

Brief Communication

Pediatric Urolithiasis: Incidence and Surgical Treatment

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Abstract

Purpose: To report our experience with pediatric urinary tract stones to determine the frequency and location of urinary stone in the urinary tract system.

Patients and Methods: All files of patients who underwent open surgery for stone between 1997 until 2009 at King Hussein Medical Center, Pediatric Surgery division were reviewed. Demographic features as well as location of stone, morbidity, associated abnormalities, surgical approach and outcome were analyzed.

Results: During the study period, 74 open stone operations were performed in our hospital. The mean age of the patient was 3.6 years, 19(25.6%) patients were females. Infants with stones represented 24.3% of the total.

The stones were in the kidneys in 46(62%) patients, the ureter in (12%) and, the bladder in (25.6%). Associated urogenital abnormalities were detected in four cases, including ureteropelvic junction obstruction and anatomic urinary bladder abnormality.

Conclusion: Surgical approaches to urolithiasis in children continue to evolve, with open surgery being reserved for particular and complex cases. The use of ESWL and endourological methods of treatment for urolithiasis in children must be generalized.

Keywords: Urolithiasis, Children, Surgery.

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Introduction

Urinary lithiasis in children is less common than in adults. Generally, the incidence is about 2-3%.¹ Data about the treatment of urinary stone in children are scant. Many of the children with urinary stones have an underlying abnormality of the urinary tract. These include obstruction of the kidney or ureter, and disease such as spina bifida and bladder extrophy.² All children with stones must be screened for infections, anatomic and metabolic risk factors, in addition to urogenital abnormalities.¹ The incidence and characteristics

of nephrolithiasis in children reflect wide geographic variations, but stone occurs in children of all ages.³⁻⁵ Although uncommon in the western countries, pediatric stone is considered endemic in developing countries.³

Diagnosis is often delayed in infants and young children as they may present with non-specific symptoms. For example, irritability, nausea, abdominal pain, microhematuria, or urinary tract infection. Occasionally, urolithiasis is detected incidentally on ultrasound or abdominal x ray;^{6,7} there is a high degree of morbidity associated

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with pediatric urolithiasis. Pediatric patients tend to form stones in a recurrent pattern, with rates of recurrence of 6.5%-44%.⁸ This tendency as well as the destructive nature of stone formation can quickly lead to progressive decline in renal function in the fragile pediatric kidney, as well as morphologic changes in the urinary tract.⁸ To decrease morbidity and long-term effects of pediatric urolithiasis, it is essential to access the characteristics and etiology of the patients' stones for carefully planned and appropriate management strategy.

Approaching pediatric urolithiasis requires a thorough metabolic and environmental evaluation of all patients on an individual basis, and as shown by Chang Kit et al.,⁸ 41% had a metabolic abnormality. More than one-half of the patients need surgical intervention.^{9,10} With recent advances in technology, stone management has changed from an open surgical approach to less-invasive approach such as extracorporeal shock wave lithotripsy and endoscopic techniques, providing a high safety profile and minimal morbidity.⁹ The universal principle of surgical treatment of stone disease entails the preservation of renal function, maximal stone clearance and minimal patient morbidity.

Patients and Methods

The medical records of 74 children (19 females and 55 males, age range 0.3-13 years) with urolithiasis between 1997-2009 were reviewed. Age, sex, location and composition of stone, associated abnormalities, surgical approach and outcome were analyzed. Diagnosis of urolithiasis was confirmed by abdominal x ray, ultrasonography, intravenous urographay and or nonenanced CT scan. Intravenous urography, voiding cystourethrography and renal radioisotope scan were performed in selected cases. Studies such as biochemical investigations and urine tests were included in the evaluation.

