Safety and efficacy of the Percutaneous Nephrolithotomy in Pediatrics; A 10-year single-center experience in Iran

Original Article

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Received: 20 July 2016
Revised: 15 Aug 2016
Accepted: 1 Sep 2016

Abstract:

Background: The aim of this study was to describe the one-decade experience in Percutaneous Nephrolithotomy surgery in children with kidney stones in Tehran, Iran.

Methods: All patients (less than 18 years old) undergoing Percutaneous Nephrolithotomy at our referral medical center, were reviewed in this cross-sectional study. All the demographics, surgical data and post-operative information were obtained to identify the stone free rates and complications.

Results: In a total, 119(56.4%) cases of 211 patients who underwent Percutaneous Nephrolithotomy in our study were male and 92(43.6%) cases were female. The mean age of participants was 137.15±60.11 months (range: 9-204). The most common presenting symptom was pain (62.6%). The mean stone burden was 23.5 ± 9.68mm and the mean operative time was 109.95±37.1 min. Overall, stone clearance rate was 73.9% after single PNL. Among those patients who had renal malformation, the stone free rate was (13/19) 68.4% for PCNL. The postoperative complication rate was 5/47 (10.6%) during all procedures and there were no major operative or postoperative complications.

Conclusions: According to the findings, pediatric PCNL with the acceptable stone free rates could be considered as a safe and effective procedure among children with complex stones and renal malformation.

Keywords: Percutaneous Nephrolithotomy, Nephrolithiasis, Pediatrics, Complications

Citation:
Nouralizadeh A, Shafi H, Zarghami A, Akbari R. Safety and efficacy of the Percutaneous Nephrolithotomy in Pediatrics; A 10-year single-center experience in Iran. Caspian J Pediatr Sep 2016; 2(2): 164-70.

Introduction:

The prevalence of renal stone disease in children varies from 5% to15%. The majority of them occur due to the predisposing factors such as: anatomic abnormalities, urinary tract infections and metabolic disturbances [1, 2]. It is also suggested that the incidence of stone disease is growing in children due to dietary and environmental factors [3]. During the past three decades, the management of renal stone has been dramatically changed by the introduction extracorporeal shockwave lithotripsy (ESWL) in children, which is now applied as the first line treatment option for the renal stones in children. ESWL has insufficient efficacy in larger stones including Staghorn or cystine and oxalate types therefore the surgical interventions can be considered [4, 5]. Percutaneous nephrolithotomy is less invasive surgery than open surgery which can be a good candidate for complex and large burden stone which has been introduced in children for the first time in 1986 by Woodside et al. [6]. Afterward, there were several studies with different power and limitations which reported the safety and efficacy of this method, nowadays this

[DOI: 10.22088/acadpub.BUMS.2.2.164]

method, nowadays this procedure has been considered as the treatment of choice for children with stone larger than 15mm [7-9].

The Percutaneous Nephrolithotomy (PCNL) procedure was performed with both adult and pediatric instruments. Since the introduction of the procedures is a challenge for minimizing PCNL – related morbidity. Thus, using the tubeless PCNL, mini-perc, ultra-mini perc and micro-perc has raised attention among specialists and has resulted in reducing the morbidity rate among patients without effecting on the clearance outcome [10-13].

There are few studies on the efficacy of this method in Iran. In this study, we aimed at describing the one-decade experience in PCNL surgery in children with kidney stones in one Hospital of Tehran, Iran.

Methods:

Participants in the present descriptive analytical

This cross-sectional study was conducted in Labbafinejad Hospital in Tehran during 2003-2013. The information of all 211 consecutive pediatric patients (less than 18 years old) who underwent PCNL for the treatment of renal stone was obtained. This protocol was approved by the institutional research review board of the Shahid Beheshti University of Medical Sciences, Tehran, Iran. Data retrieved from institutional PCNL database of the hospital included the demographic, clinical, surgical and outcome information of the patients.

All the PCNL surgeries were performed based on a standard technique under general anesthesia in a pediatric operating room by endourologist and all patients received intravenous prophylactic antibiotics before surgery. Preoperatively, patients were evaluated using urine analysis and culture, serum creatinine and biochemistry, complete blood count, coagulation tests, intravenous urography (IVU) and Urine Specific Gravity (USG).

