Comparison of Percutaneous Nephrolithotomy Results in Pediatric Kidney Stone Disease in Patients Under the Age of 10 Years and in Patients Over the Age of 10 Years

Hüseyin Çelik[1], Caner Ediz[2], Ahmet Çamtosun[1], Ramazan Altıntaş[1], Serhan Çimen[3], İbrahim Topçu[1], Cemal Taşdemir[1]

[1]Department of Urology, İnönü University Turgut Özal Medical Center, Malatya, Turkey
[2]Clinic of Urology, Üsküdar State Hospital, İstanbul, Turkey
[3]Clinic of Urology, Malatya State Hospital, Malatya, Turkey

ABSTRACT

Objective: Percutaneous nephrolithotomy (PNL) is a minimally invasive procedure that is safely performed for kidney stone surgery all over the world. In our clinic, PNL surgery was first performed in March 1998. In parallel with our increasing experience, PNL has been performed in pediatric cases. In our study, PNL operations performed in pediatric patients under the age of 10 years and in those over the age of 10 years were retrospectively investigated.

Methods: Patients were between 0 and 16 years of age. They were divided into 2 groups according to age: 0–10 and 11–16 years. The PNL procedure was performed under general anesthesia with C-arm fluoroscopy in the prone position.

Results: Between March 1998 and December 2014, a total of 208 pediatric urinary stone patients were operated on. The PNL procedure was performed in 210 renal units, 1 of which was performed bilaterally. In the ≤10-year-old patient group, 98 procedures (87.5%) were stone free, while clinically insignificant residual fragments (CIRFU) were found in 13 procedures (12.5%). In the >10-year-old patient group, 88 procedures were stone free (89.79%), while clinically insignificant residual fragments were found in 9 procedures (10.2%). In the ≤10-year-old patient group, tubeless PNL was performed in 1 patient. In both groups combined, bleeding requiring transfusion occurred in just 1 case. A tract leak requiring a double J stent was detected in 1 patient in the ≤10-year-old patient group and in 2 patients in the other group. There was no other organ injury.

Conclusion: PNL is a minimally invasive method and has become advantageous over open surgery because it offers higher security, particularly in experienced clinics, and procedures on pediatric patients can therefore be successfully performed.

Keywords: Kidney stone, pediatric patient, PNL

INTRODUCTION

Urinary tract stones are seen at all ages, and its frequency is gradually increasing in our country. Some factors such as changes in dietary habits, diet rich in carbohydrates and salt, and increase in obesity have a role in the increased frequency of urinary tract stones in pediatric patients. Moreover, due to the sedentary lifestyles of children because of televisions and computers and with improving technology, better scanning and early-diagnosis alternatives have become more efficient (1). Metabolic and anatomic disorders are among the factors involved in the formation of stones in pediatric patients. At present, pediatric urinary tract stone is included in the urology practice more often because parents are more interested in diagnosis-treatment opportunities. Our main goal is to reach maximum stone-free rates in this age group through minimally invasive methods. Therefore, the importance of percutaneous nephrolithotomy (PNL) is increasing in light of technological developments.

METHODS

This study included patients aged 16 years and below and who underwent PNL. The patients were divided into two groups: age 10 years and below and age 11–16 years. Routine hemogram, blood biochemistry, complete urine analysis, and urine culture were preoperatively evaluated. Patients with urinary tract infections underwent surgery following a sterile urine culture after antibiotherapy. The presence of urinary tract stone was preoperatively evaluated through direct urinary system radiography, urinary system ultrasonography, and intravenous pyelography (IVP). Considering the level of radiation, computed tomography was not planned unless absolutely necessary.

The procedures of PNL were performed under general anesthesia. The bladders and urethral orifices of the patients were assessed in the supine position using 9-, 5-, 11-, or 13 Fr pediatric cystoscopes according to the age group. A 4- or 5 Fr urethral catheter was inserted with a C-arm fluoroscopy in the urethral orifice and fixed on a urethral Foley catheter. After this process, the patients were placed in a prone position, and the pelvicalyceal system was entered using a chiba needle with the guidance of fluoroscopy. The duration, amount, and number of radioactive dose were considered at minimal level during fluoroscopy. A lead material was placed on the testes or ovaries of the patients. Dilatation was provided up to 22 F via an Amplatz renal dilator set. Stones were broken with the help of a pediatric nephroscopy and pneumatic lithotripter. After the procedure, a nephrostomy

Address for Correspondence: Hüseyin Çelik
E-mail: drhuseyin44@hotmail.com

Received Date: 01.02.2016 Accepted Date: 14.03.2016

DOI: 10.5152/jarem.2016.1069

catheter was inserted through a renal sheath if needed. After the PNL procedure, stones smaller than 4 mm were considered clinically insignificant stone residues.

