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Research Article

Safety and Efficacy Assessment of Pcnl in The Pediatric Population: A Single Centre Experience

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Abstract

Introduction and Objective: Renal stone disease in children is on the rise with increased incidence and better modalities to diagnose the disease. Hence there is a necessity to strategize the evaluation and treatment of children with kidney stones. Our study was conducted to assess stone distribution, stone burden, and efficacy of PCNL in pediatric age group.

Methods: All paediatric patients with renal stone disease who subsequently underwent PCNL at our department from January 2017 to December 2020 were analysed.

Results: 84 patients ranging 1-18 years were analysed. Pain abdomen was the most common presenting symptom (61.9%) followed by fever (19.04%). The mean stone size was 2.16cm with equal side distribution. Most stones were located in the lower calyx (38%). The mean operative time was 65 minutes. Exposure to radiation from C arm ranged from 1.6-8.3 minutes. Complete stone clearance was achieved in 90.47% with a mean post- drop in Hb value to 0.72 gm/dl. Mean duration of nephrostomy tube in situ was 2.4 days and with a mean hospital stay of 3.8 days. Calcium oxalate was the most common type of stone (48%)

Conclusion: PCNL is safe and effective treatment for pediatric renal calculi with minimal morbidity and increased stone free rates irrespective of stone size. Proper patient selection, surgical skill and postoperative care contribute towards the success of the procedure

Keywords: Pediatric PCNL; Pediatric Renal Calculi; Renal Stone Disease

Introduction

The prevalence of renal stone disease in children ranges from 5 to 15%. Stone disease has a higher risk of recurrence in the pediatric age group making it crucial to identify the most effective method for complete stone removal to prevent recurrence from residual fragments. The optimal management of for pediatric stone disease is still evolving [1,2]. Currently, ESWL is the procedure of choice for treating most upper urinary tract calculi in the pediatric population. However, a higher incidence of metabolic and anatomical abnormalities in pediatric patients has led to increased recurrence. Moreover, ESWL has relatively less efficacy for stones >1.5cm. Surgical intervention should be preferred in such cases so as to minimize the need for retreatment [3-5]. Percutaneous nephrolithotomy (PCNL) is less invasive than open surgery which can be a good candidate for complex and large burden stones [6]. Several studies over time with different power and limitations have reported safety and efficacy of PCNL leading to its consideration as the treatment of choice for children with stone larger than 15mm [7-9]. The advent of newer, finer instruments and increase in experience of endourological techniques such as tubeless PCNL, mini-perc, ultra-mini perc and micro-perc has resulted in reducing the morbidity rate among patients without affecting the outcomes in terms of clearance [10-14]. Therefore, our study was conducted to assess the safety and efficacy of PCNL in the pediatric age group in terms of (1) renal stone distribution & stone burden (2) the outcomes of PCNL including stone clearance, operative time, hospital stay, haemoglobin changes and (3) the associated complications of PCNL.

Materials and Methods

A prospective study was conducted at our hospital from January 2017 to December 2020 after obtaining institutional ethical committee clearance. All pediatric patients posted for PCNL at MS Ramaiah Medical College were considered in the study. The patients compatible for the study were interviewed and after

obtaining informed and written consent they were enrolled in the study.

Inclusion Criteria: All the patients below the age of 18 years undergoing PCNL.

Exclusion Criteria: Anatomic abnormalities of the kidney (horseshoe kidney/malrotated kidney); Bleeding disorders; deranged renal function.

Patients were initially evaluated with a detailed medical history and a thorough clinical examination followed by a battery of investigations including CBC, RFT, Serum electrolytes, serum levels of calcium, phosphorus, alkaline phosphatase, uric acid, total protein, carbonate, albumin, parathyroid hormone (if there is hypercalcaemia), blood group & Rh typing, HbsAg, HIV, HCV, Urine: Routine & Microscopy, Urine: Culture & Sensitivity. For imaging –ultrasonography was used as a first study followed by spiral CT KUB if no stone was found. Intravenous pyelography was performed when a need arose to delineate the calyceal anatomy prior to percutaneous or open surgery. A sterile urine culture was confirmed before surgery. In patients with evidence of infection, antibiotics were given preoperatively to clear the infection prior to surgery. All patients received broad-spectrum antibiotics beginning 12 h prior to the procedure and these were continued until 5 days postoperatively. All PCNL are performed under general anaesthesia. The patient initially placed in lithotomy position and a ureteric access catheter was placed under fluoroscopic guidance. The patient was then turned prone. After initial puncture, the tract was dilated using metallic or Teflon dilators. Paediatric PCNL was performed using adult instruments and clearance assessed intraopeartively by fluoroscopy. Ureteric stents and nephrostomy tubes were placed in most patients at the end of the procedure. Baseline patient characteristics, intraoperative and post-operative data were collected and analysed. Perioperative complications were classified using the modified Clavien Dindo system. In case of a supra-costal puncture, a chest X-ray was obtained subsequently in the post op period. An x ray of kidney ureter bladder was taken at 48 hours after PCNL. If needed a re-look procedure was done. The patient was followed up with an ultrasound & serum creatinine at 3 months, DMSA scan after 6 months to know the functional status of kidney & amount of renal scarring. Statistical analysis was performed using SPSS 22. Categorical variables were presented as number and percentage (%), whereas continuous variables were presented as mean ± standard deviation and median (Table 1).

