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Comparing Short Term Clinical Outcome of Percutaneous Antegrade Ureterolithotripsy Vs Retrograde Ureterolithotripsy in Management of Impacted Upper Ureteric Stone Patients: *A Single Centre Experience*

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Abstract:
Background*: Urinary stone disease has afflicted mankind for a long.The technical advancements in urology have profoundly changed the management of upper ureteric calculus. The aim of this study to comparing short-term clinical outcomes of Antegrade percutaneous ureterolithotripsy (APCUL) with Retrograde ureterolithotripsy (URSL) in the management of impacted upper ureteric stone patients and the feasibility of undertaking this in HUSM. This study also analyzed the local data, which reflected our performance and achievement in our Centre to the patients.*
Material and methods*: Our inclusion criteria were solitary upper ureteric stone 10-25 mm in size in a functioning renal unit. Between January 2019 and December 2020, 60 patients with solitary impacted upper ureteric stone, and only 58 patients meet the inclusion criteria. The surgical parameter, outcomes, and complication rate during and after surgery and stone-free rate immediately after one month were compared. All the parameter assessed is significant if the p-value is < 0.05.*
Results*: The mean age was 43.2±11.3 years for APCUL group and 47.5±12.7 years for URSL group. The mean stone sizes (mm) were 22.3 ± 6.5 and 20.7 ± 5.5 mm in APCUL group and URSL group, respectively. In the APCUL group, 26 patients (92.9%) had complete calculus clearance through in one session of percutaneous surgery, whereas in the URSL group, only 21 patients (70%) had complete stone clearance (P=0.032). The mean operative time was shorter in the APCUL group compared to URSL group (52.7 ± 16.4 vs. 67.10 ± 22.3 min, respectively; P=0.02). The mean hospital stay (days) in APCUL group was longer than the URSL group (4.85 ± 0.51 vs. 3.76 ± 0.78, respectively; (P=0.021). Postoperative complications encountered in APCUL group (42.8%) higher compared to URSL group (36.7%) included transient postoperative fever, blood loss required a blood transfusion and hematuria. Nine patients (30%) of URSL group experienced failure: Migration to the kidney in 8 patients, tortuosity of the ureter in 1 patient. APCUL Group patients had an average visual analog (VAS) pain score of 58 mm compared with 35 mm in URSL group patients.*
Conclusion*: APCUL can be a safe and efficient treatment modality for upper ureteric stones with better stone-free rates and enjoys better performance compared with the URSL approach.*
Keywords*: Upper ureteric stone, Antegrade Percutanenousureterolithotripsy, Retrograde ureterolithotripsy*

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I. Introduction

The impacted upper ureteral calculus is defined as a stone located between the ureteropelvic junction and above the fourth lumbar vertebra level, which remains at the same site for at least four weeks. The optimal treatment for the impacted upper ureteral stone includes extracorporeal shockwave lithotripsy, ureteroscopic, percutaneous nephrolithotomy, and rarely open surgery. Every technique has its advantage and limitation. In this study, treatment options for upper ureteric calculus included retrograde ureteroscopic lithotripsy (URSL) and antegrade percutaneous ureterolithotripsy (APCUL). Currently, percutaneous access for upper ureteric calculus is recommended only in a few special situations, such as an impacted stone with failed other treatment modalities. In literature, stone-free rates with URSL for a large upper ureteric calculus of size >10 mm range between 71% and 87%, with the stone retropulsion rates ranging from 5.4% to 27.7% amongst various studies. However, the role of APCUL had been assessed for impacted stone with a reported stone-free rate of

>90%–95% and complication rate similar to the standard percutaneous nephrolithotomy. Furthermore, there is an added advantage of the ability to remove concurrent renal calculi. Herein, we compared retrograde ureterolithotripsy(URSL) with antegrade percutaneous ureterolithotripsy (APCUL) for the upper ureteric stone of size 10–25 mm in term of the surgical parameter, clinical outcome, and complications between these two approaches and to determine the optimal therapeutic modality for patients with impacted upper ureteric stones. The Complete removal of the stone is the primary management goal to relieve obstruction and preserve renal function.

II. Material And Methods

At our Centre, from January 2019 till December 2020, we reviewed data from admission and medical records of patients with impacted upper ureteric stones. Our inclusion criteria were solitary upper ureteric calculi 10-25mm in size in a functioning renal unit. The patients were randomly divided into the APCUL Group (n =30) and URSL Group (n= 30) prospectively. Patients with ureteral stricture, ureteropelvic junction obstruction, concurrent medical problems, and defaulted follow-up were excluded. The stone size was measured by its largest dimension in the plain abdominal film, ultrasound KUB and CT scan film. The simple randomization was done. Both options of Retrograde and Antegrade percutaneous ureterolithotripsy approach were explained to the patients regarding the advantages and disadvantages of each procedure.

