Original Article

# Percutaneous Nephrolithotomy in Paediatric Patients: A Single-centre Experience

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## Abstract

**Introduction:** Paediatric urolithiasis is a common healthcare problem in the Indian subcontinent. Percutaneous nephrolithotomy (PCNL) is the gold standard for managing renal calculi. We audited our experience with paediatric PCNL, highlighting efficacy, safety, various modalities and complications. **Materials and Methods:** Records of 120 patients with 124 renal units were analysed retrospectively from June 2007 to May 2019. Patients' demographics, blood and urine analysis, computed tomography of the kidney, ureter and bladder findings and stone characteristics were noted. PCNL technique used, operative time, fall in haemoglobin, rise in creatinine, hospital stay, stone clearance and complications were also assessed. Subgroup analysis was done by comparing parameters between standard, miniperc and ultraminiperc PCNLs. **Results:** The mean stone size was 17.32 ± 5.8 mm. Seventy-three children underwent standard PCNL, 42 mini PCNL and 9 ultramini PCNL. The mean operative time was 64 min. 20% of patients encountered post-operative complications. Success rate was 84% after initial PCNL and 91% if insignificant residual stones were excluded. Eight patients underwent extracorporeal shockwave lithotripsy and 3 relook PCNL for residual stones. All operative techniques had similar outcomes, except Clavien–Dindo Grade 2/3 complications, which were lesser in mini- and ultramini PCNL group. There was no significant rise in creatinine after PCNL. **Conclusions:** PCNL is a safe and effective procedure for the management of renal calculi in children, even complicated and multiple stones. Mini- and ultramini PCNL have lesser complications, especially bleeding. Proper patient selection, careful evaluation, surgeon's experience and watchful post-operative care contribute towards the procedure's success and reduction in complications.

**Keywords:** Paediatric, percutaneous nephrolithotomy, stone, urolithiasis

## Introduction

In India, there is a high prevalence of urolithiasis not only in adults, but also in children. Globally, children present 2%–3% of total stone formers. Indian subpopulation is considered as a 'stone belt'.[1] Renal stone prevalence is as high as 15% in children <15 years of age in the Afro-Asian stone belt as compared to 1%–5% in developed countries.[2] Advancements in minimally invasive techniques are not only effective but also safe and have led to their usage in children to manage stones. Percutaneous nephrolithotomy (PCNL) has firmly established its role as an indispensable modality for treating paediatric renal calculi, especially large and complex stones. Further improvisation of instrumentation and techniques have resulted in miniperc and ultraminiperc, which have also been found to be safe and effective with lesser frequency and severity of complications.[3] Management of paediatric urolithiasis is more demanding than adults as metabolic abnormalities, renal anatomical variations and infections are commonly encountered. However, therapeutic success, recurrence and complications depend on technique adopted and experience of urologist.[4] Herein, we describe our experience with paediatric PCNL in 120 children at our tertiary care centre and also highlight the procedure and its various modalities depending on the tract size and compare outcomes and complications in each group.

## Materials and Methods

Clinical records of patients under 18 years of age who

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underwent PCNL from June 2007 to May 2019 were retrospectively reviewed. Patients with coagulopathies and poor compliance were excluded from the study. Patient's blood and urine analysis, ultrasonography of the kidney, ureter and bladder (USG-KUB), intravenous urogram and computed tomography of KUB findings were noted. Variables assessed included patients demographics, size, location and number of stones. PCNL techniques, site, route, calyceal access and number of tracts were recorded. All calyceal punctures were done under C Arm using Bulls eye technique. We used various ''as low as reasonably achievable'' (ALARA) measures to decrease radiation exposure including ultrasound guided punctures, proper positioning of patient, avoiding interference between target area and X-ray beam, pulsed instead of continuous fluoroscopy, collimation, last image fold feature, lower settings of mAs and kVps, and adequate protective measures.

The operative time, access technique, intra-operative and post-operative complications, stone clearance and treatment for residual stones were recorded. Complications were graded by the Clavien–Dindo (CD) classification.[5] Data were statistically analysed using IBM SPSS Statistics for Windows, version 24 (IBM Corp., Armonk, N.Y., USA). Analytical evaluation was carried out using Chi-Square and paired/unpaired *t*-tests and one-way analysis of variance. $P < 0.05$ was considered statistically significant.

