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Percutaneous Nephrolithotomy in Paediatric Population: A Single Center Experience

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ABSTRACT

Background: Management of paediatric stone disease is challenging as they are considered high risk group. Percutaneous nephrolithotomy is minimally invasive procedure with definite advantages in terms of higher stone clearance in single session and no long term effect in renal function.

Methods: Retrospective study was done including all patients upto the age of 18 years who underwent Percutaneous nephrolithotomy from January 2010 to December 2018 in our center after taking approval from ethical committee. Data was collected regarding gender, operative side, operative time duration, hospital stay, post-operative decrease in hemoglobin, stone size, Guy's stone score and early post-operative complications with Clavien-Dindo grade.

Results: Percutaneous nephrolithotomy was done in 48 renal units in 44 patients. 28 patients were boys and 16 were girls with mean age of 10.91 ± 5.22 years and mean stone size 17.16 ± 6.43 mm. 91.6% of cases had Guy's stone score of 1 and 2. Standard percutaneous nephrolithotomy was done in 21 renal units, mini percutaneous nephrolithotomy in 24 renal units and supermini percutaneous nephrolithotomy was done in three renal units with total stone free rate of 93.4%. Three patients required extracorporeal shockwave lithotripsy for significant residual stone. Average post-operative hemoglobin drop was 1.2 gm%. Overall complications rate was 18.1% with 4.5% of complications being grade 1 and 2 whereas 13.6% were Grade 3.

Conclusions: Percutaneous nephrolithotomy is safe and feasible in paediatric patients with large stone burden, complex anatomy or shock-wave lithotripsy failure with acceptable complication and stone free rate.

Keywords: Endourology; paediatric; percutaneous nephrolithotomy; PNL; urolithiasis

INTRODUCTION

The incidence of paediatric stone disease is thriving throughout the world, with varied prevalence in developed (1-5%) and developing countries (5-15%).[1,2] Majority of these patients have underlying metabolic abnormalities, urinary infection, anatomical factors and endemic factors.[2-4] Management of urolithiasis in paediatric population poses a challenge.[5] However, because of the advent of more miniaturized instruments and technological advancement, treating stone disease in children is now more effective and safe.

Apart from all the merits of extracorporeal shock-wave lithotripsy (SWL), in certain situations, percutaneous nephrolithotomy (PNL) has a definite advantage in terms of stone burden, obstruction and higher stone clearance in single session.[2,5] It is considered minimally invasive procedure with no long term effect in renal function and scarring.[6,7] In this study, we evaluated the outcome of patients aged 18 years and less treated with PNL over the period of 9 years.

METHODS

Retrospective study was done including all patients upto the age of 18 years who underwent percutaneous nephrolithotomy (PNL) from January 2010 to December 2018 in our center after taking approval from ethical committee. Data was collected regarding gender, operative side, operative time duration, hospital stay, post-operative decrease in hemoglobin, stone size, Guy's stone score[8] (GSS) and early post-operative complications with Clavien-Dindo grade.[9] Descriptive data analysis was done using SPSS© version 20.

Total 48 paediatric PNL were performed in 44 patients. The patient demographics is depicted in (Table 1). None

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of the patients had comorbidity or compromised renal function. Most of the renal stones were 1 and 2 whereas only 8.4% of patients had GSS 3 and 4.

Table 1. Summary of patient characteristics

Total patients (Renal Units)	44 (48)
Male / Female	28 /16
Mean age (years)	10.91 ± 5.22 (Range 2 -18)
Operating side	
Left	18
Right	22
Bilateral	4
Guy's stone score	
Score 1	21 (43.7%)
Score 2	23 (47.9%)
Score 3	3 (6.3%)
Score 4	1 (2.1%)
Mean stone size (mm)	17.16 ± 6.43
Mean hospital stay (days)	6.6 ± 3.7

All PNL were done in prone position under general anesthesia. At first, patients were kept in lithotomy position and 6.5/9F rigid ureterorenoscopewas used for placement of 0.025 inch Terumo™ glidewire through the desired ureteral orifice followed by placement of 4F ureteral catheter under fluoroscopy guidance. The ureteral catheter was fixed with Foley catheter of appropriate size before changing the patient to prone position.

