Investigating the prevalence and causes of kidney and urinary tract stones in children admitted to Shahid Beheshti Hospital in Kashan

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ABSTRACT

Kidney and urinary tract stones are one of the most important problems in pediatrics, which are increasing in prevalence today due to sedentary life, improper nutrition, wrong habits in fluid consumption, and improper use of drugs. Kidney stones can be caused by various reasons, including metabolic disorders, urinary tract anomalies, and urinary infections. The purpose of this research is to investigate the prevalence and causes of kidney and urinary tract stones in pediatric patients aged 1-15 years admitted to Shahid Beheshti Hospital in Kashan.

This was a descriptive-analytical retrospective cross-sectional study in which the files of 68 children aged 1-15 years referred to Shahid Beheshti Hospital in Kashan in the period of 2010-2019, in which the presence of stones in them was proven through ultrasound, were examined. All cases were examined in terms of family history, urine culture, examination of urine crystals and anatomical disorders. Data analysis was done using SPSS statistical software and descriptive statistics.

In this study, 68 children (70% male and 30% female) with an average age of 5.19 ± 4.22 years were investigated. 25% had a family history of urinary stones. The most common complaint when patients came to visit was abdominal pain, followed by restlessness and renal colic. In 28% of cases where urine culture was done, the result was positive. The most common anatomical disorder in patients was bladder-ureteral reflux (VUR) and ureter-pelvic junction obstruction (UPJO). At least one metabolic disorder was present in 75% of cases, the most common metabolic disorder in this study being Hypercalciuria. 50% of cases had kidney stones.

In this study, the most common disorder associated with urinary stones in children was hypercalcemia. The most common anatomical disorders in these patients are VUR and UPJO, the most common site of stone formation is the kidneys, and the most common symptom when the patients were referred was abdominal pain.

Keywords: Pediatrics, Urolithiasis, Hypercalciuria, Metabolic Disorder, Anatomical disorder.

Introduction

Kidney stones and urinary tract stones are significant issues in pediatric medicine, and more prevalence today due to modern lifestyles, poor nutrition, incorrect habits, and inappropriate use of medications. After urinary tract infections and prostate diseases, urinary stones are considered the third most common disease of the urinary system (1). The formation of urinary stones, or urolithiasis, depends on the interaction between genetic and environmental factors such as gender and age, race, climate conditions, family history, anatomical abnormalities, urinary infections, lifestyle, malnutrition, medications, and obesity. According to reports, more than 15% of Caucasian men and 6% of women in the population will experience one type of kidney stone during their lifetime (2). The prevalence of this disease varies in different regions of the world, with its incidence being 3% in Britain, 1.3% in Italy, 8.6% in Germany, 5.9% in Sweden, 12% in the United States, and between 5-10% in Iran (3). Adults are 50-75 times more likely to develop kidney stones than children. Overall, the prevalence of kidney stones in children is lower than in adults. This difference is due to higher levels of citrate and magnesium in the urine of children compared to adults, and also because children's urine contains more substances that prevent crystals from adhering to the renal epithelium (4). However, despite the relatively low prevalence and incidence in children (compared to adults), urinary tract stones are associated with morbidity and a high rate of recurrence (5). It is noteworthy that the increased incidence of urinary stones in adults is primarily due to environmental factors, including lifestyle, while in children, it is more related to anatomical abnormalities of the urinary tract and metabolic disorders (5, 6).

Different anatomical disorders, such as ureteropelvic junction obstruction (UPJO), ureterocele, vesicoureteral reflux, horseshoe kidney, tubular ectasia, and sponge kidney, lead to urinary stasis and stone formation (5). Additionally, underlying metabolic diseases are often observed in many children with kidney stones, with hypercalciuria being the most prevalent among them (7). Other metabolic risk factors also play a role with varying frequencies, among which hypocitraturia has been reported as an uncommon cause of kidney stones in children (6). The study conducted by Tohidi et al revealed the most common clinical findings in patients with kidney stones were restlessness, dysuria, flank pain, and abdominal pain. Additionally, metabolic disorders such as hypercalciuria were the most common (29.8%), followed by hyperuricosuria in 26%, hyperoxaluria in 19.2%, hypocitraturia in 12.5%, and cystinuria in 0.96% (8).

Efforts to prevent the formation of kidney stones in individuals who have previously experienced kidney stones, who are at risk of recurrence, are also very important in terms of the medical and treatment costs that these people incur (9). The complications of kidney stones, hospitalizations, and treatment costs indicate that kidney stone disease can be a serious health problem that significantly affects the quality of life of patients (10).

Therefore, due to the lack of precise information on the prevalence and types of kidney stones in children in Kashan County, this study was conducted. The aim of this research is to investigate the prevalence, causes of kidney and urinary tract stones, and laboratory and paraclinical findings in children aged 1-15 years who were hospitalized at Shahid Beheshti Hospital in Kashan during the years 2010-2019.

