Urol Res (2011) 39:45–49
DOI 10.1007/s00240-010-0272-7

ORIGINAL PAPER

Percutaneous nephrolithotomy in pediatric patients: is computerized tomography a must?

Abdullah Gedik · Ali Tutus · Devrim Kayan · Yakup Yılmaz · Kamuran Bircan

Received: 16 September 2009 / Accepted: 6 April 2010 / Published online: 16 April 2010

Abstract The aim of this study was to retrospectively evaluate the results of pediatric percutaneous nephrolithotomy (PNL) cases, and discuss the results and necessity of non-contrast computerized tomography (CT) in these cases. In all, 48 pediatric patients who underwent PNL were retrospectively evaluated. Before PNL, either intravenous urography or CT was performed. In all patients, we evaluated the PNL time, scopy time with stone burden, and complications. During the PNL procedure, we switched to open surgery in two cases: in one because of renal pelvis perforation and in the other because of transcolonic access. In one patient who was scheduled to undergo PNL, we performed open surgery, primarily because we detected a retrorenal colon with CT. The stone burden in 45 patients who underwent PNL was 445 ± 225 mm^2, the PNL time was 51 ± 23 min, and the scopy time was 6.1 ± 2.7 min. We removed nephrostomy tubes 1–4 days after the procedure. In two patients, 24 h after removal of nephrostomy tubes, we inserted double J stents because of prolonged urine extravasation from the tract. In all, 34 of the 45 patients were stone-free, 5 patients had clinically insignificant stone fragments, and 6 patients had residual stones. PNL is a safe and effective method in the treatment of pediatric patients with kidney stones. Clinical experience is the most important factor in obtaining stone-free results. CT should be performed in all pediatric patients in order to prevent colon perforation.

Keywords Computerized tomography · Percutaneous nephrolithotomy · Retrorenal colon · Transcolonic access

Introduction

Kidney stones are a major problem in pediatric urology. Symptoms of kidney stones vary according to the patient age. While irritability and gastrointestinal symptoms are dominant symptoms in the early ages, flank pain and hematuria are more frequent in older children. Sometimes kidney stones are diagnosed during the evaluation of urinary tract infections. While 1–5% of all stones are seen in pediatric patients in developed countries, this rate is 30% in underdeveloped countries [1, 2].

Tellaloğlu et al. [3] reported that kidney stones are endemic in Turkey, and that the incidence of urinary stones in children younger than 14 years is 17%. Among adults urinary stones occur more frequently in males, whereas their incidence is equal in girls and boys [4]. As it is a highly recurrent pathology, minimally invasive treatment should always be preferred, primarily in order to remove all stones, which is especially important in children [5].

Recent advancements in minimally invasive techniques have changed the treatment modalities and decreased the use of open surgery. High success rates have been reported with extracorporeal shock wave lithotripsy (ESWL), which is the most minimally invasive method, but high stone burden and some calyceal pathologies might decrease its success while increasing the treatment period [6]. Other minimally invasive methods for the treatment of kidney stones include percutaneous nephrolithotomy (PNL), which was first reported by Fernström and Johansson [7] in 1976.

A. Gedik (✉) · A. Tutus · D. Kayan · Y. Yılmaz · K. Bircan
Department of Urology, Medical School, Dicle University, 21280 Diyarbakir, Turkey
e-mail: abgedik@gmail.com

The PNL is effective for all kinds of stones, regardless of location, and is even effective for staghorn stones. PNL should be preferred, especially in ectopic or malformed kidneys with high stone burden, or in chemically ESWL-resistive stones, and must be the secondary choice if ESWL is not effective [8].

In this retrospective study, we aimed report the results and complications of PNL and evaluate the necessity of CT in pediatric kidney stone disease.

Patients and methods

Forty-eight pediatric patients with kidney stones, scheduled for PNL between September 2004 and May 2009, were retrospectively evaluated by us. Age, sex, stone burden, diagnostic method, postoperative stone position, complications, nephrostomy removal time, postoperative hematocrit values, and fever were recorded for each patient. Urine cultures from all patients were studied. Patients with urinary tract infections were treated, and the procedures were performed after making the urine sterile.

In the first 12 patients, IVU was the only imaging method used. Colon perforation occured in the 12th patient and after this case we used CT for imaging stones and plain abdominal radiography (KUB) to determine the presence of retrorenal colon. PNL was performed under general anesthesia, and ceftriaxon was the preferred prophylactic agent.

Following general anesthesia in the lithotomy position, a 4F ureteral catheter was inserted into the kidney and fixed over the urethral Foley catheter with silk sutures. Stones were visualized in the prone position with a C arm fluoroscope. Access was made with an 18G needle through the chosen calyx. A guide wire was inserted through the needle, and the tract was dilated with a 30F balloon dilator. A 30F Amplatz sheath was inserted into the collecting system over the dilator.