### Technique

All surgeries were performed under general anaesthesia. A 3–5 French (Fr) ureteric catheter was placed in pelvicalyceal system in lithotomy position and then the patient was turned prone. 18-Gauge (G) initial puncture (IP) needle was used for C-arm-guided puncture. Standard PCNL, miniperc and ultraminiperc used sheaths of 24 Fr, 15/16 Fr and 11/12 Fr, respectively. Pneumatic or laser lithotripter was used for stone fragmentation. 12 Fr percutaneous nephrostomy (PCN) and/or double 'J' (DJ) stent were placed at the surgeon's discretion.

## Results

A total of 120 patients with 124 renal units were included. The mean age and body mass index were 12.8 years and 19.7 kg/m$^2$, respectively. There was a male preponderance (70%), and maximum patients were in the adolescent age group (12–18 years) (43%) [Table 1].

Left-sided renal stones were more common, with renal pelvis being the most common site [Figure 1]. Solitary renal stone was more common than multiple stones. The mean stone size was 17+/-5.8 mm, with most patients having stones between 10 and 20 mm (63%) [Table 2].

Four patients had bilateral calculi, one had a horseshoe kidney, one had a mega ureter with bifid pelvis and one had earlier undergone pyelolithotomy and had a DJ stent *in situ*.

The mean operative time was 64 min (34–132 min). Most cases were completed with a single puncture. However, 12 cases required a two calyx access to provide clearance. Lower pole posterior calyceal puncture was employed in 68% (84) of cases. Twenty-eight cases required supracostal puncture. Forty-two patients underwent mini PCNL, 9 ultramini PCNL and the rest standard. PCN + ureteric catheter was placed in most cases (71). Tubeless PCNL (i.e. no PCN) was performed in 49 cases and 4 cases were totally tubeless (no PCN or ureteral catheter or stent). The mean hospital stay was 2.3 days [Table 3].

X-ray KUB and/or USG were done in all patients on the first post-operative day for stone clearance. Success of PCNL was defined by the absence of any residual fragments postoperatively at 1 month. However, only fragments >4 mm were considered significant. Our case series had an 84% of success rate. If clinically insignificant cases were excluded, success rate was 91.1% [Table 4].

Patients with significant renal calculi underwent second procedure with three undergoing relook PCNL, while eight received extracorporeal shockwave lithotripsy (ESWL).

The complications in our study are enumerated in Table 5. Complications were seen in 24 (20%) patients.

On stratifying post-PCNL complications as per CD classification [Table 6], 10 patients had Grade I, 9 had Grade II and 5 had Grade III complications. CD Grade 1 complications were seen in 10 patients, 5 had fever and 5 had persistent pain. Nine patients had CD Grade II complication with four requiring blood transfusions and five patients needing antibiotics for sepsis. Five children had Grade III complications, which consisted of DJ stenting in two patients for urinary leak, one failed access, one hydrothorax and one conversion to open procedure.

No significant fall in haemoglobin or rise in serum creatinine was observed in post-operative period after 2 h [Table 7].

On subgroup analysis [Table 8], there were no significant differences in most of the parameters including stone free rate, fall in haemoglobin, rise in creatinine or hospital stay. However, a significant difference was seen in the operative time ($P = 0.012$). There was a significant difference in operative time between standard PCNL and mini PCNL group (70.43 min, 60.49 min; $P = 0.007$). However, there was no significant difference in standard PCNL and ultramini PCNL and mini and ultramini PCNL group ($P = 0.07$ and 0.741, respectively). There was no significant difference in the overall complication rate, but Grade II and III complications were significantly greater in the standard PCNL group. The most common complication was prolonged surgical site pain requiring analgesics. Complications in standard PCNL group included three patients each with prolonged surgical site pain and fever (CD-I); four had haematuria requiring blood transfusion and four had sepsis (CD-II) and two patients with persistent nephrostomy leak requiring DJ stenting, one open conversion and one hydrothorax (CD-III).

