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Original Article

Study of Urinary Stones in Children at Tishreen University Hospital

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Abstract *- Urinary stones are a common disease, especially in civil societies, and the rate of stone formation in children has increased in previous decades at an annual rate ranging between 5% and 10%. The reasons leading to the formation of stones in children vary, and they may be recurrent stones that may affect the children's quality of life, the development of the urinary tract, and renal function. Aim: Determine the chemical composition of urinary stones in children, determine the metabolic and anatomical disorders that cause them, and come up with a preventive plan to prevent the recurrence of their stones. Materials and Methods: A prospective study of pediatric urinary stone patients who visited the Department of Urology at Tishreen University Hospital during 2022 and 2023. A chemical analysis was performed for the stones isolated from the patients, (129) child patients were included in the study. Results: The study included 129 patients with urinary stones: 83 male patients and 46 female patients. The patients were divided into two groups: a preschool group (46) children and a school-age group (83) children. The most common complaint in the first group was UTI (41.9%), and flank pain in the second group (40%). A positive family history was noted in 58% of the first group and 70.9% in the second group. Urinary tract abnormalities predisposing to stone formation were diagnosed in 18.6% of study patients. The most common type of stones were pure calcium oxalate stones, at a rate of 43.4%. The presence of a metabolic disorder was recorded in 84.8% of the first group and 79.5% of the second group. The most common metabolic disorder among the study patients was hypercalciuria, followed by hypocitraturia. A high rate of stone recurrence was observed when there was an early onset of stone disease, a positive family history of stone disease, or the presence of anatomical abnormalities in the urinary tract. Conclusions: It is recommended to analyze the components of urinary stones to determine the chemical composition and apply an adequate radiological and metabolic study for children with urinary stones on the Syrian coast to determine the cause of stone formation, especially in patients with stone recurrence and preschool age children, to prevent recurrence, which reflects a better quality of life for the patient, reduces treatment costs, and ensures Maintaining healthy development of the kidneys and urinary tract.*

Keywords *- Urinary stones, Urolithiasis in children, Stones recurrence, Syrian coast.*

1. Introduction

Urinary stone disease, also known as urolithiasis, is a widespread condition that is becoming increasingly common, particularly in urban and developed areas around the world. Studies show that approximately 1-15% of individuals will develop urinary stones at some point in their lives, regardless of age.

In the past, urinary stones rarely formed before the age of 20. However, in recent times, there has been a worrying increase in pediatric urolithiasis, with a reported yearly rise of 5%-10% [1]. The exact causes for this trend are not entirely clear, though some risk factors, such as obesity, metabolic syndrome, and epidemiological shifts, may be contributing to the growing incidence of urinary stones among children and adolescents [2].

Pediatric urolithiasis presents significant challenges for children and their families, as it can manifest as a singular occurrence or a recurring issue [3], posing potential long-term implications on kidney function [4]. Various predisposing factors, such as anatomical irregularities, play a crucial role in the development and recurrence of urinary stones, especially when identified early in childhood [5].

Urinary stones are classified based on their mineral composition into two primary categories:

The first group, which accounts for most cases, is calcium-containing stones. It comprises various stones, such as calcium oxalate, hydroxyapatite, and brushite stones. The second group is non-calcium stones, which include uric acid stones, struvite stones, cystine stones, and drug-induced stones [6].

Urinary stones can be classified based on the proportion of their component minerals: a pure stone consists of at least 80% of a single mineral component, while a mixed stone has a primary mineral component comprising less than 80% of the stone's composition and additional minerals [7].

2. Research Significance and Objectives

Urinary stones in children can have significant ramifications, causing complications such as recurrent urinary tract infections, colic episodes, and hydronephrosis. These complications may lead to challenges like school absenteeism, hospitalizations, and potential impacts on urinary tract development and kidney function. Long-term consequences can include kidney function deterioration or failure, affecting a child's future quality of life and resulting in substantial financial burdens. Therefore, it is imperative to conduct comprehensive studies to unveil the causes of stone formation, reduce recurrence rates, and address the underlying factors contributing to urolithiasis in children. These investigations involve clinical assessments, radiological and laboratory examinations, as well as metabolic evaluations of the stones. Accurately determining the chemical composition of the stone and identifying any associated metabolic or anatomical disorders are essential steps in developing an effective prevention plan.

