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ORIGINAL ARTICLE

Is Percutaneous Nephrolithotomy (PCNL) as Safe and Effective in Children as Adults?

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ABSTRACT
Background: Percutaneous Nephrolithotomy (PCNL) is an endoscopic procedure of choice for the larger renal stones in both adult and children. Adequate literature is present regarding the efficacy of PCNL in clearing the adult kidney stones but limited data in our part of world is available to show noticeable renal stone clearance after PCNL with minimal complications in pediatric group. We set out to compare the outcomes of PCNL in both groups so we can recommend its efficacy and safety in pediatric group.
Methods: The prospective cross-sectional comparative study conducted in 86 patients who underwent PCNL for Renal Calculi. Patients were divided into two groups. Thirty patients were in the pediatric group and 56 patients in the adult group. Both groups were compared for the safety and efficacy of PCNL. Safety will be assessed through post-operative complications and graded according to Modified Clavien grading system. Efficacy was assessed through stone clearance. The aim of study is to determine the safety and efficacy of percutaneous nephrolithotomy in children so it can be done frequently and confidently without fear of complications and incomplete clearance of stones.
Results: When we compare children with adults for safety and efficacy of PCNL, no statistical significance was observed in both groups in terms of stone clearance and postoperative complications.
Conclusion: Percutaneous nephrolithotomy is as safe and effective in pediatric age as adult age.
Keywords: Percutaneous Nephrolithotomy, Renal Stones, modified Clavien grading system.

BACKGROUND
The incidence of nephrolithiasis is increasing worldwide with estimated prevalence of 2-3% in general population (1). Renal stones are common in all age groups, but the pediatric group is listed in high risk population for kidney stones. Its incidence is increasing approximately at rate of 4% every year (1, 2). In comparison to western world, Kidney stones are more common in developing countries like Pakistan, India, Turkey and other countries of South East Asia (3, 4). Major Risk factors like anatomical abnormalities, recurrent urinary tract infection, metabolic disorders, diet, poor nutritional status and dehydration are associated with formation of renal stones. Smaldone et al. showed that hypercalciuria and hypocitraturia were present in urine studies of 84% to 87% of children with renal stones reflecting metabolic abnormality as a causative agent (5)

Percutaneous Nephrolithotomy (PCNL) is endoscopic procedure of choice for the larger renal stones (6). It has widely replaced open surgery. Stone recurrence is a common problem; estimated rate is 50% at 5-7 years that requires re-intervention (6). PCNL was first time performed in 1980 in children and now being performed worldwide for renal stones in adults and pediatric population (7). It is associated with risk of complications like sepsis, blood loss etc. (1). Clavien system is being widely used to grade these complications, first proposed in 1992 and later modified in 2004 after application and validation in cohort of 6,336 patients (8). In Pakistan there are few centers performing PCNL in pediatric age group due to concerns like parenchymal damage, technical problems, and fear of complications and incomplete clearance of stones (1).

Adequate literature is present regarding the efficacy of PCNL in clearing the adult kidney stones but limited data in our part of world is available to show noticeable renal stone clearance after PCNL with minimal complications in pediatric group. We set out to compare the outcomes of PCNL in both groups so we can recommend its efficacy and safety in pediatric group.

