ORIGINAL ARTILCE

OUTCOME OF PERCUTANEOUS NEPHROLITHOTOMY IN PRE-SCHOOL AND SCHOOL-AGE CHILDREN-SINGLE CENTER EXPERIENCE

Nadeem Iqbal, Aisha Hasan, Fasih Sami Siddiqui, Faisal Iftikhar, Syeda Maryam Ilyas, Ijaz Hussain, Faheemullah Khan, Saeed Akhter

Department of Urology, Shifa International hospital Islamabad-Pakistan

Background: Efficacy of percutaneous nephrolithotomy in adults has been studied well in past. However, such studies are sparse within paediatric age group. As this procedure is being adopted in smaller and older children alike, we wanted to determine its safety and efficacy in two different age groups of children (preschool age and school age). **Methods:** The records of 59 children undergoing PCNL at our department from December 2009 to May 2017 were reviewed retrospectively. Patients were placed into 2 age groups including children ≤7 years old (group 1) and those ≥7 years (group 2). Twenty-seven patients were put in preschool group with mean age of 4.8±2.1 years while 32 patients in school age group having mean age of 11.8±4.6 years. **Results:** Stone size was calculated showing mean 309±55 mm2 in preschool and 324±63 mm2 in school age group respectively (p=0.1). The mean operative time was 150.1±38.7 minutes and 166.3±39.6 minutes in the preschool and school age children respectively (p=0.1). The mean length of hospital stay was 3.1±1.4 days and 2.9±1.3 days in preschool and school going children (p=0.5). The stone clearance with PCNL was seen in 96.3% (pre-school group) and 93.75% (school age group) as monotherapy (p=0.1), which increased to 100% after combining it with extracorporeal shock wave lithotripsy. **Conclusion:** PCNL is equally effective in both pre-school and school age groups in terms of stone free rates. Complication rates were not different between the two groups.

Keywords: Renal Stones; Paediatric Nephrolithiasis; Per-cutaneous nephrolithotomy; Stone clearance

Citation: Iqbal N, Hasan A, Siddiqui FS, Iftikhar F, Ilyas SM, Hussain I, *et al*. Outcome of Percutaneous Nephrolithotomy in Pre-school and School-age children-Single center experience. J Ayub Med Coll Abbottabad 2019;31(3):391–6.

INTRODUCTION

Incidence of paediatric urolithiasis in the world shows a wide variation between the developing and the advanced nations, with a prevalence of 5–15% and 1–5%, respectively.[1–4] Pakistan lies in a stone belt countries and the possible reasons for such a high stone disease incidence include low fluid intake, high environmental temperature, imbalance dietary habits, metabolic causes, chronic diarrhoea and lack of public awareness about stone disease and its prevention.[4] Dietary factors that increases the risk of renal stone formation include high intake of salt (sodium) and animal protein, while low intake of calcium. The surgical management of renal calculi has changed considerably with the introduction of extra-corporeal shock wave lithotripsy and per-cutaneous nephrolithotomy (PCNL).[4]

As there are more chances of stone recurrence in children so minimally invasive interventions are preferred now a days. Important thing in children is that even when using these least invasive techniques, emphasis should be on achieving the maximum possible clearance rates.[4] These procedures have become standard for treating renal stones, with proved safety and efficacy in different age groups. They have been utilized both as monotherapy and combined as dual therapy.[5,6] Adult sized instruments for paediatric percutaneous nephrolithotomy were used for the first time that included seven children. [7]However, there is not much data available in literature on paediatric PCNL by using adult sized instrument.[6,8] There arise some technical challenges when PCNL is done in young children or if there is functional or some anatomical abnormalities. In cases where the collecting system in kidney is not dilated then the use of adult sized instruments in preschool age children may be potentially more traumatic because of their size. Other important point is that children of preschool age have relatively mobile and smaller sized kidneys as compared to the school age children.[9] In these situations special attention and skills are required. Although studies in past have reported safety of PCNL in age group below 18 years old (paediatric group) but very little attention has been given to the fact that even in the age group below 18 years there are those children who are very small for size such as those below age of seven years. They have reported on use of larger size instruments safely in paediatric

age group in general but they haven't commented on younger age children. This variation of age and size even within the paediatric age group might affect PCNL outcomes. Such studies in which paediatric group has been further sub classified into subgroups are sparse. Then there is a challenge in countries like Pakistan where there are very rare paediatric urologists and let alone paediatric endourologists. Then comes the problem of the instruments size available.

