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ORIGINAL ARTICLE

Safety and Efficacy of Mini Percutaneous Nephrolithotomy in Paediatric age Patients: Paving the Way Towards Minimally Invasive Techniques in Resources Limited Areas

TARIQ AHMAD[1], MUHAMMAD ASIF[2], FARMAN ULLAH KHAN[3], MUHAMMAD ASIF AMMAR[4], ASIF KHAN[5], NASRUM MINALLAH[6]
[1]*Assistant Professor, Paediatric Urology, Institute of Kidney Diseases, Hayatabad Medical Complex, Peshawar*
[2]*Consultant Urologist, DHQ Hospital, Mardan*
[3]*Medical Officer Urology, Timergara Teaching Hospital, Timergara*
[4]*Assistant Professor Urology, CMH Kharian Medical College, Kharian Cantt*
[5]*Senior Registrar Urology, Saidu Group of Teaching Hospital, Swat*
[6]*Registrar, Department of Urology and Renal Transplant Institute of Kidney Diseases, Hayatabad Medical Complex, Peshawar*
Corresponding author: Nasrum Minallah, Email: drnasrumminallah@gmail.com

ABSTRACT

Objectives: To assess the safety and effectiveness of mini-percutaneous nephrolithotomy (PCNL) in paediatric age patients.

Materials and Methods: This descriptive case series study was conducted in the Department of Paediatric Urology, Institute of Kidney Diseases, Hayatabad Medical Complex, Peshawar, Pakistan from June 2017 to June 2020. Children < 14 years, diagnosed with renal stone > 1cm in size on non-contrast CT of Kidney Ureter and Urinary Bladder (KUB) and having negative urine culture were enrolled in the study. Patients having abnormal renal functions and bleeding diathesis were omitted from the study. Informed written consent was taken from the parents of all the children. Children with no stone fragments in the kidney or ipsilateral ureter on non-contrast CT KUB at one month were labelled as stone free.

Results: A total of 213 children who underwent mini-PCNL were analyzed. 130 (61.03%) of the stones were 10-15 mm and 83 (38.97%) were > 15 mm in size. The mean operation time was 56.02 + 7.82 (40-81) minutes .The mean hospital stay was 2.22 + 0.67 (2-7) days. The mean decrease in haemoglobin was 1.30 + 0.67 (0.2-4.0) gm/dL. No major intraoperative complication was observed. 24 (11.27%) of the patients developed post-operative complications including 10.33 % minor and 0.94 % major complications which were statistically insignificant. As a monotherapy mini-PCNL achieved complete stone clearance at one month in 191 (89.67%) of the patients. Retreatment was required in 22 (10.33%) of the patients including extracorporeal shock wave lithotripsy (ESWL) in 7 (3.29%), ureteroscopy (URS) in 10 (4.69%) and Re-PCNL in 5 (2.35%) patients.

Conclusion: This study concludes that mini-PCNL in a paediatric population is safe and effective for renal stones > 10 mm with acceptable stone clearance and complications.

Keywords: Kidney calculi, Pediatrics, Percutaneous, Children, Urolithiasis

INTRODUCTION

The incidence of urolithiasis is increasing in both developed and under developed countries, affecting both children and adult population with recurrence rates as high as 50%1[,2,3]. With such high incidence, recurrence and serious complications like renal failure (30%) and hydronephrosis (10%), early effective and minimally invasive diagnosis and management of renal stones are mandatory[4,5]. Ultrasound is the first-line diagnostic study which allows visualization of urinary stones, signs of hydronephrosis and increased renal echogenicity[4].

Minimally invasive procedures like ESWL, URS and PCNL can effectively treat most of the renal stones in paediatric population[6,7,8]. However, PCNL remains main therapeutic modality in paediatric patients with large renal stones (> 1.5 cm), lower pole stones >1 cm, anatomical abnormality impairing stone clearance, or known cystine or infection stones[7,9].

