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EFFICACY AND SAFETY OF URSL AND MINI-PCNL FOR TREATMENT OF IMPACTED LARGE UPPER URETERAL CALCULI: A PROSPECTIVE STUDY.

Urology

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ABSTRACT

Background: For the management of large impacted upper ureteral calculi, the available minimally invasive endourologic methods are mini-percutaneous nephrolithotomy (Mini-PCNL), ureteroscopic lithotripsy (URSL), and laparoscopic ureterolithotomy. This study aimed to compare Mini-PCNL and URSL, and to evaluate the better choice for large impacted upper ureteral calculi.

Methods: Between January 2017 and December 2020, at the Urology Unit, Department of Surgery, Jawaharlal Nehru Institute of Medical Sciences (JNIMS), Porompat, Imphal, 40 patients with large impacted upper ureteral calculi (>15 mm) who were consecutively enrolled were included. The patients were randomly divided (1:1) into Mini-PCNL and URSL groups. The primary endpoint was the success of stone removal measured 1 month postoperatively and the secondary endpoints were intraoperative and postoperative parameters and complications.

Results: Eight patients after URSL and 2 patients after Mini-PCNL needed auxiliary ESWL treatment. The stone clearance rate in the Mini-PCNL group was 95 % (19/20) and 75 % (15/20) in the URSL group. Operation-related complications were similar among the two groups (all $p > 0.05$). Hospital stay was shorter in the URSL group compared with Mini-PCNL ($p < 0.001$). However, the mean operative duration was shorter in the URSL group compared to the Mini-PCNL group ($p < 0.001$).

Conclusions: Mini-PCNL and URSL are suitable treatment options for impacted upper ureteral calculus with a diameter of >15 mm. Though the success rate and stone clearance rate are lower but acceptable, URSL could be considered if the patient is not suitable for general anesthesia and with other comorbidities, or if it is the patient's preferred treatment option.

KEYWORDS

Mini-PCNL, URSL, impacted ureteral calculi, stone clearance rate.

INTRODUCTION:

Urinary calculus disease is a common disorder for more than 12% of the population, which is increasingly prevalent in many parts of the world.[1-3] Impacted ureteral calculus is the one that stays in the same location at least for a duration of 2 months and results in complete obstruction of the ureter.[4] Such calculi can cause ureteric colic and result in hydronephrosis or pyonephrosis, which may bring about loss of renal function of left untreated.[5] In almost every case, the transverse diameter of an impacted ureteral calculus is longer than the diameter of the ureter. Other parameters such as irregular surface, large volume, and uneven density will bring about ureteral obstruction, hydronephrosis, and pyonephrosis. Secondary infection, pathological lesions such as ureteral polyps, and stricture additionally arise in the impacted site.[6]

Therefore, these calculi need to be removed by using some form of intervention. In the past, the majority of large upper ureteral calculi required open invasive surgery for their removal.[7] With the advent of minimally invasive techniques, diverse treatment modalities have become available such as extracorporeal shock wave lithotripsy (ESWL), ureteroscopic lithotripsy (URSL), percutaneous nephrolithotomy (PCNL), in addition to laparoscopic ureterolithotomy, all with varied success rates.[8] In the recent guidelines, ESWL is the primary choice for upper ureteral calculi that do not pass out spontaneously, however, for large ureteral impacted calculi, ESWL has been much less successful.[9] Therefore, the best treatment modality for larger calculi of 15 mm diameter or more still remains controversial.[8] When the calculi are located in the upper ureter near the renal pelvis, there is a risk of the calculi migrating into the pelvicalyceal system, which results in the failure of URSL.[10] Both PCNL and mini-PCNL (MPCNL) have been used more often to treat upper ureteral stones in recent years.[11]

All these minimally invasive treatment modalities may be used to deal with impacted upper ureteral calculi, however, choosing the best one among them with certainty remains controversial. In a meta-analysis by Torricelli et al., it was shown that the outcomes of Laparoscopic ureterolithotomy were more favorable than for URSL, making it the treatment of choice when flexible ureteroscopy is not available.[12] It has been reported that PCNL has equal efficacy with laparoscopic pyelolithotomy, but to be associated with lesser complications.[13] Therefore, the aim of this study was to compare the two minimally invasive methods; URSL and Mini-PCNL to evaluate the better alternative for large upper ureteral stones (>15 mm) in terms of efficacy and safety profile.

Methods:

In 4 years duration from January 2017 to December 2020, forty consecutive subjects with upper ureteral stones who attended the Urology Clinic in Jawaharlal Nehru Institute of Medical Sciences (JNIMS), Porompat, Imphal, were selected for the study. The inclusion criteria were patients with a solitary upper ureteral calculus; the stone was >15 mm along its longest dimension as revealed by Kidney-Ureter-Bladder (KUB) abdominal plain film. The exclusion criteria were those cases with a prior history of any urologic intervention on the corresponding ureter, radiolucent stones, active urinary infection, or urinary tract abnormalities, coagulopathy, age below 18 years, or pregnancy. In the beginning of the study, written informed consent was obtained from all subjects. In addition to routine history and clinical examinations, the investigations included complete blood count, kidney function test, coagulation profile, urine culture and sensitivity, ultrasonography, X-ray KUB, and Intravenous pyelogram. Randomisation of the study subjects was done by using a computer-generated random number table.

