

# SAFETY AND EFFICACY OF PERCUTANEOUS NEPHROLITHOTOMY FOR THE TREATMENT OF PAEDIATRIC UROLITHIASIS: A SINGLE CENTER EXPERIENCE

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## ABSTRACT

### *Background*

Children are more prone to the recurrent stone formation. To treat these cases, a procedure with a high success rate, less morbidity and the short convalescent period is needed. Percutaneous nephrolithotomy (PCNL) has become a well-established procedure for the management of renal calculi that are not amenable to (ESWL) in children of all age groups.

### *Objectives*

We report our center experience and outcome of pediatric percutaneous nephrolithotomy (PCNL).

### *Patients and Methods*

This prospective data analysis of 109 consecutive patients under the age of 17 who underwent PCNL from September 2009 to January 2016. All PCNL procedures were performed in prone position by a single experienced faculty urologist under general anesthesia and under fluoroscopic guidance. Rigid nephroscope was used.

### *Results*

One hundred and sixteen PCNLs were performed on 109 patients (six patient had bilateral PCNL), (65 boys and 44 girls), with a mean (range) age  $6.57 \pm 4.51$  (1-17) years, and mean (range) stone size was  $2.341 \pm 1.105$  (0.6-6) cm. Stones were complex staghorn stones in (16 cases), multiple stones in (51 cases) and single stones in (48 cases). Stones were present in complex anatomy included malrotated kidney (2 cases), previously treated pelviureteric junction obstruction (2 cases) and previously treated renal stones by open pyelolithotomy in 14 cases. Two tracts were made in six (5.1) cases, due to the large stone burden. Stone-free rate after PCNL monotherapy was 93%, which increased to 96.5% after shock wave lithotripsy, and it was significantly lower in complete staghorn stones (75 %). In the current study, 25 (21.72%) procedures were noted to had intraoperative/postoperative complications and most of them (92%) were minor and all were managed conservatively.

### *Conclusion*

PCNL in children is an effective and safe procedure for managing simple as well as complex renal calculi.

**Keywords:** *Percutaneous nephrolithotomy, Stone, Children, Complications.*

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## INTRODUCTION

Paediatric Urolithiasis is a common problem in developing countries, more so than in the industrialized world, and the incidence of pediatric Urolithiasis is on the rise in children of all age groups worldwide (1-3). It is usually associated with urinary tract infection, anatomical and metabolic abnormalities, together with climate and dietary factors. Therefore, nephrolithiasis in children has a high rate of recurrence; with an overall 5-year recurrence rate of 55% (95% confidence interval: 38-70%) (1,3).

Percutaneous nephrolithotomy (PCNL) has become a well-established procedure for the management of renal calculi that are not amenable to ESWL in children of all age groups (1,3-8). Moreover, with the miniaturization of instruments, the acceptability of pediatric PCNL has widely increased (1) and PCNL is now the procedure of choice in children requiring surgical intervention and has been shown to cause no longer anatomical or functional renal damage irrespective of age or size of instruments (9-11). Stone-free rates in recent studies were  $\geq 90\%$  in children of all age groups using different sizes of instruments (5,9,12,13). Despite the high success rates, PCNL is a highly invasive procedure and the potential or serious complication is a major concern. The overall reported complication rate in children, varied from 12.9% to 30.4% (7-9,12,17-20), fever and blood transfusion being the most common complications varying from zero to 31% and 23.9% respectively (5-8,12,13,17,20). Herein we report our experience of a single surgeon center. It is the first center in the locality treating this cross-section of patients.

## PATIENTS AND METHODS

A prospective data analysis of 109 consecutive patients under the age of 17 who underwent PCNL from September 2009 to January 2016, in urology department, Sulaymania teaching hospital as 116 PCNLs were performed on 109 patients (six patients had bilateral renal stones).