Puncture was made using triangulation technique under C-arm guidance after visualization of pyelogram by retrograde injection of diluted contrast through the ureteral catheter. Tracts were then dilated using telescopic metal Alken serial dilators and desired size of amplatz sheath (Cook Medical™) was placed. Stones were fragmented using either pneumatic lithotripter or holmium:YAG laser. Nephrostomy tube and double J stent were kept as per surgeon's decision. Patients were evaluated for post-operative hemoglobin drop, hospital stay, peri-operative complications, residual stones and requirement of any ancillary procedures.

RESULTS

The operative summary is outlined in (Table 2). Average operating time was 84 ± 38.2 minutes. Standard PNL was done in 21 cases in which the access tract was dilated only upto 24F. Similarly, mini PNL was done in 24 cases which used 16F amplatz sheath and supermini PNL was done in three cases which used 14F amplatz sheath. In both mini and supermini PNL, miniaturized nephroscope of 12F size or rigid ureterorenoscope of 6.5/9F was used. Double J stenting and placement of nephrostomy tubes were done in 25 and 42 renal units respectively with only one case of total tubeless PNL.

Table 2. Summary of operative findings.

Operating time (minutes)	84 ± 38.2 (Range 25 - 180)
Hemoglobin drop (gm%)	1.26 ± 0.98 (Range 0.1 - 4.0)
PNL (Tract size)	
Standard (20 – 24F)	21/48 renal units (43.7%)
mini (16F)	24/48 renal units (50.0%)
supermini (14F)	3/48 renal units (6.3%)
Nephrostomy tube	42/48 renal units (87.5%)
Double J stenting	28/48 renal units (58.3%)
Stone free rate (SFR)	93.2%
Ancillary procedures	
SWL	3 renal units

Table 3. Complications using Clavien-Dindo grading system.

Significant residual stone requiring SWL later	Grade III-a	6.8% (3/44)
Postoperative urethral stricture requiring DVIU	Grade III-b	2.3% (1/44)
Persistent leakage from nephrostomy tract requiring double J stenting	Grade III-b	2.3% (1/44)
Hematuria requiring bladder wash	Grade III-b	2.3% (1/44)
Hematuria managed conservatively	Grade II	2.3% (1/44)
Hematuria requiring blood transfusion	Grade II	2.3% (1/44)
Total		18.1% (8/44)

Stone free rate was 93.2% which was assessed intraoperatively under C-arm fluoroscope, post-operatively on 2nd day by X-ray KUB and/or ultrasonography KUB prior to removal of nephrostomy tube. Patients were followed up in one month after dischargewith X-ray KUB or ultrasonography and double J stent (DJ) was removed if present. Stone size of less than 4mm in ultrasonography was considered insignificant. Three patients had significant residual stone postoperatively and were managed by extracorporeal shock wave lithotripsy (SWL) during follow-up in four weeks. Mean drop in hemoglobin level was 1.26 ± 0.98 gm% with blood transfusion requiring in only one patient. Hematuria requiring bladder clot evacuation was seen in one patient which was done under anesthesia. One patient developed urethral stricture and another one had persistent urine leak from nephrostomy tract which resolved after placement of DJ stent.

DISCUSSION

Over the few decades, the management of stone disease in children has undergone major changes.[1] Various modalities like SWL, PNL, RIRS or combination thereof are available. Treatment options for renal calculi in paediatric population are same as those for adults. However, SWL is regarded as the first choice of treatment given the indications are met since children tend to pass fragments more rapidly as compared to adults.[5,10] In our practice, we do not choose SWL if the stone size is >20mm, has complex anatomy or lower pole stone with acute infundibulo-pelvic angle.

PNL has been proven to be safe and efficacious in adult population.[1] It's safety in children has also been established using both adult instruments by Woodside et al. and miniaturized instruments by Jackman et al. who introduced mini-perc technique using 11F nephroscope.[11,12] In our series, maximum tract dilation was done upto 24F in standard PNL, 16F in mini PNL and 14F in supermini PNL. In a study by Desai et al, they showed that limiting the tract size to 20-22 F as compared to conventional 30F, significantly reduces morbidity. In their series, 56 complex renal calculi were treated with PNL and stone free rate of 89.8% was achieved with average hemoglobin drop being 1.9gm% and only four patients requiring blood transfusion.[13] In our series,hematuria requiring bladder wash and blood transfusion occurred in 4.6% of standard PNL whereas one case (2.3%) of hematuria in mini PNL was managed conservatively. Average hemoglobin drop was 1.2 gm%.

