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Efficacy and safety of in situ percutaneous neprolithotomy in upper ureteric impacted stones

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Abstract
Background: There are many surgical options for the management of impacted upper ureteric stones. The durations as well as the degree to which the calculus is impacted result in renal function derangement. Surgical options include Extracorporeal shockwave lithotripsy (ESWL), PCNL, open and laparoscopic surgeries. The aim of the study to evalute the efficacy & safety of in situ management of impacted upper ureteric stone with mini- percutaneous nephrolithotomy.
Methods: This was a prospective study and was conducted in Chevron Specialized Hospital in Chattogram from July 2020 to January 2023. A total of 40 patients were included in this study. All patient underwent prone mini PCNL, with 15Fr amplatz sheath with fluoroscope guided access. Stones fragmented by holmium laser.
Results: The mean age (in years) of patients was 44.5 and range 22-62, the male female ratio was 28:12. The mean stone size was 17.5 mm. The disease laterity (left: right) was 24:16. The mean procedure time was 65.9 minutes. Hydronephrosis appeared in all paitents, but the renal units were functional. 85% paitents were discharged on within next post-operative day. After one month of follow-up the stone free rate was 95.5% while as the stone free rate on discharge was 87.8%. Complication rate was 12% which include post operative fever, pain, prolonged hematuria and mild thoracic complication. Residual stone found in three paitent after four weeks follow-up. No hollow visceral Perforation and no ureteral injurey was noted.
Conclusions: We conclude here in situ mini-PCNL is safe and effective procidure for impacted upper ureteric stone. So, it can be done with higher success, good stone clearance & with minimal complication.

Keywords: Holmium laser, impacted upper ureteral stone, hydronephrosis

Introduction
There are many surgical options for the treatment of impacted upper ureteral stones. Depending on the duration and extent of stone hardening, impaired renal function may result. Surgical options include extracorporeal shock wave lithotripsy (ESWL), PCNL, open surgery, and laparoscopic surgery [1]. Impacted stones cannot be successfully treated with ESWL and require additional procedures [2]. Hardened upper ureteral stones cannot be bypassed with a ureteral catheter or guidewire [3, 4]. Recent advances in minimally invasive surgery have significantly reduced mortality and morbidity. PCNL is a safe and effective procedure with few complications for the treatment of impacted hardened upper ureteral stones [5]. For ureteral stones 15 mm or larger, the stone removal rate is high and kidney stones can be treated simultaneously. In contrast, URS results in shorter hospital stays and shorter operative times [6]. This study describes our experience with mini-PCNL by adjusting the midcalyx or easy calyx approach for retained upper ureteral stones. Since 1980, ESWL has become the preferred treatment for removing both renal and ureteral stones due to its minimal invasiveness and was recommended as the first-line treatment [7]. Recently, the introduction of small-caliber semirigid and flexible ureteroscopes and the development of laser lithotripsy have enabled experienced surgeons to treat almost all stones in the upper urinary tract using retrograde ureteroscopy. However, the treatment of large retained proximal ureteral stones remains controversial. In cases where ESWL and ureteroscopic lithotripsy have failed, open surgery or laparoscopic ureterolithotomy may be required. Percutaneous nephron lithotomy was introduced as an alternative treatment for large renal stones, and the percutaneous approach for treatment of proximal ureteral stones has also achieved some success [8, 9].

However, bleeding and fever are the common complications. Laparoscopic ureterolithotomy is associated with a shorter period of convalescence when compared to an open procedure but is associated with a higher learning curve [10, 11]. Open ureterolithotomy is indicated for failure of all minimally invasive modalities in presence of a concomitant open procedure and the presence of large impacted stone where patients don't consent for multiple procedures [12].

Methods

This was a prospective study and was conducted in Chevron Specialised Hospital in Chattogram from July 2020 to January 2023. A total of 40 patients were included in this study. All patient underwent prone mini PCNL, with 15Fr amplatz sheath with fluoroscope guided access. Stones fragmented by holmium laser. Patients of either gender with impacted upper ureteric stones ≥ 15 mm (no contrast seen below the filling defect on IVU) were included in the study. Patients with abnormal coagulopathy state (increased PT& APTT), active urinary tract infection (presence of pus cells on urine routine examination), pregnant ladies, and abnormal upper urinary tract anatomy such as ectopic kidney, horseshoe kidney, and retrocaval ureter were excluded from the study. The mean age of the patient was 45.5 (22-62) years. Each patient/attendant(s) was fully explained the nature of procedure and the possible inherent complications associated with the procedure. Informed consent was taken from patients/attendants before procedure. The patients/attendants were explained for the possible need of tube thoracostomy and consent was taken pre- operatively for same.