2.1. Research Sample

The study included pediatric patients (under 18 years old) diagnosed with urolithiasis who visited Tishreen University Hospital in Lattakia, Syria, in 2022 and 2023. The extracted stones from each patient were analyzed, and a comprehensive case study was conducted.

2.2. Exclusion Criteria

Some patients were excluded from the study if they did not undergo stone analysis, lost to follow-up did not complete the required laboratory and radiological investigations, or were over 18 years of age.

3. Materials and Methods

The study conducted a comprehensive analysis of pediatric patients with urolithiasis who visited the study centre. Chemical analysis of extracted stones was performed [8,9] using chemical reagents from Medichem Middle East under the license of the parent company in Germany [10]. Following the identification of stone components, patients were enrolled in the research plan with informed written consent from parents after receiving comprehensive information on the research methodology. A dedicated form was created for each patient, including:

1. Patient information: age, sex, weight, comorbidities, previous medical and surgical history, and primary complaint.
2. Family history: To determine the presence of a positive family history of stones among relatives and to determine any consanguinity between the parents.
3. Stone information: number, location, history, and method of stone extraction (spontaneous passage, medical treatment, minimally invasive surgery, or invasive surgery).
4. Laboratory tests: urinalysis, 24-hour urine collection, analysis of calcium, magnesium, phosphorus, citrate, and oxalate levels, kidney function tests, and PTH when necessary.
5. Radiological investigations: ultrasound, KUB, CT scan, intravenous urography, VCUG, PET scan.
6. Follow-up results: To determine the presence of stone recurrence and study the history of the patient with stones.

4. Results

The research sample included 129 pediatric patients who visited Tishreen University Hospital and were diagnosed with urolithiasis. The children were divided into two groups for ease of study and analysis: the first group comprised preschool patients (under 6 years old), and the second group comprised school-age patients (6 years > age <18). The patients' ages ranged from 1.5 to 17.5 years, with 83 males (64%) and 46 females (36%) included in the study.

Table 1. Distribution of study patients by gender

	Number of patients	Male	Female	P-value
The first group	46	28	18	0.4
The second group	83	55	28	0.1

Table 1 shows a male-to-female ratio of 1.59:1 and 1.89:1 in the two groups, respectively, with a P-value greater than 0.05.

This indicates that gender does not have a statistically significant influence on the formation of stones in children.

Table 2. Distribution of study patients by the main complaint

The main complaint	The first group	The second group
Abdominal pain/flank pain	32.3%	40%
Urinary tract infection	41.9%	30.9%
Urine discoloration/hematuria	12.9%	9.1%
Lower urinary tract symptoms	……	3.6%
Nausea and vomiting	6.4%	5.5%
Asymptomatic	6.5%	10.9%

The primary complaints for the initial visit of the study's patients, whether to the clinic or the emergency department, varied as shown in the following table.

According to the findings presented in Table 2, urinary tract infections were found to be the most common complaint in children under the age of six, while loin or abdominal pain was a more prevalent complaint among school-age children. Therefore, it is important not to overlook the presence of a urinary tract infection in children, especially if it is recurring or unresponsive to treatment.

It was also noted that incidental stones were diagnosed in a significant number of children in both age groups. Consequently, it is recommended that periodic radiological follow-ups be implemented for children, particularly those with a history of stones.

After reviewing the medical records, it was observed that a positive family history of urinary stones among relatives is a prevalent finding. Additionally, the presence of consanguinity between parents was noted to escalate the likelihood of stone formation at younger ages. A considerable percentage of patients exhibited urinary abnormalities that predisposed them to stone formation. Notably, four cases in the school-age group, representing 7.3% of the cohort, presented with chronic kidney failure, possibly attributed to the presence of stones, particularly in cases of frequent recurrence.