Antegrade Percutaneous ureterolithotripsy (APCUL)

Briefly, percutaneous ureterolithotripsy with the size of a nephroscope 18-24Fr were used and performed under general anesthesia, and the patient is placed from lithotomy into the prone position, with all pressure points padded. At the beginning of the procedure, a 7Fr Angiocatheter inserted above the calculus and park at the kidney's upper pole. Percutaneous access using a chiba needle was performed under fluoroscopic guidance with the Image Intensifier X-ray beam perpendicular to the tract. Upper pole and lower pole puncture are used. In the case of unable to put Angiocatheter and cannot be performed Retrograde pyelogram, the access puncture was performed under ultrasound guidance. We used upper pole puncture as it provided the most reliable access toward the renal pelvis and the ureter as a straight tract to the stone. After puncturing the targeted calyx under fluoroscopy, a Road Runner guidewire was inserted into the collecting system. After dilation to 18 or 24 F, a second "working" road runner guidewire was inserted in the collecting system and left as a safety guidewire. The tract dilation was performed with a central rod of Alken metallic dilators advanced over the working-guidewire. Then, directly an Amplatz dilator of 18 to 24 F with its corresponding sheath advanced over the metallic rod into the calyx entry. An 18F to 24Fr rigid nephroscope (Richard-Wolf or Storz) was used depending severity of hydronephrosis. After confirming the stone's location, the Amplatz sheath was placed near the stone to prevent stone fragments from migrating into the kidney. Stone fragmentation was performed using ultrasound or pneumatic or laser lithotripsy according to the surgeon's preference. Final exploration of all the pelvicalyceal system under fluoroscopy was done after complete stone clearance. Removal of Amplatz sheath was done at the end of the procedure, and a ureteral stent with or without nephrostomy tube drainage in the postoperative period was inserted.

Retrograde ureterolithotripsy (URSL)

Ureteroscopic lithotripsy was conducted with the patient under spinal anesthesia using a 7/8 or 8/9.8 F semi-rigid ureteroscope (Richard Wolf). The working channel inside the ureteroscope was a generous 4-5Fr working channel to improved therapeutic ability. A hydrophilic guidewire was inserted below the stone before dilation of the ureteral orifice using Marberger serial dilators from 7 to 10 F. Insertion of the ureteroscope is performed beside the guidewire, which is left as a safety guidewire. The stones were fragmented with laser lithotripsy. Ntrape@stone entrapment was inserted to prevent the stone from migrating up before continuing stone fragmentation until the stone's extraction using the baskets. A retrograde pyelogram was performed at the end of the procedure to exclude ureteric perforation and any migrating stone into the kidney. A ureteric stent was placed in all patients at the end of the procedure.

Operative time in URSL is defined as the time from cystoscopic with ureteral catheter insertion until the end of the entire procedure, whereas for APCUL from skin puncture till the end of the procedure. Patients were evaluated their pain using a visual analog scale (VAS) graded from 0 to 10, of which 0 corresponded to lack of pain and 10 correspondings to the maximum pain. The following cut-off points were determined as 'mm' VAS: No pain 0, mild pain 1-3, moderate pain 4-6, severe pain 7-9, and very severe pain 10. Length of hospital stay was the number of days the patients were admitted in the ward until postoperative discharge. At the same time, Postoperative complications were complications that occurred or were diagnosed within 30 days postoperatively. The ureteric stent was kept in place for two weeks. Stone-free status defined as no residual stones or less than 4 mm detected on plain CTU after one month. Failure of the procedure was different between the two groups as for APCUL group there was residual stone more than 4mm and URSL group defined as

impossibility of retrograde progression of the ureteroscope and migrating of stone into renal calyx system. Surgical parameters, clinical outcomes, and postoperative complications were assessed and recorded between the two groups of patients. The statistical analysis will be using SPSS version 20.0. We use a statistical test of independent t-test, Chi-Square, and Fisher Exact test. Significant duration of operating time and length of hospital stay in this study were analyzed with the Chi-Square test. All the parameter assessed is significant if the p-value is < 0.05.

III. Result

A total of 58 patients were included in this study, of whom 28 were treated by APCUL, and 30 were treated by URSL. Two patients in the APCUL group were excluded from this study due to loss of follow-up and missing data. The patient demographic and clinical characteristics were summarized in Table 1. There were no statistically significant differences in the age, gender, stone size, and serum BUN level between the two groups of patients. In the URSL group, the creatinine level was significantly higher compared to the APCUL group. The mean glomerular filtration rate (GFR) (mL/ min) in the APCUL group was 27.8 ± 7.4 and 25.6± 6.6 in the URSL group. The mean stone size was 22.3 ± 6.5 and 20.7 ± 5.5 mm in APCUL and URSL groups, respectively.