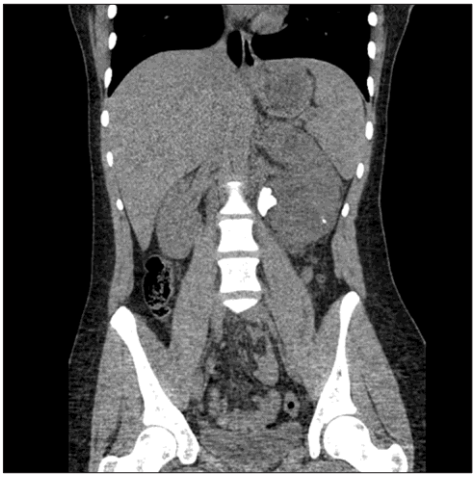


**Figure 1:** Left renal pelvic stone in a child

**Table 1: Demographic characteristics of the patients who underwent percutaneous nephrolithotomy**

| Variables | Value |
|---|---|
| Number of patients (number of renal units) | 120 (124, 4 had bilateral stones) |
| Mean weight (BMI) | 32 kg (21.6 kg/m$^2$) |
| Mean age (years) | 12.8 years (1–17) |
| Age group | |
| Toddler (1–3) | 16 |
| Pre-school (3–6) | 27 |
| School age (6–12) | 25 |
| Adolescent (12–18) | 52 |
| Gender | |
| Male | 84 |
| Female | 36 |

BMI: Body mass index

**Table 2: Stone and anatomical characteristics**

| Variables | Value |
|---|---|
| Laterality | |
| Right | 54 |
| Left | 62 |
| Bilateral | 4 |
| Stone location | |
| Pelvic | 73 |
| Calyceal | 37 |
| Staghorn | 14 |
| Stone number | |
| Single | 84 |
| Multiple | 40 |
| Stone size (mm) | |
| <10 | 21 |
| 10–20 | 78 |
| >20 | 25 |
| Mean stone size (mm) | 17.32±5.8 |

In mini PCNL patients comparatively lesser complications were encountered. Two patients had persistent surgical site pain and 1 had fever (CD-I): 1 had sepsis (CD-II) and 1 had failed access (CD-III). In ultramini PCNL, Group 1 patients had post-operative fever. None of the patients had CD-IV or CD-V grade complications in any group. Overall bleeding/haematuria are significantly less in the mini PCNL and ultramini PCNL group.

Calcium oxalate stones were most commonly found (in 72 patients), followed by struvite, uric acid and calcium phosphate stones.

## Discussion

Paediatric stone disease is challenging to treat, because of high incidence of anatomical abnormality, infections, progression to renal failure and recurrence if left untreated.[6] Therefore, a highly effective surgical procedure with rapid and good stone free rates with minimal post-operative complications is mandatory. Hence, PCNL is considered surgical procedure of choice for renal calculi. The first successful case of PCNL in children was described in 1984 by Woodside *et al*.[7] Efficacy of PCNL is described even in complicated staghorn calculi and multiple renal stones. Retrograde intrarenal surgery (RIRS) has gained widespread popularity in recent years in children because it is less invasive and lesser morbid nature. Greater expertise, decreased availability of miniature instruments and comparatively lesser stone-free rate after first procedure limit the use of this novel procedure in children.[8] ESWL is a treatment of choice for small renal calculus.[4]

Open surgery like anatrophic nephrolithotomy for staghorn renal calculus leads to 6%–16% loss of renal function.[9] Dawaba *et al*.[10] confirmed that paediatric PCNL leads to minimal scarring and no significant loss of function. Complications commonly encountered in PCNL include bleeding, fever, sepsis, pleural injury and parenchymal injury. Miniaturisation of PCNL technique from 24 to 30 Fr sheath size to miniperc (13-20 Fr) to ultramini PCNL (10-12 Fr) has further led to decreased incidence of these complications. The aim of the minimally invasive PCNL is to reduce complications such as blood loss, intraoperative and post-operative pain and hospital stay. Unsal *et al*.[11] compared the efficacy of PCNL using adult versus paediatric sized instruments and found it to be safe and efficient except slight increased bleeding with larger tracts. Desai *et al*.[12] also showed that miniaturisation of PCNL instruments led to significantly decreased blood loss.