A KUB X-ray and ultrasound were performed for all study patients, and some other investigations were conducted as needed, such as IVP, VCUG, CT, and Renal Scintigraphy.

Both groups had similar incidences of urinary tract abnormalities, leading to stone formation, as diagnosed by the radiological investigations. Ureteropelvic junction obstruction was the most common abnormality found, then Vesicoureteral reflux and Obstructive megaureter, while Ureterocele had the lowest percentage (Table 3).

Table 3. Urinary tract abnormalities associated with stone formation

Anatomical malformation	The first group		The second group	
	N	%	N	%
Ureteropelvic junction obstruction	4	8.7%	8	9.6%
Vesicoureteral reflux	2	4.3%	4	4.8%
Obstructive megaureter	3	6.5%	2	2.4%
Ureterocele	0	0%	1	1.2%
The total	9	19.5 %	15	18.1 %

Chemical analysis was performed to determine the components of the isolated stones. It was observed that pure calcium oxalate stones were the most frequently diagnosed stones, accounting for 43.4% of all cases in the pediatric urolithiasis study. Moreover, mixed stones containing calcium oxalate and other chemical compounds were also commonly diagnosed. Interestingly, pure cystine stones were only detected in seven patients, while no cases of Struvite stones were recorded in the study. It was also observed that mixed stones were more common in school-age children.

After a 24-hour urine study of the patients, it was noted that 39 patients had a metabolic disorder in the first group, at a rate of 84.8%, and 66 patients with a metabolic disorder were recorded in the second group, at a rate of 79.5%. Hypercalciuria was the most common disorder among all the children in the study, followed by hypocitraturia, then hyperuricosuria in the children of the first group, and hyperoxaluria in the children of the second group.

Table 4. Distribution of patients according to the chemical composition of the stones

Chemical composition of stones	The first group		The second group	
	N	%	N	%
Pure stones	33	71.7%	51	61.4%
Calcium oxalate	19	41.4%	37	44.6%
Calcium phosphate (Carbonate Apatite)	6	13%	5	6%
Uric acid	2	4.3%	3	3.6%
Ammonium urate	3	6.5%	2	2.4%
Struvite	0	0%	0	0%
Cystine	3	6.5%	4	4.8%
Mixed stones	13	28.3%	32	39.6%
Calcium oxalate + Carbonate apatite	7	15.3%	16	19.3%
Calcium oxalate + Uric acid	2	4.3%	7	8.5%
Calcium oxalate + Ammonium urate	3	6.5%	3	3.6%
Calcium oxalate + Cystine	1	2.2%	4	4.8%
Uric acid + Cystine	0	0%	2	2.4%