The preoperative workup includes urinalysis, urine culture, renal function tests, complete blood count, coagulation profile, abdominal ultrasonography, intravenous urography (IVU) and/or NCCT (non-contrast computerized tomography). All PCNLs were performed by a single experience endourologist. The basic technique was used; patients were treated in prone position under general anesthesia (GA). Prophylactic

antibiotics were administered to all children. A 4Fr or 5 Fr ureteral catheter was inserted in a retrograde fashion for opacification of pelvicalyceal system. C-arm fluoroscopy-guided puncture was done at lower posterior calyx with the patient in prone position. Tract formation was performed by serial coaxial dilatation using Alken dilators. Afterward, Amplatz sheaths 20-26 Fr used, A slender nephroscope 17 French (Karl-Storz) was used for all cases. Stones were fragmented with pneumatic lithotripter and extracted by a grasper. Number and location of access points, blood loss, hospitalization times, and a stone burden were assessed.

To reach inaccessible calyces through rigid nephroscope a flexible cystoscope serves as a flexible nephroscope used to examine and remove stones. In case of multiple or migratory calyceal stones, and to avoid another tract, initial puncture (IP) needle was introduced in the calyx containing stone and the stone was flushed out with saline irrigation. The stone-free status is confirmed using both fluoroscopy and endoscopic examination with flexible nephroscopy). Success was defined if stones are totally removed without the need for the auxiliary procedure. On completion of the procedure, urethral catheter left inside the urinary bladder, 14-16 Fr nephrostomy was left in situ in all cases in addition to double-J stent (DJS) inserted in most of the cases. KUB was performed on the first postoperative day to verify the absence of stones and when the urine was clear, nephrostomy and urethral catheter were removed, and the patient was discharged home when there is no urine leakage or fever. Stone fragments of less than 4 mm in diameter are regarded as clinically insignificant (1). We use plane KUB x-ray and ultrasonography for the follow up at 2 weeks and later every month for 3 months. The DJS was removed when auxiliary treatment no more needed after two weeks under short anesthesia. Data were analyzed using the Statistical Package for Social Sciences (SPSS, version 19). Chi-square test of association was used to compare between proportions. When the expected count of more than 20% of the cells of the table was less than 5, Fisher's exact test was used. Student's t-test was used to compare between means of two groups. A p-value of  $\leq 0.05$  was considered statistically significant.

## RESULTS

One hundred and sixteen PCNLs were performed on 109 patients (six patients had bilateral PCNL), (65 boys and 44 girls), with a mean (range) age  $6.57 \pm 4.51$  (1-17) years, and mean (range) stone size was  $2.341 \pm 1.105$  (0.6-6) cm.

These stones were complex staghorn stones (16 cases), multiple stones (51 cases) and single stones (48 cases). Stones were present in complex anatomy included malrotated kidney (2 cases), previously treated pelviureteric junction obstruction (2 cases) and previously treated renal stones by open pyelolithotomy in 14 cases. Patient demographics and preoperative variables are summarized in Table 1.

In the majority of cases 109/115, a single puncture alone was required to achieve maximal stone clearance although six cases did require the placing of two punctures. No case required more than two punctures. Of the single punctures, 107 were via a lower pole calyx, 2 via an upper pole calyx. Semirigid ureteroscope was used in two patients to push back an upper ureteric stone. Detailed operative variables and outcomes are described in table 2. Intraoperative DJS placement was performed in 89 children (77.4%) and these were removed under short anesthesia 2–4 weeks after surgery.

In the current study, 25 (21.72%) procedures were noted to have intraoperative/ postoperative complications and most of them (92%) were minor and all managed conservatively.

There was significant bleeding/hematuria encountered in 9 patients, either during the operation or in the post-operative setting, only 4 patients required a blood transfusion. The need for blood transfusion was

decided on the basis of brisk intraoperative hemorrhage, hemodynamic instability (not quickly responding to crystalloid infusion) or postoperative hemoglobin  $\leq 8$  g %).