Procedures:

URSL

The procedure was done under spinal anesthesia with the patient placed in the lithotomy position. A 6 to 6.5 F semi-rigid ureteroscope (Richard Wolf GmbH, Germany) was employed and it was pushed into the ureter through the ureteral orifice with the help of a 0.035-inches floppy tip hydrophilic guidewire and the calculi were fragmented with a pneumatic lithotripter through the ureteroscope. A double-J stent was placed in all cases at the end of the procedure and removed when the patient was stone-free on follow-up evaluation.

Mini-PCNL

Under general anesthesia, the patient was placed initially in the lithotomy position and a 6 Fr ureteral catheter was inserted i through a cystoscope for performing retrograde pyelogram. Then the patient was repositioned by rotating to the prone position with bolsters placed adequately under the body. Retrograde pyelography was done and C-

Arm guided percutaneous puncture was made into the desired calyx, either mid or upper calyx with an 18-gauge 3 part puncture needle and through it, a flexible guidewire was then inserted through the calyceal puncture into the renal pelvis and if possible across the ureteropelvic junction into the ureter. The percutaneous nephrostomy tract was dilated upto 20 Fr using a serial telescopic Teflon fascial, followed by placement of an Amplatz sheath through the tract. All the calculi were fragmented with a pneumatic lithoclast and the fragments were retrieved by using turbulence of irrigating saline or by forceps. At the end of the procedure, a 5 Fr double-J stent was inserted via the percutaneous access over the guidewire. At the end of the procedure, 20 Fr Silastic nephrostomy tube was put in all the cases.

All these patients were subjected to X-ray KUB examination within 3 days after the primary procedure. Patients requiring ESWL were referred to the Regional Institute of Medical Sciences, Imphal as there was no such facility in our institute. The primary outcome was successful treatment. Complete removal of the target calculus or the presence of insignificant residual stone fragments (4 mm) was counted as successful treatment. After one month from the day of surgery, the patients were asked to attend the urology clinic to remove the double-J stent after assessing the outcome with X-ray KUB film. Absence of stone fragments on the KUB film was taken as Stone clearance. For assessing the secondary outcomes, intraoperative and postoperative complications were taken into consideration. Complications arising intraoperatively and postoperatively, and hospitalization days after surgery were thoroughly assessed and noted.The surgical complications were classified based on the Clavien method [17]. All the patients were followed up at 6 and 12 months to ensure that there was no stone recurrence or ureteric stricture.

STATISTICALANALYSIS

Data analysis was performed by the SPSS (version 24.0, Chicago, Illinois, USA) using chi-squared test, Fisher's exact test, Wilcoxon test, paired-sample t-test and Man-Whitney test. P value < 0.05 was taken as statistically significant for the analysis.

Table 1. Baseline characteristics of the patients

Variable	URSL group	Mini-PCNL group	*p* value
Mean age (years)	50 ± 12	48 ± 14	0.32
Male: Female	12: 8	13: 7	0.37
Side (Right/Left)	24/16	18/22	0.50
Mean stone size (mm)	18.6 ± 3.6	19.1± 4.1	0.34
Hydronephrosis (mm)	35 ± 5	40 ± 8	0.01

Table 2. Patient outcomes after the procedure

Variable	URSL group	Mini-PCNL group	*p* value
Success rate	60 % (12/20)	90 % (18/20)	0.020
Mean operative duration (min)	55 ± 22 min	125 ± 40	0.001
Hospital stay after surgery (day)	2 ± 1	5 ± 2	0.001
Auxiliary ESWL after 3 days	40 % (8/20)	10 % (2/20)	0.170
Stone-free rate after 1 month	75 % (15/20)	95 % (19/20)	0.042

Table 3. Complications of the procedure

Variable	URSL group	Mini-PCNL group	*p* value
Grade I			
Pain	5%	15 %	0.149
Fever	5 %	15 %	0.149
Nausea/ vomiting	5 %	5 %	0.500
Urine leak	0 %	0%	NS
Grade II			
Minor pelvic/ ureteral perforation	5 %	0 %	NS
Urinary tract infection	5 %	10 %	0.182
Ureteral stricture	5 %	0 %	NS
Grade III			
Blood transfusion	0 %	5 %	NS
Grade III - V	0 %	0 %	NS

