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Outcomes of mini-percutaneous nephrolithotomies in children: a single centre experience

Abdülkadir Kandemir[1], Mehmet Balasar[2], Mehmet Mesut Pişkin[2], Ahmet Öztürk[2]

[1]*Department of Urology, Kelkit State Hospital, Kelkit, Turkey*
[2]*Department of Urology, Necmettin Erbakan University, Meram Medical Faculty, Konya, Turkey*

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Corresponding author
Abdülkadir Kandemir
Kelkit State Hospital
Department of Urology
29600 Kelkit/Gümüşhane, Turkey
drkandemir87@gmail.com

Introduction The aim of this study was to present to present our experiences with pediatric mini-percutaneous nephrolithotomies (MPNL) in our center.

Material and methods A total of 85 MPNLs performed on 79 pediatric patients being treated for upper urinary tract stones from 2007 to 2017 were analyzed retrospectively in order to determine their safety, efficacy, and relevant outcomes.

Results 85 MPNLs performed on 79 patients with a mean age of 6.58 (1–14) years were included in this study. The mean size of the stones was 1.99 (1–6.4) mm. A 17 Fr rigid pediatric nephroscope with a pneumatic intracorporeal lithotripsy was used through a 20 Fr access sheath. The stone-free rate was 87.1% at 1 month postoperatively. Mean operative time was 56.4 (20–120) min. Mean fluoroscopy screening time was 183.2 (40–510) sec. Average hospitalization duration was 4.78 (2–13) days. Auxiliary procedures were performed on 7 (8.2%) patients (5 extracorporeal shock wave lithotripsy, 2 re- percutaneous nephrolithotomy). The complication rate of these cases was 6.3% according to the modified Clavien Classification System. However, no major complications classified as Clavien IV–V were observed in the study group.

Conclusions The outcomes of the contemporary analysis confirm that MNPL is a safe and efficient method of intervention resulting in a stone-free state in pediatric cases.

Key Words: children ‹› complication ‹› mini-PNL ‹› renal stone

INTRODUCTION

Whereas pediatric cases constitute 2–4.3% of the total population of patients with kidney stones [1], important changes have been witnessed in the surgical management of pediatric urolithiasis in the last few years. Among the numerous treatment modalities, mini-percutaneous nephrolithotomy (MPNL) offers various advantages.

MPNL, a modified standard percutaneous nephrolithotomy (PNL) with a smaller percutaneous tract size (14–20 F), has been proven a safe and efficacious treatment option for both adult and pediatric cases [2].

As the pelvicalyceal system in children is less robust and the tolerance for blood loss is more limited, there are fewer margins of error, thus presenting an important challenge to the endourologist. According to the literature, pediatric PNL tends to use different surgical equipment for different age groups [3, 4].

The aim of the present study is to evaluate the safety and efficacy of mini-PNL to treat kidney stones in patients aged <14 years.

MATERIAL AND METHODS

Data was reviewed retrospectively for 79 patients who underwent one-stage MPNL for upper urinary tract calculi between 2007 and 2017 in the Necmettin Erbakan University Urology Department, for a total of 85 procedures. Stone size, location, infection and hydronephrosis were the necessary indications for MPNL. Urine culture, serum biochemistry and co-

agulation tests were obtained from every patient. Radiological studies performed included urinary tract ultrasound, intravenous urography and, if necessary, non-contrast computed tomography. Preoperatively, broad-spectrum antibiotics were administered for prophylaxis in all patients with sterile urine. Before the intervention, all patients with culture-proven bacteriuria were first treated with antibiotics according to their antibiogram.

All cases were categorized as pediatric, in the 0–14 year age range, according to World Health Organization age classification criteria.