RESULTS

A total of 3003 PNL procedures were performed in adult and pediatric patients in a 16-year period from March 1998 to December 2014. Of these patients, 208 were pediatric patients, one of which was bilateral, and they underwent PNL procedures in 210 renal units. The mean age was 5.5 years (8 months–10 years) in the age group <10 years (group 1) and 13.47 years (11–16 years) in the age group 11–16 years (group 2). In the group 10 years and below, 65 patients (58.55%) were males and 46 patients (41.45%) were females. These rates were 48 (49.48%) and 49 (50.51%) in the group 11 years and above. In the group 10 years and below, 11 patients (9.90%) had a history of passing a stone at any time before the surgery. Similarly, in the other group, 11 patients (11.34%) had passed a stone at any time before the surgery. In the group 10 years and below, stone-free patients were obtained in 98 processes (87.5%), and below, clinically insignificant residual fragments (CIRF) remained in 13 processes (12.5%). In the other group, residual fragments were found in 88 (89.79%) and 9 (10.2%) operations, respectively. In the group 10 years and below, tubeless PNL was performed in one patient. For both groups, transfusion was required due to bleeding in one case. A leak in the tract that required the insertion of the DJ stent was observed in one patient in the group 10 years and below and in two patients between the ages of 11 and 16 years. No other organ injury occurred (Table 1).

Table 1. PNL results in the age groups below and above 10 years

	10 years and below	Between the ages of 11 and 16 years
Number of patients	111	97
History of spontaneously passing stone	11 (9.9%)	11 (11.34%)
Number of right PNL	55 (49.1%)	49 (50%)
Number of left PNL	55 (49.1%)	47 (47.95%)
Number of bilateral PNL	1 (0.9%)	1 (1.03%)
Number of tubeless PNL	1 (0.9%)	0 (0%)
Number of stone-free patients	98 (87.5%)	88 (89.79%)
Patients with CIRF	13 (12.5%)	9 (10.2%)
Bleeding	1	1
Insertion of DJ stent	1	2

PNL: percutaneous nephrolithotomy; CIRF: clinically insignificant residual fragments

DISCUSSION

In recent years, the incidence of urinary tract stone is increasing day by day worldwide and in our country. Malnutrition in the pediatric group and a sedentary lifestyle in parallel with developing technology and the presence of metabolic diseases are involved in the formation of stone. While the rate of pediatric stone disease is reported to be 5%–15% in developing countries, this rate is 1%–5% in developed countries (2). Turkey, because of its geographic location, is among the countries where endemic stone disease is seen. Particularly, the climatic characteristics in the Eastern and Southeastern Anatolia Regions lead to an increase in the frequency of stones. In the pediatric age group, the locations of stones replaced from the kidney toward the ureter beginning from the neonatal period to the last periods of childhood (3). It was reported that urinary tract stone is more common in boys below 10 years and in girls above 10 years (4). On the other hand, the rate of urinary tract stone is equal in boys and girls in the pediatric age group (5). The fact that our clinic is located in a geographically endemic region is one of the main reasons for pediatric stone disease. In the evaluation of the patients undergoing PNL because of the diagnosis of kidney stones in our clinic, the rate of male patients was higher in the group below 10 years, and the rate of female patients was higher in the group above 10 years, in parallel with the literature.

In the treatment of pediatric urinary system stone disease, medical treatment must be applied first. Then, stone removal and stone-free patients for a long time must be the aims. In appropriate patients, follow-up and medical expulsive therapy can sometimes be the first steps depending on the size and clinical course of the stone.

Extracorporeal shock wave lithotripsy (ESWL) is the primary minimally invasive treatment method. It is the first treatment of choice for stones smaller than 10 mm (6). However, considering the growth curve in childhood, each of the pediatric patients that undergo ESWL must be given general anesthesia and exposed to radiation. The main cause of complications associated with ESWL is increased stone load (7). Therefore, in cases with larger stones, more attention must be paid when deciding on ESWL in pediatric patients than in adult patients.