Due to small kidney size and higher mobility, mini-PCNL is challenging task to perform in children keeping high level of safety and efficacy. In the intended study paediatric age patients who underwent mini-PCNL were prospectively assessed with the aim to assess the outcomes of mini-PCNL in paediatric population in terms of stone free rate and complication rate.

Objective: To evaluate safety and effectiveness of mini-PCNL in pediatric age patients

MATERIAL AND METHODS

This descriptive case series study was conducted in the Department of Paediatric Urology, Institute of Kidney Diseases, Hayatabad Medical Complex, Peshawar Pakistan from June 2017 to June 2020 after obtaining approval from hospital ethical committee. Children < 14 years, diagnosed with renal stone > 1cm in size on non-contrast CT KUB and having negative urine culture were enrolled in the study. Patients having abnormal renal functions and bleeding diathesis were omitted from the study. Informed written consent was taken from the parents of the children. Children with no stone fragments in the kidney or ipsilateral ureter on non-contrast CT KUB at one month were labelled as stone free and declared as procedure success. The presence of residual fragments of any size in the kidney at one month was defined as failure of the procedure.

Procedure: All the subjects were admitted to the unit one day prior to PCNL procedure. Baseline investigations including clotting profile were performed. All children underwent mini-PCNL under general anaesthesia (GA) in prone position. Cystourethroscopy was performed and ureteric catheter 3 Fr passed in lithotomy position. Position of the patient was changed into prone. Pelvicalyceal system (PCS) was opacified by retrograde administration of contrast (urograffin). PCNL needle (18G) was used for PCS puncture under C-arm guidance using Bull's Eye technique. The glide wire (0.035 inch) was passed through the needle into PCS and ureter. Dilatation of the tract was done with single step dilatore and secured with 12 or 14 Fr access sheath. 10 Fr paediatric nephroscope was then introduced to reach the stone under direct vision through the access sheath. Stone fragmentation was done with Swiss Pneumatic lithoclast (2 mm probe). Fragments were extracted using two prongs forceps. Tubeless procedure was defined as procedure in which only DJ-Stent was passed without placing a nephrostomy tube whereas totally tubeless procedure was defined as procedure in which neither DJS nor nephrostomy was placed. CT KUB was performed at one month post-operatively to look for any residual stone fragments in the kidney or ipsilateral ureter. DJ-Stents were removed four weeks after the procedure under GA.

RESULTS

Table-1 shows patient and stone characteristics. 213 children were enrolled in the study. 139 (65.26%) were male and 74 (34.74%) were female. 130 (61.03%) of the stones were 10-15mm in size and 83 (38.97%) of the stones were > 15 mm in size. 88 (41.31%) of the stones were on the right side and 125 (58.69%) of the stones were located on the left side. Majority of the stones 177 (83.10%) were located in the renal pelvis. The remaining stones

were either located in the upper/middle pole 4 (1.88%) or lower pole 23 (10.80%). 9 (4.22%) stones were staghorn stones. 25 (11.74%) had grade 0 hydronephrosis (HDN), 49 (23.00%) had grade 1, 116 (54.46%) had grade 2 and 23 (10.80%) had grade 3 HDN.

Table-2 shows perioperative and postoperative characteristics of patients. The mean operation time was 56.02 + 7.82 (40-81) minutes .The mean hospital stay was 2.22 + 0.67 (2-7) days. The mean decrease in haemoglobin was 1.30 + 0.67 (0.2 to 4.0) g/dL. Supracostal access was obtained in 127 (56.62%) and subcostal access was obtained in 86 (40.38%) of the cases. Single puncture was required in majority of the cases 201/213 (94.4 %) to achieve maximum stone clearance although multiple punctures were required in 12/213 (5.6 %) of the cases. In 195 (91.55%) of the patients DJS was inserted at the completion of the procedure and in 18 (8.45%) neither nephrostomy nor DJS was placed. No major intraoperative complication was observed. 24 (11.27%) of the patients developed post-operative complications including postop fever in 8 (3.76%), transient hematuria in 11 (5.16%), 4 of which needed blood transfusion, UTI in 3 (1.41%) and urosepsis in 2 (0.94%) of the patients.