We report the comparison of outcomes of PCNL in two age groups of children in terms of stone free rates and the complication rates seen among them. It is perhaps the first study to our knowledge from a developing country like Pakistan, where paediatric urology is present only in very few health care centres.

MATERIAL AND METHODS

It is a retrospective comparative study of 59 children who underwent PCNL procedure from December 2009 till May 2017 at our department. After taking Ethical committee approval for this study from our hospital, Patients were divided into 2 age groups including those ≤7 years old (Group 1) and those ≥7 years (Group 2). All the children included in these groups underwent PCNL for treating renal stones> 2cm in size and were below age of 18 years. Patients having positive urine cultures, deranged renal functions, history of open renal surgery on same side previously and bleeding disorders were excluded from the study.

Children were initially diagnosed after taking full history and physical examination. Radiological investigations used for renal stone included X-ray KUB (Kidney ureter and Bladder), Ultrasound KUB (Kidney ureter and Bladder) and Computed tomography. Stone burden in these children were calculated as mm^2 after multiplying the two largest dimensions of the stone seen on radiography. In cases of multiple stones, all stones individual measurements were taken and their sum was used. Once decision for percutaneous nephrolithotomy (PCNL) was made, a complete blood count (CBC), serum urea, creatinine, electrolytes and PT/APTT were done one day before the PCNL procedure. Preoperatively one unit of blood was arranged after doing blood cross match and grouping, if need for transfusion arise during the surgery or after PCNL. Children having positive urine cultures were treated preoperatively with antibiotics according to the culture and sensitivity reports of urine culture.

Consent was taken from the parents of the children after explaining in detail about the technical challenges and possible outcomes in terms of success rates (stone clearance) and complications that could arise during or after the procedure. PCNL was done in all children by standard technique under general anaesthesia. Children were kept in lithotomy position, cystoscopy was done and then with the help of fluoroscopy imaging (SEIMENS model no.07721710, made in Germany) a three French (3 Fr Boston scientific) open end catheter was passed up to renal pelvis in lithotomy position. Patient position was then changed on the operating table to prone position. Pelvi-calyceal system was punctured by using an 18 G spinal needle under fluoroscopic guidance. The glide wire (0.035 inch, Boston scientific TM Guide, USA) was passed through the spinal needle into pelvi-calyceal system. The tract was dilated by using serial metallic dilators passed over glide wire. Twenty Fr paediatric nephroscope (Karl Storz made in Germany) was then introduced to reach the stone under fluoroscopic control through the PCNL sheath. Swiss Pneumatic lithoclast (2 mm probe) was used to break the stones into smaller fragments and three prongs grasper was used to extract these stone fragments. Ante grade ureteric catheter was used if there was fear of blockade of ureter later on due to the fragments left per-operatively. Nephrostomy tube was passed in patients having bled per operatively. In those children where we didn't pass nephrostomy tube 4/0 silk was used to close the wound. Manual compression of wound site was done for 5 minutes for achieving haemostasis, in case nephrostomy tube was not placed. Injection Bupivacaine 0.025% diluted equally in 2-3 ml distilled water was used for injecting in the peri-tube area or the wound site (that was closed) to minimize immediate post op pain and so the need for narcotic analgesics. We removed Nephrostomy tube on 2nd or third postoperative day followed by removal of the catheter. Ureteric catheter (Double J stent, Boston scientific) was removed after two weeks under general anaesthesia.