Table 1: Demographic data and clinical characteristic of patients in the APCUL and URSL group

	APCUL group (n=28)	URSL group (n=30)	*p*
Age	**43.2 ± 11.3**	**47.5± 12.7**	**0.24**
BMI	**28±6.5**	**26±7.4**	**0.51**
Etnicity			
Malay	**24**	**28**	
Chinese	**3**	**2**	
Indian	**1**	**-**	
Others	**-**	**-**	
Gender (M/F)	**15/13**	**16/14**	**0.201**
BUN(mg/dl)	**10.2±7.28**	**14.3±5.56**	**0.54**
Creatinine (mg/dl)	**1.25±0.15**	**1.86±0.67**	**0.32**
Stone laterality, R/L	**10/18**	**13/17**	**0.12**
Stone size (mm)	**22.3±6.5**	**20.7±5.5**	**0.435**
GFR (mL/min)	**27.8±7.4**	**25.6±6.6**	**0.61**

APCUL: Antegrade percutaneous ureterolithotripsy, URSL: Retrograde ureterolithotripsy, GFR: Glomerular filtration rate, BUN: Blood, Urea, nitrogen. R: right, L: Left. Data presented as n(%) or mean ± standard deviation

The mean operative time was 52.7±16.4 in APCUL shorter than in the URSL group 67.10±22.3 (P=0.02). The mean hospital stay (days) in APCUL group was longer than the URSL group (4.85 ± 0.8 vs. 3.67 ± 0.6, respectively;(P=0.021). The postoperative complications included stone migrating, transient postoperative fever, blood loss required a blood transfusion and hematuria that are shown in Table 2. In the APCUL group, four patients had a transient postoperative fever and five patients had hematuria and three patients required blood transfusion. The postoperative fever and hematuria were managed with appropriate antibiotics, supportive treatment and resolved spontaneously. There was no ureter perforation or adjacent organ injury that occurred during the procedure. In the URSL group, two patients had a transient fever, one patient had hematuria, and eight patients who had stones showing upward migration during the procedure. No major complications in the URSL group were seen. In the APCUL group, 26 (92.9%) patients had complete stone clearance through a single tract in one session of percutaneous surgery. Only one patient who had residual stone underwent ESWL in the APCUL group.In the URS group, 21 patients (70%) had complete stone clearance, Nine (30%) patients experienced failure during the procedure. The causes of failure were the migration of stone and extreme tortuosity of the ureter in one patient; seven of these stones were subsequently treated by SWL and two patients underwent APCUL treatment. In APCUL Group patients had an average VAS pain score of 58 mm compared with 35 mm in URSL group patients. The double-J stent was kept in place for two weeks. None of these complications required rehospitalization and no major complications were encountered.

Table 2: Surgical outcome of patients

	APCUL group (n=28)	URSL group (n=30)	*p*
Mean Operating time (min)	**52.7±16.4**	**67.10±22.3**	**0.02**
Postoperative hospital stay (day)	**4.85±0.51**	**3.76±0.78**	**0.021**
Stone free (%)	**26 (92.9)**	**21(70)**	**0.032**
Mean % decrease in Hemoglobin	**0.56**	**0.21**	**0.43**
Operation related complication (%)			**0.041**
• **Fever**	**4 (14.2)**	**2(6)**	
• **Blood loss required blood transfusion**	**3(10.7)**	**-**	
• **Hematuria**	**5(17.8)**	**1(3)**	

• **Stone upward migration**	**-**	**8(26.7)**	
Failure (%)	**1(3.6)**	**9(30)**	
Pain score (VAS) mm	**58**	**35**	**0.03**

APCUL: Antegrade percutaneous ureterolithotripsy, URSL: retrograde ureterolithotripsy,
VAS: visual analog scale. Data presented as n(%) or mean ± standard deviation.

