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Percutaneous nephrolithotomy in children: experience with 138 cases in a developing country

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Abstract Our aim was to evaluate our experience with percutaneous nephrolithotomy (PCNL) in children in the Republic of Yemen. Between January 1993 and December 1998, 135 children underwent 138 percutaneous nephrolithotomies in Yemen. The patient's age ranged between 8 months and 14 years (average 8.9 years). There were 117 boys and 18 girls (male:female ratio 6.5:1). The stone size ranged between 124 and 624 mm² (average 507 mm²). A 26 F adult nephroscope was used. The stone free rate was 98.5% (136 out of the 138 cases). Two patients had clinically insignificant fragments. A second session had to be performed because of residual stone in one patient. No severe intra- or postoperative complications were observed. We conclude that percutaneous nephrolithotomy is a safe and effective method for the treatment of kidney stones in children. It reduces morbidity and hospital stay and thus the cost of treatment. To our knowledge, this is the largest reported series.

Keywords Percutaneous nephrolithotomy · Children · Endemic stones

Since the early 1980s when percutaneous nephrolithotomy (PCNL) was introduced, open surgical procedures have virtually been replaced in the adult population.

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This technological advance was only slowly applied to the pediatric population, primarily due to the technical limitations associated with smaller patients (e.g., size) and secondarily to the uncommonness of pediatric urolithiasis.

Although exact statistics are not available from developing countries, pediatric urolithiasis is definitely more common there than in industrialized countries. Urolithiasis in childhood is rare in the developed world, it represents 1–5% of all urinary tract stones, but in developing countries the occurrence of pediatric urolithiasis is 30% of all urinary tract stones [1, 2, 11, 17]. The application of the new technologies to children has been reported by others, but even in recent years the number of reported cases is usually less than a hundred [5, 8, 12, 16, 19].

Here, we evaluate retrospectively our experience with PCNL in the Republic of Yemen. To our knowledge this is the largest reported series.

Patients and methods

Between January 1993 and December 1998, 135 children underwent 138 percutaneous nephrolithotomies in Arabia Felix Modern Hospital, Sana'a, Republic of Yemen. The patient's age ranged between 8 months and 14 years (average 8.9 years). There were 117 boys and 18 girls (male:female ratio 6.5:1). The size of the stones ranged between 124 and 654 mm² (average 507 mm²). There were 55 left and 82 right sided stones. The stone was located in the pyelon in 96 cases, in a single calyx in nine, in multiple calyces in 21, in the upper part of the ureter in five, and in the middle part of the ureter in six cases. Stones located in the ureter were pushed back to the pelvis with a ureteric catheter. Four solitary kidneys (three congenital, one after contralateral nephrectomy) and three horseshoe kidneys were operated. Nineteen of the stones were staghorn. In four cases, pyonephrosis was found. In five cases PCNL + endopyelotomy (EPT), in ten cases PCNL + ipsilateral ureteroscopy (URS), in

five cases PCNL + percutaneous cystolithotomy (PCCL), in two cases (6 and 10 year olds) bilateral PCNL were carried out in the same session. In a 10 and a 12 year old boy, laparoscopically assisted PCNL was performed on the stone-holding pelvic dystopic kidney and the 12 year old was found to have a staghorn stone.

The method of these endoscopic procedures is well known. We used a 26 F adult nephroscope, telescopic metal dilators and ultrasonic disintegration, except in three very small children for whom a ureteroscope was applied for the PCNL through a 19 F Teflon sheath. The method used for the laparoscopically assisted PCNL has been detailed in our previous report [20].

Preoperative urine culture was carried out in 70 patients (51.8%). The culture was positive in six (8.7% of the cultures), including the four pyonephrosis cases.

Results

Our success rate was 100%, while the stone free rate was 98.5%. In two cases, 2–3 mm “clinically insignificant” fragments remained. In one case, a second session was needed because of residual stone.