METHODS
This prospective cross-sectional comparative study was conducted in patients who underwent Percutaneous Nephrolithotomy for renal calculi at our center from August 2018 to January 2019. A total of 86 patients were included in the study. All Procedures were done under general anesthesia. Following cystoscopy, the ureteric catheter was inserted for contrast instillation to delineate the anatomy under fluoroscopic guidance and ureteric catheter was secured with Foley's catheter per urethram. Later on, the patient's position was changed to prone and marking for puncture was made under image intensifier. Renal calyceal puncture was done with a spinal needle 23 G, a guide wire was introduced and serial tract dilatation with Alkins metal dilators was done up to 30 Fr and same sized Amplatz sheath inserted for adults population. In the pediatric population tract was dilated up to 21 Fr and 22 Fr Amplatz sheath was used. A nephroscope of 26 Fr was used for adult population and an 18 Fr nephroscope was used in the pediatric population. Stones were fragmented with a pneumatic lithoclast and taken out with stone forceps. At the end of procedure, a Percutaneous Nephrostomy tube was placed and secured which was removed on 1st post-operative day. Patients with coagulopathies, uncontrolled diabetes, hypertension, ischemic heart disease, and pregnant females were excluded from the study. Patients with positive urine cultures were treated with sensitive antibiotics. All patients were given intravenous antibiotics at induction and post-operatively till discharge of the patient. The study participants were divided into two groups. There were 30 patients in the pediatric age group (aged between 2 - 14 years) and 56 patients (aged more than 14) in the adult group. Both groups were assessed for stone size, location of stone, duration of surgery, length of hospital stay, stone clearance, and creatinine clearance before and after the procedure, complications, safety and efficacy of PCNL. Creatinine clearance was calculated by Cockcroft–Gault equation and was used to estimate Glomerular Filtration Rate (eGFR). Stone clearance was calculated by ultrasound and X-ray of the kidney ureter and bladder region on next day of surgery as percentage of the stone removed. Safety was assessed through post-operative complications and graded according to Modified Clavien grading system (Figure 01). No complications or Clavien grade I and II complications were classified as 'safe'. Efficacy of PCNL was assessed through stone clearance. Complete stone clearance or residual fragments less than 3 mm was regarded as effective Percutaneous Nephrolithotomy. Data was entered using SPSS version 21. Mean (SD) or Median was recorded as appropriate for all continuous variable. Frequency and percentage were recorded for all categorical variables. Chi-square test/Fisher exact test was applied

as appropriate to check the significant difference association of stone size, duration of surgery, length of hospital stay, stone clearance, and creatinine clearance before and after the procedure, complications, safety and efficacy of PCNL as compared to both groups. P value ≤ 0.05 was considered significant.

RESULTS

A total of 86 participants were enrolled in this study. 40 participants had a surgery on right side and 46 had surgery on left side. Only 8 (9%) participant received blood transfusion while 78 (91%) participant did not receive any blood transfusion. The pediatric group had a stone clearance of 90% post-operatively, as compared to 98.2% in the adult population. There was however no statistically significant difference between the 2 populations (p=0.253). Safe surgeries, as defined by either no post-operative complications or a modified Clavien score of either I or II, was seen in 99.9% of pediatric surgeries and 89.1% of adult surgeries, with a p value of 0.468. There was no significant difference in renal function (as measured by GFR) between the pre-operative GFR and the post-operative GFR (p=0.319). Furthermore, adult patients were found to have significantly larger stone size, longer duration of surgery and more drop in post-surgery hemoglobin in comparison to pediatric patients (Median: 30mm vs 18mm, p=0.000; 75min vs 60 min, p=0.010; 1.1g/dL vs 0.4g/dL, p=0.028, respectively). (Table: 01) that is given at the end of document file.

List of Abbreviation

PCNL	Percutaneous Nephrolithotomy
SD	Standard Deviation
ESWL	Extracorporeal shockwave lithotripsy
SPSS	Statistical Packages for social science

This table should be included in the result section of article.