The patients with stones located between the pelviureteric junction and the upper border of the 4th lumbar vertebra, upper ureteral stone ≥15mm in largest diameter by plain film/ultrasound, with split glomerular filtration rate of the affected kidney ≥20ml/min and patients with a stone diameter ≥12mm with previous history of abdominal surgery or repeated sessions of ESWL treatment were included. Exclusion criteria were uncorrected coagulopathy, pyonephrosis, or glomerular filtration rate<20ml/min. Preoperatively, patients were evaluated by a urine routine test, urine culture and sensitivity test, plain radiography of kidneys, ureters and bladder (KUB), and intravenous urography. Ultrasonography or unenhanced helical computed tomography for the degree of hydronephrosis, computed tomography urography (CTU) and radionuclide imaging were also performed if necessary. Antibiotics were administered prophylactically to all patients with WBC-positive urine. Calculus clearance was assessed on next postoperative day with a plain film of KUB. 'Stone-free' was defined as no residual stones or fragments ≤3mm detected on KUB, as fragments ≤3mm have a likelihood of passing spontaneously. The operative time was calculated from performing the puncture to placing of DJ stent. No Nephrostomy tube used in this study. The time from insertion of the ureteric catheter to the turn in the prone position was not included.

Results

The mean age (in years) of patients was 44.5 and range 22-62, the male female ratio was 28:12. The mean stone size was 17.5 mm. The disease laterity (left: right) was 24:16. The mean procedure time was 65.9 minutes. Hydronephrosis appeared in all patients, but the renal units were functional. 85% patients were discharged on within next post-operative day (table-1). After one month of follow-up the stone free rate was 95.5% while as the stone free rate on discharge was 87.8%. Complication rate was 12% which include post operative fever, pain, prolonged hematuria and mild thoracic complication. Residual stone found in three patients after four weeks follow-up. No hollow visceral Perforation and no ureteral injury was noted. All stones could be reached and treated through the nephrostomy tract. Holmium laser (Jena surgical GmbH, Germany) used to fragment all stone and stone washed out by SHAH Superperc SHEATH suction device. DJ stents was given in every case. DJ stents size was 5/6 fr. No urinary tract perforation or adjacent organ injury occurred during the procedures. The operation- related complications are shown in Table 2. Stone composition did not influence the efficiency of fragmentation, operation time, or operation-related complications.

Table 1: Demographic and clinical characteristics of patients

Age (yr) (range)	44.5±11.2 (22-62)
Male/female	28/12
BUN (mg/dL)	14.47±3.69
Creatinine (mg/dL)	1.23±0.27
Stone laterality (left/right)	24/16
Stone size (mm)	17.5±5.4
Stone surface area (mm)	232.8±113.2
Associated renal stone (%)	17 (42.5)
Operation time (min)	69.5±22.1
Postoperative hospital stay (days)	1.8±0.7

Table 2: Post operative complications in the patients

Postoperative complications	Patients, n (%)
Fever	05 (12.5)
Significant blood loss	3 (7.5)
Prolonged hematuria	4 (10.0)
Perforation	0-0.0
Sepsis	0-0.0
Stone-free	38 (95.0)
Thoracic complication	2(5.0)