Retroperitoneal fluid collection after PCNL + EPT was found in one patient (0.7%). After percutaneous drainage, the patient healed within 3 days. There was postoperative bleeding requiring a 500 ml blood transfusion in one patient (0.7%). Postoperative urine leakage after the nephrostomy drain removal for more than 3 days was found in 11 patients (8%). The average hospital stay was 4.8 days (range 2–8 days). We tried to be more careful with the children than with adult patients: usually the drains were kept in a day longer and the patients were discharged a day later.

The occurrence and size of the stones increased with the patient's age (Figs. 1, 2).

The nucleus and/or the main component of the stones was ammonium acid urate in 73 patients (54%) (Table 1), but under the age of 5 years this rate was 75% (101 patients) (Fig. 3).

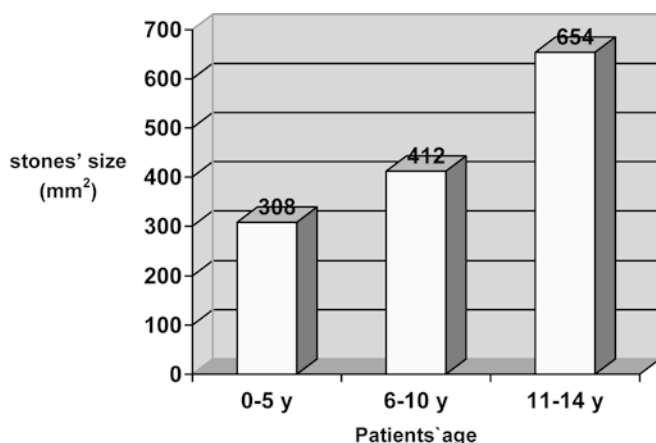


Fig. 1 The size of kidney stones correlated to the patient's age

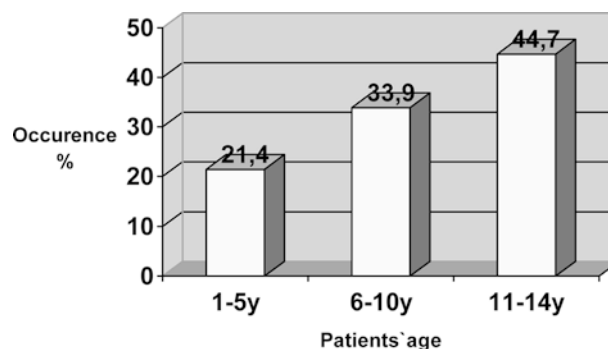


Fig. 2 The occurrence of kidney stones correlated to the patient's age

Table 1 Analysis of Yemeni and Hungarian pediatric kidney stones

	Yemeni (%)	Hungarian (%)
<i>n</i>	135	55
Ammonium urate	8.8	0
Ammonium urate + calcium oxalate	39	0
Ammonium urate + uric acid	6.6	0
Uric acid	4.4	3.7
Calcium oxalate	36	63
Struvite + carbonate apatite	3.7	32.7
Cystine	1.5	0
Total	100	100

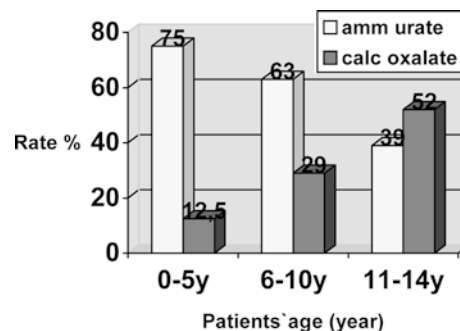


Fig. 3 Analysis of Yemeni pediatric kidney stones correlated to the patient's age

The occurrence of the ammonium urate stones decreased and that of the calcium oxalate stones increased with age (Fig. 3).

Because of social and financial status, metabolic work-up and long-term follow-up of stone recurrence was not possible.