Results

Out of the 74 patients with urinary tract stones, the mean age was 3.6 years, 19 patients (25.4%)

were females. The peak age for surgical treatment was between 2-3 years (24, 4%); 85% of them were boys. Followed by infants (24%) were less than two years of age. In females' patients older than three years, lithiasis was found more than in males (Figure 1). Only 2 (2.7%) patients older than 10 years were submitted into surgical treatment. The clinical presentation of this pathology dominated by the history of urinary tract infection and nonspecific abdominal pain. As for the stone location, forty-six stones (62%) were renal, nine (12%) were ureteral, and nineteen (25%) were in the bladder. Bilateral kidney stones were found in 3 patients.

In those with unilateral urolithiasis, the stone was located in 37(50%) patients on the right side and in 15(20%) patients on the left side (Table 1).

Urolithiasis was more frequently among boys. The sex ratio 2.8 to 1 (55 males and 19 females). Bladder stone was more frequently seen among boys (n=16) more than girls (n=3) and were more frequent among infants and children less than three years old (Figure 2). Multiple stones involving kidney and ureter were seen in 4 patients.

Four patients (5.4%) had underlying anatomic abnormalities including pelvi-uretric stenosis, bladder augmentation in one each, and ectopia vesica in two. Biochemical stone analysis showed calcium oxalate in 81% of patients (Table 2).

The treatment used was open surgery: nephrolithotomy, ureterolithotomy and cystolithotomy in all patients. Following open surgery, 69(93.2%) were completely stone free, 2(2.7%) had residual stone and recurrence was noted in a further 1 (1.3%).

The intraoperative complication was seen in 2 (2.7%) cases (Table 1): iatrogenic injury to the ureteropelvic junction (avulsion) which was repaired using uretero-calyceal anastomosis and, uncontractable bleeding during nephrolithotomy required nephrectomy, another two nephrectomies were performed due to Hydatid cyst, and Xanthogranulomatous disease which were combined with urolithiasis.

Table (1): Associated Abnormalities and Outcome.

	No. of pt.	Stone's location	RL	LL	♂	♀	%	Associated abnormalities	Outcome
Kidney	46	Unilateral	31	12	22	11	62.16		3 Nephrectomies 1 Recurrence 2 Missing stones
		Bilateral			1	2			
Ureter	9	Unilateral	6	3	7	2	12.16		
Bladder	19		19		16	3	25.6	Bladder Augmentation (N.B)(1) Ectopia vesica(2) Pelvi-ureteric junction Obstruction(1)	

Table (2): Chemical Analysis of Urinary Stone.

<u>Type of stones</u>	<u>Children</u>			<u>Adults</u>		
	No. of pt.	Rate (M:F)	(%)	No. of pt.	Rate (M:F)	(%)
Calcium Oxalate+ Ammonium Magnesium phosphate (.AMP)	5	3:2	15.6	48	35:13	31.1
Calcium Oxalate+ Uric Acid	5	2:3	15.6	18	13:5	11.6
Calcium Oxalate+.AMP+ uric acid	3	2:1	9.3	11	8:3	7.14
Calcium Oxalate+ Uric Acid+cystine	0			1	1:0	0.64
Calcium Oxalate+.AMP+ uric acid + cystine	0			1	1:0	0.64
Calcium Oxalate+ Uric Acid+cystine	0			1	1:0	0.64
Calcium Oxalate	12	7:5	37.5	63	53:1	40.9
AMP	1	0:1	3.1	2	2:0	1.3
Uric acid+ AMP	0			2	1:1	1.3
Uric Acid	0			2	1:1	1.3
Cystine	5	4:1	15.6	5	3:2	3.2
Total		32			154	