On follow up visits ultrasound KUB (Kidney, Ureter and Bladder) and X-Ray KUB was done at 2 weeks and one month to see for any residual stone fragments radiologically. We didn't do CT scan of the children in follow up to see the residual stones size to avoid further exposure of these children to radiation. Children having absence of stone fragments were declared stone free and those having less than 4 mm residual stones were labelled as clinically insignificant residual stone fragments (CIRF). While patients having residual stone fragment size of more than 4 mm were declared as procedure failure. The PCNL Procedural success was considered in those children who had either no stone fragments (stone free) or clinically insignificant residual stone fragments (<4 mm size) on follow up.

For data collection, a questionnaire was completed after chart review to evaluate different variables. The patients included in the respective groups were analysed for gender, age, Stone size, stone site, PCNL approach, operative time, stone clearance, hospital stay and per operative and post-operative complications (fever, sepsis, peri-nephric collection, haemorrhage). Per operative blood loss was estimated by subtracting post-operative haemoglobin from preoperative haemoglobin.

SPSS ver16 was used for data analysis. Mean±SD was calculated for quantitative variables like age, stone size and operative time. Frequency percentage was calculated for qualitative variables like gender, location of stone, per-operative stone clearance and per-operative and post-operative complications. Independent t-test was used to find *p*-value for comparing numerical values such as hospital stay, operative time and Chi square test was used for percentage stone clearance. The *p*-value of less than 0.05 was considered as statistically significant.

RESULTS

Two groups having age of ≤7 years (preschool) and ≥7 years (school age) with 13/27 (48.1%) boys and 14/27 (51.9%) girls in preschool group while 24/32 (75%) boys and 8/32 (25%) girls in school age group were analysed. Stone size was calculated showing mean 309± 55mm^2 in preschool and 324±63 mm^2 in school age group respectively (p=0.1). Access was through lower pole in 20/27(74%) patients and via mid pole in 7/27 patients (26%) in preschool age group. In school age group access was done through lower pole in 25/32 (78.12%) patients, via mid pole in 7/32 (21.87%) patients. The mean operative time was 150.1±38.7 minutes and 166.3±39.6 minutes in the preschool and school age children respectively (p=0.1). The mean length of hospital stay was 3.1±1.4 days and 2.9±1.3 days in preschool and school going children (p=0.5). The stone clearance with PCNL was seen in 96.3% (pre-school group) and 93.75% (school age group) as monotherapy (p=0.1). Stone clearance increased to 100% by combining it with ESWL as shown in table 1. DJ (double J) stent was placed in total of 6/27 (22.2%) and 7/32 (21.87%) preschool and school age children. The range of follow-up was 4–12 months. The most common presenting symptom was abdominal or flank pain in 19/27 (70.3%) preschool children compared to 22/32 (68.75%) school age children. The other common symptoms were haematuria in 18/59 (30.5%) patients. The most frequent location of the stones was in the pelvis, followed by the lower calyx. Transfusion was required in 7 % among ≤7 year age group and in 4 % in ≥7 year age group. Most of the complications were of minor grades (Table-2).

Table-1: Demographics and clinical study variables

Variables	Frequency & Percentage (%)		Mean ±SD *		*p*-value
	Pre-School Age (≤7 years)	School Age (≥7 years)	Pre-School Age (≤7 years)	School Age (≥7 years)	-
Total number of patients (*n*=57)	27	32	-	-	-
Number of boys	13/27 (48.1%)	24/32 (75%)	-	-	-
Number of girls	14/27 (51.9%)	8/32 (25%)	-	-	
Stone size	-	-	309±55mm^2	324±63mm^2	0.1
Lower pole PCNL **	20/27 (74%)	25/32 (78.12%)	-	-	-
Mid pole PCNL**	7/27 (26%)	7/32 (21.87%)	-	-	
Operative time	-	-	150.1±38.7 minutes	166.3±39.6 minutes	0.1
Length of hospital stay	-	-	3.1±1.4 days	2.9±1.3	0.57
Stone clearance with PCNL monotherapy	-	-	96.3%	93.3%	0.17
Number of patients with ancillary ESWL for residual stones^	1/27 (3.7%)	2/32 (6.25%)	-	-	-
Number of patients with ancillary DJS for residual stones^^	6/27 (22.2%)	7/32 (21.87%)	-	-	-