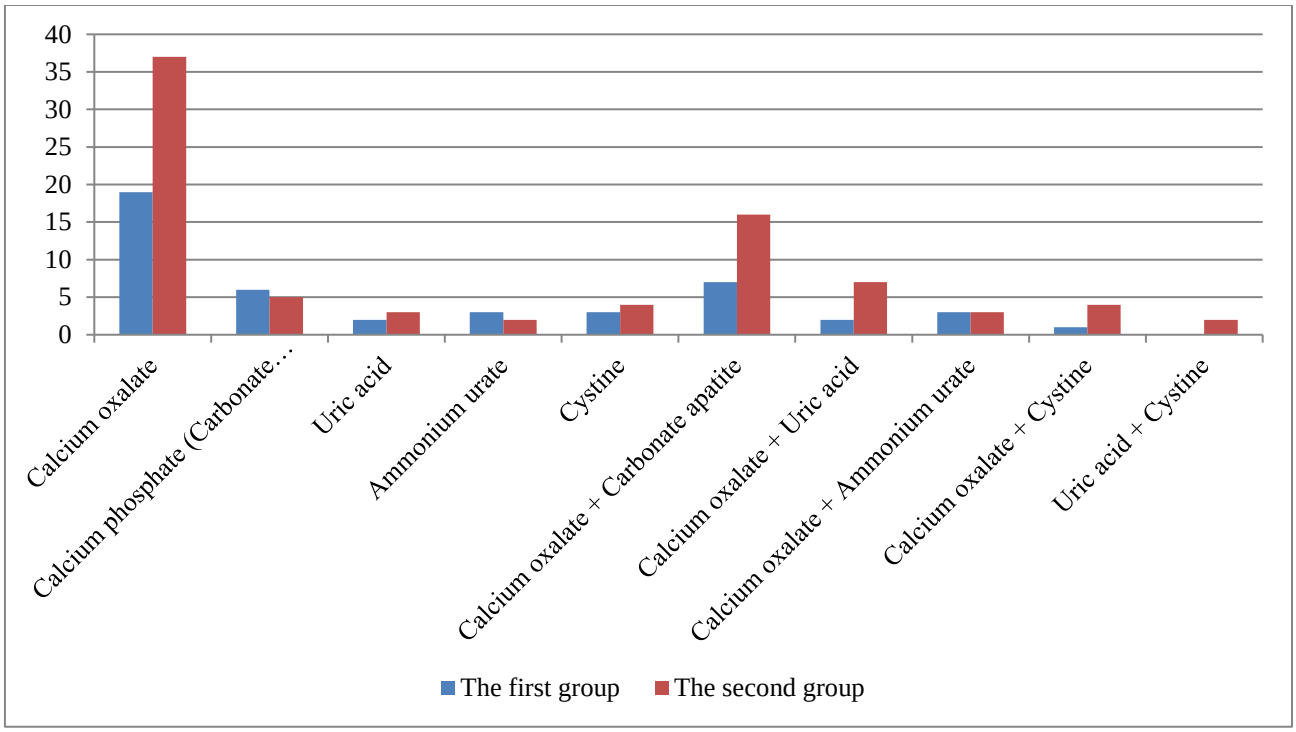

Fig. 1 Distribution of patients according to the chemical composition of the stones

Table 5. Distribution of patients according to the type of urinary metabolic disorder

Metabolic disorder in urine	The first group		The second group	
	N	%	N	%
Hypercalciuria	15	32.6%	39	48%
Hyperoxaluria	7	16.2%	15	18%
Hyperuricosuria	9	19.5%	12	14.5%
Hypocitraturia	12	26%	25	30.1%
Hypomagnesiuria	3	6.5%	7	8.4%

Table 6. Distribution of patients according to the type of urinary metabolic disorder and the occurrence of stone recurrence

Metabolic disorder in urine	Diagnosing stones for the first time		stone recurrence		P-value
	N	%	N	%	
Hypercalciuria	30	41.7%	24	42.1%	0.21
Hyperoxaluria	5	6.9%	18	31.6%	0.01
Hyperuricosuria	12	16.7%	27	47.4%	0.03
Hypocitraturia	15	20.8%	5	8.8%	0.5
Hypomagnesiuria	9	12.5%	3	5.2%	0. 1

According to Table 5, hypercalciuria was the most prevalent metabolic disorder found in all of the children in the study, followed by hypocitraturia, then hyperuricosuria in the children of the first age group. In children belonging to the second age group, hyperoxaluria was the second most common disorder found.

All study patients were divided according to stone recurrence into two groups - the first group comprised 72 patients with no history of stone recurrence. In contrast, the second group included 57 patients who had previously been diagnosed with at least one urinary stone (patients with stone recurrence). The relationship between the occurrence of stone recurrence and accompanying metabolic disorders in patients was studied, and the following results were observed.

We notice from the previous table that the incidence of stone recurrence in the study patients was high when one of the following disorders was present: hyperoxaluria and hypocitraturia, where the P value was smaller than 0.05, which indicates the presence of significant statistical significance among patients in this group.