A 26F Storz or 24F Olympus nephroscope was used. Stones were disintegrated with a pneumatic lithotripter (Swiss lithoclast®) and were removed with forceps. In two patients with staghorn stones, we had to make two accesses, but we used only one access in the remaining patients. Following stone removal, either a re-entry tube or pesser tube was used as a nephrostomy tube.

In the second tract of patients with double access, we placed a 14F pesser tube for drainage. Before removal of the nephrostomy tube we used KUB, and all patients were evaluated with KUB and USG at the first month follow-up in order to image residual stones. During follow-up stone-free status was accepted as success. Stones <3 mm without obstruction were accepted as clinically insignificant fragments, but stones >3 mm were accepted as residual stones.

Results

The PNL was scheduled for 48 children (28 boys and 20 girls) aged 4–16 years (mean 11.5 ± 4.8 years). Stone burden calculated by measuring the diameters of stones in two dimensions in KUB images was 110–800 mm^2 (mean 445 ± 225 mm^2). Localization of the stones is summarized in Table 1.

Operation time was between 25 and 80 min (mean 51 ± 23 min), and scopy time was between 3 and 10 min (mean 6.1 ± 2.7 min). In one patient, we switched to open surgery as the stone moved to the retroperitoneal area following pelvis renalis perforation during PNL. In another patient, the colon perforated during access to the kidney; in order to repair this perforation and to remove the stone from the kidney, we switched to open surgery. We observed complete retrorenal colon in the CT of a 6-year-old patient who underwent surgery because of Hirschsprung disease (Fig. 1a, b). In this patient, we primarily performed nephropyelolithotomy.

Mean preoperative hematocrit value of the patients was 36.8 ± 5.2. Intraoperative blood transfusion of 10 ml/kg was performed in two patients with staghorn stones. Postoperative mean hematocrit value of all other patients was 34.2 ± 3.8. Postoperatively, two patients had fever >38°C for more than 24 h. Blood and urine cultures were repeated in these patients and were sterile. In one patient with right distal ureteral and left kidney stones, we performed right urethroscopy and JJ stenting, and left PNL at the same time, and this patient was stone-free (Fig. 2a–c).

We preferred using either a 16F pesser or 16F re-entry as the nephrostomy tube. In patients with two accesses, we inserted a 14F pesser in the second tract. All nephrostomy tubes were removed 1–4 days postsurgery when urine was free of hematuria (mean 2.4 ± 0.6 days). In two patients, a JJS was inserted to stop prolonged urine drainage from the tract. Foley catheters were removed 24 h after cessation of urine from the tract, and then patients were discharged. Patients were hospitalized for 3–5 days (mean 3.6 ± 0.6 days). Postoperative follow-up results, based on KUB, are summarized in Table 2.

Table 1 Stone localizations

Stone localization	Number of patients (%)
Pelvis renalis	24 (51)
Pelvis renalis + lower calyx	13 (26)
Staghorn	2 (6)
Upper calyx	1 (2)
Middle calyx	2 (4)
Lower calyx	6 (11)