Fig 1: age distribution in patients with urolithiasis

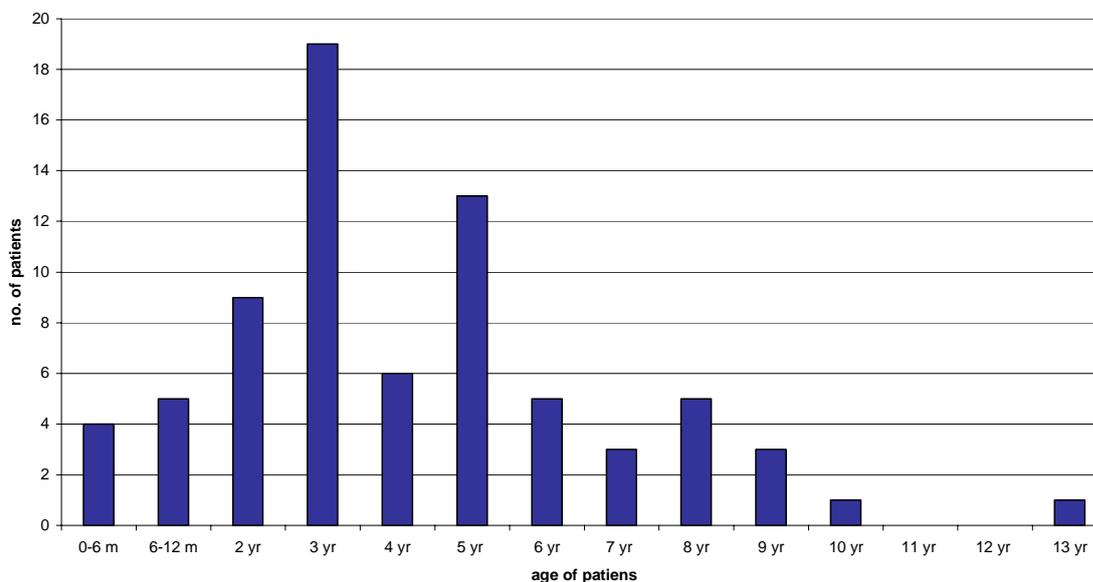
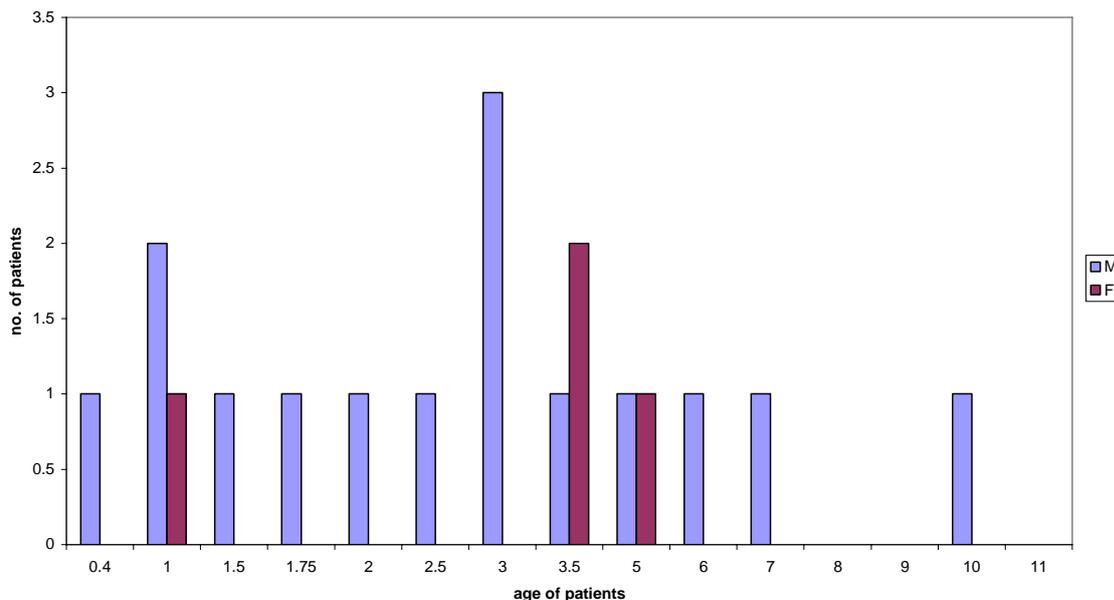


Fig 2: bladder stone distribution



Discussion

Urolithiasis in children is a delicate medical problem because of poor symptomatology and impairment of kidney function and generates an important burden for the patient, family and society.⁸

Pediatric stone disease varies widely in etiology, presentation, incidence and natural history depending on geographic location and economic environment.^{1,8}

The average age of presentation of about 4 year old patients younger than the ones reported in the literature (mean 7.3) and a similar rate between the sexes 2.8:1 male-to-female, comparable with the ratio seen 3:1 in developing countries.^{1,8}

The well-known male preponderance has been confirmed in our series; according to some publications urolithiasis mainly affects infants less than two years of age, 20-55%;^{4, 11} in our study, infants accounted for 24% of the cases.

