The Mini Percutaneous Nephrolithotomy (Mini-PCNL) and Percutaneous Nephrolithotomy (PCNL) in Pediatric Patients

A. Haşegan[1], V. Pîrvuţ[1], I. Mihai[1], N. Grigore[1]
[1] *Lucian Blaga University of Sibiu, Faculty of Medicine*

Abstract

Introduction and Objectives. Kidney stones in childhood have an increasing incidence in developed countries with high risk of recurrence and a prevalence of around 2%. Experience in standard percutaneous nephrolithotomy (PCNL) and mini-PCNL at the adult patients lead us to use these techniques in the treatment of reno-ureterale stones at the children. The basic concern in children is to minimise the radiation exposure and the need of retreatment. The purpose of this paper is to analyze the efficacy and safety of PCNL and mini- PCNL in pediatric patients.

Materials and methods. We prospectively analyzed 12 patients (p) which received mini-PCNL and PCNL for kidney stones in the period January 2014 - March 2017.

Results. The mean age of patients was 6.5±4.7 (2-17 years). Gender distribution: 5 girls (41.6%) and 7 boys (58.5%). The distribution of stones by location in the pyelocaliceal system was: renal stone in the ureteropelvic junction (UPJ) in 3 p (25%), multiple urolithiasis in 4 p (33.3%), coraliform stones in 5 p (41.6%). Surgical instruments: nephroscope Karl Stortz 26 Fr., semirigid ureteroscope 9.5 FrKarl Stortz, renal access sheath 30 and 14 Fr, rigid cystoscope 11 Fr., ultrasonic fragmentation stone Calcuson Storz. PCNL was performed at 5 patients (41.66 %) who was diagnosed with coraliform lithiasis. Mini-PCNL was performed in 7 patients (58.34%), who were diagnosed with calculus in UPJ or multiple lithiasis under 1 cm.

Conclusions. PCNL and mini-PCNL at pediatric patients are feasible therapeutic options in the treatment of urolithiasis.

Key-words: PCNL, mini-perc, mini-PCNL, kidney stone, semi-rigid ureteroscope, tubeless

Correspondance to: Dr. Nicolae Grigore M.D., Ph.D.
Lucian Blaga University of Sibiu, Faculty of Medicine
2A Lucian Blaga st., code 550169, Sibiu, Romania
Tel: 0745381064
E-mail: office@urologiesibiu.ro

Introduction and Objectives

Urolithiasis is considered to be adisorder with important socioeconomic characteristics, which influences the quality of life.

Kidney stones in childhood have an increasing incidence in developed countries with high risk of recurrence and a prevalence of around 2% [1]. It is associated with urinary tract infection, renal excretory malformations with geneticand metabolic disorders. Technological advances have improved the treatment of renal stones and extracorporeal shock wave lithotripsy (ESWL), percutaneous nephrolithotomy (PCNL and mini-PCNL), retrograde intrarenal surgery (RIRS,) have now replaced open surgery[2]. The treatment chosen must not impair the development in function of the growing kidney.

Experience in PCNL and mini-PCNL at the adult patients lead us to use these techniques in the treatment of reno-ureterale stones at the children. The basic concern in children are to minimise the radiation exposure and the need of retreatment[3].

Percutaneous nephrolithotomy (PCNL) is a feasible treatment option for the stones between 1-2 cm of the lower renal pole when unfavorable factors for ESWL exist and the treatment of choice for renal stones larger than 2 cm [2].

PCNL is a challenging procedure in pediatric patients because of the small kidney and the low tolerance to blood loss.

Mini-perc or mini-PCNL was developed to reduce the potential kidney damage related to the standard percutaneous nephrolithotomy (PCNL). General indication include failure of ESWL, or ureteroscopic lithotripsy, or as a secondary access for inaccessible or residual fragments resulting after standard PCNL[4,5].

The purpose of this paper is to analyze the efficacy and safety of PCNL and mini-PCNL in pediatric patients.

Materials and Methods

We prospectively analyzed 12 patients which received mini-PCNL and PCNL for kidney stones in the period January 2014 - March 2017.

