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**Original Research Article**

# Evaluation of the efficacy and safety of percutaneous nephrolithotomy in children

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## ABSTRACT

**Background:** Children represent 2-4.3% of the total population of stone formers. Currently, the majority of stones in children can be managed either with shock-wave lithotripsy (SWL), percutaneous nephrolithotomy (PCNL), ureterorenoscopy (URS), or a combination of these modalities. Open surgery is currently necessary in a few selected cases only. In our study, we wanted to evaluate the overall results of pediatric percutaneous nephrolithotomy (PCNL).
**Methods:** This study was based on patients of age <14 years who underwent PCNL at Nizam's Institute of Medical Sciences, Hyderabad, India from January 2019 to December 2020. This was a retrospective study. Children with >1 cm calculi were included and the exclusion criteria were stones of <1 cm, deranged renal functions, and bleeding disorders.
**Results:** We performed 73 PCNL procedures on 65 children, achieved complete stone clearance in 93% and residual calculi (<10 mm) was seen following five cases; three patients underwent redo-PCNL. The complication rate in the present study was (16.4%) however, 100% of the total complications were minor i.e. Clavien score I and II, which were managed conservatively.
**Conclusions:** Thus, PCNL is a suitable treatment option for children with nephrolithiasis as avoiding open surgery in children. Higher rates of failure and numerous sessions under anesthesia with short wave lithotripsy (SWL) makes it a non-viable option in children. RIRS is not widely available, non-affordable by many and long-term outcomes not clearly known with respect to ureteral strictures in children.

**Keywords:** Pediatric PCNL, Pediatric PCNL complication, Pediatric renal calculus, Pediatric stone outcomes

## INTRODUCTION

Children represent 2-4.3% of the total population of stone formers.[1,2] The incidence of urolithiasis in children has increased globally over the last few decades. Lifetime anticipation is longer in children than adults, so they have a considerable risk of stone recurrence.[3] The clinical manifestations of stone disease are often more subtle in children when compared with the more dramatic adult presentation. Flank pain is the predominant symptom in adults, while abdominal pain (55-70%) is the most common presenting symptom in children, followed by gross hematuria (14-33%) and urinary tract infection (UTI) (8-46%).[4] Due to the high incidence of predisposing factors for urolithiasis in children and high stone recurrence rates, every child with urinary stones should be made to undergo a complete metabolic evaluation.[5]

Currently, the majority of stones in children can be managed either with shock-wave lithotripsy (SWL), percutaneous nephrolithotomy (PCNL), ureterorenoscopy

(URS), or a combination of these modalities. Open surgery is currently necessary in a few selected cases only.[8] Since the first pediatric series reported by Woodside and associates in 1985, PCNL has become an established technique in children as monotherapy, or as part of a multimodal approach for children with large stone burdens.[6] Although there is no current international consensus, relative indications for PCNL as the primary treatment modality in children include large upper tract stone burden (>1.5 cm), lower pole calculi greater than 1 cm, concurrent anatomic abnormality impairing urinary drainage and stone clearance, or known cystine or struvite composition.[7]

Though there are geographical variations, there remains a common theme in that this is a high-risk population with regard to stone formation and recurrence. Consequently, it is important to keep the number of procedures performed to a minimum and to save the developing kidney from the deleterious effects of the intervention. The reluctance to perform PCNL in children previously was due to concerns regarding long-term renal damage, small kidney size, relatively large instruments, radiation exposure, and risk of major complications such as bleeding.[4] In our study, we want to evaluate the overall results of pediatric percutaneous nephrolithotomy (PCNL).