During the follow up, radiological assessment of stone clearance was performed after surgery. Stone clearance or stone free rate (SFR) was defined as the absence of any residual fragments greater than 4 millimeters on urinary system plain radiography, postoperatively. A checklist containing the preoperative parameters (sex, age, onset manifestations, comorbidities, family history, stone characteristics such as size and location, levels of hemoglobin and creatinine), surgical information (technical details, side of operation, total procedural time,) post-operative data (duration of admission, levels of hemoglobin and creatinine, complications, SFR) was documented for each patient. The assessment of post-operative complications was done based on Clavien classification of surgical complications which is a valuable tool in surgical audit or clinical investigation. This classification was firstly introduced in 1992 as the general principles to categorize the complications of surgery based on a therapy-oriented, 4-level severity grading index and ranges from grade I (i.e. any deviation from the normal postoperative course without the need for pharmacological treatment or surgical, endoscopic, and radiological interventions) to grade V (i.e. death) [14].

Data were statistically analyzed using SPSS18 (Chicago, ILI, USA). Descriptive data were indicated by frequency and mean± standard deviation. Analytical evaluation was carried out using chi-square and independent T-test. P value less than 0.05 was considered significant.

Results:

From 211 patients underwent PCNL in the current study, 119(56.4%) and 92(43.6%) were male female, respectively. The mean age of participants was 137.15±60.11 months with the age range from 9 to 204 months. The most common presenting symptom was pain (62.6%) which followed by urinarytract infection (UTI) (figure1). Most of the stones located in the left kidney (54%). Based on the anatomical distribution, 36.5% of patients had single stone located in calyx, pelvic and ureter, 26.5% of them had multiple stones located in pelvic and calyx, and 37% of patients had staghorn. Sixteen patients had the positive family history for renal stone. Six patients had history of open surgery. The most common kidney anomaly was single kidney (5.6%). Baseline characteristics of 211 patients who underwent PCNL are indicated in table 1. The mean stone burden was 23.5±9.68mm.

The mean operative time was 109.95±37.1 min. (range, 45–233 min.). Most of the PCNL procedures (92.4%) were done via one access and PCNL were performed on the other 16 (7.6%) patients through 2 accesses. Tubeless PCNL was carried out in 18 renal units. JJ stents were implanted for two patients. There was no significant difference between changes in creatinine (0.81±0.44 vs. 0.85±0.38) and hemoglobin levels (12.7±2.1 vs. 11.3±1.6) in preoperative and post-operative measurements.

[DOI: 10.22088/acadpub.BUMS.2.2.164]

During the follow-up period based on the KUB and ultrasonography, the SFR was 73.9% (156/211) in the present study. One patient required transurethral lithotripsy, 41 (19.4%) patients required supplementary SWL in order to be rendered stone free and 13 (6.2%) patients underwent a second PCNL. All 18 patients who underwent the tubeless PCNL became stone free. As indicated in table 2, the patients' characteristics and operative parameters were compared based on PCNL outcome. There was no significant difference between two groups in respect of sex, age, renal stone location, hemoglobin and creatinine difference and amplatz size. Nevertheless, patients with stone free outcome had significantly shorter operation time than other group (103.9±34.6 vs.127±38.7; P<0.001). Among 78 patients with staghorn renal stone, 36 (46.2%) of them did not become stone free. From those patients who had renal malformation, PCNL achieved stone-free rates of 68.4% (13/19). In addition, 5 out of 7 PCNL surgeries among patients with single kidney was unsuccessful.

Totally, the post-operative complications (fever, diarrhea, hemorrhage) were noted for 82 from 211 (38.8%) patients. The postoperative complication rate, according to the Clavien classification system is shown in table 3. Clavien grade II was seen in 50 patients. Twelve patients required blood transfusion after operation because of Hb drop and hemostatic change.

Table 1: Baseline characteristics of 211 patients underwent PCNL

Variables		Amount
Mean age(month)		137.15±60.11
Mean weight(kg)		38.44±18.8
Age groups	≤5yrs	36(17.1%)
	6-11yrs	53(25.1%)
	≥12yrs	122(57.8%)
Gender	Male	119(56.4%)
	Female	92(43.6%)
Positive Family history for Renal stone		16(7.6%)
Stone location	Right	97(46%)
	Left	114(54%)
Anatomical location	Staghorn	78(37%)
	Calyceal	37(17.5%)
	Calyceal+ Pelvic	56(26.5%)
	Pelvic	37(17.5%)
	Ureter	3(1.5%)
Kidney Anomaly	Single	12(5.6%)
	Horse shoe	5(2.4%)
	Malrotated	1(0.5%)
	Duplex system	1(0.5%)

Table 2: The comparison between patients underwent PCNL with and without stone free condition