Fourteen patients developed post-operative pyrexia within the first 24 hours, requiring the continuation of parenteral antibiotics; in these patients, the removal of the nephrostomy tube was deferred by 24 hours, resulting in an increase in a hospital stay of 24 hours.

All 7 children with a previous history of PCNL were approached through the lower calyx, one developed extravasation, exploration with drainage of extravasated fluid done; nephrostomy was left for three days and the patient was hospitalized for four days.

The patient with colonic injury was a 12- year old boy with a single pelviureteric junction stone (20mm in diameter) with moderate hydronephrosis. On the first postoperative day, he developed fever and tachycardia, with abdominal pain and tenderness. CT scan showed air inside and outside the kidney with fluid. The nephrostomy tube was located inside the colon, as it has gone through-and-through. There was fecal peritonitis. Colostomy was performed and closed after 2 months.

Complications stratified according to different age groups found to be statistically not significant as shown in figure 1 ( $p=0.65$ ).

Complete stone clearance was achieved in 107 kidneys (93%), while four (3.5%) had clinically insignificant residual fragments (CIRF) ( $\leq 4$  mm) that passed spontaneously on follow-up. Final stone clearance was achieved in 111 units with a success rate of 96.5% after SWL.

**Table 1. Preoperative characteristics of patients.**

<b>Parameters</b>	
No. of renal units (patients), <i>n</i> (%)	115 (109)
Male/female, <i>n</i> (%)	65/44 (60/40)
Side: left/right, <i>n</i> (%)	57/58 (50.4/49.6)
Mean±SD (range) age, years	6.57±4.51 (1-17)
Mean ±SD (range) stone size, cm	2.341±1.105 (0.6-6)
Mean ± SD preoperative haemoglobin, g%	11.44±1.23
Mean ± SD preoperative serum creatinine, mg%	0.68±0.12
Renal anomalies, <i>n</i> (%) Malrotated kidney	2 (1.7 ) 2 (1.7 )
<b>Previous stone related surgery, n (%)</b>	43 (37.0 )
PNL	7 (6.1)
URS	2 (1.7)
ESWL	16 (13.9)
Open	18 (15.7)
Cystolithotomy	2 (1.7 )
Pyelolithotomy	14 (12.2)
Pyeloplasty	2 (1.7)
<b>Stone complexity and location, n (%)</b>	
Single	48 (41.7)
Renal pelvic	36 (31.3)
middle calyx	7(6.1)
Inferior calyx	5 (4.3)
Multiple (multiple calices or pelvic + calyces)	51(44.3)
Staghorn	16 (14)
Partial staghorn	8 (7)
Complete staghorn	8 (7)
Degree of hydronephrosis	
No hydronephrosis	12 (10.4)
Mild hydronephrosis	52 (45.2)
Moderate hydronephrosis	49 (42.6)
Sever hydronephrosis	2 (1.7)
<i>n</i> , number of patients	

**Table 2. Operative and postoperative data.**

<b>No. and site of punctures, n (%)</b>	
One puncture	109 (94.7)
Lower pole	107 (93)
Supracostal puncture	2 ( 1.7 )
Two punctures	6 ( 5.1)
Lower pole + middle pole	2 (1.7 )
Lower pole + upper pole	2 ( 1.7 )
Lower pole +supra costal puncture	2 ( 1.7 )
Mean ± SD (range) operative duration, min	54.57±18.43 (40-80)
Mean ± SD (range) drop in hemoglobin, g%	1.34±0.53 (0.40-3.00)
Mean ± SD (range) hospital stay, days	2.25±1.016 (1-10)
JJ stent, n (%)	89 ( 77.4 )
Nephrostomy, n (%)	115 (100)
Prolonged nephrostomy	6 (5.2)
<b>Operative and post-operative complication, n (%)</b> Hematuria/ bleeding:	25 (21.72)
Blood transfusion *	9 (7.8)
Extravasation	4 (3.5)
Fever	1 (0.86)
Sepsis	14 (12.2)
Pleural injury	0 (0)
Colon injury	(0)
Mortality	(0.86)
	0 (0)
<b>Stone clearance (PCNL – single session), n (%)</b>	
Complete clearance	107(93 )
CIRF (≤4 mm)	4( 3.5 )
Residual	4( 3.5 )
<b>Ancillary procedures, n (%)</b>	
SWL	4( 3.5)
Relook PCNL	0( 0 )
<b>Final clearance, n (%)</b>	
Cleared	111(96.5 )
Residual	4(3.5)