In recent years, retrograde intrarenal surgery (RIRS) has been applied with technological developments. As of 2007, the use of this technique has increased (8). It is suggested to be superior to ESWL, particularly in lower pole renal stones. However, it has some disadvantages such as a lack of adequately experienced practitioners because its use is still uncommon in our country because it is a newly developed technique, short-life flexible ureterorenoscopes, and complications developing secondary to increased intrarenal pressure in patients for whom a ureteral sheath cannot be used or drainage cannot be continuously provided. Although RIRS is a promising technique, stone-free rates are known to prominently decrease with this technique, particularly in stones larger than 15 mm (9). Therefore, PNL is the method that should be preferred for stones larger than 15 mm and staghorn stones.

The first PNL operation was performed in 1985 (10). Since this date, PNL has replaced open surgery with developing technology and increased experience. Its most important advantages include its applicability to all age groups, high stone-free rates, and faster wound healing than does open surgery. Especially in patients who have lower pole renal stones larger than 15 mm and with anatomic problems such as narrow infundibulum and

for whom ESWL or RIRS is unsuccessful, PNL should be the first line of treatment. In the literature, stone-free rates at a single session vary from 87% to 98% (11). In our study, stone-free rates at ages below and above 10 years were found to be consistent with the literature. The stone-free rate is very important in pediatric cases because the disease rapidly recurs in the early stage in children, and the possibility of recurrence during follow-up is higher than that in adults. In a study by Lao et al. (12), the rate of recurrence was reported to be approximately 55%. The few residual stones are the basis of PNL in pediatric stone cases. The rates of 12.5% at ages below 10 years and 10.2% at ages above 10 years are thought to be acceptable values. These patients should be informed about the recurrence of the disease, and their control examinations should be more often compared to adult patients. In the comparison of scar existence in preoperative and postoperative renal tissue, no new formation of scar tissue was observed in pediatric patients with PNL (13). For these reasons, PNL is considered to be a safe method for protecting the renal tissue in the growth period. However, a prolonged duration of surgery for getting stone-free patients leads to an increased number of complications (14). The primary major complication of PNL technique is organ injury. Bleeding, urine leakage and urinary tract infection are other complications that can be encountered. The number of entries into the renal tissue, the amount of dilatation in each entry, and duration of the operation increase these risks. Particularly, 20–22 Fr dilatations are accepted to be optimal. Here, the cut-off value is 24 Fr (15). In the studies conducted, the risk of bleeding and major complications was specified to be prominently lower in patients undergoing 14 Fr dilatation (16). While these studies demonstrate that a decreased degree of dilatation causes decreased rates of complications, it should be kept in mind that the duration of the surgery is prolonged and stone-free rates can relatively increase. Based on the increased experience in our clinic, we think that 22 Fr dilatation is appropriate in terms of efficiency and safety. Therefore, we suggest that higher stone-free rates and lower residual stone rates were found in PNL patients age 10 years and above. However, we believe that the renal structure and stone size should be considered when deciding on the degree of dilatation in the pelvicalyceal system in the group below the age of 10 years. Our results including PNL-induced blood transfusion necessity, the need for the insertion of DJ stent, and organ injury in both age groups were compared to the results of the PNL complication rates in a 96-centered study, and the results of this comparison were found to support the applicability of 22 Fr dilatation. However, it should be remembered that higher complication rates can be seen in PNL operations performed with devices for adults, the stone-free rates will not increase, and serious complications can develop, especially in patients younger than 7 years old (18). At present, in parallel with the improving technology and experience, some techniques, including mini, ultra-mini and micro PNL, are used in pediatric cases. These developments show that PNL is a highly important and efficient method in the pediatric age group.

CONCLUSION

In pediatric patients, PNL operations should be performed in experienced clinics because of many factors such as lower rates of applications with typical symptoms in pediatric urinary system stone disease, coexistence of more metabolic and anatomic disorders, growing bodies being more sensitive to radioactive rays, more frequently seen perioperative major complications, less tolerance to complications, and more rapid recurrence of stones in the postoperative stone-free period.

Ethics Committee Approval: Authors declared that the research was conducted according to the principles of the World Medical Association Declaration of Helsinki "Ethical Principles for Medical Research Involving Human Subjects", (amended in October 2013).

Informed Consent: This study is a retrospective study, there is not patient consent.

Peer-review: Externally peer-reviewed.

