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Percutaneous nephrolithotomy in children with pediatric and adult-sized instruments

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Summary

Objective
Pediatric stone disease is a significant health issue which has increased in incidence because of lifestyle changes, dietary habits, and obesity. The incidence of urolithiasis among pediatric age groups varies according to region and is high in Turkey. The management of stone disease in children has improved dramatically over the last two decades. The high success rate of percutaneous nephrolithotomy (PNL) have led modern researchers to suggest that it be used as a first-line treatment of kidney stones greater than 2 cm in size. This study compared the outcomes, including morbidity and success rates, of different groups of pediatric patients who underwent PNL via pediatric- and adult-sized instruments.

Methods
Percutaneous nephrolithotomy was performed in 194 children in a clinical setting between the years 2000 and 2015. Patients were categorized into 2 groups (group 1: pediatric-sized devices used, $n = 90$ [46.4%]; group 2: adult-sized devices used, $n = 104$ [53.6%]). The children in group 2 were further divided into subgroups: a 24 F nephroscope was used for group 2a ($n = 84$ [43.3%]) and a 26 F nephroscope was used for group 2b ($n = 20$ [10.3%]) (Figure).

Results
For this study, a total of 194 pediatric patients (99 boys and 95 girls ranging from 8 months to 17 years of age, with a mean age of 9.43 years) underwent PNL for the removal of kidney stones in a clinical setting. Between the examined groups, there were no significant differences in patient height or weight, stone site or localization, pre- and post-operative creatinine levels, duration of nephrostomy, or hospitalization time. There was also no significant variation in minor complications such as fever or urinary infection. However, the stone burden was notably smaller in the group wherein pediatric-sized nephroscopes were used. Additionally, the incidence of hemorrhage was markedly lower in groups where a 17 F nephroscope was used than in groups where treatment was administered via 24 and 26 F nephroscopes.

Conclusions
Stone disease is considered to be relatively rare in childhood, but recent studies have indicated that it presents a considerable health problem. According to some researchers, a decrease in instrument size has not meaningfully reduced complication rates. In contrast, some studies have reported that the use of smaller sized nephroscopes may reduce rates of morbidity and mortality. In this study, success rates of PNL were similar across all groups, regardless of nephroscope size. However, the use of a 17 F nephroscope significantly decreased the rate of hematocrit level reduction ($p < 0.001$). While instrument size does not affect the success of PNL, smaller instruments can be used to reduce various complications such as bleeding.

Figure Nephroscopes with different diameters.

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Introduction

The prevalence of pediatric urolithiasis has been on the rise because of infection, obesity, changing dietary habits, and environmental factors [1]. Some important risk factors responsible for the high incidence and recurrence rates in children include malnutrition, racial factors, and metabolic abnormalities [2]. The incidence of urolithiasis in pediatric patients varies according to region and is of particular concern in Turkey [3].

The treatment of kidney stones has evolved over time. Surgical treatments were traditionally used when stones were larger than 2 cm, had greater complexity, or were unbroken by extracorporeal shock wave lithotripsy (ESWL) [1]. Such open surgery methods began to lose favor because of the introduction of percutaneous nephrolithotomy (PNL) in 1976 [4]. The first pediatric PNL procedure was performed in 1985 and the method quickly became the first-line treatment for kidney stones greater than 2 cm in size according to established guidelines [5,6]. The success rate of PNL is affected by many factors such as kidney anatomy, stone burden, and localization. According to literature, the stone-free rate of PNL rests between 73% and 96% [7–9]. Large-sized nephroscopes were initially utilized during PNL; however, nephroscope diameters began to decrease over time. The administration of PNL with adult-sized instruments can present problems in pediatric patients because of the small size and mobility of pediatric kidneys, the possibility of frail renal parenchyma, and the small size of the collecting system [9]. However, some centers have reported using different sized instruments when administering PNL to pediatric patients [10–12]. This study compared the outcomes, including morbidity and success rates, of different groups of pediatric patients who underwent PNL via adult-sized (24F and 26F) and pediatric-sized (17 F) nephroscopes.