As a monotherapy mini PCNL achieved complete stone clearance at one month in 191 (89.67%) of the patients. Additional therapy was required in 22 (10.33%) of the patients which included ESWL in 7 (3.29%), URS in 10 (4.69%) and Re-PCNL in 5 (2.35%) of the cases. 187 (87.79%) of the stones were CaOx.CaP, 4 (1.88%) were uric acid, 8 (3.76%) were Cystine, 12 (5.63%) were struvite stones and in 2 (0.94%) cases stone composition was unknown.

Table 1: Patient and Stone Characteristics

Characteristic	Result
Gender	
Male	139(65.26%)
Female	74(34.74%)
Stone Size (mm)	
10 to 15 mm	130 (61.03%)
> 15 mm	83 (38.97%)
Stone Laterality	
Right	88 (41.31%)
Left	125 (58.69%)
Stone Location	
Renal Pelvis	177 (83.10%)
Upper/Middle Pole	4 (1.88%)
Lower Pole	23 (10.80%)
Staghorn	9 (4.22%)
Grade of HDN	
Grade 0	25 (11.74%)
Grade 1	49 (23.00%)
Grade 2	116 (54.46%)
Grade 3	23 (10.80%)

Table 2: Perioperative and postoperative characteristics of patients

Characteristic	Result
Operative Time (minutes)	56.02 + 7.82
Hospital Stay (days)	2.22 + 0.67
Puncture Location	
Supracostal	127 (56.62%)
Subcostal	86 (40.38%)
Puncture Number	
Single	201 (94.37%)
Multiple	12 (5.63%)
Exit Strategy	
Totally Tubeless	18 (8.45%)
Tubeless	195 (91.55%)
Drop in Haemoglobin (g/dl)	1.30 + 0.67
Stone Free Rate	191 (89.67%)
Re-treatment Rate	22 (10.33%)
ESWL	7 (3.29%)
URS	10 (4.69%)
Re-PCNL	5 (2.35%)
Complications	
Intraoperative Complications	None
Postoperative Complications	24 (11.27%)
Clavien Grade I	
Postop Fever	8 (3.76%)
Transient Hematuria	11 (5.16%)
Clavien Grade II	
UTI	3 (1.41%)
Clavien Grade III	-
Clavien Grade IV	
Urosepsis	2 (0.94%)
Stone Composition	
CaOx.CaP	187 (87.79%)
Uric acid	4 (1.88%)
Cystine	8 (3.76%)
Struvite	12 (5.63%)
Unknown	2 (0.94%)

DISCUSSION

Paediatric kidney stones are big public health problem in developing countries as the incidence is rising and may reach up to 30%[10]. Moreover, paediatric renal stones should be evaluated thoroughly as they may recur later in the life and may cause serious complications primarily due to underlying anatomical defects and metabolic abnormalities. Furthermore, stone clearance rates are also important in paediatric population as even the residual stone fragments of 4–5 mm in size, which are considered clinically insignificant in adults, may become symptomatic in pediatric population and require therapeutic intervention. Moreover, minimally invasive procedures should be opted to overcome the adverse effects and interference with renal development and function[11].

Although ESWL is considered non-invasive treatment for kidney calculi, other minimally invasive procedures like mini-PCNL and flexible URS are considered more effective and safe as residual stone fragments may not clear following ESWL. Even with flexible URS, similar problem of residual stone fragments retention occurs and need of stenting before the procedure arises although it is less invasive procedure than PCNL. Therefore, PCNL can be an effective alternative for larger stones > 1.5 cm in renal pelvis, > 1 cm stones in lower pole and when residual stone fragments cannot be cleared due to anatomical abnormality by ESWL or fURS modalities[7,9].