## METHODS

This study was based on patients of age <14 years who underwent PCNL at Nizam's Institute of Medical Sciences, Hyderabad, India from January 2019 to December 2020. This was a retrospective study. After getting ethical clearance from the institutional ethical committee patients were recruited in the study as per the inclusion and exclusion criteria. We reviewed the medical records of all the patients included in the study to know the pre-operative investigations, intraoperative findings, postoperative complications, and follow-up data. Children with >1 cm calculi were included and the exclusion criteria were stones of <1 cm, deranged renal functions, and bleeding disorders. All patients underwent PCNL under GA, 3 Fr open-end ureteric catheter was passed cystoscopically under fluoroscopic guidance up to renal pelvis in patients positioned in the lithotomy position. The patient was then put into the prone position. Under fluoroscopic guidance, the pelvicalyceal system was punctured using a 23 Fr spinal needle. The guidewire was passed through the spinal needle into the pelvicalyceal system. The tract was dilated using dilators over the glide wire and a PCNL sheath of variable diameter was used, the smallest size used being 19 Fr to the largest of 30 Fr was introduced over dilator into the pelvicalyceal system under fluoroscopic guidance. The nephroscope was then introduced into the PCNL sheath to visualize the stone and pneumatic lithoclast was used to break the stones and a three-prong grasper was used to extract the stone fragments. Double J ureteric stent or ureteric catheter with PCN tube were left in place for all patients. Postoperatively i.v. antibiotics were given for 24hours, except in cases that developed fever was continued till clinical improvement. Foleys catheter removed on the first postoperative day and PCN tube removed on the second postoperative day. Postoperatively hemoglobin was evaluated after 12 hours of surgery and USG and x-ray KUB were done after 24 hours to look for stone clearance. As per retrospective data analysis we found we found 73 PCNL were done in 63 children and all were included in the study. Analysis of data was done by using statistical software for the social sciences (SPSS version 20.0; IBM, Chicago, Illinois, USA).

## RESULTS

We performed 73 PCNL procedures on 65 children with the mean age of 8.68±3.6 years (range 1-14 years). There were 35 male and 30 female children with various sizes of the kidney units as given in Table 1. The mean stone size was 2.45±1.16 cm with Guy's score for stone in the renal units being given accordingly as score 1 in 53.4% score 2 in 9.5%, score 3 in 19.2%, and score 4 in 17.8%. Out of 73 PCNL, 4 were pushback PCNL due to associated ureteric calculus with 75.3% of cases performed over 24 F sheath.

**Table 1: Demographics and stone-related characters of the study population.**

| Variables | Result |
|---|---|
| **Mean age** | 8.648±3.6 years. |
| **Gender** | Male: 35 |
| | Female: 30 |
| **Kidney size** | <7.3 cm: 12(16.4%) |
| | 7.3-8 cm: 15(20.5%) |
| | 8-9 cm: 27(37%) |
| | >9 cm: 19(26%) |
| **Mean stone size** | 2.45±1.16 cm. |
| **Guy's score** | Score 1: 39 (53.4%) |
| | Score 2: 7 (9.5%) |
| | Score 3: 14 (19.2%) |
| | Score 4: 13 (17.8%) |

**Table 2: Correlation of Guys score and stone clearance.**

| Guys score | Number of cases | Incomplete clearance |
|---|---|---|
| **1** | 39 | 0 |
| **2** | 7 | 0 |
| **3** | 14 | 1 (7.14%) |
| **4** | 13 | 3 (23.07%) |

We achieved complete stone clearance in 93% and residual calculi (<10 mm) was seen following five cases; three patients underwent Redo-PCNL. Middle or inferior calyceal puncture was used for access in 60% of cases and multiple access was required in 30.1% of cases. The correlation of stone clearance with Guy's score was given

in Table 2 with residual calculus in Guy's scores 3 and 4. The mean hospital stay was 5.6±2.9 days.

The complication rate in the present study was (16.4%) however, 100% of the total complications were minor i.e. Clavien score I and II, which were managed conservatively. Postoperatively 9 (12.3%) patients had episodes of fever but no patient developed septic shock. The mean hemoglobin drop was 0.66±0.58 gm/dl, which was clinically not alarming. Two patients required blood transfusion and one patient had ascending colon injury which was managed conservatively, with parenteral nutrition support.