*Standard deviation (SD), **Percutaneous nephrolithotomy (PCNL), ^Extracorporeal shock wave lithotripsy (ESWL), ^^Ureteric DJ stents

Table-2: Complications (modified Clavien Classification) of PCNL$^+$

Complication grade	Complication	Group (<7 years age)	Group (>7 years age)	*p*-Value
1	Transient Urine leak	3(11.1%)	4 (12.5%)	1.0
1	Transient haematuria	2(7%)	3 (9.3%)	1.0
2	Transfusion need	2 (7%)	1 (4%)	0.58
2	UTI*	1 (3.7%)	**2/32(6.6%)**	0.45
2	Wound infection	-	-	-
3a				
3b	Dj stent for urinoma	-	1 (3.1%)	1.0
4a	Urosepsis	-	1 (3.1%)	1.0
4b	-	-	-	-
5	-	-	-	-

*Urinary tract infection. +Percutaneous nephrolithotomy

DISCUSSION

The prevalence of renal stone disease has been noted to be alarmingly high in Pakistan as it is located in the stone belt region.[9] It is known that the recurrence rate for stone disease increases as time passes and children are more prone to this risk.[10] That is why individuals who forms stone at such an early age needs very keen attention with a target of achieving the maximum possible stone clearance rates by using minimal invasive surgical interventions.[10,11,12]

Wickham *et al.*[11] first reported PCNL to be a feasible as a one-stage procedure. The tract can either be formed by an interventional radiologist or a urologist; at our centre it is formed by the urologist on operation table. Some people have the notion that a smaller calibre nephroscope is less damaging to nephrons.[6] From the same perspective, Jackman *et al.*[8] used a 7 Fr rigid cystoscope. Many centres have used adult-sized nephroscopes in pediatric group, without increase in complications rates. Some studies have even mentioned about using double punctures or even going for the options of secondary and tertiary PCNL in children to attain complete or maximum stone clearance.[5,6] It has been witnessed that such minimal invasive approach has significantly reduced the costs of the treatment.[7,13,14] As we receive children from far flung north region of the Pakistan (including long difficult journey in hilly areas) so we have utmost effort to gain maximum stone clearance in one treatment which is possible by using the mode of PCNL even in children of less than 7 years of age.

PCNL has clearance rates of ≥90% in some reports even those children harbouring complex calculi.[15,16] Adult-sized nephroscopes have been used with acceptable outcomes in children, with lesser rates of complication and little or no evidence of scarring or sequelae.[17] But some studies have different opinion like the one by Gunes *et al.*[18] reporting a significant increase in complications rates in children who were aged less than 7 years while using adult-sized equipment. Doing PCNL procedure in children requires a good grip about knowledge of renal anatomy and a much meticulous technique to minimize complications such as loss of blood and need for the transfusion.[19] We used a 20 Fr nephroscope after a single tract dilatation without much effort, and completely cleared stones with minimal injury to the renal tissue, retrieving the large fragments swiftly. In the present series the duration of surgery included, the initial cystoscopy and retrograde open-end catheter placement and the change of position of child from lithotomy to prone.

In literature 83–90% at maximum and 63% at minimum stone clearance was reported with PCNL in children.[5,6,13] Overall complication rate was 6%, with the commonest complication being pyrexia; others report an equally high incidence of pyrexia.[16,17] In a study conducted by Unsal *et al*., the nephrostomy tract was dilated up to 12F-18F using Amplatz dilators in those ≤7 years of age in their study while we had it dilated up to 24 Fr and we used adult size nephroscopes in children younger than 7 years of age. They had dilated the tract up to 26 Fr only in a subgroup of the children of ≥7 years of age in which they had used adult sizes nephroscopes.[9] They noted that blood transfusion was required in 5.9 and 13.3% of the children in the younger and older groups, while in our study transfusion was required in 7 % among ≤7 year age group and in 4 % in ≥7 year age group. They had comparatively higher transfusion rates in the older children group as compared to ours that may be due to variations in surgical expertise of a surgeon who is operating on children.