The MPNL interventions were performed under general anesthesia. A retrograde 4 Fr ureteral catheter was inserted into the patients in the lithotomy position. Subsequently, the patients were moved to a prone position for MPNL. C-arm fluoroscopy or ultrasonography was used for percutaneous access. Following the renal puncture, a flexible tip guidewire was inserted. A nephrostomy tract was established using fascial dilators between 14 and 18 Fr, as considered appropriate after the insertion of a corresponding sized sheath. In complex stone cases in which multiple percutaneous tracts were considered necessary, these accesses were made during the same session. During the intervention, a 17 Fr pediatric nephroscope (Karl Storz, Germany) was employed. Stone fragmentation was achieved with a Holmium:YAG laser and/or pneumatic lithotripters. A pulse perfusion pump was used for irrigation and for flushing out small (<3 mm) stone fragments, while stone forceps were used for larger ones. At the end of the procedure, 8 to 14 Fr nephrostomy tubes were placed. A nephrostomy tube was placed in 57 of 85 procedures and was not placed in the remaining 28 procedures.

The urinary catheter was generally removed during the first postoperative day. However, the nephrostomy tubes were removed once the patients were stone-free or had clinically insignificant stones (4 mm) and if they were afebrile, asymptomatic and did not have significant drainage from the nephrostomy tube. Upon the removal of the nephrostomy tube, patients were generally discharged.

RESULTS

Between January 2007 and January 2017, 79 cases underwent 85 MPNL procedures in our institute (six patients had treatment for bilateral renal stones). Thirty-eight of these were female (48.1%) and 41 male (51.9%). The mean stone size was 1.99 (1–6.4) cm (evaluation was made on the largest stone diameter). Demographics, preoperative, intraoperative and postoperative findings of patients, stone composition and factors that affected the stone-free status of the patients are summarized in Tables 1 and 2.

Briefly, 81 (95.3%) procedures required a single nephrostomy tract, and 4 (4.7%) required two tracts. In these cases, stones were located on the right in 37 (46.8%) and on the left in 36 (45.6%), and 6 (7.6%) of the stones were bilateral.

The mean operative time for PNL was 56.4 (20–120) min, and the mean fluoroscopy screening time was 183.2 (40–510) sec. The mean hemoglobin (Hb) loss was 0.79 (0.2–2.4 g/dl), and blood transfusion was required for four of the patients, including two cases during the perioperative period. The mean postoperative third-month serum creatinine levels were not statistically different as compared to the mean preoperative levels, $p = 0.083$. The mean hospital stay was 4.78 days (2–13 days).

During the third-month postoperative controls, a complete stone-free state was achieved in 87.1% of cases (74/85). Still, clinically significant (n = 2 cases) or insignificant (n = 5) residual stones were determined in the children. Cases with clinically significant stones underwent re-PNL (n = 2), and those with insignificant stones underwent extracorporeal shock wave lithotripsy (ESWL) (n = 5).

There were complications in five cases, categorized according to the modified Clavien Classification System. Postoperative hypertension, observed in one case, was immediately treated until the patient became normotensive (grade 2). Another patient revealed postoperative convulsions and was treated with anti-epileptic drugs after the necessary consultations. Thus, the convulsions were stopped, and no recurrence was reported (grade 2). A further patient developed postoperative abdominal distension. The patient's oral intake was stopped, and appropriate diuretic treatment was administered (grade 2). Two other patients required postoperative blood transfusion (grade 2), due to low Hb levels.

DISCUSSION

Upper tract urolithiasis management for children includes shock wave lithotripsy, percutaneous nephrolithotomy, retrograde intra-renal surgery (RIRS) and open surgery.

Nevertheless, despite the presence of various alternatives, a balance between stone clearance and procedure-related morbidity must be considered. Although it is a low-risk procedure, ESWL has high retreatment rates (18–67%), often leading to persistent residual stones [5]. RIRS, on the other hand, can minimize the risks associated with bleeding and visceral injury, but seeing as the pelvicalyceal anatomy is not always ideal, and due to the anatomical delicacy

of the pediatric ureter, flexible ureteroscopy may not be the golden option [6]. PNL in children was first described by Woodside et al. in 1985, with 100% stone removal in one session, using standard adult instruments in seven children (24–34 F) [7].