Methods

Study design

This retrospective cross-sectional study was conducted on 68 children (48 males + 20 females) diagnosed with urinary tract stones, with a mean age of 22.4 ± 19.5 years (age range 1 to 15 years), who visited Shahid Beheshti Hospital in Kashan from 2010 to 2019. Initially, the patients' records were extracted from the hospital's HIS system and retrieved from the archives, during which 78 records were reviewed. The records of children under one year were separated and excluded from the study (due to differences in etiology). The study was conducted on the remaining 68 records. To enter the study, confirmation of stone presence via ultrasound was required; in 2/3 of the records, ultrasound reports were available, while in the remaining 1/3, there were references to the ultrasound in parts of the records (medical history, order sheets, and physician reports) along with brief information, and thus no records were excluded on this basis. Information regarding demographic variables (age, gender, and family history of kidney stones), abnormalities in urinary tests (hypercalciuria, hyperoxaluria, hyperuricosuria, hypercystinuria, and hypocitraturia), serum parameters (calcium and creatinine), and anatomical abnormalities were extracted and analyzed from the medical histories recorded in the files.

Due to the update of the hospital's HIS system in 2014 and the lack of access to information regarding tests for patients admitted before that year, only the information recorded in their files was utilized. In the review of tests, urine cultures, urinalysis, 24-hour urine collections, random urine tests, and stone analyses were examined. Unfortunately, 24-hour urine collections and random urine tests had not been performed for many patients. Given the importance of

these two tests for this study, the request forms for all records were checked, and in several cases, the requests for these tests were noted after discharge in the comprehensive laboratory, which were followed up in coordination with the laboratory manager. It is worth mentioning that no tests were requested to analyze urinary salts for 20 patients. Due to the absence of urinary stone analysis in the laboratory of Shahid Beheshti Hospital, the analysis of the stones for the relevant patients was pursued in the comprehensive laboratory, where only four stone analyses were available, three of which were calcium oxalate and one was cystine. The serum electrolyte analysis was collected from the Shafa system, and for the records prior to 2014, the information was gathered from what had been manually recorded in the files. Imaging studies conducted were reviewed in the records from 2014 onwards through the reports of radiologists, and for records prior to 2014, the information was obtained from the data recorded in the files.

Statistical Analysis

Data analysis was performed using SPSS statistical software (version 16). The data were analyzed using descriptive statistics (frequency distribution, measures of central tendency, and dispersion).

Table 1. Standard Levels of Urinary Factors at Different Ages.

Urinary Factor	Age	Relative to Creatinine mmol/mmol	mg/mg
Calcium	0-1 year	2.29	0.81
	1-2 years	1.58	0.56
	2-3 years	1.41	0.50
	3-5 years	1.16	0.41
	5-7 years	0.85	0.30
	7-10 years	0.71	0.25
	10-17 years	0.68	0.24
Oxalate	> 6 months	0.37	0.29
	6 months - 2 years	0.26	0.20
	2-5 years	0.14	0.11
	6-12 years	0.08	0.063
	< 18 years	0.04	0.031
Cystine	> 1 month	85	180
	1 month - 6 months	53	112
	< 6 months	18	38
Uric Acid	> 12 months	1.5	2.2
	1-3 years	1.3	1.9
	3-5 years	1.0	1.5
	5-10 years	0.6	0.9
	< 5 years	0.4	0.6
Citrate	0-5 years	0.25	0.42
	< 5 years	0.15	0.25
Magnesium	0-1 year	2.2	0.48
	1-2 years	1.7	0.37
	2-3 years	1.6	0.34
	3-5 years	1.3	0.29
	5-7 years	1.0	0.21
	7-10 years	0.9	0.18
	10-14 years	0.7	0.15
	14-17 years	0.6	0.13

Results

In this study, the records of 68 children (48 males + 20 females) with urinary tract stones were examined, with a mean age of 22.4 ± 19.5 years (age range 1 to 15 years). Table 2 shows the frequency distribution of patients based on clinical and paraclinical characteristics.