Samad *et al*[19] reported that mean operative time for PCNL was 80 minutes and 93 minutes for children of age ≤5 years and ≥5 years respectively while we noted in our study the operative time longer as compared to their experience. This prolonged operative time in our study, 150.1±38.7 minutes and 166.3±39.6 minutes for age ≤7 years and ≥7 years respectively (p=0.1) may be due to our initial minimal invasive surgical experience. The mean stone burden in their groups was 20.5 and 31.4 mm in the respective groups compared to mean stone burden of 309±55mm^2 and 324±63mm^2 in age ≤7 years and ≥7 years respectively in our study population. Most of the children in their study had a lower pole approach in the respective age groups similar to our study.[19]

Aron M *et al*[20] in a study of 19 children of age range 20 months to 5 years documented that complete clearance with PCNL monotherapy was achieved in 17 patients (89%), which increased to 94.7% with adjunctive shockwave lithotripsy.[20] In yet another study on 20 children of mean age of 3.1 years (preschool age) having stone size of (20–46) mm, the stones were successfully cleared in 79.16% of the children, which increased to 91.67% when extracorporeal shockwave lithotripsy was used as adjunctive procedure.[6] These results were comparable to our data where stone clearance with PCNL was 96.3% (pre-school group) and 93.75% (school age group) as monotherapy (p=0.1), which increased to 100% by combining it with ESWL.

In post-operative complications we noted UTI in 1/27 (3.7%) in preschool while 2/32 (6.6%) in school age children. In one study post-operative UTI was seen in 2% and 4% in these age groups after PCNL.[19] While in another study UTI was seen in 13.3% of children more than 7 years of age. In a very few recent studies regarding use of the instrument

size in paediatric patients it has been shown that no significant differences in the complication rates were found between the instrument groups, according to the modified Clavien classification system.[21,22] They found that bleeding in PCNL procedure seems to be linked with diameter of dilatation, calibre of nephroscopes used and importantly the stone burden.[21–23] In our study it should be noted that there was no hypothermia especially in preschool age group after PCNL, as we do the best possible effort to drape and cover the child, the temperature of operation theatre is set high and also the fluids for irrigation purpose are warmed enough before use.

There is a recent literature coming regarding use of smaller sized nephroscopes for small size stones (size up to but less than 2 cm) however its evident that there are some limitations of Ultra Mini PCNL (UMP), such as longer operative time is taken to fragment and completely clear out stones having size more than 2 cm through 11–13F sheaths. Similarly, for a larger burden of stone, multiple calculi or branched calculi (especially in a dilated pelvi-caliceal system, UMP has not been so successful to be able to replace standard PCNL. Thus, the role of UMP technique appears to be more suitable for low-volume upper tract urolithiasis only.[23,24] We had stone size more than 2 cm size so micro perc and ultramini PCNL were not the feasible options even if we had these instruments available at our facility. In a recent study done in turkey it was found that staghorn stones, right-sided PCNL, Younger age, use of mini-PCNL, longer operative time, and blood transfusion rates were among the risk factors for postoperative febrile urinary tract infections.[25]

In a recent study comparing PCNL and RIRS in preschool children; no major complications were observed for both groups. Minor complication of Clavien grades 1–3 were seen in 15.5% and 12.5% for the PCNL and RIRS group, respectively.[26] We had seen clavien grade 1–3 in 19% patients in the preschool children but that may be due to the higher stone burden in our cases as compared to that in that study. In another study by Bodakci *et al*[27] mean hospital duration was 4.3 days in infants who underwent mini PCNL, while we had mean hospital stay of 3.1 days in preschool children. Three (6.2%) of their patients, needed blood transfusions while in our series we had 7% transfusion rates in preschool age group which was slightly higher as compared to them. Colonic perforation developed in one case (2%) while we had no such complication. Seven patients (14%) had UTI in their cases while we had a lower rate of 3.7% in our preschool children. Stone-free rate reached 81.2 % in their series[23] while we had stone free rate of 96.3%. Tubeless mini PCNL has been tried successfully in preschool children as well.[27] Xiao B *et al*[28] observed that transfusion requirements may be sometimes low in mini PCNL cases but overall complications and stone free rates are not superior in mini PCNL patients as compared to standard PCNL groups.[28] Senocak *et al*[29] found that degree of hydronephrosis, operative time and number of tracts were among the important risk factors for bleeding in children who underwent PCNL[29].