Discussion

Urolithiasis is one of the major problems in Bangladesh. It may not only cause recurrent urinary tract infection but may also cause obstructive uropathy which ultimately leads to loss of one or both kidneys [13]. American Urological Association specified that for the treatment of proximal-ureteral stones <1 cm, Shock Wave Lithotripsy, ureteroscopy, and PCNL are all adequate decisions [1]; however, ureteroscopy may become less appropriate as the calculi encountered become larger. The stone clearance rate is also highly affected by the ureteral wall thickness [14]. The selection of proper treatment options for large impacted upper ureteral calculi remains controversial, especially at those institutions where limited resources are available [15-17]. EAU guidelines recommend PCNL as management of choice for large impacted proximal ureteral stones [18]. In comparison to other procedures, PCNL has greater stone clearance with less operative time [19]. Futher, complete stone clearance can be achieved through PCNL, however laparoscopic ureterolithotomy has been successful in patients with large size stones [20]. Technical achievements have revolutionized the methodology for the removal of ureteral stones. Open ureterolithotomy, once used to be the standard treatment for impacted, upper ureteric stones, however, with the advent of lithotripters, endourology and laparoscopy, less invasive procedures are preferred. Both

PCNL and retrograde ureteroscopy are accepted treatment modalities for large, impacted, proximal ureteric calculi. ESWL has proved to be safe and relatively effective for treating upper ureteral stones. Many centers state in their studies ESWL as first-line treatment for ureteral stones. Although traditional PCNL has many advantages, such as clear vision, high stone clearance rate and short operation time, the indications were strictly limited for a number of serious complications [19]. In a study done by Lijie *et al*. PCNL and Ureterolithotripsy (URS) were compared for upper ureteric stones over 15 mm size, favored PCNL with low residual stone rate, and high stone clearance rate. However, the loss of Haemoglobin was greater in PCNL [21]. A longer mean operative time, longer mean hospital stay and higher stone clearance rate in antegrade than in retrograde approach for large, impacted, upper ureteric stones has been reported previously [20-22]. In this study, a significantly longer mean operative time was seen (Table 2). In present study, the mean hospital stay was significantly less (Table 2). The main aim of stone operation was to get a high stone clearance rate, so it is important to deal with the stone fragments effectively. Clinically Insignificant Residual Fragments (CIRFs) after PCNL remains a major concern, e.g. Skolarikos A *et al*, believed that if CIRFs were left untreated, approximately half of the patients would experience a stone-related event for which more than a half would also need a secondary surgical intervention [23]. The mean age (in years) of patients was 44.5 and range 22-62, the male female ratio was 28:12. The mean stone size was 17.5 mm. The disease laterity (left: right) was 24:16. The mean procedure time was 65.9 minutes. Hydronephrosis appeared in all patients, but the renal units were functional. 85% patients were discharged on within next post-operative day (table-1). In present study, at discharge from the hospital, stone free rates were 87.8% and at 1 month follow-up, the stone free rates were 95.5%, i.e., 5 patients had a successful spontaneous passage of residual fragments. A significantly higher success rate (95.5%) was noted in present study. Similar comparisons were observed in various previous studies [21, 24]. Fever and hematuria are known complications of the procedure [25-27]. In this study, a higher number of patients developed post- operative fever and prolonged hematuria 12% and 10% respectively. Two patient required blood transfusion. Supracostal approach is known to lead to thoracic complications ranging from 5 to 25% [28, 29]. Two patients in this study with supracostal approach, developed thoracic complications. One patient developed pneumothorax and one had hydrothorax. All patients were diagnosed perioperatively and required placement of a chest drain. The clinical conclusion of this study is that the nephroscope is easy to manipulate and allows access to all calyces where stone fragments float and become blocked during fragmentation. Furthermore, once the urinary catheter is removed, saline is injected through the ureteral catheter, pushing stone fragments remaining in the ureter back to the calyces where they are retrieved by the suction mechanism. In this way, the need for additional interventions is also limited. No patient required multiple tracts. In cases where a previous urinary diversion procedure has been performed and retrograde access is difficult, an antegrade approach is possible, providing a greater scope for nephroscopic fragmentation. During a mean follow-up period of 1 year, two patients developed significant ureteral stenosis, which was treated in a timely manner. The authors' experience shows that a thorough preoperative examination can effectively reduce the risk of sepsis. Percutaneous renal access was performed by experienced surgeons. In cases of difficult puncture, a combination of ultrasound and fluoroscopic guidance may be useful. Experienced teamwork can be very helpful in reducing the operative time and, as a result, reduce complications due to prolonged operative time associated with both septic shock and severe renal bleeding.

Conclusions

We conclude here in situ mini-PCNL is safe and effective procidure for impacted upper ureteric stone. So, it can be done with higher success, good stone clearance & with minimal complication.

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