Table 2. Frequency Distribution of Patients in the Study Based on Clinical and Paraclinical Characteristics

Variable	Frequency (Percentage)
Family history of urinary stones (Yes)	17 (25.0)
Family history of urinary stones (No)	51 (75.0)
Retention	1 (1.5)
Restlessness	13 (19.4)
Fever and chills	8 (11.9)
Abdominal pain	16 (23.9)
Renal colic	12 (17.9)
Dysuria	8 (11.9)
Hematuria	9 (13.5)
Not recorded in the file	1
Bladder location of stone	14 (21.2)
Kidney location of stone	23 (34.9)
Ureter location of stone	17 (25.8)
Urethra location of stone	2 (3.0)
Multiple	11 (16.6)
Not recorded in the file	2
Negative urine culture	35 (71.4)
Coagulase-negative staphylococcus	1 (7.1)
Enterococcus	2 (14.3)
Escherichia coli	6 (42.8)
Unknown	5 (35.8)
Not recorded in the file	19
None anatomical disorder	4 (23.5)
bladder diverticulum	1 (5.9)
Reflux	3 (17.6)
Single kidney	1 (5.9)
UPJO (Ureteropelvic Junction Obstruction)	1 (5.9)
Absence of urinary tracts	1 (5.9)
Nephrocalcinosis	1 (5.9)
Duplication left	2 (11.8)
Hypospadias	1 (5.9)
Duplication right	1 (5.9)
Urethral stricture	1 (5.9)
Not recorded in the file	51
Hypercalciuria	21 (43.8)
Hyperoxaluria	8 (25.0)
Hyperuricosuria	10 (31.2)
Cystinuria	2
Mean creatinine (Cr)	0.19 ± 0.66

Variable	Frequency (Percentage)
Calcium 8-10	17 (51.5)
Calcium 10-11	13 (39.3)
More than 11	3 (9)
Not recorded in the file	35

Table 2 shows that 25% of patients had a family history of urinary stones in first-degree relatives. The most common symptom upon presentation was abdominal pain (23.9%), followed by restlessness in 13 patients (19.4%), renal colic in 12 patients (17.9%), hematuria in 9 patients (13.5%), fever and chills in 8 patients (11.9%), dysuria in 8 patients (11.9%), and urinary retention in 1 patient (1.5%).

The most common location of the stone was in the kidney (34.9%), followed by bladder stones (21.2%), ureter stones (24.3%), and urethral stones (3%). Sixteen point six percent of cases had multiple stones. In total, considering multiple cases, 50% had kidney stones, 30% had ureter stones, 21.2% had bladder stones, and 3% had urethral stones.

In 19 records, no information was recorded about urine cultures (in some cases, these tests were not requested, and in some older records, the ability to record was not possible due to the HIS system change in 2014 and the lack of system access to the tests).

Among the 49 urine culture tests conducted, 35 (71.4%) were negative, and 14 (28.6%) were reported positive. Among the positive cases, 42.8% were contaminated with Escherichia coli, 14.3% with Enterococcus, 7.1% with coagulase-negative staphylococcus, and in 35.8% of cases, the type of contamination was unspecified.

In the medical history of 48 patients, no anatomical disorder was reported (in other words, the anatomical examination and system review were reported negative), and no additional imaging studies were performed. Anatomical disorders were determined based on direct observation and examination of abnormalities in imaging, which indicated that in the remaining 20 cases, two cases had labial adhesions, one case had undescended testis, and one case had hypospadias reported. In 16 cases, based on imaging studies (IVP KUB, DMSA, etc.), four cases (23.5%) had normal imaging. Three cases (17.9%) had reflux, three cases (17.9%) had obstruction at the ureter-pelvic junction (UPJO), one case (5.9%) had absence of urinary tracts, one case (5.9%) had nephrocalcinosis, two cases (11.8%) had duplication of the urinary system, one case (5.9%) had urethral stricture, one case (5.9%) had a single kidney, and one case (5.9%) had a bladder diverticulum with right kidney reflux.

Diagnosis of metabolic cases is made through random urine and 24-hour urine tests, which were not requested for 20 patients. Results regarding urinary salts indicated that 24-hour urine tests were requested for 32 patients. In these patients, the levels of calcium, oxalate, and uric acid in urine were examined, and only in three cases was cystine testing requested. Citrate was not requested or reported in any of the cases. Additionally, random urine tests were requested for 16 patients, but only urinary calcium was reported. According to the obtained results, among the 48 cases in which urinary calcium was examined (the total of 24-hour and random urine cases), 21 patients (43.8%) had hypercalciuria. Among the 32 patients who underwent 24-hour urine tests, 8 patients (25%) had hyperoxaluria, and 10 patients (31.2%) had hyperuricosuria. Of the three cases in which cystine was checked, two cases were positive for cystinuria. Furthermore, among these 32 cases, 11 cases (34%) had mixed disorders, 13 cases (40%) had a single disorder, and 8 cases (25%) had no disorders. Overall, 75% of the cases that underwent 24-hour urine tests had disorders. Among the 11 cases with mixed disorders, 8 cases (72%) had metabolic disorders. The mean creatinine level in these patients was 0.66, and only 9% of cases had calcium levels above 11.

