and coiled below the stone before dilation of the ureteral orifice using Marberger sequential dilators from 7 to 10 F. Insertion of the ureteroscope is performed beside the guidewire, which is left as a safety guidewire. The calculus was fragmented with ballistic lithotripsy. When a space created between the stone and the ureteral wall, a guidewire is advance beyond the stone to the renal collecting system, before continuing stone fragmentation and extraction using baskets. At the end of the procedure, retrograde ureterography performed to exclude perforation. A double-J catheter placed in all patients at the end of the procedure.

Operative time in both procedures defined as the time from cystoscopy with ureteral catheter insertion until the end of the entire procedure. Patients evaluated their pain using a visual analog scale (VAS) graded from 0 to 100 mm. In this tool, 0 corresponds to lack of pain and 100 to maximum pain. The following cut-off points were determined on a 100 mm VAS: No pain 0-2 mm, mild pain 2-17 mm, moderate pain 17-47 mm, severe pain 47-77 mm, very severe pain 77-96 mm, most severe pain imaginable 96-100 mm.

The average costs per patient per procedure incurred during hospitalization including anesthesiology, surgical supply, operating room time, length of stay and number of total complications estimated to determine whether either treatment bestows a specific cost advantage. Calculus clearance assessed on post-operative day 1 with a plain film of the kidney, ureter, and bladder (KUB) region. The double-J stent kept in place for 4 weeks. Stone-free status defined as no residual stones detected on plain abdomen X-ray film 1 month after therapy. An IVU performed 2 months after PCNL. Failure of the procedure was different between the two groups. For group 1 it was impossibility of puncture or progression of the nephroscope into the proximal ureter. With regards group 2 defined as impossibility of retrograde progression of the ureteroscope. Failure of each procedure led to conversion to open ureterolithotomy. Intra-operative and post-operative morbidity, operating time, hospital stay, time of convalescence, VA Spain, stone clearance at discharge, and at follow-up were compared between the two groups of patients.

Statistical analysis Performed using SPSS (statistical package for social sciences, version 16.0). Quantitative variables described using means and standard deviations and qualitative variables described using frequencies and percentages. Bivariate analysis used the Student *t*-test and the Mann-Whitney test to compare two means. Chi-square and Fisher's exact tests were used to compare two percent ages. The significance level was set at 0.05.

## RESULTS

Fifty-two patients (13 women and 39 men) were included in the present study. Twenty-two patients in group 1 and 30 patients in group 2. The two groups were comparable in age, sex, body mass index (BMI), and in metabolic and anatomic features [Table 1].

**Table 1: Demographic and clinical data of the patients**

| | Perc-URS group | URSL group | *P* |
|---|---|---|---|
| No. of patient | ***n***=22 | ***n***=30 | |
| Mean patient age (years)±SD | 41.18±14 | 43.10±11.67 | 0.5 |
| Gender (F/M) (%) | 6/22 (27.2) | 7/30 (23.3) | 0.5 |
| Mean body mass index (kg/m$^2$)±SD | 29±8.0 | 27±7.5 | 0.54 |
| Mean stone size (mm)±SD | 34±1.2 | 29.3±1.8 | 0.52 |
| Previous SWL (*n*=12) (%) | 5/12 (22.72) | 7/12 (23.33) | 0.48 |
| Mean GFR (mL/min)±SD | 29.8±7.3 (17-40) | 28±6.9 (15-39) | 0.6 |
| Stone analysis (%) | 20/22 (90) | 30/30 (100) | 0.61 |
| Calcium oxalate (%) | 17 (88) | 25 (84) | |
| Calcium phosphate (%) | 2 (7) | 3 (8) | |
| Mix calculi (%) | 1 (5) | 2 (4) | |

PCNL: Percutaneous nephrolithotomy, SWL: Shock wave lithotripsy, URS: Ureterolithotripsy, GFR: Glomerular filtration rate, SD: Standard deviation