\* The indication for blood transfusion was clinical (vital signs) or when hemoglobin cut of point becomes 8 gm or below.

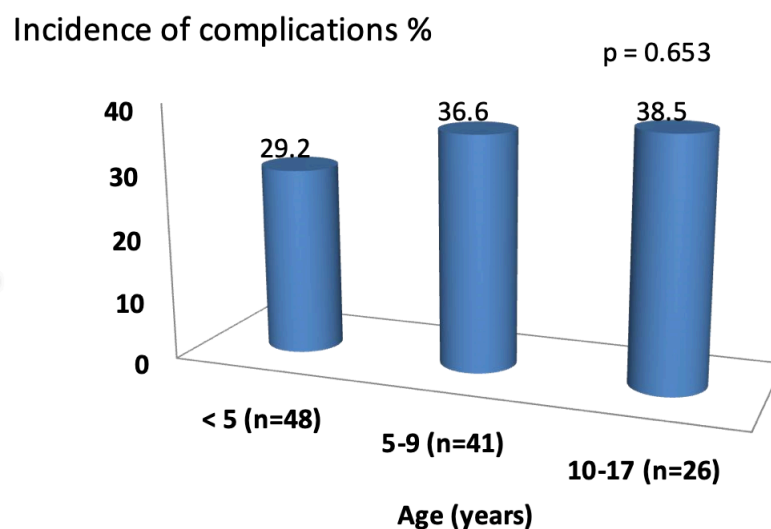


Figure 1. The incidence of complication in deferent age groups (P=0.653).

## DISCUSSION

The presence of associated metabolic and anatomical anomalies in 20–40% of children with urolithiasis differentiates them from adults, making them more prone to stone recurrence<sup>(21)</sup>. Therefore, a minimally invasive procedure, with a high success rate and minimal morbidity, is desirable in children. ESWL is safe and effective, maintaining its status as the preferred approach for treating upper-tract calculi up to 1.5 cm in size; however, its efficacy falls with increasing stone size/multiplicity<sup>(22, 23)</sup>. With the increasing experience of urologists and refinements in instrumentation and technology, PCNL has become established as one of the standard treatments in pediatric cases<sup>(1)</sup>.

Our results show that pediatric PCNL is a safe treatment modality with good stone clearance rates (93%) after a single session of PCNL, increasing to 96.5% after ancillary procedures (ESWL) with overall complications rate of 21.72% and the majority of complications are minor in magnitude. This compares favorably with published series over the past 18 years (Table 3)<sup>(8-10, 13, 18-20, 24-32)</sup>. Previous series have shown that PCNL can be performed safely in children with stone clearance rates of 58–93% and complication rates of 0–30%.

The largest pediatric PCNL experience was reported by Samad *et al.*<sup>(8)</sup> who reported 188 PCNLs on a population with a mean age of 6.5 years using a 22 Fr tract. In this series, 90% of cases were completed using

a single tract with an overall clearance rate of 76% and a complication rate of 5%. Nouralizadeh *et al.*<sup>(9)</sup> reported a 10% complication rate for patients with a mean age of 3.1 years (lowest in series), with an average stone burden of >30mm. Aron *et al.*<sup>(29)</sup> used multiple tracts and achieved a stone clearance rate of 89% with no reported complications.