Discussion

The aim of the present study was to investigate the prevalence, causes of kidney and urinary tract stones, and laboratory and paraclinical findings in children aged 1 to 15 years hospitalized at Shahid Beheshti Hospital in Kashan. In this study, the incidence of urinary stones in males was significantly higher than in females. Similarly, a study conducted in 2024 on children under 15 years of age indicated a significant increase in the incidence of urinary stones in boys compared to girls. This increase may be related to higher sodium intake, the use of antimicrobial medications, reduced calcium and water consumption, poor nutrition, obesity, and a sedentary lifestyle (11). Additionally, researchers have reported that the incidence of urinary stones in the first decade of life is higher in males than in females, while in females, this incidence increases in the second decade of life (12). The results of the present study showed that the most common symptom upon patient presentation was abdominal pain, followed by restlessness, renal colic, hematuria, fever and chills, dysuria, and urinary retention. Additionally, 25% had a family history contributing to the formation of urinary stones. Similarly, a study by Tohidi and colleagues in Kermanshah on 104 children under one year of age with urinary stones found that 65% had a positive family history. The common clinical symptoms in patients were restlessness, dysuria, flank pain, and abdominal pain (8). Considering the common sites of stones among patients, such as upper/middle/lower calyces, renal pelvis, upper/middle/lower ureter, and bladder (13), the most frequent location of stone

formation in the present study was in the renal calyces. According to studies conducted, due to rising temperatures, dehydration, and increased heat in certain regions, the location of stones varies between developing and developed countries (14). One of the most significant risk factors for stone formation is the occurrence of metabolic disorders, which were examined in 75% of the cases in this study. Hypercalciuria, hyperuricosuria, and hyperoxaluria were the most common disorders, respectively. According to studies, metabolic disorders such as hyperuricosuria, hypercalciuria, hypocitraturia, hyperoxaluria, and cystinuria are very common among individuals with urinary stones (8, 15). Additionally, in a study conducted on adult patients, 92.8% of individuals had metabolic disorders (16). In a study involving 300 children with a mean age of 11.2 years, the ratio of males to females was found to be 1.15 to 1. Similarly, the most common clinical symptoms and metabolic factors among patients were renal and abdominal pain and hypercalciuria. Furthermore, urinary tract infections were reported in women (41%) and men (18.1%). The most common site of stones in these patients (97.5%) was recorded in the upper urinary tract (12). Differences in the most common metabolic disorders among patients may also be due to variations in dietary habits, genetics, socio-economic status, race, culture, and differences in local water quality, etc. (12). In another study on patients with urinary stones (under 14 years old with a mean age of 3.35 ± 3.2), the most common metabolic factor reported was hypocitraturia at 56.8% (17), which could be due to the lack of citrate testing in the present study.

In the current study, urine culture tests were positive in 28% of patients (49 out of 68), with Escherichia coli being the most common causative microorganism. Anatomical disorders in the urinary system are one of the predisposing factors for stone formation. In the medical history of 48 cases, no anatomical disorder was mentioned, and no additional imaging was performed. In the remaining 20 cases, the most common anatomical disorder was reflux from the bladder to the ureter and obstruction at the ureter-pelvic junction. In line with these findings, a study by Mohkam and colleagues showed that 5.8% of urinary stone cases were associated with anatomical problems, and 19.8% were associated with urinary infections. In examining the metabolic causes of urinary stones, it was found that hypercalciuria was present in 73.5% of all patients (18). Additionally, a study on 106 patients with urinary stones in Brazil showed that the most common anatomical abnormality among patients was stenosis at the junction of the renal pelvis to the ureter. Furthermore, in most patients, metabolic changes such as hypercalciuria, hypocitraturia, and hyperuricosuria were reported. The most common sites of stones were recorded as 34% in the renal pelvis and ureter, 29% in the kidney, 17% in the ureter, 9% in the bladder, and 1.9% in the urethra (19).

Limitations

This study was conducted retrospectively, and its main limitation was the incompleteness of patient records, including incomplete medical histories, incomplete documentation (ultrasound and imaging reports), failure to perform 24-hour or random urine tests in some patients, and lack of complete access to tests conducted before 2014.

Research Recommendations

It is recommended to maintain accurate and continuous monitoring of information, and in the future, to conduct 24-hour or random urine tests for all hospitalized patients due to kidney stones. Additionally, it is suggested that a similar study be conducted prospectively to allow for a thorough evaluation of all studied factors.

Conclusion

The present study indicated that the most significant risk factor for stone formation is the presence of metabolic disorders, with hypercalciuria being the most common. Other influencing factors in the occurrence of urinary stones included urinary tract infections and anatomical disorders. In this study, the most common symptom at the time of patient presentation was abdominal pain, and the most common site of stone formation was the kidneys.

Ethical Issue

In this study, all ethical considerations were taken into account. This study has been registered with the ethical code IR. KAUMS.MEDNT.REC1400.071.

Conflict of Interests

There was no conflict of interest in this study.

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