The mean value of glomerular filtration rate (GFR) (mL/min) in group 1 was 29.8 ± 7.3 (17-40); in group 2 it was 28 ± 6.9 (15-39). The mean stone size was 34 ± 1.2 and 29.3 ± 1.8 mm in groups 1 and 2, respectively. Twelve patients had a history of initial failed SWL (five and seven in the groups 1 and 2, respectively; mean number of session: 4). In the Perc-URS group, 21 patients had complete calculus clearance through a single tract in one session of percutaneous surgery [Table 2]. The remaining patient underwent open ureterolithotomy. The mean operative time was 66.5 ± 21.7 min (range 38-115 min). Complications included transient post-operative fever (2 pts) managed with appropriate antibiotics and stone downward migration resulting in incomplete disintegration of calculus (1 pt). Two patients experienced urinary leakage from the percutaneous tract 48 h after nephrostomy removal, possibly due to ureteral edema and stented successfully. In the URS group, 20 patients (66.7%) had complete stone clearance. The mean operative time was 52.13 ± 17.3 min (range 24-110 min). Ten patients (33.3%) experienced failure during the procedure. The causes of failure were inability to catheterize the ureteral orifice (1 pt), migration of calculus (3 pts), ureteral perforation and false passages (2 pts), extreme tortuosity of the ureter beyond the calculus (2 pts), and fibrous epithelial polyps interfering with direct visualization of calculus (2 pts).

Group 1 patients had an average VAS pain score of 47 mm compared with 31 mm in group 2 patients. The mean analgesia requirement for group 1 (paracetamol chlorhydrate + codeine 12 ± 3 g) was significantly more compared with group 2 (6.8 ± 2 g) ($P < 0.01$). The mean hospital stay (days) in group 1 was higher than the group 2 (2.27 ± 0.8 vs. 1.67 ± 0.6, respectively; $P = 0.01$) [Figure 2]. URS group patients took 3 to 7 days for complete convalescence, whereas Perc-URS patients recovered in 7 to 10 days. The double-J stent kept in place for 4 to 6 weeks. None of these complications required re-hospitalization. No renal pelvis perforation occurred. No major complications encountered.

Median total costs (Moroccan Dirham; MDH) associated per patient per procedure were 15000 MDH (1357 Euro, 1785$), and 13400 MDH (1252 Euro, 1595$) for groups 1 and 2, respectively. The difference was not statistically significant between the two groups ($P > 0.05$).

There was no difference between the two groups in terms of stone composition ($P > 0.05$). In the first group, of 20 patients whose stones were available for analysis, 17 (88%) were composed of calcium oxalate, 2 (7%) of calcium phosphate, and 1 (5%) of mixed composition. In the second group, of 30 patients whose stones were available for analysis, 25 (84%) were composed of calcium oxalate, 3 (8%) of calcium phosphate, and 2 (4%) of mixed composition [Table 1]. The mean follow-up was 14 months.

**Table 2: Surgical outcome of patients**

| Standard PCNL | Perc-URS group | URSL group | *P* |
|---|---|---|---|
| Mean operative time SD (range) | 66.05±21.7 | 52±17.3 | 0.013 |
| Success rate (%) | 21/22 (95.5) | 20/30 (63.3) | 0.007 |
| Mean % decrease in hemoglobin | 0.36 | 0.23 | 0.5 |
| Mean hospital stay (day) | 2.27±0.8 | 1.67±0.6 | 0.01 |
| Median total costs (mdh) | 15000±2300 | 13400±2400 | 0.05 |
| Complications (%) | 5/22 (22.72) | 4/30 (13.3) | 0.01 |
| Transient fever (%) | 2 (9) | 1 (3.33) | |
| Pleural effusion (%) | 0 | 0 | |
| Hematuria (%) | | 2 (6.66) | |
| Another (%) | 3 (10) | 1 (3.33) | |
| Failure (%) | 1/22 (4.5) | 10/22 (33.3) | 0.012 |
| VAS pain score | 47 | 31 | 0.01 |
| Analgesia requirement (g) | 12±3 | 6.8±2 | 0.01 |

PCNL: Percutaneous nephrolithotomy, VAS: Visual analog scale, URSL: Ureterolithotripsy