Discussion

Our 100% success rate (98.5% stone free rate) is much higher than that which can be reached with extracorporeal shock wave lithotripsy (SWL) monotherapy. Although SWL is a less invasive procedure, its clearance rate is also less in the pediatric population than in

adults: 45–82% has been reported, but even a 28% stone free rate has been reported in the literature [3, 9, 12, 13, 14, 18]. To attain a high success rate, more sessions are required in the case of large and/or dense stones, but the subsequent need for auxiliary procedures and the chance of complications increases as well. The late bioeffects of SWL on children are still controversial: recently alterations in the predicted renal growth rates have been reported [3, 13, 18].

In our series, the average stone size was 507 mm² (about 2.5×2 cm). Only ten stones (7.2%) were less than 1 cm. Most of the stones were rather dense. In terms of the indications for PCNL in the case of small stones, social viewpoints were respected: most of these patients came from remote villages where there was no health care service within a reasonable distance. Thus, there were no facilities for correct follow-up. We agree with Lim and coworkers' [12] opinion that in the cases of dense stones above 10 mm, primary PCNL is the preferable method in the pediatric population. In their series, one of the reasons for failed SWL was a calculus greater than 10 mm (their stone free rate was 46%). Goel and coworkers reported a better clearance rate (82%), but in about 40% of their cases four or more sessions of SWL were needed [9]. The question is: are four or more sessions of SWL still less invasive than a PCNL? Recently, better results with second generation SWL lithotripters had been reported, but in experienced hands the high success rate and the immediate stone clearance make PCNL superior to SWL [4, 6, 21].

On the basis of our experience, it should be emphasized that no complications related to the relatively large size of the instruments (26 F nephroscope) were observed, but in the cases involving very small children a ureteroscope can be applied as well, percutaneously through a smaller sheath.

Upper tract pediatric urolithiasis is discussed in the literature under the common category, "endemic" stones. These have not yet been differentiated [7]. On the basis of the evaluation of the Yemeni and Hungarian pediatric upper tract stones, our experience differs from that previously reported. A total of 55 previously studied upper tract stones from Hungarian children were compared to the recently studied Yemeni pediatric stones (Table 1) [10]. The role of calcium oxalate in the mixed stones was different: it always composed the exterior part of the stones, and did not take part in the original stone formation. Therefore, only the pure calcium oxalate stones were considered. In Table 1, it can be seen that 54% of the Yemeni upper urinary tract stones were ammonium urate, which did not occur in the Hungarian population at all. This rate was 75% under 5 years (Fig. 3). On the other hand, the rate of calcium oxalate was about half, and that of struvite was about nine times less frequent in the Yemeni pediatric population (Table 1).

In Fig. 3, the percent composition of the two main stone forming components can be seen for the Yemeni pediatric population correlated to the patients' age:

ammonium urate decreased, but calcium oxalate increased with age.

Similarly to the endemic bladder stones, the size of upper tract stones increased with age as well (Fig. 1). The explanation must be the same: the larger stones were formed in early childhood but were only recognized later.

Another rate from our series, the male:female ratio of 6.5:1, is quite different from the 1:1 rate in the literature [7, 12].

Anatomical/structural predisposing factors were found in 10.3% of cases, which is also much less than has usually been reported [12, 15].

Conclusion

Several important conclusions can be inferred from our data: in this country more than half of the stones' dominant component is ammonium urate, which virtually does not occur in developed countries. The etiology of these stones—similarly to endemic bladder stones—is nutritional and most probably they were formed in early childhood. In our opinion, a new category relating to the etiology of pediatric upper urinary tract stones should be created and called "endemic kidney stones", as this appears to be a similar entity to "endemic bladder stones".

The rate of the struvite stones was negligible in our series and the occurrence of calcium oxalate increased significantly after 6 years of age.

As a nutritional etiology is dominant in pediatric urolithiasis in this country, the best way to bring about a dramatic decrease in this disease would be the education of the population, but to change people's attitudes requires years or decades: until then PCNL is the available minimally invasive, safe and effective method.

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