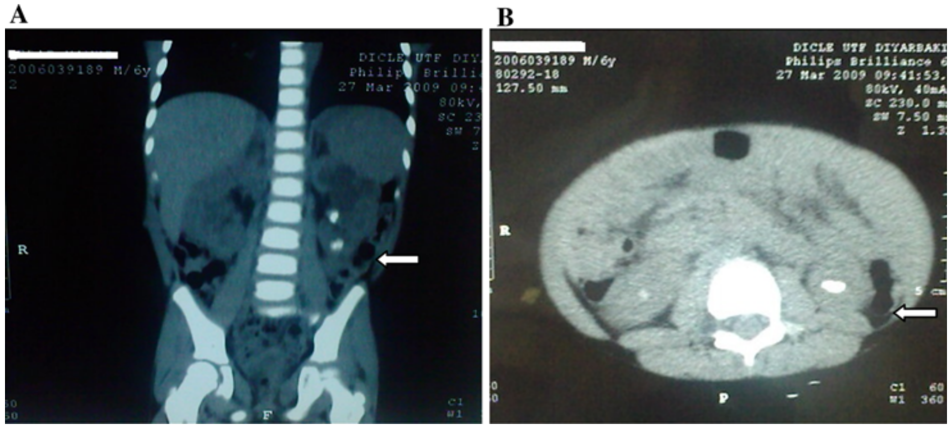

Fig. 1 CT images of the patient with complete retrorenal colon

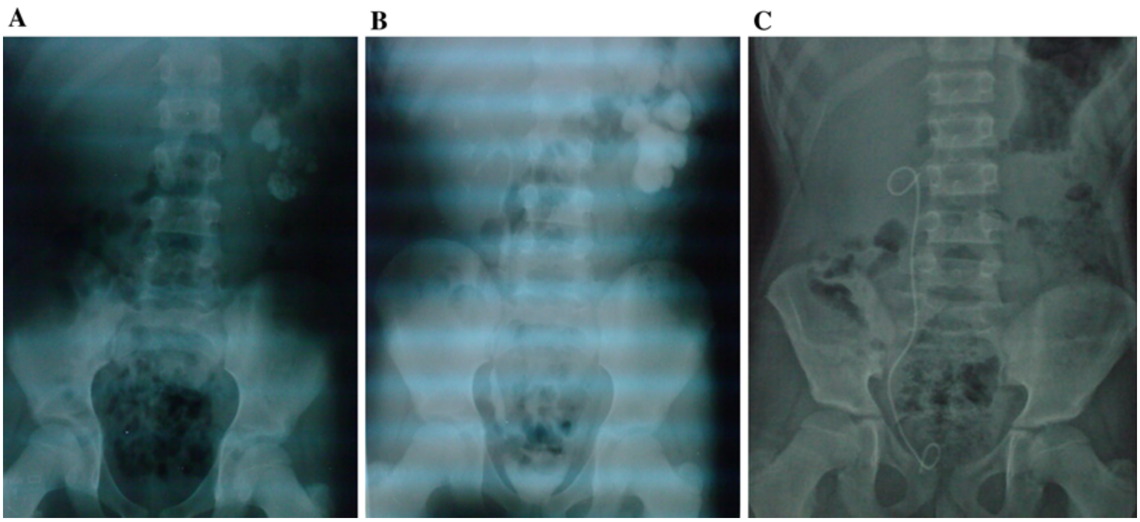

Fig. 2 Pre- and postoperative images of the patient with a right distal ureteral stone and a left kidney stone that we treated with right urethroscopy and left PNL during the same session

Table 2 PNL results

PNL results	Number of patients (%)
Stone-free	34 (76)
Clinically unimportant fragments	5 (11)
Residual stones	6 (13)
Open surgery	3 (6.25)

The ESWL was performed for residual stones 1 month after PNL and if necessary was repeated with 20-day intervals. Residual stones were between 5 and 7 mm, and in three patients there was >1 residual stone. Five patients treated with ESWL became stone-free. One patient with a 5-mm lower calyx stone resistant to ESWL was followed up without any additional procedure. Postprocedure, all patients were referred to the nephrology clinic for metabolic evaluation.

Discussion

Following the development of new endoscopic devices, surgical treatment of kidney stones switched from invasive open procedures to relatively less invasive PNL. ESWL is a highly effective method for the treatment of kidney stones, with a success rate of about 90%. In children, general anesthesia is mandatory for ESWL, which is a disadvantage of ESWL, especially in recurrent cases. For stones <2 cm ESWL is always the first choice, but for larger stones, ESWL-resistant stones, and in cases of calyceal diverticula or ureteropelvic stenosis PNL is preferred.

In the past we preferred using IVU for diagnosis in pediatric patients. The high dose of radiation of CT had discouraged us from using the technique. Until the 12th case in the presented series, we did not use CT, but after colon perforation in the 12th case we realized that the advantages of CT outweighed its disadvantages, and now always visualize stones in pediatric cases with CT. We think CT should be used prior to performing PNL—for two reasons in particular: the first is to detect the presence of retrorenal colon and the second is to plan the most suitable access route. It is reported that CT-planned access increases the success rate of PNL [9].

In the literature, the success rate of PNL was reported to be 69–89.5% [10, 11]. In our series, the overall success rate was 76%. We think that the most important factor in achieving a high success rate in PNL is clinical experience. If we consider our last 20 cases separately, the stone-free rate was about 88%.

The method used for evaluating patients postoperatively is also changing according to the literature. Küpeli et al. [12] compared USG with CT and reported that CT is more sensitive than USG in detecting residual stones postoperatively. We used KUB and USG in evaluating postoperative residual stones; we did not use CT in order to limit the patients' exposure to high levels of radiation.

One of the most important complications in PNL is bleeding, which is primarily related to stone burden and the number of accesses. Lee et al. [13], Şahin et al. [14], and Özden et al. [15] reported that 12, 7, and 33% of their patients required blood transfusion, respectively. In our series, we needed to perform transfusion in two patients (4%) with staghorn stones; we made two accesses in these two patients. In all the patients, we cauterized the bleeding vessels with a resectoscope during PNL; this could be the reason for needing transfusions in only two of our patients.

One of our patients had renal pelvis perforation and one had colon perforation. Adjacent organ injury is quite rare during PNL. The colon is injured more frequently during PNL, and the risk increases, especially in unsuitable lateral accesses, in hypermobile kidneys and in the presence of retrorenal colon. In order to limit the exposure to high-level radiation, we did not use CT to diagnose kidney stones in the past, but after the colon perforation in our 12th case we began to use CT in all cases scheduled for PNL.