Table 1: Association of patients' demographic and post-surgery characteristics with type of patient				
	Patient Type			
	Adults	Pediatric	Total	P-value
Gender; n (%)				
Female	39 (69.6)	23 (76.7)	62 (72.1)	0.489[f]
Male	17 (30.4)	7 (23.3)	24 (27.9)	
Total	56 (100)	30 (100)	86 (100)	
Side of Surgery; n (%)				
Left	24 (42.9)	16 (53.3)	40 (46.5)	0.353[f]
Right	32 (57.1)	14 (46.7)	46 (53.5)	
Total	56 (100)	30 (100)	86 (100)	
Blood Transfusion; n (%)				
NO	51 (91.1)	27 (90)	78 (90.7)	1.000[f]
Yes	5 (8.9)	3 (10)	8 (9.3)	
Total	56 (100)	30 (100)	86 (100)	
Type of puncture; n (%)				
Supra coastal	45 (80.4)	16 (53.3)	61 (70.9)	1.000[f]
Infra coastal	11 (19.6)	14 (46.7)	25 (29.1)	
Total	56 (100)	30 (100)	86 (100)	
Complication Grade				
None	30 (54.5)	19 (65.5)	49 (58.3)	0.468[f]
Grade I	15 (27.3)	9 (31)	24 (28.6)	
Grade II	4 (7.3)	1 (3.4)	5 (6)	
Grade IIIa	5 (9.1)	0 (0)	5 (6)	
Grade IIIb	1 (1.8)	0 (0)	1 (1.2)	
Total	55 (100)	29 (100)	84 (100)	
Stone Clearance; n (%)				
Not Cleared	1(1.8)	1(3.3)	2(2.3)	0.295[f]
Partially Cleared	0(0)	2(6.7)	2(2.3)	
Almost Cleared	12(21.4)	6(20)	18(20.9)	
Cleared	43(76.8)	21(70)	64(74.4)	
Total	56(100)	30(100)	86(100)	
Complication Between the group; n (%)				
None	45 (80.4)	27 (90)	72 (83.7)	0.440[f]
Sepsis	3 (5.4)	1 (3.3)	4 (4.7)	
Blood loss	2 (3.6)	3 (10)	5 (5.8)	
Hydrothorax	4 (7.1)	0 (0)	4 (4.7)	
Hemothorax	1 (1.8)	0 (0)	1 (1.2)	
UTI	1 (1.8)	0 (0)	1 (1.2)	
Perinephric collection	1 (1.8)	0 (0)	1 (1.2)	
Severe pain	1 (1.8)	0 (0)	1 (1.2)	
Urine culture; n (%)				
Positive	14 (25)	7 (23.3)	21 (24.4)	1.000[c]
Negative	42 (75)	23 (76.7)	65 (75.6)	
Total	56 (100)	30 (100)	86 (100)	
Stone size (mm)				
Min-Max	18-90	12-80	12-90	0.000[**m]
Median (IQR)	30(22-50)	18(15-27)	25.85 (20-42)	
Length of stay (days)				
Min-Max	2-25	2-27	2-27	0.615[m]
Median (IQR)	3(3-4)	3(3-4)	3(3-4)	
Duration of surgery in minutes				
Min-Max	30-135	25-120	30-135	0.010[*i]
Mean ± SD	85.44±28	69± 29	79.0 ± 29.7	
Pre-op Hb (mg/dL)				
Min-Max	9 - 18	8.7 - 14	8.7 - 18	0.000[**i]
Mean ± SD	13.2 ± 2.1	11.4 ± 1.2	12.6 ± 2.0	
Post-operative Hb (mg/dL)				
Min-Max	8 - 16	6.7 - 14	6.7 - 16	0.004[*i]
Mean ± SD	12 ± 1.9	10.8 ± 1.9	11.6 ± 1.94	
Drop in hb (mg/dL)				
Min-Max	0 - 4	0 - 3	0-3.8	0.028[*m]

Median (IQR)	1.1 (0.4 - 2)	0.4 (0.1 - 1)	1 (0.28-1.7)	
Pre-operative GFR (mL/min)				
Min-Max	80.2-92.3	83.6±93.6	80.2-93.6	0.448
Mean ± SD	85.9 ±3.5	87.4±4.7	86.6±4	
Post-operative GFR (mL/min)				
Min-Max	76.3-91.5	77.6-89.7	76.3-91.5	0.284
Mean ± SD	82.7±4.8	85.8±5.8	84.2±5.9	
Difference in GFR (mL/min)				
Min-Max	0.8-3.9	3.9-6	0.8-6	0.319
Median (IQR)	3.2	1.6	2.6	
**P-value<0.0001, *P-value<0.05, c: Pearson Chi-square test, f: Fisher-Exact test, i: independent sample T-test, m: Mann-Whiteny U test				

DISCUSSION

Percutaneous Nephrolithotomy is a safe and effective procedure, which is less invasive than open surgery, which has been used for the management of patients with large renal calculi and provides early recovery, shorter hospital stay, less chance of infection, and preservation of cosmetic by preventing big surgical scars (17).