Another major complication following PNL apart from bleeding is sepsis. Guven et al. in their multicenter study involving 107 patients found infective complication to be around 14%.[14] The infective complication rate was found as high as 30% as reported by Zeren et al.[15] Fortunately, in this series, we did not encounter infective complications. This might be because of small number of patient cohort of this study. Various studies on paediatric PNL has been shown in (Table 4) comparing number of patients, mean stone size, stone free rates and rate of major/minor complications. Clavien-Dindo grade I and II are considered as minor complications whereas major complications are grade III and above.

PNL as a monotherapy in children has a comparable stone free rate (SFR) to adults ranging from 68 - 100% after single session and further increased clearance rate following ancillary procedures like SWL, URS or PNL.[10] Our SFR was 93.2% in PNL as a monotherapy and three patients required SWL as ancillary procedure. A large retrospective study in 1,157 patients reported complete stone free rate of 81.6%, postoperative complications of 20% including hematuria requiring blood transfusion in 2.2%, fever 12% and urinary extravasation requiring stenting in 0.2%.[22] We also encountered one case of persistent urinary extravasation from nephrostomy tract which required retrograde DJ stent insertion. One of the patient was diagnosed with urethral meatal stricture during follow-up at one month which was treated with urethrotomy (DVIU) under anesthesia. The cause of stricture maybe due to intra-operative instrumentation or catheterization.

Table 4. Comparison of studies on paediatric PNL.

Study	Year	Patient no (Renal units)	Mean age (years)	Mean stone size (Range)	SFR %	Complications % Major (minor)
Badawy et al.[16]	1999	60	6.0	227 mm^2	83.3	11.6 (1.6)
Desai et al.[17]	1999	40 (45)	9.2	20.4 mm (9 - 45 mm)	91	15 (27.5)
Zeren et al.[15]	2002	55 (62)	7.9	283 mm2 (25 - 2075 mm^2)	86.9	1.8 (53.7)
Desai et al.[13]	2004	56	9.1 ± 4.7	337.6 mm2 (110 - 989 mm^2)	96.4	5.3 (14.2)
Dwaba et al.[6]	2004	65 (72)	5.9	260 mm2 (60 - 2060 mm^2)	86	0 (6.1)
Holman et al.[18]	2004	134 (138)	8.9	507 mm2 (124 - 624 mm^2)	98.5	
Unsal et al.[1]	2010	44 (45)	9.2	30.6 mm (14 - 65 mm)	82.2	6.8 (38.6)
Dogan et al.[19]	2011	45 (51)	5.9 ± 3.6	424 ± 203 mm^2	86.2	4.4 (20)
Guven et al.[20]	2011	130 (140)	10.2	26.28 mm (10 - 60 mm)	82.9	12.9 (15)
Bhageria et al.[21]	2013	95 (102)	11.9	-	83	29.5 (4.2)
Onal et al.[22]	2013	1157 (1205)	8.8 ± 4.7	409 ± 406 mm^2	81.6	28.6 (1.4)
Our study	2019	44 (48)	10.9 ± 5.2	17.16 ± 6.43 mm	93.2	13.6 (4.5)

Data regarding metabolic analysis of the included patients could not be extrapolated as they were managed on the outpatient basis. Assessment of residual stones during follow-up would have been more precise by plain computed tomography (CT KUB) but was not done due to concern regarding increased radiation hazard. Functional outcome of the renal units as well as scarring subsequent to PNL has not been evaluated in this study although studies have shown there is no significant loss of function or scarring following paediatric PNL.[6,7] A multivariate analysis could have been better in evaluating complications in respect to tract size which was not possible because of small number of patients.

CONCLUSIONS

Percutaneous nephrolithotomy is safe and feasible in paediatric patients with large stone burden, complex anatomy or SWL failure with acceptable complication and stone free rate.

CONFLICT OF INTEREST

None.

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