At the end of the study, the recurrence rate was calculated by dividing the number of stone recurrences by the period

between the first diagnosis of a stone and the current recurrence, estimated in years, according to the following equation:

Recurrence rate = (number of stone recurrences)/(the period)

In the study, it was noted that the rate of stone recurrence was markedly higher in the preschool-age group, with statistical significance (P-value=0.01), suggesting a correlation between early onset of stone disease in children and increased recurrence rates. Furthermore, the findings indicated that a positive family history of urinary stones was associated with elevated recurrence rates, underscoring the significant influence of family history on the likelihood of stone recurrence in children diagnosed with urinary stone disease.

In addition to the above, it was also found that stone recurrence rates were higher when there was an anatomical deformity in the urinary tract.

5. Discussion

This study aimed to investigate the characteristics and metabolic disorders associated with pediatric urinary stone disease. The study included 129 child patients who visited the center during the years 2022 and 2023 under the age of 18, and urinary stones were extracted from them. We found that there was no significant difference between males and females in the formation of stones in children. The most common symptom was UTI in preschool children, flank pain or abdominal pain in school-age children, and some cases of asymptomatic stones. Urinary tract abnormalities were seen in both age groups, and the ureteropelvic junction obstruction was the most common abnormality. Pure calcium oxalate stones were the most common stones at a rate of 43.4%, with several types of pure and mixed stones containing calcium oxalate and other chemical compounds diagnosed. Metabolic disorders were prevalent in both age groups, with hypercalciuria being the most common disorder. Stone recurrence was recorded in 57 children, and urinary stone recurrence was high when there was a metabolic disorder present, especially hyperoxaluria and hypocitraturia. The rate of stone recurrence increases in preschool children when there is an anatomical abnormality and when there is a positive family history of stone disease in one of the parents.

Recent trends indicate a rising occurrence of urinary stone disease among children, accompanied by changes in stone composition and reduced risk factors for recurrent disease. This evolving landscape in the incidence and characteristics of pediatric stone disease has sparked research endeavors aimed at unraveling the underlying metabolic disorders and pathogenesis of this condition. Notably, various studies have provided valuable insights into the nuances of pediatric stone disease, shedding light on its complexities and contributing to the body of knowledge in this field.

In discussing this study in the context of existing literature, it is necessary to explore how our findings correlate with or diverge from other significant research in the field of urology about urinary stones. The studies by D'Alessandro et al. (2017) [11], Elmacı et al. (2014) [12], and Lee et al. (2016) [13] provide substantial insights that can be used to frame our discussion.

Starting with the study by D'Alessandro et al. Calcium oxalate stones were the most frequently diagnosed stones in a Tunisian study involving 205 children, with mixed calculi having the highest prevalence counts in the pediatric population. This study recommends analyzing urinary stones because it is a useful tool for determining calculi composition and follow-up to prevent recurrence.

In the study by Elmacı et al., A retrospective analysis of 143 preschool-age children with urolithiasis in southeast Anatolia found that the most common clinical finding was abdominal pain, and the majority of children had obstructive uropathy at presentation. The most common metabolic abnormality was hypercalciuria, followed by hypocitraturia. The study recommended metabolic evaluation for all children with urolithiasis to diagnose and manage possible coexisting metabolic abnormalities.

Furthermore, the work by Lee et al. conducted a study on the clinical findings and metabolic etiology of urolithiasis in Korean children. The study included 73 newly diagnosed Korean children with urolithiasis, analyzed retrospectively. Hypercalciuria was the most common metabolic abnormality, followed by hypocitraturia.

6. Conclusion

The prevalence of pediatric urinary stone disease is on the rise, emphasizing the importance of identifying and addressing metabolic disorders linked to urolithiasis in children. This proactive approach is crucial for mitigating stone recurrence and minimizing associated morbidity. It is essential to conduct thorough characterizations of urinary stones in children through chemical analyses to ensure accurate evaluation. Additionally, all children diagnosed with urolithiasis should undergo 24-hour urine analysis to assess metabolic profiles and detect potential infections, thereby aiding in comprehensive management and prevention strategies.

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