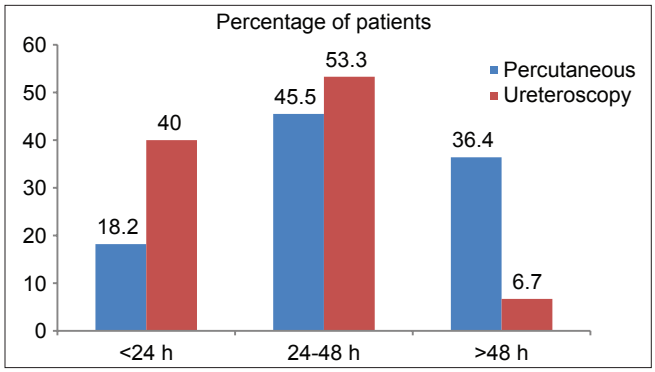


**Figure 2:** Diagram showing average hospital stay between groups 1 and 2

## DISCUSSION

Proximal ureteral calculi are located between the ureteropelvic junction and the lower border of the fourth lumbar vertebra. Complete removal of the stone is the primary management goal to relieve obstruction, eliminate infection, prevent further stone growth, and preserve renal function.[3,4] Although open ureterolithotomy for patients with proximal ureteral stones had a median stone-free rate of 97%, it not recommended as a first-line treatment, because of longer hospitalization and greater post-operative morbidity.[3,5,7,8] In the era of modern endourology, most ureteral stones can be treated with ureteroscopy or SWL. Actually, SWL for the treatment of large stones >20 mm has a reported stone-free rate of 45% to 60%.[1,3] Impacted stones known to respond less well to SWL,[2] according to expansion space theory, expounding that stones embedded in the ureteral mucosa have no natural expansion space and therefore respond poorly to SWL,[3] that is why endoscopic lithotripsy is considered as a first line therapy for chronically impacted stones.[2-4]

The joint American Urological and European Association Ureteral Stones Clinical Guidelines Panel had recently reported its recommendations for the treatment of ureteral stones.[9] Thus, percutaneous antegrade approach to the ureteral stone can be proposed instead of a retrograde endoscopic approach. This treatment option is indicated in selected cases with large impacted stones in the upper ureter, combined with renal stone removal, in cases of ureteral stones after urinary diversion, and in selected cases resulting from failure of retrograde ureteral access to large impacted upper ureteral stones.[3,4,7-9] A chronically impacted stone may cause inflammation and edema of the ureteral wall, and these changes may involve the surrounding tissues. In addition, they are frequently associated with ureteral polyps or strictures resulting from failure of retrograde access or dislodgement of the stone in the kidney. Mugiya[10] and co-workers retrospectively evaluated endoscopic findings in 165 patients with impacted ureteral stones to determine the incidence of associated ureteral lesions. Inflammatory ureteral polyps and ureteral stricture were observed in 51 patients (30.9%) and in 28 patients (17.0%), respectively.

URS has the advantage to manage safely associated lower ureteral stones simultaneously and carried out in cases for which Perc-URS is contraindicated like morbid obesity, malrotated kidneys, or pregnancy.[2,3,7,11] URS remains a less invasive approach with high patient tolerance even with repeated procedure and has fewer adverse effects.[12] Nevertheless, large calculi could require several passages with the ureteroscope to remove all fragments after intra-corporeal lithotripsy and add to increase the ureteral trauma. Pneumatic URS has a back-pressure effect and pushes the calculi back into the kidney.[2,9,11,13] Several techniques and devices have been reported to prevent migration in the kidney but both had its cost and risks. Furthermore, URS was dependent on the experience of the surgeon with potential problems due to inflammatory local conditions.[10] In our series, we failed to reach the renal pelvis in five patients due to local inflammatory conditions (2 ureteral edema, 1 polyp) or lack of space to pass a wire of the cone stone (1 pt). We experienced ureteral perforations in two patients, which were secondary to the edema and fragility of the mucosa and hematuria due to mucosal abrasion impairing visualization of the calculi. They occurred at the beginning of our experience; they managed conservatively, and had no long-term consequences.