Variable \ Group		Stone free N=156	Stone residue N= 55	P value
Age (month)		139.53±61.28	131.40±56.68	0.38
Age group	≤5yrs	28(17.9%)	8(14.5%)	0.17
	6-11yrs	34(21.8%)	19(34.5%)	
	≥12yrs	94(60.3%)	28(50.9%)	
Sex	Male	89(57.1%)	30(54.5%)	0.75
	Female	67(42.9%)	25(45.5%)	
Stone location	Right	70(44.9%)	27(49.1%)	0.63
	Left	86(55.1%)	28(50.9%)	
Anatomical location	Staghorn	42(26.9%)	36(65.5%)	<0.001
	Calyceal	31(19.9%)	6(10.9%)	
	Calyceal+Pelvic	47(30.1%)	9(16.4%)	
	Pelvic	33(21.2%)	4(7.3%)	
	Ureter	3(1.9%)	0	
Operation time		103.9±34.6	127±38.7	<0.001
Ampletz size		27.5±1.7	28.2±1.5	0.53
Hb Diff*		-1.5±1.6	-1.3±2.2	0.46
Cr Diff**		-0.04±0.25	-0.02±0.2	0.73

*(Postoperative – Preoperative) level of hemoglobin, **(Preoperative – Postoperative) level of creatinine

[DOI: 10.22088/acadpub.BUMS.2.2.164]

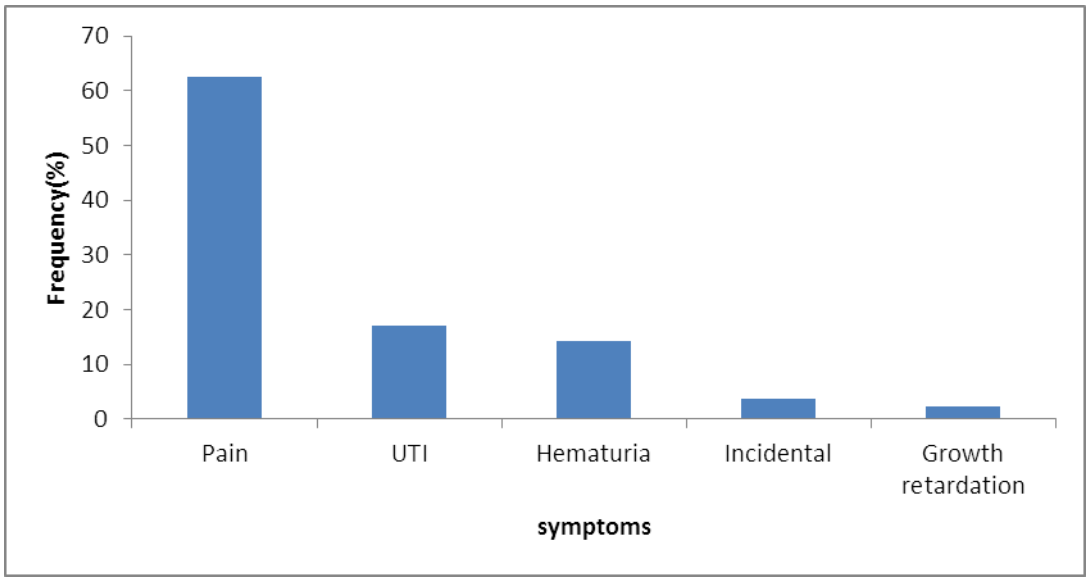

Figure 1: Distribution of presenting manifestations in 211 patients underwent PCNL

Table 3: Postoperative complication rate, according to the Clavien classification system

Clavien grade	Frequency
0	129(61.2%)
1	25(11.8%)
2	50(23.7%)
3a	2(0.9%)
3b	5(2.4%)
4	0
5	0

Discussion:

Based on our experience in our center, pediatric PCNL considered as a safe treatment option with acceptable stone clearance rates (74%) without major surgical complications. According to the authors' knowledge, the current study had the largest study population of PCNL surgeries in pediatrics.

Previous studies reported different SFR after PCNL in pediatrics, which varies between 60-100%. It is suggested that the efficacy and reach to almost 100% SFR can be improved by adding SWL to monotherapy with PCNL [15]. In a study among 38 Iranian children who underwent PCNL using adult sized instrument, it was reported 67% SFR in a 2-week follow up [16]. Similarly, our follow-up period was short and reach to higher rate of stone clearance may be possible by extending this period. Samad et al. retrospectively evaluated 188 consecutive PCNLs in 169 children with the mean stone burden 19.1-33.3 mm and the mean duration of PCNL was 69-115 min and stone clearance rate with single tract access was 90-100% among patients [17].