Other challenges that are encountered during paediatric PCNL are smaller surface area of kidneys, need of constant body warming (to avoid hypothermia), longer length of instruments and concern about the long term effects of treatment modalities. Hypothermia is correlated with the duration of the procedure and pre-operative preparation.[3]

Our study reviewed 120 children, in whom 124 PCNLs were done, which is a large sample size compared to other contemporary studies. Samad *et al*.[13] reported the largest paediatric PCNL experience. We reported a higher mean age

**Table 3: Operative characteristics**

| Variable | Value |
|---|---|
| Mean operating time | 64 minutes |
| Number of punctures | |
| Single | 112 |
| Double | 12 |
| Site of puncture | |
| Lower calyx | 84 |
| Middle calyx | 32 |
| Upper calyx | 20 |
| Costal relation | |
| Supra-costal | 28 |
| Infra-costal | 108 |
| Type of PCNL | |
| Standard | 73 |
| Mini | 42 |
| Ultramini | 9 |
| Tubes | |
| PCN + ureteral catheter/DJ stent | 59/12 (71) |
| Tubeless (no PCN) | 40/9 (49) |
| Totally tubeless | 4 |
| Hospital stay (days) | 2.3 |

DJ: Double J, PCNL: Percutaneous nephrolithotomy, PCN: Percutaneous nephrostomy

**Table 4: Stone clearance**

| Clearance | *n* (%) |
|---|---|
| Complete after initial PCNL | 101 (84%) |
| Incomplete | |
| Significant | 11 (8 - ESWL, 3 - relook PCNL) |
| Insignificant | 12 |

PCNL: Percutaneous nephrolithotomy, ESWL: Extracorporeal shockwave lithotripsy

**Table 5: Complications**

| Type of complication | N | Management |
|---|---|---|
| Intra-operative | | |
| Bleeding | 3 | Underwent relook PCNL |
| Failed access | 1 | |
| Conversion to open | 1 | Due to large size of stone and inability to access all calyces |
| Hydrothorax | 1 | ICD was inserted; later relook PCNL |
| Post-operative | | |
| Fever | 5 | All managed conservatively with antibiotics |
| Haematuria | 3 | Subsided with conservative management |
| Blood transfusion | 4 | |
| Persistent nephrostomy leak | 2 | DJ stenting |
| Sepsis | 5 | All managed conservatively with antibiotics |
| Additional intervention | | |
| ESWL | 8 | |
| Relook PCNL | 3 | |
| Average hospital stay | 3 days | |

DJ: Double J, PCNL: Percutaneous nephrolithotomy, ESWL: Extracorporeal shockwave lithotripsy, ICD: Inter-costal drain

of 12.8 years, compared to a mean age of 8 years in Samad *et al*. as we included patients up to 18 years of age.

In our study, we used conventional PCNL (59%), as well as miniperc (34%) and ultramini PCNL (7%). Miniperc and ultramini PCNL were used for patients with solitary stone and size <1.5 cm, as per surgeon's discretion. The mean time taken for surgery in our study was 64 min, which is well within the recommended time. Samad *et al*.[13] reported the mean duration in their study as 69–115 min. Operative time depends on stone location, size and other renal complications presence of hydronephrosis. Lesser time is taken by the experienced surgeon. More than 1 h of operative time is associated with increased oxidative stress. Hence, it is in the best interest of the patient to shorten the operative time.

In children the amount of radiation exposure is an important consideration and all ALARA measures, as mentioned earlier, should be stringently followed. We should learn from our experience and increasingly use USG guided punctures to reduce fluoroscopy time.

Although safe, PCNL has its own set of complications, which can rarely become serious and fatal. Complication rate of 20% was encountered in our paper. Our findings coincide with the findings of Badawy *et al*.[14] and Samad *et al*.,[13] where also fever was encountered commonly in 5 and 83 patients, respectively, which were self-limiting in 24–48 h. Dawaba *et al*.[10] and Badawy *et al*.[14] recorded only 3% of complication rate, which is lesser than our study.