Methods

Upon approval of the study by the ethics committee of clinical research (protocol number 2016/3-2), researchers retrospectively evaluated the files of 194 pediatric patients with kidney stones (198 renal units), all aged 17 years or younger, who underwent PNL between January 2000 and October 2015. Patients were categorized into two groups (group 1: pediatric-sized devices used, $n = 90$ [46.4%]; group 2: adult-sized devices used, $n = 104$ [53.6%]). The children in group 2 were further divided into subgroups: a 24 F nephroscope was used in group 2a ($n = 84$ [43.3%]) and a 26 F nephroscope was used in group 2b ($n = 20$ [10.3%]). For group 2, researchers preferred to examine the use of adult-sized instruments in children with a large stone burden or a dilated collecting system. All parameters, including patient age and body mass, caliceal dilatation, and calculi size, were considered when selecting the size of nephroscope.

The percutaneous access tract was dilated using Amplatz dilators over a guide wire; researchers used 22 F for 17 F nephroscopes, 26 F for 24 F nephroscopes, and 30 F for 26 F nephroscopes. Pneumatic lithotripters were used to fragment stones. When residual fragments were not seen on fluoroscopic controls, the operations were completed. Nephrostomy tubes were placed into the renal tract; an antegrade radiopaque study was routinely applied to check for perforations and proper positioning of the nephrostomy tube.

Ureter catheters were left in place following completion of the surgery and were generally extracted on the first postoperative day. Plain abdominopelvic radiography and antegrade nephrostography were performed as needed on the second or third postoperative day. The nephrostomy tube was removed if no drainage problems were encountered. When the patients were afebrile, comfortable, and without evidence of drainage from the nephrostomy tract, they were discharged and asked to attend follow-up control appointments after 1 month.

At each control appointment, a urinalysis, urine culture, serum creatinine analysis, plain abdominal film examination, and urinary system ultrasound were performed. Procedure success was defined as the patient being fully stone-free or possessing clinically insignificant residual fragments (CIRFs) of less than 4 mm, as seen on plain films obtained during early postoperative days. Stone location and burdens, the number and location of renal tracts, the occurrence of complications, the duration of nephrostomy, and hospitalization times were compared across groups according to nephroscope size. Patients with missing data were not included.

Statistical analysis was performed using SPSS version 23 (SPSS Inc., Chicago, IL, USA) and recorded as median (min–max) frequencies with percentages. Normality was evaluated using the Shapiro–Wilk test. Kruskal–Wallis, Pearson chi-square, and Mann–Whitney *U* tests were appropriately used in statistical analyses. Multiple comparisons were carried out via Mann–Whitney *U* tests with Bonferroni corrections. Significance was considered at $p < 0.05$.

Results

A total of 194 pediatric patients (99 boys and 95 girls ranging from 8 months to 17 years of age, with a mean age of 9.43 years) who had applied for and undergone PNL for kidney stones were included in this study. Patients were evaluated in two groups according to the use of either pediatric-sized or adult-sized nephroscopes. The children in group 2 were further divided into subgroups; these subgroups used either a 24 F or a 26 F nephroscope, respectively. Mean patient age was 9.1 years in the pediatric-sized 17 F group, 10.9 years in the adult-sized 24 F group, and 9.9 years in the adult-sized 26 F group ($p = 0.001$). One hundred and six procedures were performed on the right sides of patients and 92 were performed on the left sides ($p = 0.841$). The mean body weight of patients was 26.5 kg in the 17 F group, 30.5 kg in the 24 F group, and 34.3 kg in the 26 F group ($p = 0.125$). The most common presenting symptom was abdominal or flank pain, which occurred in 173 (89.1%) patients. Other common symptoms were hematuria, which occurred in 95 (48.9%) patients, and fever, which occurred in 12 (6.2%) patients.

The mean stone burden across all groups was 1.844 ± 0.513 cm^2. The mean stone burden was 1.65 cm^2 in