Author Contributions: Concept – H.Ç.; Design – C.E., A.Ç.; Supervision – C.T., R.A.; Resources – H.Ç., C.E., S.Ç., İ.T.; Materials – İ.T.; Data Collection and/or Processing – C.E., S.Ç., İ.T.; Analysis and/or Interpretation – H.Ç.; Literature Search – H.Ç.; Writing Manuscript – H.Ç., C.E.; Critical Review – R.A., C.T.

Conflict of Interest: No conflict of interest was declared by the authors.

Financial Disclosure: The authors declared that this study has received no financial support.

REFERENCES

1. Sarica K, Eryildirim B, Yencilek F, Kuyumcuoglu U. Role of overweight status on stone-forming risk factors in children: A prospective study. Urology 2009; 73: 1003-7. [CrossRef]
2. Straub M, Strohmaier WL, Berg W, Beck B, Hoppe B, Laube N, et al. Diagnosis and metaphylaxis of stone disease: Consensus concept of the National Working Committee on Stone Disease for the Upcoming German Urolithiasis Guideline. World J Urol 2005; 23: 309-23. [CrossRef]
3. Kalorin CM, Zabinski A, Okpareke I, White M, Kogan BA. Pediatric urinary stone disease--does age matter? J Urol 2009; 181: 2267-71. [CrossRef]
4. Önen A. Çocuklarda üriner sistem taş hastalığı. Çocuk Cerrahisi Dergisi 2013; 27: 8-32.
5. Bal A, Şahudak Bal Z, Alparslan C, Yavaşcan Ö, Anıl M, Anıl AB, ve ark. Çocukluk çağı üriner sistem taş hastalığında etiyolojik faktörler ve tedavi. Türkiye Klinikleri J Med Sci 2013; 33: 1127-32. [CrossRef]
6. Preminger GM, Tiselius HG, Assimos DG, Alken P, Buck C, Gallucci M, et al. 2007 guideline for the management of ureteral calculi. J Urol 2007; 178: 2418-34. [CrossRef]
7. D'Addessi A, Bongiovanni L, Racioppi M, Sacco E, Bassi P. Is extracorporeal shock wave lithotripsy in pediatrics a safe procedure? J Pediatr Surg 2008; 43: 591-6. [CrossRef]
8. Salerno A, Nappo SG, Matarazzo E, De Dominicis M, Caione P. Treatment of pediatric renal stones in a Western country: a changing pattern. J Pediatr Surg 2013; 48: 835-9. [CrossRef]
9. El-Hout Y, Elnaeema A, Farhat WA. Current status of retrograde intrarenal surgery for management of nephrolithiasis in children. Indian J Urol 2010; 26: 568-72. [CrossRef]
10. Woodside JR, Stevens GF, Stark GL, Borden TA, Ball WS. Percutaneous stone removal in children. J Urol 1985; 134: 1166-7.
11. Smaldone MC, Corcoran AT, Docimo SG, Ost MC. Endourological management of pediatric stone disease: Present status. J Urol 2009; 181: 17-28. [CrossRef]

12. Lao M, Kogan BA, White MD, Feustel PJ. High recurrence rate at 5-year followup in children after upper urinary tract stone surgery. J Urol 2014; 191: 440-4. [CrossRef]
13. Samad L, Qureshi S, Zaidi Z. Does percutaneous nephrolithotomy in children cause significant renal scarring? J Pediatr Urol 2007; 3: 36-9. [CrossRef]
14. Dogan HS, Onal B, Satar N, Aygun C, Piskin M, Tanriverdi O, et al. Factors affecting complication rates of ureteroscopic lithotripsy in children: Results of multi-institutional retrospective analysis by Pediatric Stone Disease Study Group of Turkish Pediatric Urology Society. J Urol 2011; 186: 1035-40. [CrossRef]
15. Kapoor R, Solanki F, Singhania P, Andankar M, Pathak HR. Safety and efficacy of percutaneous nephrolithotomy in the pediatric population. J Endourol 2008; 22: 637-40. [CrossRef]
16. Bush WH, Brannen GE, Gibbons RP, Correa RJ Jr, Elder JS. Radiation exposure to patient and urologist during percutaneous nephrostolithotomy. J Urol 1984; 132: 1148-52.
17. Guven S, Frattini A, Onal B, Desai M, Montanari E, Kums J, et al. Percutaneous nephrolithotomy in children in different age groups: data from the Clinical Research Office of the Endourological Society (CROES) Percutaneous Nephrolithotomy Global Study. BJU Int 2013; 111: 148-56. [CrossRef]
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: 477-81. [CrossRef]