Ünal et al. [16] reported two bilateral and three unilateral retrorenal colons in a study in which they evaluated 296 abdominal CTs in patients with anatomic variations of the colon. Sherman et al. [17] reported an incidence of retrorenal colon of 1%. In our study, which was not an incidence study, we encountered two retrorenal colons in our series of 48 patients (4.16%). As colon perforation is a serious complication with a high risk of morbidity and sometimes mortality, in order to avoid this complication, optimum diagnosis should be reached. Even though the use of CT in children is a contentious issue because of high-level radiation, we think that CT should always be performed before PNL, in order to detect the presence of retrorenal colon and to avoid colon perforation. During CT, one must be careful to minimize the radiation dose. White et al. [18] reported that low-dose CT could be performed safely during pregnancy; therefore, we think that all children should be evaluated before PNL with low-dose CT.

Conclusion

The PNL is a safe and effective method for the treatment of children with renal stones. The high success we obtained is related to clinical experience. Preoperative CT can aid in increasing the success rate of treatment and in decreasing the occurrence of complications by visualizing the renal anatomy and the presence of retrorenal colon.

References

1. Menon M, Resnick MI (2002) Urinary lithiasis: etiology, diagnosis and medical management. In: Walsh PC, Retik AB, Vaughan ED Jr, Wein AJ (eds) Campbell's urology, 8th edn, Chap 96. WB Saunders, Philadelphia
2. Hulbert JC, Reddy PK, Gonzales R et al (1985) Percutaneous nephrolithotomy: an alternative approach to the management of pediatric calculus disease. Pediatrics 76:610–614
3. Tellaloglu S, Ander H (1984) Stones in children. Turk J Pediatr 26:51–60
4. Tekgül S, Riedmiller H, Beurton D, Gerharz E, Hoebeke P, Kocvara R, Radmayr C, Rohrmann D (2008) EAU guidelines on pediatric urology urinary stone disease, pp 52–63
5. Newman DM, Coury T, Lingeman JE et al (1986) Extracorporeal shock wave lithotripsy experience in children. J Urol 136:238–240
6. Lingeman JE, Coury TA, Newman DM, Kah-noski RJ, Mertz JHO, Mosbaugh PG, Steele RE, Woods JR (1987) Comparison of results and morbidity of percutaneous nephrostolithotomy and extracorporeal shock wave lithotripsy. J Urol 138:485
7. Fernström I, Johannson B (1976) Percutaneous pyelithotomy. A new extraction technique. Scand J Urol Nephrol 10:257–259
8. Ramakumar S, Segura JW (2000) Renal calculi. Percutaneous management. Urol Clin North Am 27:617–622
9. Thiruchelvam N, Mostafid H, Ubhayakar G (2005) Planning percutaneous nephrolithotomy using multidetector computed tomography urography, multiplanar reconstruction and three-dimensional reformatting. BJU Int 95:1280–1284
10. Kapoor R, Solanki F, Singhania P, Andankar M, Pathak HR (2008) Safety and efficacy of percutaneous nephrolithotomy in the pediatric population. J Endourol 22:637–640
11. Nouralizadeh A, Basiri A, Javaherforooshzadeh A, Soltani MH, Tajali F (2009) Experience of percutaneous nephrolithotomy using adult-size instruments in children less than 5 years old. J Pediatr Urol 5:351–354
12. Küpeli B, Gürocak S, Tunç I, Şenocak S, Karaoğlan U, Bozkırlı I (2005) Value of ultrasonography and helical computed tomography in the diagnosis of stone free patients after extracorporeal shock wave lithotripsy. Int Urol Nephrol 37:225–230
13. Lee WJ, Smith AD, Cubbeli V et al (1986) Percutaneous nephrolithotomy: analysis of 500 consecutive cases. Urol Radiol 8:61–66
14. Sahin A, Tekgul S, Erdem E, Ekici S, Hascicek M, Kendi S (2000) Percutaneous nephrolithotomy in older children. J Pediatr Surg 35:1336–1338

15. Özden E, Sahin A, Tan B, Doğan HS, Eren MT, Tekgül S (2008) Percutaneous renal surgery in children with complex stones. J Pediatr Urol 4:295–298
16. Unal B, Kara S, Aktas A, Bilgili Y (2004) Anatomic variations of the detected on abdominal CT scans. Tani Girisim Radyol 10:304–308
17. Sherman JL, Hopper KD, Greene AJ et al (1985) The retrorenal colon on computed tomography: a normal variant. J Comput Assist Tomogr 9:339–341
18. White WM, Zite NB, Gash J, Waters WB, Thompson W, Klein FA (2007) Low-dose computed tomography for the evaluation of flank pain in the pregnant population. J Endourol 21:1255–1260