A fall in haemoglobin and a rise in serum creatinine were observed in post-operative period, but when compared to pre-operative values, it is not significant. Our findings are consistent with findings of Singh Dongol and Limbu.[15] In our case series, only 3% (4) of patients required blood transfusion, when the haemoglobin falls below 10 g/dL postoperatively. Hydrothorax (needing an intercostal drain), conversion to open (due to very large burden of stones) and failed access to pelvicalyceal system were encountered rarely, as each seen only in one patient as all operating surgeons were well experienced in performing PCNL with >5 years' experience. Persistent urinary leak requiring DJ stent insertion was observed in two patients, similar to results seen in the series by Desai *et al*.[12]

We also compared the different modalities of PCNL. We found that operative time was significantly more in the standard PCNL group. The largest study comparing standard PCNL, mini PCNL and ultramini PCNL groups in the paediatric population is by Celik *et al*.,[16] who could not find a significant difference in operative time. The difference in our study can be due to patients undergoing standard PCNL had a larger stone burden.

There was no significant difference in complication rate in the three subgroups, but the rates of Grade 2 and 3 complications were significantly more in the standard PCNL group. It was noted that bleeding and haematuria, although insignificant, increased as the tract size increased. Studies by Celik

**Table 6: Clavien–Dindo classification**

| Grade | Definition | Number of complications |
|---|---|---|
| I | Any deviation from the normal post-operative course without the need for pharmacological treatment or surgical, endoscopic and radiological interventions allowed therapeutic regimens are: Drugs as antiemetics, antipyretics, analgetics, diuretics and electrolytes and physiotherapy. This grade also includes wound infections opened at the bedside | 10 |
| II | Requiring pharmacological treatment with drugs other than such allowed for Grade I complications. Blood transfusions and total parenteral nutritionare also included | 9 |
| III | Requiring surgical, endoscopic or radiological intervention | 16 |
| IV | Life-threatening complication (including CNS complications) requiring ICU-management | 0 |
| V | Death of a patient | 0 |

ICU: Intensive care unit, CNS: Central nervous system

**Table 7: Pre- and post-operative parameters of haemoglobin and serum creatinine**

| Variables | Pre-operative | Post-operative (after 2 h) | *P* |
|---|---|---|---|
| Hb (g/dL) | 13.8 | 12.5 | 0.42 |
| Creatinine (mg/dL) | 1.1 | 1.15 | 0.62 |

Hb: Haemoglobin

**Table 8: Comparison of standard, mini and ultramini percutaneous nephrolithotomy**

| | Standard | Mini PCNL | Ultramini | *P* |
|---|---|---|---|---|
| Number of cases (*n*) | 73 | 42 | 9 | |
| Age (years) | 13.46±3.30 | 7.86±4.49 | 6.63±2.5 | <0.001 |
| Sex (male:female) | 39:31 | 26:16 | 6:2 | 0.527 |
| Stone size (mm) | 17.09±5.19 | 14.13±3.53 | 12.13±1.72 | 0.83 |
| Operative time (min) | 70.43±19.51 | 60.49±18.20 | 58.13±5.30 | 0.012 |
| Fall in Hb (g/dL) | 0.74±0.54 | 0.77±0.62 | 0.42±0.51 | 0.42 |
| Rise in creatinine (mg/dL) | 0.23±0.8 | 0.19±0.09 | 0.1±0.02 | 0.62 |
| DJ stent | 35 | 20 | 6 | 0.989 |
| Complications | | | | 0.183 |
| CD I | 6 | 3 | 1 | |
| CD II | 8 | 1 | | 0.02 |
| CD III | 4 | 1 | | 0.04 |
| CD IV/V | | | | |
| Stone free rate | 89% | 83% | 100% | 0.396 |
| Hospital stay (days) | 3.8±3.5 | 3±3.10 | 2.15±0.46 | 0.413 |

DJ: Double J, CD: Clavien–Dindo, Hb: Haemoglobin

*et al*.[16] and Desai *et al*.[12] both showed a significant correlation between the tract size and the fall in haemoglobin. None of the patients had CD-IV or CD-V grade complications in any group. Overall bleeding/haematuria are significantly less in mini PCNL and ultramini PCNL group. This conclusion has encouraged urologists including us to push the limit of ultra or mini PCNL in performing bigger stones and correlate with safety and stone free rates.