Mini-PCNL uses access sheath ranging from 14 to 20 Fr and is considered the safest and most effective minimally invasive technique compared to Micro-PCNL which is more time-consuming and requires highly selected indications[12]. Standard PCNL causes more complications like post-operative fever, bleeding, transient hematuria and longer duration of hospitalization[13].

In the current study the stone free rate (SFR) was 89.67% which was higher than the study of Baydilli et al. which was 80.6%[14]. Our SFR is comparable to Ahmad et al. which was 86.6 %[15]. In contrast Nerli et al, reported 94.5 % SFR which was much higher than our study[16]. In our study supracostal access was obtained in 127 (56.62%) and subcostal access in 86 (40.38%) of the patients. However site of puncture does not cause significant difference in terms of SFR and adverse effects as both supracostal and subcostal access for paediatric renal stone have same results[17].

Increased operating time, female gender, stone size and multiple punctures to gain access can lead to more bleeding1[8,19]. In this study the mean operation time was 56.02 + 7.82 (40 to 81) minutes which was shorter than the study by Baydilli N et al. which was 77.5 (20-240) minutes [14]. Our operation time was comparable to the study performed by Ahmad et al. which was 53 + 15 minutes [15]. However it is comparatively longer than the study conducted by El-Tabey et al. which was 46.6 + 6.3 minutes[20].

The mean hospital stay in our study was 2.22 + 0.67 (2 to 7) days. The mean hospital stay in the study conducted by Rehman et al. was 4.3 + 2.2 days which shows longer hospital stay than our study[21]. In Arthy et al. the mean hospital stay was 17.25 + 11.23 hours which is shorter than our study [22]. It was similar to hospital stay in study by Brodie et al. which was 2.24 days[23]. In our study

the mean drop in haemoglobin was 1.30 + 0.67 (0.2 to 4.0) g/dL which is similar to that mentioned in literature[24,25].

In our study we did not observe any major intraoperative complication. Post-operative complication rate was 11.27% including postop fever in 8 (3.76%), hematuria in 11 (5.16%), 4 (1.88 %) of which needed blood transfusion, UTI in 3 (1.41%) and urosepsis in 2 (0.94%) of the patients which were treated with long term intravenous antibiotics. Our overall complication rate is similar to Baydilli et al. which is 12.9 %[14] and much better than Ansari et al. which is 49.1 %[17]. Arthy et al. showed a complication rate of 8.7 %, lesser than our study including urosepsis in 2.9 % and hematuria in 5.7 % of the patients which did not require any blood transfusion[22]. This reduce rate of complication may be due to their small sample size (70) in comparison to our study (213).

Tubeless PCNL is associated with reduced urinary leakage, post-operative pain, need of analgesia, short duration of hospital stay and quicker recovery in comparison to standard PCNL[26]. In the current study DJS was placed in 195 (91.55%) of the patients and in 18 (8.45%) no tube was placed.

In the current study re-treatment rate was 10.33%, which included ESWL in 7 (3.29%), URS in 10 (4.69%) and Re-PCNL in 5 (2.35%) of the cases. However all patients were stone free after additional therapy. Bilen et al. reported a re-treatment rate of 6.52%, lower than our study which may be due to use of adult size instruments in their study[27]. However re-treatment rate in our study is lower than the study by Nouralizadeh et al. i.e 20.84 %[28].

Stone analysis showed CaOx.CaP in 87.79% of the patients, followed by struvite (5.63%), cystine (3.76%) and uric acid (1.88%). In 0.94 % the composition was not known.

Limitations: The limitation of the study may be the conversion of mini PCNL to conventional PCNL in very large stones due to bleeding in the pelvicalyceal system which further make the vision blurred.

CONCLUSIONS

This study concludes that mini-PCNL in a paediatric population using access sheath of 12 or 14 Fr is safe and effective for renal stones > 10 mm with high stone clearance rate and acceptable complications.

Conflict of Interest: None
Financial Disclosure: None

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