Limitations of this study are that the number of patients was smaller in the study groups and it was a retrospective study. However, our sample size was still relatively better than the very few studies available in the literature regarding the outcomes of PCNL. We had done sub classification of the paediatric age group to know differences in outcomes. We had stone size more than 2 cm size so micro perc and ultramini PCNL were not the feasible options even if we had these instruments available at our facility. In literature role of mini PCNL has been proven beneficial for smaller size stones only. Multicentre prospective study has not been done yet to compare the role of mini PCNL and standard PCNL instruments in paediatric age groups especially for stone size larger than 2 cm size and needs to be done to elaborate the differences between different age groups in paediatric renal stones.

CONCLUSION

We here concluded that results for PCNL are comparable in the very young children (less than 7 years) and in children of more than 7 years of age. PCNL can be performed safely even in younger children with minimal complications.

Declaration of conflict of interest: None of authors declare have any conflict of interest.

AUTHORS' CONTRIBUTION

NI, AH, FSS, FI: Literature search. AH, FSS, SMI: Concept. FI, AH, SMI, FSS: Data collection & data analysis. NI, SA, FK: Interpretation and proof reading.

REFERENCES

1. Shah AM, Kalmunkar S, Punekar SV, Billimoria FR, Bapat SD, Deshmukh SS. Spectrum of paediatric urolithiasis in Western India. Indian J Pediatr 1991;58(4):543–9.
2. Lee LC, Violette PD, Tailly T, Dave S, Denstedt JD, Razvi H. A comparison of outcomes after percutaneous nephrolithotomy in children and adults: A matched cohort study. J Pediatr Urol 2015;11(5):250.e1–6.
3. Elsobky E, Sheir KZ, Madbouly K, Mokhtar AA. Extracorporeal shock wave lithotripsy in children: Experience using two second-generation lithotripters. BJU Int 2000;86(7):851–6.
4. Rizvi SAH, Naqvi SAA, Hussain Z, Hashmi A, Hussain M, Zafar MN, *et al*. The Management of stone disease. BJU Int 2002;89(Suppl 1):62–8.