Several studies noted a strong association between urolithiasis and urinary tract infection, frequency was about 15 to 57% of lithiasis patients in the years 1970-1980, and does not

exceed two percent in Europe at present.¹¹

The main factor that leads to the formation of bladder stone is a nutritionally poor diet low in animal protein, calcium and phosphate and high in cereal.¹ Bladder stones were observed in the rural areas of developing countries (51% in Morocco and 71% in Cameroon).¹¹ As nutrition improves in developing countries, bladder stone gives way to upper urinary tract stones¹ in our series bladder stones which consisted of 25.6%.

In Europe, urinary stones are mainly located in the upper urinary tract and the proportion of bladder calculi does not exceed 14%, it is absent even in industrialized countries such as the United States.¹¹ Bladder stones in the United States are most commonly associated with urinary tract reconstruction, either for bladder extrophy or neurogenic bladder, stones often form in bladders that have been enlarged or "augmented",¹² this is noted in 4% of our cases.

The majority of urinary stones in children are, as in adults, composed of calcium oxalate in approximately 80%.^{6, 11, 13} In our study, calcium oxalate presented in 81% of stones, in comparison to 91.5% which occurred in adult population (Table 2). However, these values were much

higher than those described in the Western countries.¹¹

Clinical symptoms of urolithiasis in children may be nonspecific and misleading.

The classic adult presentation of sudden, debilitating flank pain is uncommon in children. Urolithiasis in infants may mimic colic.^{1,14}

In most children less than 5 years old presented with UTI, and most patients older than 5 years presented with abdominal, flank, pelvic pain has been reported in approximately 50%.¹ Gross or microscopic hematuria is found in 33% to 90% of children who have urolithiasis and occurs equally across age groups.¹⁴

However, a child presenting with flank or abdominal pain and or gastrointestinal complains (nausea, vomiting) should always be investigated to evaluate possible stone disease.⁸

In our study, UTI and non-specific abdominal pain were the most common causes of presentation, probably due to the lower mean age of our cases (3.6 years) compared with the mean age 7-10 years reported in most literature.¹

Perrone et al. identified idiopathic hypercalciuria as the most common abnormality in children with urinary stones in developed countries. In contrast, hypocitruria and hypomagnesuria are the most common abnormalities in children with urinary stones in developing countries.^{8,15,16}

The rates of metabolic abnormalities in pediatric stone formers have been quoted as 48-68%.⁸

The presence of ammonium urate is especially considered as a marker of endemic urolithiasis when it is pure or associated with calcium oxalate. It is particularly rare in industrialized countries where it reaches 4.7% in France and abundant for childhood stones of developing countries such as Cameroon where it reaches 57.1%. In our children, it reaches 28%.

Unfortunately, we have an inadequate result, of only 32 patients out of 74 (Table 2). However,

that is under scope of our nephrologists.

The importance of metabolic evaluation in first-time pediatric stone formers is for early, appropriate treatment and close follow-up for the recurrence of stone formation.

It has been observed an incidence of 5.4% of different underlying associated urinary anatomical malformations concurrent with stone formation; however this rate is not comparable with the literature of 14% to 29%.^{17,18}

Plain film radiography, ultrasonography and intravenous urography have been used to diagnose urinary tract calculi, and or, unenhanced CT scan.¹⁷⁻¹⁹ In addition, the most radiological methods which were most commonly used were ultrasonography and or abdominal plain film radiography, particularly at the day of surgery, to confirm previously detected stones.