The main advantage of Perc-URS is to allow immediate stone-free rate. Although the stone-free rate following PCNL is between 80% and 95%, significant complications may be associated with the procedure, including urinary extravasations, transfusion, and fever. Major complications such as sepsis, colonic injury, and pleural injury are even rarer but still a source for concern.[14,15] The positive considerations for Perc-URS included reliable access to the kidney and ability to use larger caliber instruments and working space for nephroscopic manipulation and a limited need for secondary procedures cost effective. In addition, Perc-URS was conceivable in select cases after urinary diversion and after failure of retrograde access or dislodgement of the stone in the kidney. Kumar and colleagues[16] reviewed 86 PCNLs performed on 80 patients in whom eleven presented with solitary kidney. Total clearance was achieved in 74 units (86%) by the anterograde approach alone. Karami and coworkers[17] in a prospective randomized study reported their experience in management of large impacted calculi. They compared the morbidity and stone free-rates of 35 patients who underwent tubeless Perc-URS with blind access to a cohort of 35 patients undergoing URS. They were able to achieve extraction en bloc of calculi in 33 patients (94.3%) with a mean operative time of 38 min (range 25-48 min) and 1-day hospitalization stay. In the URS group, a stone-free rate in a single session was achieved only in 18 patients (51.4%) with a mean operative time of 34 min (range 20-58 min). The investigators concluded in select patients with moderate hydronephrosis that the Perc-URS is a valuable treatment modality option and in providing lower costs and higher speeds than URS. Maheshwari *et al*.[18] also reported that PCNL resulted in a 100% success rate in 23 patients with large (greater than 1.5 cm) impacted upper ureteral stones although 2 patients (9%) needed a blood transfusion. Sun *et al*.[19] treated 91 patients having impacted ureteral calculi assigned in a randomized sequential order in two groups using either tubeless Perc-URS or URS prospectively randomized for antegrade (44 pts) or retrograde (47 pts) ureterolithotripsy. Each group experienced one complication: Bleeding for Perc-URS and ureteral injury for URS. Perc-URS was associated with longer operative times (75.4 ± 11.8 vs. 30.6 ± 7.8 min; $P < 0.001$), longer hospital stay (6.3 ± 0.5 vs. 2.1 ± 0.4 days; $P < 0.001$), and a longer interval to return to normal activities (7.8 ± 0.7 vs. 2.7 ± 0.6 days; $P < 0.001$). Nevertheless, the authors recommend percutaneous removal as the primary approach for such calculi. Goel and associates[20] described complete stone clearance in 65 of 66 patients who had impacted proximal ureteral stones greater than 1.5 cm. Kahn *et al*.[21] described the success of an antegrade approach for treating 35 of 37 proximal third stones with an average size of 10 × 8 mm, often without the need for intracorporeal lithotripsy. Analysis of 175 procedures from three studies[16,18,20] reported complications, hemorrhage-necessitated transfusion (3%), fever (15%), and overall complications (14%). Further, there is a notable chance for ureteral stricture rate (3%) or injury rate (5%).

Transperitoneal and lumboscopic approaches for extraction of impacted ureteral stones became a good alternative to traditional open surgery for cases that have failed endoscopic management or SWL, avoiding parenchymal injury with nephron loss.[17,18,22]

Lopes Neto and co-coworkers[1] in a prospective randomized study reported their experience in management of large impacted calculi on 48 patients assigned to SWL, semi-rigid ureterolithotripsy or laparoscopic ureterolithotomy. Extracorporeal shock wave lithotripsy had a 35.7% success rate, semi-rigid ureterolithotripsy 62.5%, and laparoscopic ureterolithotomy 93.3%. Stone-free rates showed a statistically significant difference among the groups ($P = 0.005$). Skolarikos *et al.*[23] tried to identify the level of the evidence and grade of recommendation, according to the evidence-based medicine criteria, in studies supporting the laparoscopic approach to stone extraction. The highest level of evidence (IIa) was found for laparoscopic ureterolithotomy. Nevertheless, three small incisions were needed instead of one for the percutaneous approach. Moreover, specific material and skills are also required. New technologies such as flexible ureteroscopy or laser lithotripter are very expensive and not available at many institutions in developing countries. They also require technical skills and frequent repair (approximately 30 procedures between interval repairs).[20]

Operative time in our series was slightly shorter than reported in the literature and can be explained by several raisons. Most of our patients presented with a markedly dilated renal collecting systems leading to rapid access and optimal exposure of the UPJ. The "one-shot" procedure, that we have previously reported, is less-time consuming in a dilated urinary system and decreased trauma and X-ray exposure.[24] PCNL in the modified lateral position has several advantages for the patient and the urologist, with greater versatility of stone manipulation along the entire urinary tract. During the procedure, using high forceful pulse flow through the ureteral catheter helps to prevent downgrade migration of small fragments and stone debris.

Some limitations of our study warrant considerations. First, the present study limited by both its retrospective nature and the fact that conducted at a single institution. Therefore, it carries with it all the inherent potential issues associated with such studies. Secondly, the relative small sample size is another limitation. However, according to our experience to avoid complications, in the antegrade approach, we recommend to stent the ureter in the presence of inflammatory polyp or important ureteral edema. However, if disimpaction maneuvers precluded but the passage of the wire beyond the stone is possible we advocate the antegrade placement of double J stent and a retrograde approach in better conditions 1 month later. At last, we did not recommend immediate fragmentation but to gently try to disimpact the calculi especially when they are close to the uretero-pelvic junction.

## CONCLUSION

With an immediate stone-free rate of 95%, we concluded that Perc-URS is a safe and efficient treatment option for proximal impacted ureteral stone >15 mm and enjoys better performance compared with the retrograde approach. Semi-rigid ureteroscopy may become less appropriate for management of such calculi.

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