The statistical analysis of this paper was done by using chi-square test, the Fischer exact test and the Mann-Whitney U test for parametric variables. A p value <0.05 was considered statistically significant.

Results

Patient demographics are shown in Table 1. The mean age of patients was 6.5±4.7 (2-17 years). Gender distribution: 5 girls (41.6%) and 7 boys (58.5%).

	PCNL	mini-PCNL	Total
Patients	5 p (41.66 %)	7 p (58.34 %)	12 p
Mean age	7.2±3.9 (4-17)	5.9±3.5 (2-14)	6.5±4.7 (2-17)
Boys	3 p (25 %)	4 p (33.3 %)	7 p (58.3 %)
Girls	3 p (35 %)	2 p (16.6 %)	5 p (41.6 %)
Rigth	4 p (33.3 %)	2 p (16.6 %)	6 p (50 %)
Left	1 p (8.3 %)	5 p (41.6 %)	6 p (50 %)
Distribution of stones			
Calculi in the pielo-ureteral junction	-	3 p (25 %)	3 p (25 %)
Multiple urolithiasis	-	4 p (33.3 %)	4 p (33.3 %)
Coraliform stones	5 p (41.6 %)	-	5 p (41. 6%)

Table 1. Patient distribution according the gender, age, lithiasis localization, size and number

	PCNL 5 p	Mini-PCNL 7 p	P-value
Mean hopsital stay (days)	4±1.5 (3-6 days)	3±1.2 (2-4 days)	0.048
Mean duration of the procedures (min)	55±30 (30-90 min)	35±15 (25-45 min)	0.017
Intra and postoperative blood loss (ml)	65±37 (60-120 ml)	44±22 (30-70 ml)	0.029
Stentless	-	2 p (16.6 %)	0.001
Tubless	-	5 p (41.6 %)	0.001
Postoperative complication			
Pain	2 p (16.6 %)	1 p (8.33 %)	0.043
Tract infection-pielonephritis	1 p (8.33 %)	-	0.001

Table 2. Intraoperative and postoperative results

The diagnosis was established by clinical examination, laboratory tests, ultrasound, and intravenous urography.

The distribution of stones by location in the pyelocaliceal system was: calculi in the pielo-ureteral junction in 3 p (25%), multiple urolithiasis in 4 p (33.3 %), coraliform stones in 5 p (41.6%).

Surgical instruments: nephroscope Karl Stortz 26 Fr., Karl Stortz semirigid ureteroscope 9.5 Fr, renal access sheath 14 Fr., rigid cystoscope 11 Fr., fragmentation stone with ultrasonic Calcuson Storz.

PCNL was performed at 5 patients (41.66 %) who were diagnosed with coraliform lithiasis. All patients were in the prone position under general anesthesia with endotracheal intubation. The patients were placed in lithotomy position, and a 4-6 Fr. retrograde ureteric catheter was placed into the pelvic-calyceal system (Photo 1). Then is insert a 6-12 Fr. bladder catheter (the size depends on the patients age). The patient will be repositioned in prone position.

Photo 1. Patient in lithotomy position prepared for ureteral catheterization

Photo 2. Patient in prone position

The ureteral catheter injected the contrast substance and the methylene blue with the opacification of the pyelocaliceal system under fluoroscopic guidance (Photo 3). Lower calyx were puncture in 7 patients and middle calyx in 5 patients.

Photo 3. Percutaneous renal puncture- lower calyx, under fluoroscopy guidance

A guide wire was inserted into the collector system on the puncture needle (Photo 4) with progressive dilatation of the paths with Alken dilators, after practicing a skin incision of approximately 1 cm. Was introduced nephroscope Stortz 26 Fr. using continuous irrigation with isotonic solution. Once the calculus has been identified, it is disintegrated using the ultrasonic lithotripter. The lithiasis fragments are extracted with the grasper forceps or with Dormia probe. At the end of the intervention, the pyelocaliceal system is inspected both endoscopically and radiologically. A nephrostomy probe is positioned in the renal pelvis and fixed with suture on the skin.