Van Savage et al. showed a decrease in the spontaneous stone passage rate in children with stones larger than 3 mm, whereas Pietrow et al. showed a decrease occurring with stone larger than 4 mm.⁸

In our study, stones requiring intervention were about twice as large, at 6-9 mm. The size, location, persistent urinary calculi, morbidity of stone, and urinary tract anatomy were the indication for surgical therapy.⁸

In 74 cases, stone removal was achieved by open surgery; procedure may still provide an opportunity to clear stone in complex situations.²⁰

Stone recurred in 1.3% during the total period of this study, unlike the 6.5% to 44% recurrence rate which has been reported.^{8,21} In children with renal calculi, the aims of management should be complete clearance of stones, preservation of renal function and prevention of recurrence.

There have been remarkable breakthroughs in the last 15 years in the treatment of urinary stones. Most urinary tract stones in children can be treated with ESWL, endoscopic approach either ureteroscopically or percutaneously.

Lately, laparoscopy and robotic-assisted laparoscopy have been utilized successfully in children. These new therapeutic approaches are extremely successful in resolving urolithiasis of children.²

Prior to this time, the only option for the removal of stones was an open operation. Nowadays, open surgery is very rarely performed for stone disease. Less invasive treatment which is available should be used. A better health education and disease management could decrease this relatively rare, but kidney-impairing disease.¹⁷

Conclusion

The use of ESWL and endourological methods of treatment for urolithiasis must be generalized. With technological advances, the treatment of urolithiasis has improved and major complications have decreased. Open surgery is being reserved for particular and complex cases. Surgical approaches to urolithiasis in children continue to evolve. However, with so many therapeutic options to choose from, there is a need to audit the various therapeutic options and select those associated with the least morbidity rates.

References

1. Fakhrossadat M, Laila MM. Clinical features and risk factors of pediatric urolithiasis. *Iran J Ped* 2007; 17: 2: 129-123.
2. Docimio SG, Orth, CR, Schulam PG. Percutaneous cystolithotomy after augmentation cystoplasty: Comparison with open procedure. *Techniques in Urology*. 1999; 4:43-45.
3. Marc C Smaldone, Bishoy AG, Michael C. Ost. The evaluation of endourologic management of pediatric stone disease. *Indian Journal Urology*. 2009; 25 (3): 302-311.
4. Alaya A, Nouri A, Najjar MF. Urolithiasis in Tunisian children: A study of 100 cases. *Saudi Journal of Kidney Diseases and Transplantation*. 2009; 20 (6): 1096-1100. (Medline).
5. Erbagi A, Erbagi AB, Yilmaz M et al.: Pediatric Urolithiasis-evaluation of risk factors in 95 children *Scand J Urol Nephrol*. 2003; 37(2):129-133.
6. Thomas JN, Tanja B, Nenad B et al.: Urinary Oxalate excretion in urolithiasis and Nephrocalcinosis. *Arch Dis Child*. 2000; 82:322-326.
7. Jallouli M, Mhiri R, Nouri A. Urolithiasis in Infants. *Pediatric Surg Int*. 2007; 23:295-299.
8. Laura Chang Kit MD, Guido Filler MD, Jhon Pike MD et al.: Pediatric Urolithiasis: Experience at a tertiary care pediatric hospital. *CUAJ*. 2008; 2 (4): 381-386. (Medline)
9. Surendra B Kolla, Pankaj Wadhwa, Monish Aran. Current status of minimally invasive management of pediatric upper urinary tract calculi. *Journal of Indian Association of Pediatric Surgeons*. 2006; 11 (2): 73-78. (Medline)
10. Saudi Al-Rasheed, Nasir A.M Al-Jurayyan, Mohamed N Al- Nasser et al. Nephrolithiasis in children and adolescents in South Western region of Saudi Arabia. *Saudi Journal of Kidney Diseases and Transplantation*. 1995; 6: 396-399.
11. Akran Alaya, Nouri Abdellatif, Mohammed Fadhel Najjar. Pediatric urolithiasis in coastal Tunisia. *Urology Annals*. 2009; 1: 39-43.
12. Greg Kraushaar, Sheri L. Harder. Kishore Visvanathan. Traumatic Uretero-Pelvic Junction Disruption. *The Internal Journal of Radiology*. 2005; 4 (1) (Medline).
13. Danko Milsevic, Danica Batinic, Pasko Konjevoda et al.: Analysis of calcium, oxalate, and citrate interaction in isoipathic calcium urolithiasis in children. *J. Chem. Inf. Comput. Sci*. 2003; 43:1884-1887.
14. Robert S. Gillespie, F. Bruder Stapleton. Nephrolithiasis in children *Pediatric in Review*. 2004; 25:131-139.
15. Joaquin Escrbano, Albert Feliu, Albert Balaguer et al.: Symptomatology and development of urolithiasis in children with frequency-dysuria syndrome associated with hypercalciuria. *Croatian Medical Journal*, March 1997; 40 (1): 1-6 (Medline).
16. Leonard G, Feld; Kevin E.C. Meyers, Bernard S. Kaplan, F. Bruder Stapleton. Limited evaluation of microscopic hematuria in pediatrics. *Pediatrics*. October 1998; Vol, 102, No 4; pp: 1-5.
17. Muhammad Rafique. Nephrectomy: indications, complications and mortality in 154 consecutive patients. *J Park Med Assoc*. Jun 2007; 57 (6): 308-311.
18. Palmer JS, Donaher ER, O'Riordan MA, Dell KM. Diagnosis of pediatric urolithiasis: role of ultrasound and computerized tomography. *J. Urol*. 2005; 174:1413-1416.