In literature, PCNL has been reported safe in both adult and pediatric population. A recent Pakistani Study done by Shohab D et al. in 2016 showed no significant difference in hospital stay (2.76 ±1.14 vs 3.12 ±1.27 days, P=0.1881 and stone clearance (93.28 ±9.23% vs 90.81 ±12.23%, P=0.331). These are the results similar to our study. Moreover, none of the patients in both the groups experience post-operative complication accept one patient in adult group who developed post-operative urosepsis (1). In our study, Grade IIIa and Grade IIIb complications are seen in adult while in pediatric age group almost no complication was observed in Grade IIIa or Grade IIIb. Also to note is that our adult population had a larger stones compared to pediatric group. That could be the possible reason for more complication in adults as larger stones would require longer intra operative time and instrumentation. Although P value was not significant (pediatric vs adult: 99.9% vs 89.1% P=0.468).

Bayrak et al. in 2013, compared the safety of PCNL in pediatric with adult and found no statistically significant difference between the two groups in terms of grade I, II, or III complications (p>0.05) they concluded that pediatric patients can be safely treated with PCNL with low complication rates similar to those in adult patients (7). Veeratterapillay et al. studied 31 pediatric patients, all underwent PCNL for renal stone and found stone clearance in pediatric population following PCNL is about 84% with almost no complication (9). Zeng G et al. conducted large scale analysis comparing efficacy and safety of percutaneous Nephrolithotomy in pediatric vs adults and resulted that the stone-free rate in pediatric patients is as good as in adults with minimal risk of complication. Both groups showed low rate of high grades of Clavien complications (10). Similar study done by Alam Z et al. showed that percutaneous Nephrolithotomy is equally effective and safe in pediatric as in adults for renal stones. They reported stone free rate of 74% in pediatric age group vs 64% in adults in single session of PCNL (p 0.162) (11).

Desai et al. (17) reported their results on pediatric renal calculi in 56 patients who underwent PCNL and achieved a nearly 90% stone clearance rate with PCNL monotherapy where in our study we found 84% of stone clearance after PCNL. Boormans et al. (13) studied efficacy of PCNL in pediatric and found primary stone free rate was 58% which increased to 81 % after ESWL of residual fragments. Similarly El-Nahas et al. (12) reported 77% clearance rate following PCNL which increased to 92.5% after lithotripsy. Jackman SV et al. (14) performed PCNL in infants and pre-school age children and reported 85% of stone clearance with minimal morbidity.

M Mahmud et al. (15) determined the efficacy of PCNL in pre-school age children and showed the stone clearance of 60% as monotherapy, which increased to 100% by combining it with extracorporeal shockwave lithotripsy (ESWL) while our study showed the 90% of stone clearance with PCNL as monotherapy. Another study done by Samad L et al. (16) compared the outcome of pediatric PCNL for atypical cases with standard pediatric PCNL and showed the overall stone clearance of about 90% similar to results of our study. Dogan et al. reported that PCNL can be done to children of all ages both efficiently and safely (19). Kumar et al. showed the significant stone clearance and minimal complications in PCNL done for patients with staghorn stones (20). Guven et al. stated in his study that PCNL can be done safely in children below the age of 3 years with stone disease (21). But In out part of world PCNL in pediatric population is yet considered as agonizing for many surgeons. With the present results of our study we have found overall pediatric PCNL is as safe and efficacious as adult PCNL.

CONCLUSION

Our study has revealed that Percutaneous Nephrolithotomy is safe and effective in the removal of large stone. It should be done frequently in all population since it carries a minimal risk of complications and high rates of stone clearance. Percutaneous Nephrolithotomy in children is as safe and effective as in adults since our study shows comparable stone clearance and complications rates in both groups.

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