Mini-PCNL was performed in 7 patients (58.34%), who were diagnosed with calculus in the pielo-ureteral junction or multiple lithiasis under 1 cm. The operative technique is the same as described in the PCNL, only that the dilatation of the paths is performed with fascial dilators and then was insert a 14 Fr Amplatz sheath on which was introduced the semi-rigid ureteroscope Stortz of 9.5 Fr (Photo 4).

Photo 4. Intraoperativ aspect of the ureteroscope into the Amplatz sheath

Removal of stones was performed with the ureteric grasping forceps or with Dormia probe. In 2 p (16.6 %). the ultrasound guiding was used for the puncture of calyx, as the contrast did not reach in the renal pelvis due to the obstructive lithiasis. At the end of the procedure, the working sheath is extracted, without nephrostomy. The remaining plague is left open in order to drain the lavage fluid which remained in the retroperitoneal space. Optional for esthetic consideration a 3-0 polypropylene suture is mounted and left aside (to be bound after 24 hours) (Photo 5).

Photo 5. Skin scar after mini-PCNL

The intraoperative and postoperative results recorded in the two groups are shown in Table 2 (pag.6)..

Mean hospital stay was 4±1.5 (3-6 days) in PCNL group and 3±1.2 (2-4 days) in mini-PCNL.

Intraoperative and postoperative bleeding was minimal 65±37 (60-120 ml) / 44±22 (30-70 ml), without the need of transfusion. The mean duration of the procedure was higher 55±30 (30-90 min) in PCNL group than 35±15 (25-45 min) in mini-PCNL group. Stone-free rate was 100%. Postoperative complications: pain in 3 patients and pielonephritis in 1 patient who was hospitalized with urinary infection, and were resolved conservatively.

For patients with mini-PCNL 2 p (16.6%) were stentless and 5 p tubeless.

In all patients, suppression of urinary catheter was done in first day and nephrostomy ablation in day 2 after surgery.

Follow-up period was 12 months (average 2-18 months).

Discussions

The first report of Mini-PCNL was by Jackman et al. using a 13 Fr. avascular access sheath and reported an 85% stone-free rate for 7 children with a mean age of 3.4 years[6].

Wah TM et al., Yahn X et al., Bhageria A et al. declared that mini-PCNL is safe and effective for the management of renal stones in children, with a mean stone burden of 1.5 cm, and stone-free rate of 75-95% [7,8,9]. In our study mini-PCNL was performed for renal stones ≤ 1.5 cm in the pyelo-ureteral junction, and multiple lithiasis < 1 cm, with a stone-free rate of 100%.

The most common instrument used in mini-PCL are a rigid or semi-rigid ureteroscope 8/9.8 Fr. and a special designed 12 Fr. mini nephroscope with a 6 Fr. working channel and automatic pressure control[10,11,12].

In our study one patient (8.33 %) presented transient fever with pyelonephritis one day after surgery. Ozden et al[13] reported the first perioperative complications of PCNL in pediatric patients using the modified Clavien grading system. Transient fever is one of the most frequent complication. Xiao et al says that it is not always microbial in origin14. It is determined that transitory fever rate is 31% in 188 PCNLs in Bilen et al study[15]. Samad et al reported approximately 6% of pediatric patients with postoperative fever[16].

PCNL has been successfully used in pediatric patients for coraliform stones as well Samad et al found that age and weight not to be a barrier to performing PCNL[17].

Schuster et al. described PCNL as completely replacing the open surgery for kidney stones in children[18]. Shokeir et al. compared PCNL versus ESWL and found that PCNL is better for treatment of renal stones in rage 1-2 cm[19]. Zeng et al compared 331 children with adults, with a mean age of 7.8±3.9 years, mean stone size of 2.3±0.6 cm. Operative time was 73.6±20.2 minutes, stone free rates were 80.4% and mean hospital stay was 5.2±2.4 days[20].

Conclusions

PCNL and mini-PCNL at pediatric patients are feasible therapeutic options in the treatment of urolithiasis. The complications rate after percutaneous surgery depends on the surgeon experience in endourological surgery.