5. Choong S, Whitfield H, Duffy P, Kellett M, Cuckow P, Van't Hoff W, *et al*. The management of paediatric urolithiasis. BJU Int 2000;86(7):857–60.
6. Nouralizadeh A, Basiri A, Javaherforooshzadeh A, Soltani MH, Tajali F. Experience of percutaneous nephrolithotomy using adult-size instruments in children less than 5 years old. J Pediatr Urol 2009;5(5):351–4.
7. Woodside JR, Steven GF, Stark GL, Borden TA, Ball WS. Percutaneous stone removal in children. J Urol 1985;134(6):1166–7.
8. Kumar R, Anand A, Saxena V, Seth A, Dogra PN, Gupta NP. Safety and effiacy of PCNL for management of staghorn calculi in pediatric patients. J Pediatr Urol 2011;7(3):248–51.
9. Unsal A, Resorlu B, Kara C, Bozkurt OF, Ozyuvali E. Safety and efficacy of percutaneous nephrolithotomy in infants, preschool age, and older children with different sizes of instruments. Urology 2010;76(1):247–52.
10. Delvecchio FC, Preminger GM. Management of residual stones. Urol Clin North Am 2000;27(2):347–54.
11. Wickham JE, Miller RA, Kellett MJ, Payne SR. Percutaneous nephrolithotomy: one stage or two? Br J Urol 1984;56:582–5.
12. Goyal NK, Goel A, Sankhwar SN, Singh V, Singh BP, Sinha RJ, *et al*. A critical appraisal of complications of percutaneous nephrolithotomy in paediatric patients using adult instruments. BJU Int 2014;113(5):801–10.
13. Saad KS, Youssif ME, Al Islam Nafi Hamdy S, Fahmy A, El Din Hanno AG, El-Nahas AR. Percutaneous Nephrolithotomy vs Retrograde Intrarenal Surgery for Large Renal Stones in Pediatric Patients: A Randomized Controlled Trial. J Urol 2015;194(6):1716–20.
14. Smaldone MC, Docimo SG, Ost MC. Contemporary surgical management of pediatric urolithiasis. Urol Clin North Am 2010;37(2):253–67.
15. Ramakumar S, Segura JW. Renal calculi. Percutaneous management. Urol Clin North Am 2000;27(4):617–22.
16. Holman E, Khan AM, Flasko T, Toth C, Salah MA. Endoscopic management of pediatric urolithiasis in a developing country. Urology 2004;63(1):159–62.
17. Boormans JL, Scheepe JR, Verkoelen CF, Verhagen PC. Percutaneous nephrolithotomy for treating renal calculi in children. BJU Int 2005;95(4):631–4.
18. Gunes A, Yahya Ugras M, Yilmaz U, Baydinc C, Soylu A. Percutaneous nephrolithotomy for pediatric stone disease - our experience with adult-sized equipment. Scand J Urol Nephrol 2003;37(6):477–81.
19. Samad L, Aquil S, Zaidi Z. Paediatric percutaneous nephrolithotomy: setting new frontiers. BJU Int 2006;97(2):359–63.
20. Aron M, Yadav R, Goel R, Hemal AK, Gupta NP. Percutaneous nephrolithotomy for complete staghorn calculi in preschool children. J Endourol 2005;19(8):968–72.
21. Celik H, Camtosun A, Dede O, Dagguli M, Altintas R, Tasdemir C. Comparison of the results of pediatric percutaneous nephrolithotomy with different sized instruments. Urolithiasis 2017;45(2):203–8.
22. Celik H, Camtosun A, Altintas R, Tasdemir C. Percutaneous nephrolithotomy in children with pediatric and adult-sized instruments. J Pediatr Urol 2016;12(6):399.
23. Bodakci MN, Daggülli M, Sancaktutar AA, Söylemez H, Hatipoglu NK, Utangaç MM, *et al*. Minipercutaneous nephrolithotomy in infants: a ssingle-center experience in an endemic region in Turkey. Urolithiasis 2014;42(5):427–33.
24. Agrawal MS, Agarwal K, Jindal T, Sharma M. Ultra-mini-percutaneous nephrolithotomy: A minimally-invasive option for percutaneous stoneremoval. Indian J Urol 2016;32(2):132–6.
25. Kaygısız O, Satar N, Güneş A, Doğan HS, Erözenci A, Özden E, *et al*. Factors predicting postoperative febrile urinary tract infection following percutaneous nephrolithotomy in prepubertal children. J Pediatr Urol 2018;14(5):448.
26. Pelit ES, Atis G, Kati B, Akin Y, Çiftçi H, Culpan M, *et al*. Comparison of Mini-percutaneous Nephrolithotomy and Retrograde Intrarenal Surgery in Preschool- aged Children. Urology 2017;101:21–5.
27. Song G, Guo X, Niu G, Wang Y. Advantages of tubeless mini-percutaneous nephrolithotomy in the treatment of preschool childrenunder 3 years old. J Pediatr Surg 2015;50(4):655–8.
28. Xiao B, Zhang X, Hu WG, Chen S, Li YH, Tang YZ, *et al*. Mini-percutaneous Nephrolithotomy Under Total Ultrasonography in Patients Aged Less Than 3 Years: A Single-center Initial Experience from China. Chin Med J (Engl) 2015;20;128(1596–600.
29. Senocak C, Ozbek R, Bozkurt OF, Unsal A. Predictive factors of bleeding among pediatric patients undergoing percutaneous nephrolithotomy. Urolithiasis 2018;46(4):383–9.

Submitted: 1 December, 2018	*Revised: 4 February, 2019*	*Accepted: 3 March, 2019*

Address for Correspondence:

Nadeem Iqbal, Post graduate trainee Urology at Shifa International Hospital Islamabad-Pakistan
Email: dr_nadeemiqbal84@yahoo.com