RESULTS

Baseline data

In this study, there were 25 men and 15 women. The baseline parameters of the patients are depicted in Table 1. There were no statistically significant differences between the two groups for stone size and extent of hydronephrosis (both p > 0.05; Table 1). All patients were followed up at 6 and 12 months. ESWL on the residual stone was performed 2 weeks after surgery in both the groups, URSL group (n = 8), and Mini-PCNL group (n = 2). The successful treatment rate was 12/20 (60%) in the URSL group and18/20 (90%) in the Mini-PCNL group. The differences were significant between the two groups (Table 2), and differences of stone clearance rate 1 month after operation between the two groups were also statistically significant ($p < 0.05$). Auxiliary ESWL was required in a large number of patients in the URSL group (n = 8), but only in two patients in the Mini-PCNL group. There were no statistically significant differences in the length of major axis and surface area of stones as well as in the complications and morbidity ($p > 0.05$). The mean operative duration was significantly different between the groups; URSL group took 55 ± 22 min and Mini-PCNL group took 125 ± 40 min ($P < 0.05$). A similar result was found with the length of post-operative hospital stay: a significantly shorter time was needed after URSL (2 ± 1 days) than after Mini-PCNL (5 ± 2 days, all $P < 0.05$).

There were no severe complications in any of the patients except for 3 patients in Mini-PCNL group who had post-operative bleeding, out of which only one patient required blood transfusion. In the URSL group, the main postoperative complications were stone fragment migration, ureteral perforation, and ureteral stricture. In the Mini-PCNL group, bleeding occurred in 3 cases and only one of them needed a blood transfusion. Three cases had post-operative fever because of urosepsis (Table 3).

DISCUSSIONS

There are numerous modalities for the management of impacted upper ureteral calculus disease, which includes URSL, Mini-PCNL, and laparoscopic ureterolithotomy. ESWL is usually not effective in impacted stones due to the fact that they are usually wrapped around or adhere to an ureteral polyp.[14] White et al. reported that if upper ureteral calculus smaller than 10 mm, ESWL gave a stone clearance rate of 69%, however; whilst the diameter changed into above 10 mm, it gave 59% only.[14] All these procedures have their own advantages and limitations. PCNL has a high efficacy rate, however, at the cost of large surgical trauma and bleeding, complicating the recovery of the patients and prolonging hospital stay.[8,15] URSL is not as effective as laparoscopic ureterolithotomy and PCNL, and is prone to push the calculi upward; even though the surgical trauma by URSL is minimal, leading to short recovery.[8,16] Ureteroscopic surgery is a minimally invasive procedure, which has a good acceptance rate and fast recovery for patients. In this study, there was 60 % success rate and the stone clearance rate was 75% at the end of 1 month after the procedure in the URSL group. In previous studies, URSL has approximately 35–87% success rate.[17,18] In most instances, URSL can be carried out under spinal anesthesia, wile general anesthesia is preferred in Mini-PCNL. In fact, URSL is particularly suitable for patients who are not fit for general anesthesia. However, there are numerous drawbacks with URSL whilst coping with impacted upper ureteral calculi. To start with, the stone clearance rate is surprisingly low. In most of the instances, the stones are large and close to the pelviureteric junction. During URSL, the stone and its fragments are susceptible to go up into the pelvicalyceal system (PCS) with the flow of irrigating saline solution, ensuing in residual stones. Secondly, ESWL is usualy indicated as an auxiliary procedure for residual stone fragments after URSL. Chen et al. found out in their study with URSL that ESWL as an auxiliary procedure was needed in 16% of the cases.[19] In the present study, there were two cases of ureteral stricture following URSL, which could be because of longstanding obstruction, chronic persistent inflammation, and formation of mucosal polyp. For these patients, we propose that the double-J stent ought to be left for at least 12 weeks. With the advancement of endoscopy and lithotripsy instruments in the last two decades, PCNL, instead of open surgery, has already become an option for minimally invasive lithotripsy for renal stones and is gradually being done for upper ureteral stones.[9,20] Karami and co-workers compared the outcome of URSL and PCNL in 70 cases of impacted upper ureteral calculi >10 mm.[21] It was observed that the stone clearance rate was 96% in the PCNL group, while 32% of patients in the URSL group had stone migration into the renal pelvis and managed with ESWL after surgery. It gave the conclusion that PCNL was the first treatment option for this type of stones. Our observation was that the stone clearance rate was 95% one month after surgery in the Mini-PCNL group and 75% in URSL group. We found a similar complication rate in these 2 groups. If the stone is close to the PUJ and hydronephrosis is significant, the chance of stone migration into the PCS during the procedure is high, which will give a negative impact on the success rate of the URSL procedure. The limitation of the study is that the sample was from one single centre and the study

sample was quite less. And, there has been no post-operative CT examination at the time of calculation of the stone clearance rate. And finally, the follow-up of 6–12 months was quite short, so we cannot provide any comparative figure on recurrence rates or long term complications between the two groups.

CONCLUSIONS

In our opinion, both Mini-PCNL and URSL are suitable treatment options for impacted upper ureteral calculus with a diameter of >15 mm. Though the success rate and stone clearance rate are lower but acceptable, URSL could be considered if the patient is not suitable for general anesthesia and with other comorbidities, or the patient's preference with prior information for the need of ancillary treatment with ESWL in case need arises.

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