References

1. Turney BW, Reynard JM, Noble JG, Keoghane SR. *Trends in urological stone disease*. BJU Int.2012;109:1082–7.
2. Turk C, Knoll T, Petrik A, Sarica K, Skolarikos A, Straub M, et al *Guidelines on Urolithiasis.* Arnhem (The Netherlands): European Association of Urology (EAU), 2013.
3. Woodside JR, Stevens GF, Stark GL, Borden TA, Ball WS. *Percutaneous stone removal in children.* J Urol 1985;134:1166-7.
4. Chan DY, Jarrett TW. *Mini percutaneous nephrolithotomy.* J Endourol 2000;14:269-72.
5. Monga M, Oglevie S. *Minipercutaneous nephrolithotomy,* J Endourol 200;14:419-21.
6. Jackman SV, Hedican SP, Peters CA, Docimo SG. *Percutaneous nephrolithotomy in infants and preschool age children: Experience with a new technique.* Urology. 1998;52:697–701.
7. Wah TM, Kidger L, Kennish S, Irving H, Najmaldin. *A. MINI PCNL in a pediatric population.* CardiovascInterventRadiol. 2013;36:249–54.
8. Yan X, Al-Hayek S, Gan W, Zhu W, Li X, Guo H. *Minimally invasive percutaneous nephrolithotomy in preschool age children with kidney calculi (including stones induced by melamine-contaminated milk powder).* PediatrSurg Int. 2012;28:1021–4.
9. Bhageria A, Nayak B, Seth A, Dogra PN, Kumar R. *Paediatric percutaneous nephrolithotomy: Single-centre 10-year experience.* J Pediatr Urol.2013;9:472–5.
10. Nagele U, Schilling D, Sievert KD, Stenzl A, Kuczyk M. *Management of lower-pole stones of 0.8 to 1.5 cm maximal diametrer by the minimally invasive percutaneous approach.* J Endourol 2008;22:1851-3.
11. Zeng G, Zhao Z, Wan S, Mai Z, Wu W, Zhong W, et al. *Mminimally invasive percutaneous nephrolithotomy for simple and complex renal caliceal stones: A comparative analysis of more than 10.000 cases.* J Endourol 2013;27:1203-8.
12. Lix, He Z, Wu K, Li SK, Zeng G, Yuan J, et al. *Chinese minimally invasive percutaneous nephrolithotomy: The Guangzhou experience.* J Endourol 2009;23"1693-7.
13. Ozden E, Mercimek MN, Yakupoglu YK, Ozkaya O, Sarikaya S. *Modified Clavien classification in percutaneous nephrolithotomy: assessment of complications in children.* J Urol. 2011;185:264–268.
14. Xiao B, Hu W, Zhang X, Chen S, Li Y, Li J. *Ultrasound-guided mini-percutaneous nephrolithotomy in patients aged less than 3 years: the largest reported single-center experience in China.* Urolithiasis. 2015:Epub ahead of print.
15. Bilen CY, Koçak B, Kitirci G, Ozkaya O, Sarikaya S. *Percutaneous nephrolithotomy in children: lessons learned in 5 years at a single institution.* J Urol. 2007;177:1867–1871.
16. Samad L, Qureshi S, Zaidi Z. *Does percutaneous nephrolithotomy in children cause significant renal scarring?* J Pediatr Urol. 2007;3:36–39.
17. Samad L, Aquil S, Zaidi Z, *Paediatric percutaneous nephrolithotomy: stting new frontiers*. BJU Int. 2006; 97:359-63.
18. Schuster TK, Smaldone MC, Averch TD, Ost MC. *Percutaneous nephrolithotomy in children.* J Endourol 2009;23:1699-705.
19. Shokeir AA, Sheir KZ, El-Nahas AR, El-Assmy AM, Eassa W, El-Kappany HA. *Treatment of renal stones in children: a comparison between percutaneous nephrolitithomy and schok wave lothotripsy,* J Urol 2006;176:706-10.
20. Zeng G, Zhao Z, Wan S, Zhong W, Wu W. *Comparison of children versus adults undergoing mini-percutaneous nephrolithotomy: large scale analysis of a single institution.* PLoS One 2013;24:8