Pediatric PCNL series using adult instruments have reported high efficacy with acceptable morbidity<sup>(7, 8, 12, 18)</sup>, and shown similar levels of safety to pediatric instruments<sup>(9, 19, 20, 32)</sup>.

Recent reports have shown that almost any version of PCNL can be applied safely in children, with age no longer a limiting factor<sup>(1)</sup>. Bilen *et al.*<sup>(17)</sup>, Unsal *et al.*<sup>(31)</sup>, Nouralizadeh *et al.*<sup>(9)</sup> and Guvenet *et al.*<sup>(34)</sup>, they found that smaller tracts did not significantly affect stone-free rates but achieved lower transfusion rates and complication rates.

Large tracts and instruments can facilitate more rapid and complete stone clearance. In addition, with access to flexible endoscopes and multimodal energy sources for stone destruction and removal, complete stone clearance can be achieved in most patients.

In conclusion, percutaneous nephrolithotomy in children using the appropriate instruments is an effective and safe procedure for managing simple as well as complex renal calculi.

**Table 3. Pediatric PCNL series in the literature.**

<b>Authors</b>	<b>Number of patients</b>	<b>Number of PCNLs</b>	<b>Mean age (years)</b>	<b>Stone burden (average)</b>	<b>Tract size (Fr)</b>	<b>Single tracts (%)</b>	<b>Stone clearance (%)</b>	<b>Complications (%)</b>
Mor <i>et al</i> , 1997 <sup>18</sup>	25	25	8	-	-	100	68	0
Jackman <i>et al</i> , 1998 <sup>24</sup>	11	11	3.4	120 mm <sup>2</sup>	11	100	89	0
Badawy <i>et al</i> , 1999 <sup>25</sup>	60	60	6	-	24	100	83	3
Sahin <i>et al</i> , 2000 <sup>26</sup>	14	16	11	301 mm <sup>2</sup>	24-30	100	69	7
Guneset <i>al</i> , 2003 <sup>19</sup>	23	25	10.9	3.42 cm <sup>2</sup>	24-30	88	70	30
Desai <i>et al</i> , 2004 <sup>13</sup>	56	56	10	22 mm	22	40	89	0
Dawaba <i>et al</i> , 2004 <sup>10</sup>	65	72	5.9	-	22	85	93	3
Boormans <i>et al</i> , 2005 <sup>27</sup>	23	26	9.5	608 mm <sup>2</sup>	18	100	58	8
Raza <i>et al</i> , 2005 <sup>28</sup>	37	46	6.4	56 mm	18	100	79	6
Aron <i>et al</i> , 2005 <sup>29</sup>	19	19	4.2	972 mm <sup>2</sup>	24	26	89	0
Samad <i>et al</i> , 2006 <sup>8</sup>	169	188	6.5	26.2 mm	22	90	76	5
Kapoor <i>et al</i> , 2008 <sup>30</sup>	31	31	9.6	15mm	24-30	100	84	0
Nouralizadeh <i>et al</i> , 2009 <sup>9</sup>	20	26	3.1	33mm	26	100	79	10
Unsal <i>et al</i> , 2010 <sup>31</sup>	44	45	9.3	15-52 mm	12-18, 24-26	90	83	22
Kumar <i>et al</i> , 2011 <sup>32</sup>	11	12	11.7	848 mm <sup>2</sup>	24-30	83	58	8
Veeratterapillay <i>et al</i> , 2012 <sup>20</sup>	31	32	10.8	28 mm	28	81	84	0
Goyal <i>et al</i> , 2014 <sup>33</sup>	153	158	10.03	376 mm <sup>2</sup>	24-30	109	83	27.8
Present series	109	115	6.57	23.4 mm	20-26	94.7	93	21.72

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*Safety and Efficacy of Percutaneous Nephrolithotomy for the Treatment of Paediatric ...*

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