Table 1: Demographic and intraoperative characteristics of the study population. (n=84).

Characteristics(n=84)	
Mean Age	11.04 years
H/o of previous surgery	4 (4.7%)
Positive Urine Culture	8 (9.52%)
Mean Stone Size	2.16 cms
Mean operative Time	65.04 mins (30-120 minutes)
Exposure to radiation from C Arm	3.93 mins (Range 1.6-8.3 minutes)
Tubeless PCNL	36(42.85%)
PCN Placement	48(57.14%)
Mini Perc	30(35.71%)
Standard PCNL	54(64.28%)
Single tract access	72(85.71%)
Double tract access	12(14.2%)
Complete Stone clearance	76(90.47%)
Mean drop in Hb	0.72gm/dl (0.1-3gm/dL)

Results

84 patients ranging between 1-18 years of age were analysed with the mean age of study population of 11.04 years. Pain abdomen was the most common presenting symptom (61.9%) followed by fever (19.04%) with 4/84 having had prior surgical intervention for stone disease (Figure 1). The mean stone size was 2.16cm with equal side distribution. Most stones were located in the lower calyx (38%) followed by renal pelvis – 33%, middle calyx 17% and upper calyx 12% (Figure 2a). The total operative time ranged from 30 minutes to 120 minutes with a mean of 65 minutes. Exposure to radiation from C arm ranged from 1.6-8.3 minutes. Intraoperative location of stone, puncture and after clearance are shown in Figures 1a,1b,1c. Complete stone clearance was achieved in 90.47% with a mean post- drop in Hb value to 0.72 gm/dl. Mean duration of nephrostomy tube in situ was 2.4 days and with a mean hospital stay of 3.8 days. Intra-operative and post-operative complications in the study population are depicted in Table 2. Calcium oxalate was the most common type of stone (48%) (Figure 3).

Figure 1a: Pre procedure placement of ureteric catheter under fluoroscopic guidance.

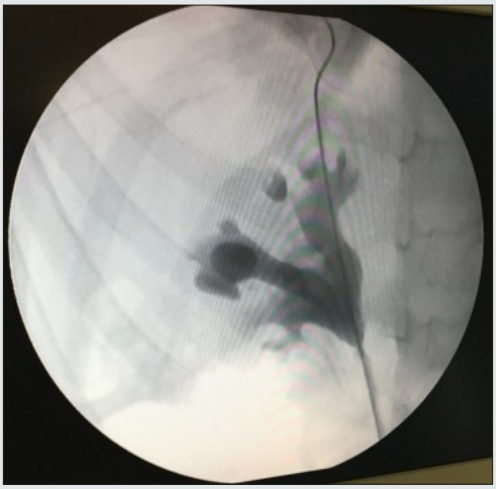

Figure 1b: Superior calyx supracostal access.

Figure 1c: Complete clearance depicted on fluoroscopy.

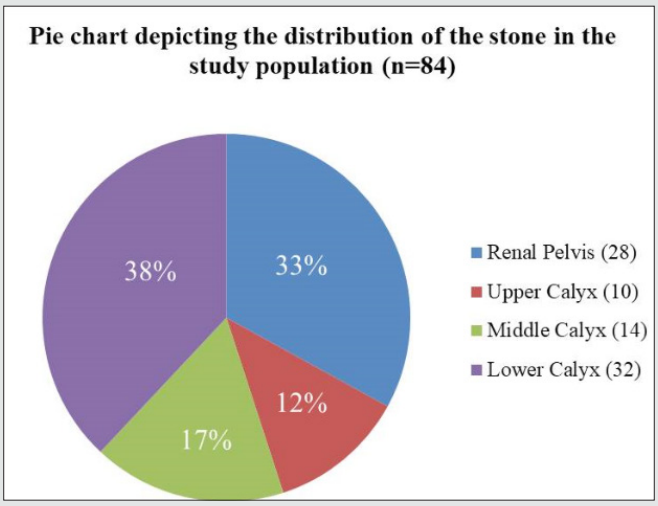

Figure 2a: Pie chart depicting the distribution of the stone in the study population.