19. Pramod P Reddy. Recent Advances in Pediatric Uroradiology. Indian J Urol. 2007; 23 (4): 390-402. (Medline).
20. Adnan Abu-Qamar, Kalaf M Aljader, Hazem Habbob. Isolated renal hydatid disease: Experience at Queen Rania Urology Center, the King Hussein Medical Center. Saudi Journal of Kidney Diseases and Transplantation. 2004; 15 (2): 149-154.
21. Sang Won Han MD, Koon Ho Rha MD, Hye-Young Lee MD. Ureteropelvic Junction Obstruction Urology. EMedicin Pediatrics. Surgery, Jun 2006; 28: 1-5. (Medline).

الحصى البولي: الإصابة والعلاج الجراحي

ابراهيم درادكة

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الملخص:

أجريت هذه الدراسة في مدينه الحسين الطبيه، قسم جراحه الأطفال في الفترة ما بين 1997-2009 حيث اشتملت على 74 طفلاً (19 إناث 55 ذكور) تراوحت أعمارهم ما بين 3 أشهر و13 عاماً، اهتمت الدراسة بالعمر، الجنس، مكان وجود الحصى، التكوين الكيميائي للحصى، التشوهات الخلقية المصاحبة وكذلك نوع الإجراء الجراحي. حيث أظهرت ان نسبة الإصابة دون سن الثانية من العمر (24%) منهم (85%) من الذكور أما مكان وجود تلك الحصى فكان مانسبته 62%، 12%، 25.6% في الكلى، الحوالب، المثانة على التوالي. وما نسبته (43%) (Metabolic) يعود الى بعدة الايضى و 3% إلى التشوهات الخلقية المصاحبة (Association congenital abnormalities) في الحوالب والمثانة. أما البعد الجغرافي فإن إنتشار الحصى عند الأطفال في الدول المتقدمة أقل بكثير مما هي عليه في الدول النامية. كما أظهرت الدراسة بأن أعراض المرض متعددة ومتنوعة وغير خاصة (Nonspecific) عند الأطفال وخاصة ممن هم دون سن الثانية من العمر. أما طرق العلاج، بالإضافة إلى الجراحة التقليدية وبواسطة المنظار فما يزال تكسير الحصى بواسطة (الأمواج القصيرة الترددية (ESWL) في المقدمة وهي الافضل.

الكلمات الدالة: الحصى البولي، الأطفال، الجراحة.