IV. Discussion

Long-term impacted ureteral stones may cause interruption of urinary flow and progressive backpressure on the ureter and kidneys, resulting in hydroureteronephrosis. The increased backflow resulting from intrapelvic pressure leads to a decline in renal blood flow with progressive focal ischemia, compression of the papillae with a decrease in the glomerular filtration rate, and thinning of the parenchyma due to a loss of nephrons. Significant cortical atrophy will ultimately result in renal function impairment [1]. Complete stone clearance is the primary management goal to relieve obstruction, eliminate infection and preserve renal function [2,3]. In the modern era of endourology, most ureteric stones can be treated with ureteroscopic or ESWL. However, ESWL for treating large stones >20 mm has been reported stone- free rate of 45% to 60%[2,4].This explains why the endourologic lithotripsy procedure is still considered a first line therapy for this stone [3,5].Ureteroscopic lithotripsy was initially introduced as a technique for managing distal ureteral stones and has achieved a high success rate [6]. Because of the improvement in fiberoptics and small caliber semi-rigid ureteroscopes, we can now directly access the whole ureter without ureteral dilatation. Irrespective of the stone size, Park et al. [7] reported an overall stone-free rate of 87.8%. In URSL combined with different kinds of lithotripters, the stone-free rate ranges widely from 35% to 87% for proximal ureteral stones >15 mm in diameter [2,8,9]. However, APCUL can achieve a total stone-free rate from 86% to 98.5% for stone sizes >15 mm in diameter, which is superior to that with any other treatment [10,11]. In this study, the stone-free rate was 92.9% in the APCUL group at the 1-month follow-up visit, similar to the international standard. The other advantage of APCUL is that any associated renal stones can be removed simultaneously. Here we have three patients who had concurrent renal stones with upper ureteric stone and were able to remove both simultaneously in all patients. On the other hand, URSL has the advantage to manage safely associated lower ureteral stones simultaneously and carried out in cases for which APCUL is contraindicated like morbid obesity, malrotated kidneys, or pregnancy [2,5,12,13]. URSL remains a less invasive approach with high patient tolerance even with repeated procedures and has fewer adverse effects [14]. We report that the URSL group has lower postoperative complications compared to the APCUL group (36.7% vs. 42.8%) respectively.Nevertheless, large proximal ureteric calculi could require several passages with the ureteroscope to remove all fragments after intracorporeal lithotripsy and add to increase the ureteral trauma. Several approaches and devices have been reported to prevent migration in the kidney such as Ntrap@stone entrapment. Furthermore, URSL depended on the surgeon's experience with potential problems due to local inflammatory conditions [15].

The main advantage of APCUL is to allow a rapid stone- free rate. Although the stone- free rate following APCUL is between 80% and 95%, they have significant complications that related to the procedure, including urinary extravasations, blood transfusion and fever. Other complications such as sepsis, colonic injury, and pleural injury are rare but still can be a concern [16,17].The advantage considerations for APCUL included easily accessible to the kidney. They can use larger caliber instruments with working space for nephroscopic manipulation and less needed for secondary procedures, cost-effective.

Sun et al. [18]showed that APCUL has significantly longer operative times, postoperative hospital, and longer intervals to return to normal activities ($P < 0.001$). However, in our study, the APCUL group have a shorter operating time with an expected longer hospital stay postoperatively. This because of the advancement of recent technology such as ultrasonic and shock pulse lithotripter gives more efficient and effective to stone fragmentation with shorter time. Furthermore, each group experienced one complication: Bleeding for APCUL and ureteral injury for URSL. Nevertheless, the authors recommend APCUL as the primary approach for such calculi. Goel and associates [10] described complete stone removal in 98.4% of patients who had impacted proximal ureteral stones greater than 1.5 cm. Kahn et al. [19]described the success of an antegrade approach for treating 35 out of 37 proximal ureteric stones with an average size of 10 mm, often without the need for intracorporeal lithotripsy.

Operative time in our data was slightly shorter than reported in the literature and can be explained by several reasons. Most of the cases presented with some degree of dilated collecting systems lead to rapid access to the renal pelvis and the ureter. The "one- shot" procedure that we have reported previously is less- time consuming in a dilated urinary system and decreased trauma and X-ray exposure [20].The complications observed with URSL mainly depend on the surgeon's experiences and skills. The most serious complication is a ureteral perforation reported with an incidence of 2–25% [9,21]. Most of the ureteral perforations are minor and can be managed by ureteral stents. Other complications include migrating stones, postoperative fever, gross hematuria, and ureteral strictures. Upward migration of ureteral stone fragments is the leading cause of incomplete and failure URSL treatment [22,23]. Continuous high-pressure irrigation for obtaining a clear operative visual field may result in an ascending stone. Nine(30%) patients in the URSL group needed auxiliary

SWL for ascending stones and APCUL treatment. Dretler [24] designed a stone cone for preventing and minimizing ascending stones during the URSL procedure. Complications of bleeding can be managed conservatively in most cases; only about 10.7% of patients need a blood transfusion in the APCUL group and arterial embolization is rarely required [25]. With preoperative prophylactic broad-spectrum intravenous antibiotics, the present incidence of transient fever was 14.2% and no patient experienced severe sepsis. All the transient fevers were managed conservatively. We demonstrated that for impacted upper ureteral stones 10-25mm mm in diameter, APCUL met the stone-free rate goals, shorter operating time and simultaneously can treat coexisting renal stones. URSL has the advantages of shorter postoperative hospital stays and fewer postoperative complications, but the main disadvantages are the lower initial stone-free rates and easy stone upward migration.

V. Conclusion

APCUL can be a safe and efficient treatment modality for upper ureteric stones with better stone-free rates and reduced need for secondary procedures to clear the retropulsed stones. It has lower postoperative complications, acceptable morbidity and enjoys better performance compared with the URSL approach.

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