Many studies have reported the efficacy and safety of pediatric PNL. Likewise, we have also reported our experience using our version of MPNL in infants as young as 36 months with complex stone disease [8].

The stone free ratio (SFR) after PNL in pediatric patients ranged from 59 to 98%. Samad et al. reported a 59% SFR after PNL monotherapy. The mean stone burden was 3.1 cm [2]. Badawy et al. reported an 83.3% SFR after single treatment session [9]. In another series of 135 children with an average age of 8.9 years, Salah et al. reported a 98.5% SFR [10]. Pelit et al. reported a SFR of 84.7% and 94.4% after single and additional sessions respectively [11]. In the present study, patients' records revealed that on the first postoperative day, complete stone-free state was achieved in 87.1% of cases (74/85). Only two of the children with clinically significant stones underwent re-PNL (n = 2).

Table 1. *Demographics and preoperative clinical characteristics*

Characteristics	N, Mean (±std) or percentage
Number of patients	79
Number of procedures	85
Mean age (range) (yr)	6.58 (1–14)
Number of patients by sex	
Male	41 (51.9%)
Female	38 (48.1%)
Mean stone size (range) (cm)	1.99 (1–6.4)
Number of stones	
Staghorn	4 (4.7%)
Multiple	9 (10.6%)
Single	72 (84.7%)
Stone locations	
Pelvis	34 (40.5%)
Pelvis+calyx	13 (16.5%)
Calyx only	38 (43%)

Table 2. *Peroperative and postoperative characteristics*

Characteristics	N, Mean (±std) or percentage
Number of procedures	85
Number of tracts	
Single	81 (95.3%)
Two	4 (4.7%)
Mean operative time (range) (min)	56.4 (20–120)
Stone-free rate	87.1%
Mean hemoglobin drop (range) (g/dl)	0.79 (0.2–2.4)
Mean postoperative stay (range) (d)	4.78 (2–13)
Overall complications rate	5 (6.3%)

The main concern in pediatric cases is related to the percutaneous access renal damage potential. Traditionally, PNL required a 30 Fr nephrostomy sheath for renal access. However, the development of smaller sheaths allowed for mini-PNL or 'miniperc' (tract size ≤20 F) to be performed with minimal damage to renal parenchyma of children resulting with reduced procedure related morbidity without conceding from therapeutic efficacy [12, 13]. Besides the undesired conditions in adults that may occur during and after PNL, some of the drawbacks of PNL in children are small kidneys operated with relatively big endoscopic devices, the inability of pediatric cases to tolerate massive hemorrhage, comparatively easier hypothermia, liquid absorption and overload. Among these complications, hemorrhage is the most common. The most important factor is the dilatation diameter and the number of tracts. Multiple tracts and dilatation with more than 24 F have been reported to lead to critical drops in Hb [14]. Rates of blood transfusion vary according to the stone burden reported in the series [14, 15, 16]. Although a maximum 20 F dilatation was used in our series, the need for transfusion emerged in 2 cases (2.1%).

The present study is the first of its kind using the modified Clavien system to compare MPNL driven complications in children. Complications according to the Clavien classification were reported in 29.2% of the adults by Tefekli et al. [17] and in 30% of children by Ozden et al. [18]. Yadav et al. reported complication in 21.66% of cases and the majority of patients (97.9%) had minor complications (Clavien grade 1 & 2) [19]. In our study, complications emerged in 5 children (6.3%). According to the modified Clavien Classification System, all of the complications were Grade 2 (hypertension, transient convulsions, abdominal distention, and blood transfusion). No complications of grade III, IV, or V emerged, nor selective angiographic embolization was required in the MNPL intervened pediatric cases.

The drawbacks of this study are the small sample size and retrospective nature.

CONCLUSIONS

With the findings of the present study, MPNL has been reaffirmed as a safe and effective treatment modality for children with large upper urinary tract stone disease. Complications after PNL, as assessed by the Clavien classification system, are mild and PNL in pediatric patients is safe.

CONFLICTS OF INTEREST

The authors declare no conflicts of interest.

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