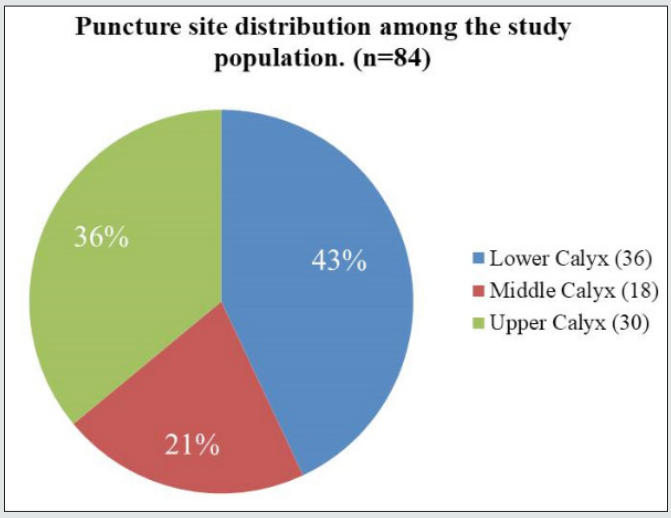

Figure 2b: Puncture site distribution among the study population. (n=84).

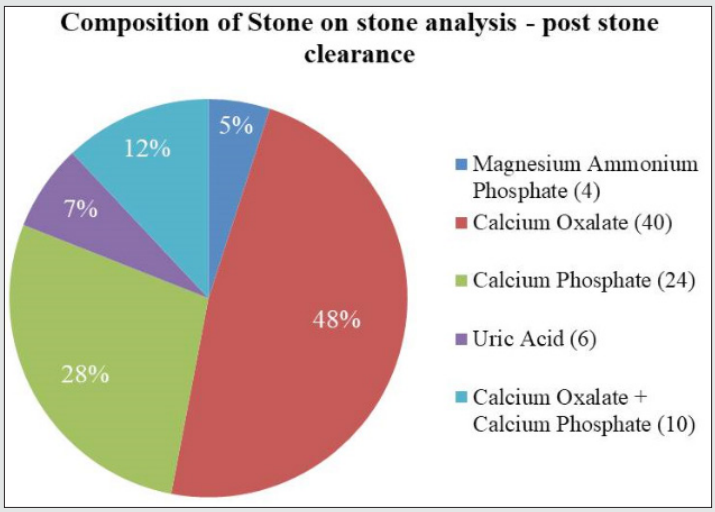

Figure 3: Composition of stone-on-stone analysis post stone clearance. (n=84).

Table 2: Intraoperative and post-operative characteristics among the study population (n=84).

Variable	Number (%)
Intraoperative complications	
Mucosal perforation	2(2.38%)
Bowel Injury	-
Pleural injury	-
Urinary extravasation	6 (7.14%)
Stone migration	4 (4.76%)
Postoperative Complications	
Fever	8 (9.52%)
Vomiting	4 (4.76%)
Blood transfusion	2 (2.38%)
UTI	8 (9.52%)
Sepsis	2 (2.38%)