Management of residual stones is integral part after incomplete clearance post-primary PCNL. Options include relook PCNL, RIRS or ESWL. In our series, we performed three relook PCNLs and eight ESWLs for residual stones. Desai *et al*. performed relook on four cases and six children underwent relook PCNL out of total 10 residual stones. We have reported a stone free rate of 84% after initial PCNL. This went up to 91% when only significant residual calculi were considered. This is within the range reported by other studies.

Demerits of our series include the retrospective nature of study, multiple surgeons performing surgeries and a shorter follow-up. Although necessary in children, metabolic evaluation was not offered to all children, as a lot of our patients are from poor socio-economic backgrounds and a proper metabolic evaluation can be expensive.

## Conclusions

PCNL is a safe and effective treatment for paediatric renal calculi, with high stone-free rates and fewer complications. Standard, mini and ultramini PCNL are all safe in children with lesser Grade II and Grade III complications and bleeding in mini and ultramini PCNL groups. PCNL has, thus, proven to be a gold standard, dependable and reproducible procedure in the management of renal calculi in children even in complex and large burden stones. The radiation exposure is an important consideration, especially in children, and all measures to decrease exposure should be ensured. Proper patient selection, careful evaluation, experienced surgeons and vigilant post-operative care and use of miniaturised instruments contribute to higher stone-free rate and reduction in the complications.

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### Conflicts of interest

There are no conflicts of interest.

## References

1. Sharma AP, Filler G. Epidemiology of pediatric urolithiasis. Indian J Urol 2010;26:516-22.
2. Rizvi SA, Naqvi SA, Hussain Z, Hashmi A, Hussain M, Zafar MN, *et al*. Pediatric urolithiasis: Developing nation perspectives. J Urol 2002;168:1522-5.
3. Ganpule AP, Mishra S, Desai MR. Percutaneous nephrolithotomy for pediatric urolithiasis. Indian J Urol 2010;26:549-54.
4. Veeratterapillay R, Shaw MB, Williams R, Haslam P, Lall A, De la Hunt M, *et al*. Safety and efficacy of percutaneous nephrolithotomy for the treatment of paediatric urolithiasis. Ann R Coll Surg Engl

2012;94:588-92.
5. Ozden E, Mercimek MN. Percutaneous nephrolithotomy in pediatric age group: Assessment of effectiveness and complications. World J Nephrol 2016;5:84-9.
6. Boormans JL, Scheepe JR, Verkoelen CF, Verhagen PC. Percutaneous nephrolithotomy for treating renal calculi in children. BJU Int 2005;95:631-4.
7. Woodside JR, Stevens GF, Stark GL, Borden TA, Ball WS. Percutaneous stone removal in children. J Urol 1985;134:1166-7.
8. Pan J, Chen Q, Xue W, Chen Y, Xia L, Chen H, *et al*. RIRS versus mPCNL for single renal stone of 2-3 cm: Clinical outcome and cost-effective analysis in Chinese medical setting. Urolithiasis 2013;41:73-8.
9. Ramchandraiah G, Devraj R, Shaik JA, Vidyasagar S, Ramreddy C, Murthy VL. An open label study to evaluate the safety and efficacy of percutaneous nephrolithotomy in children aged 2-14 years. Int J Contemp Med Res 2016;3:3105-8.
10. Dawaba MS, Shokeir AA, Hafez A, Shoma AM, El-Sherbiny MT, Mokhtar A, *et al.* Percutaneous nephrolithotomy in children: Early and late anatomical and functional results. J Urol 2004;172:1078-81.
11. 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;76:247-52.
12. Desai MR, Kukreja RA, Patel SH, Bapat SD. Percutaneous nephrolithotomy for complex pediatric renal calculus disease. J Endourol 2004;18:23-7.
13. Samad L, Aquil S, Zaidi Z. Paediatric percutaneous nephrolithotomy: Setting new frontiers. BJU Int 2006;97:359-63.
14. Badawy H, Salama A, Eissa M, Kotb E, Moro H, Shoukri I. Percutaneous management of renal calculi: Experience with percutaneous nephrolithotomy in 60 children. J Urol 1999;162:1710-3.
15. Singh Dongol UM, Limbu Y. Safety and efficacy of percutaneous nephrolithotomy in children. J Nepal Health Res Counc 2017;15:130-4.
16. 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;45:203-8.