In our study population, the SFR among patients with anomalous kidney was approximately close (68.4%) to the patients with normal kidney (73.9%) and the complications were not comparable. In another study, comparing the characteristics and outcomes of PCNL in patients with and without renal malformations using PCNL Global Study database revealed that PCNL achieved 76.6% SFR in patients with anomalous kidneys and 76.2% in those with normal kidneys. Although, the frequency of complications was similar, the operative time was likely to be extended in patients with renal malformations [18]. Similarly, Mousavi-bahar et al. conducted PCNL for complex calculi within malformed kidneys and reported that the SFR was 81%(13/16) and 2 of their patients had staghorn calculi in horseshoe kidneys [19]. However, our result showed that the SFR among patients with renal malformations who underwent PCNL was 68.4% (13/19).

In a single-center retrospective study, assessing the associated factors on complication rates of PCNL in children was determined that several factors such as stone history, positive urine culture, operative time, length of hospitalization, treatment success, punctured calyx and location of the stone were as contributing factors. While in multivariate logistic regression analysis, factors including operative time, sheath size, mid calyceal puncture and partial staghorn formation

[DOI: 10.22088/acadpub.BUMS.2.2.164]

were statistically significant parameters affecting the complication rates [20]. In a similar way, we compared the characteristics of the patients in terms of the stone free outcome. There was no significant difference in respect of parameters evaluated except for the operation time and stone location. Our findings indicated that in unsuccessful PCNL surgeries, 65% had staghorn stones and the significant difference between two groups might be due to the time-consuming procedure of removing staghorn stones. Moreover, El-Nahas et al. found that the presence of complete staghorn stones could affect the incidence of residual stones after PNL [21]. In a recent systematic review, Whitington et al. evaluated current tools for scoring stone complexity and stratification of stone complex related to outcomes and they concluded that a firm evidence based on scoring system was superior than others [22].

Although PCN procedure in children using adult sized instruments is considered as an effective and safe method for managing both simple complex renal calculi [23], due to the operative damage, a technique in which 15F peel-away vascular sheath known as "mini-perc", smaller skin incision and tract size are used has been applied [24]. Unsal et al. compared the efficacy of PCNL using adult versus pediatric sized instruments and showed that the clearance rates were nearly (81-83%). Whereas, there was more bleeding associated with larger tracts and the mean hemoglobin drop was significant for larger tracts [25]. Their findings were consistent with those of Guven et al. study [26]. Fattini et al. performed 19 PCNL procedures on 15 children aged from 8 months to 16 years with complex renal stones with the instrument and position (prone and supine) and 14/15 patients were stone-free and no relevant complications were reported [27]. On the other hand, it is suggested that in children with a large size kidney stones, the use of adult-type instruments might have a positive impact on SFR, operation time and fluoroscopy time without increasing the complication rate [28]. However, the safety and complication of adult size instrument versus conventional PCNL still remain controversial [29-31]. Therefore, further randomized clinical studies are needed to clarify the evaluation of the safety and efficacy between these two different methods.

We had several limitations in our study. Primarily, our study population was from single referral center, which may not be generalizable for all the areas of the country but it was reported the valuable data as the first study with this large sample size in Iran during one decade. Besides, due to the referral characteristics of our urology center in the capital of Iran, many patients continued their follow-up care in another city and thus we lost their follow-up outcome and we had to design our study in a short period of post-operative admission, which discussed above. Regarding the surgical procedures, both the conventional nephrostomy and tubeless methods were performed but the number of the tubeless procedures was not high enough to be capable of making comparison between these two methods. On the other hand, the rate of post-operative complications reported in our study may be due to the long duration of study from the introduction of PCNL among pediatrics in our center (more than 10 years ago) and the low experience of the team at the beginning.

The SFR for our study population who underwent PCNL surgery was approximately 74% among patients with complex stones and renal malformation, which can be acceptable in a series of cases in our 10-year single-center experience. According to our findings, PCNL as a single treatment modality for children with large renal stones can be considered safe and effective. Nevertheless, future studies should be performed to evaluate the efficacy of utilizing different instruments and approaches during surgery among this age group.

Acknowledgment:

We would like to appreciate our colleagues in Labbafinejad hospital. We also thank the chancellor for research and technology of Shahid Beheshti University of Medical Sciences for their support to our research project.

Funding: The research project was funded by the vice chancellor for research and technology of Shahid Beheshti University of Medical Sciences, Tehran, Iran.
Conflict of interests: Authors declared no conflict of interests.

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[DOI: 10.22088/acadpub.BUMS.2.2.164]

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[DOI: 10.22088/acadpub.BUMS.2.2.164]