Discussion

Although short wave lithotripsy (SWL) is considered the treatment of choice for symptomatic upper urinary tract calculi in children, but not a preferred option in patients with large stone burden, owing to higher rates of failure and residual stones. In such cases, PCNL with proven advantages can be safely advocated as a suitable treatment option in order to avoid numerous SWL sessions under anesthesia. Despite pediatric PCNL being described as early as 1985 by Woodside et al. [6], pediatric surgeons had their reservation in performing PCNL in children. This apprehension was due to the fear of parenchymal damage, early exposure to radiation and risk of major complications associated with the surgery. However, Dawaba et al. [9] proved the fear to be baseless by demonstrating that PCNL in paediatric population improved overall renal function without causing renal scarring. Similarly, Mor et al. reported no significant scarring or loss of renal function in radionuclide renal scans (19). He concluded that adult type tract dilation to 24Fr to 26Fr was not associated with significant renal function loss [19]. The size, number and site of tracts are not well defined in pediatric PCNL. While Gunes et al. reported a higher complication rate in children <7 years operated with adult sized instruments [17], Desai et al. observed that intraoperative bleeding during PCNL in children is related to the size and number of tracts and suggested the need for technical modifications in children [20]. Although this calls for reduction in tract size, it may have an effect on the clearance rates. In our study, 54(64.28%) underwent standard PCNL vs 30(35.71%) underwent Miniperc. We used amplatz sheath sizes in the range of 16F-28F. Size of tract dilatation was based on dilatation of pelvicalyceal system, the stone burden and no of punctures. Our clearance rates & transfusion rates were found to be similar in miniperc & standard PCNL. Our results are in concurrence with Bilen et al. who reported that smaller tracts did not significantly affect stone-free rates but achieved lower transfusion rates [21]. They concluded that a 20Fr tract was as effective as working with adult sized devices and did not significantly increase the operative time. (18) Provided the quality of the puncture and subsequent tract is high, there is no greater morbidity than that reported from miniperc. Large tracts and instruments can facilitate more rapid and complete stone clearance (Table 3).

Table 3: Results from our study compared to previous studies.

Author	Year	Mean Age	Stone size (mean)	Tract F	Mean operative time in mins	SFR%	Overall complications %
Ozden et al. [23]	2010	9.5 yr	2.5 cms	20.8	79.1	85	25
Kumar et al. [24]	2011	11.7 years	33 mm	24-30	78	84	8
Resorlu et al. [25]	2012	9.6 years	23.7 mm	22-Dec	76.3	85	17
Yan et al. [26]	2012	42.6 months	1.85 cms	14-16	86.5	95	15
Wah et al. [27]	2013	4.76 years	3.44 cms	16	109.4	83	14
Onal et al. [28]	2013	8.8 years	4.09 cms	20	93.5	81	27.7
Elderwy et al. [29]	2014	8 years	2.3 cms	20-24	90	91.4	10.6
Desoky et al. [30]	2015	9.5 years	2.4 cms	20	65.1	90.9	36.3
Brodie et al. [31]	2015	7.3 years	Not measured	16	Not measured	76	Not measured

Akbar Nouralizadeh et al. [32]	2016	137.15 months	23.5 mm	24-30	109.9	68.4	10.6
Udaya Man Singh et al. [33]	2017	9.3 years	2.0 cms	22-24	92	88	8
Our study	2017-2020	10.4 years	2.3 cms	16-28	65.04	90.47	9.52

Most of the stone burden was located in lower calyx (38%) in most of our cases with staghorn calculus noted in 4 patients. Single tract access was done in 72 patients with lower calyceal puncture being used mostly (43%) (Figure 2b). Multiple punctures were required in 12 cases (14.2%). We did not find any significant increase in complications following an upper calyceal puncture or with multiple punctures in our study which is comparable to Sedat Oner et al. who concluded that an upper pole approach did not prolong operative time or add to the complications, making it a good alternative. A surgeon who has reached competence at performing PCNL should therefore not hesitate to use a superior caliceal approach in pediatric patients if deemed appropriate for stone removal [22]. Our length of hospital stay duration of nephrostomy tube in situ is comparable to previously published data. 42.85% of our cases were tubeless, which is safe when performing uncomplicated PCNL [34]. Prior renal surgery on the same side didn't have any impact on outcome of PCNL [35]. Aldaqadossi et al. have suggested that a previous open pyelolithotomy or nephrolithotomy does not affect the efficacy and morbidity of subsequent PCNL in pediatric patients [35]. We achieved a complete clearance rate of 90.47% which is similar to the published literature. Residual calculi noted in 8 cases were managed by ESWL. The complication rate during and after PCNL in paediatric patients varies widely in the literature. The difference in complication rates may be explained by the difference in stone burden location and experience of the surgical team. Our complication rate was 9.52% with fever being the most common. The lower incidence in complications could be attributed to the surgeon expertise at our center.

Limitations

Our study population was from single referral center, which may not be generalizable considering small sample size. Another limitation is the lack of comparative groups such as ESWL/RIRS while evaluating the efficacy of PCNL.

Conclusion

PCNL is safe and effective treatment for pediatric renal calculi with minimal morbidity and increased stone free rates irrespective of stone size. Proper patient selection, surgical skill and postoperative care contribute towards the success of the procedure and reduces the complications.

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Conflict of Interest: None

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