## DISCUSSION

Pediatric nephrolithiasis is very rare in developed countries (1% to 5%) but its incidence is increasing in developing countries.[8] Fernstrom and Johansson were the first to report PCNL in adults in 1976 and Woodside and colleagues were the first to report PCNL in pediatrics in 1986.[6]

Our study has shown good stone clearance rate (93%). This is favourably comparable with published series by Nouralizadeh et al, Samad et al.[9,10] The largest series was reported by Nouralizadeh et al in 2016 reported on 211 cases in Iran with a mean age of 137. 15 months with overall clearance rate of 73.9% using a single tract and post-operative complication rate of 10.6%.[10]

Increased operative time of >1 hour during PCNL procedure has been associated with increased oxidative stress. Hence, it is in the best interest of the patient to restrict the operative time within 1 hour. Operative time depends on stone size, location and other renal factors such as hydronephrosis; less time is taken by the experienced surgeon.[11,12] Mean time taken for surgery in our study was 43 minutes by our surgeons, which is well within the recommended time. Samad et al have reported mean duration in their study as 69-115 minutes.[9]

Studies have documented that few patients may require bilateral PCNLs, though number is less. We performed bilateral PCNL in 8 patients. Synchronous procedure on both kidneys cannot be done in fear of blood loss, loss/impairment of function and increased operation time, we feel that staging the procedure and selecting patients is very important to reduce complications. Use of small caliber instruments for larger stones decreases the chances of injury avoiding torque forces while manipulating the instruments.

Our overall complications rate was 16.4% and majority of complications are minor in magnitude i.e. grade I and II. Dongol et al reported a stone free rate of 88% in a study of 25 children with complication rate of 12%.[13] Higher rate of 30.3% has been reported by Mousavi-Bahar et al which included severe complications renal parenchymal and duct injury, colon perforation, damage to major vessels, pneumothorax and hemothorax.[14] Fever has been reported as common postoperative complication which was seen in 12.3% patients in our study. Various studies have reported it to be 3.0319-12.90% and lower rate was reported by Mousavi-Bahar (1%).[4] Due to high renal vascularity along with variable vascular anatomy makes it more prone to complicate with percutaneous punctures.

Another important point to notify is site of pelvicalyceal system entry. The superior calyx provides best access to the renal pelvis, major calyces and upper ureter which was partly responsible to give a high clearance rate with single access. In this current study, we preferred to enter the PCS from where the stone can easily be removed based on best visible access and if required supracostal puncture also taken (not above 11$^{th}$ rib due to significant risk of pleural injury).

The requirement to take multiple tracts in staghorn calculi depend upon the stone anatomy, calyx and stone size so it is preferable to re-look through the original tract in the second sitting because sometimes stones are not visible during the initial PCNL due to bleeding and clot in the collecting system. In present study, we did second stage procedure in 3 (4%) staghorn stones

In our study 23 patients had sheath size upto 22 Fr and 44 patients had sheath of 24 Fr. We believe that the adult 21 Fr nephroscope through a 24 Fr sheath allows optimum visualization with minimal need for special equipment. In our study we did not find significant change in complications with increase in sheath size from 22 to 24 Fr. The 24 Fr sheath allows use of a 21 Fr adult nephroscope which is routinely available at centers performing PCNL in adults. This scope also permits use of a larger grasping forceps capable of removing larger fragments and this decreases the need for finer pulverization of stone and potential residue. It is possible that this also allows better visualization and improved clearance through a single tract. While Desai et al found a significant difference in the blood loss between sheaths below and above 22 Fr, an increase of 2 Fr from 22 to 24 is unlikely to be of major concern.[15]

The limitation of our study is, it was a retrospective study and not compared with other treatment options of pediatric nephrolithiasis. Further prospective studies are required to compare various PCNL techniques with other options like RIRS in pediatric patients for better management of such cases.

## CONCLUSION

This study shows that PCNL is a suitable treatment option for children with nephrolithiasis as avoiding open surgery in children. Higher rates of failure and numerous sessions under anesthesia with short wave lithotripsy (SWL) makes it a non-viable option in children. RIRS is not widely available, non-affordable by many and long-

term outcomes not clearly known with respect to ureteral strictures in children.

Our study shows that >90% stone clearance with PCNL in pediatric stone cases and we conclude it as suitable option for stone management in children. we evolved from 19 Fr to 24 Fr with not much increase in complications and increased stone free rates, we now use 24 Fr for children with higher stone burden thus increasing clearance and decreasing intraoperative time and sepsis. Careful evaluation, selection of patients, skill of surgeons and good postoperative nursing care contribute towards the success of the procedure.

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