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Original research article

Metabolic evaluation and stone analysis in cases of pediatric urolithiasis: A prospective study

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Abstract

Aim: This study aims to analyze the stones and evaluate for any metabolic cause in pediatric patients with urolithiasis.

Materials and methods: A prospective observational study was done in the department of urology, NIMS, on 30 patients with urolithiasis.

Results: Calcium oxalate stones were the most common type of stone found in patients with renal stones and ureteric stones discreetly. Hypercalciuria was the most prevalent metabolic abnormality found in this study.

Conclusion: Owing to the high prevalence of metabolic risk factors and the significant risk of recurrence, all children with urolithiasis need complete evaluation with metabolic workup and ensure complete removal of stone.

Keywords: Metabolic evaluation, pediatric urolithiasis, hypercalciuria

Introduction

Urolithiasis is associated with significant morbidity in the pediatric age group. An estimated incidence of pediatric stone disease is between 1:10,000 to 1:7000 pediatric admissions [1]. Urolithiasis in the pediatric population is observed less frequently than in adults but causes significant morbidity, financial burden, and higher recurrence rates (6.5-44% with a 3-6 year recurrence interval) and may have detrimental long-term effects on renal function [2]. Urolithiasis in the pediatric population is more likely secondary to a metabolic abnormality.

The incidence of stone disease in children is very much in increasing trend currently. This could be due to the recent recognition of varied presentations of stone disease, the use of improved radiographic techniques and advances in medical facilities that have resulted in survival through childhood and adolescence of an increasing number of patients with conditions that are associated with urolithiasis like cystic fibrosis, metabolic disorders.

Due to high recurrence rates, all pediatric cases with urolithiasis must undergo thorough metabolic evaluation and ensure complete clearance of stone [3].

The most common type of stone was found to be calcium oxalate and the most common abnormality was hypercalciuria [4].

The significance of identifying the underlying metabolic cause lies in the fact that the recurrence of stone can be avoided by treating the metabolic abnormality and also the most dreaded complication of end-stage renal disease could be prevented by appropriate treatment at appropriate time. This can also help us and the family to understand the prognosis of the disease, especially in children with inborn errors.

The scope of this study is to identify the prevalence of various metabolic parameters causing urolithiasis. This would help in formulating effective preventive strategies since this is a recurring problem in a significant proportion of patients.

Aims and Objectives

Aim

To evaluate pediatric patients presenting with urolithiasis for metabolic abnormality.

Objectives

To evaluate the correlation between pediatric urolithiasis and its association with metabolic abnormalities

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and to prescribe effective strategies as prophylactic measures for patients with detected metabolic abnormality.

Materials and Method

A Prospective observational study was conducted on 30 pediatric patients with urolithiasis, admitted for undergoing surgery, in the Department of Urology at Nizam's Institute of Medical Sciences, from January 2022 to May 2023.

Inclusion criteria

All Patients under 14 years attending Urology Outpatient and Inpatient department at Nizam's Institute of medical sciences, Hyderabad who have been diagnosed to have urolithiasis were included in this study with their guardian's consent.

Exclusion criteria

Children age more than 14 years and Patient with diagnosed metabolic dysfunctions were excluded from this study.

Procedure

After ethical committee approval and informed consent, patients were preoperatively evaluated by history, clinical examination, relevant blood profile (blood urea nitrogen and serum creatinine), and urine investigations (urine routine examination and culture). Diagnosis of stone disease is based upon the findings of ultrasound KUB, intravenous urography (IVU)/ NCCT KUB/CT Urogram. The evaluation was done to rule out any anatomic genito-urinary abnormalities, the number of stones, and the location of the stone.

After the confirmation of the stone disease, the patient and guardians were counseled regarding surgery. The surgical procedure was planned based on the size and location of the stone. Stone fragments extracted during surgery were sent for analysis to the Department of Biochemistry

Postoperative stone clearance was confirmed with X Ray KUB.

Three months after complete de-stoning, patients were prescribed blood and urinary workup to evaluate for the presence of any metabolic abnormality. like serum calcium, serum phosphorous, serum PTH, serum uric acid, urinary measurements of calcium, creatinine, uric acid, magnesium, citrate, and oxalate ABG (in renal tubular acidosis).

- If the child had urinary tract infection, the same was treated and then the child was evaluated for renal stones after a month. Subjects who were on pharmacologic doses of vitamin D, calcium, antacids, diuretics, potassium citrate, and vitamin C were asked to discontinue the medications for at least one 1 week, after which the metabolic evaluation was done. If the child had undergone any surgical procedure, the child was evaluated 3 months later.

Statistical analysis

Data were entered in Microsoft Excel and analyzed by using SPSS software v.25.0. Categorical data were expressed in terms of counts and percentages. Continuous data were expressed by Mean and SD. Appropriate tables and graphs were presented for data representation.

Results

In this study, 15 patients had renal stones and the other 15 patients had ureteric stones. The mean age of the patients with renal stones was 4.46±3.13 years and in patients with ureteric stones, it was 5.46±3.88 years. The overall mean age was 4.96±3.50 years. Majority of patients with renal stones (n = 8 (54%) and patients with ureteric stones (n =9 (60%) were below 5 years of age. Males: females ratio 1.5 :1.

Most of the renal stones patients (n =14 (93.3%) and ureteric stones patients (n =11 (73.3%) had complaints of pain abdomen.

The mean size of the renal stone was 14±2 mm and the ureteric stone was 9±5 mm. The overall mean size of the stones was 11±4 mm.

N =13 (86.7%) patients had renal stones of size more than 10 mm and only 2 (13.3%) patients had of size less than 10 mm. In the case of patients with ureteric stones, 4 (26.7%) patients had stones of size more than 10 mm, and 11 (73.3%) patients had them of size less than 10 mm.

It was observed that 4 (26.7%) patients had bilateral renal stones and 6 (40%) patients had bilateral ureteric stones.

Among the patients with renal stones, 2 (13.3%) of them had poly microbes in their urine and 1 (6.7%) patient had the presence of Klebsiella. However, in patients with ureteric stones, none of the patients had any bacteria in the urine.

In the case of patients with renal stones, the PCNL or RIRS method was applied and in the case of patients with ureteric stones, URSL was used.

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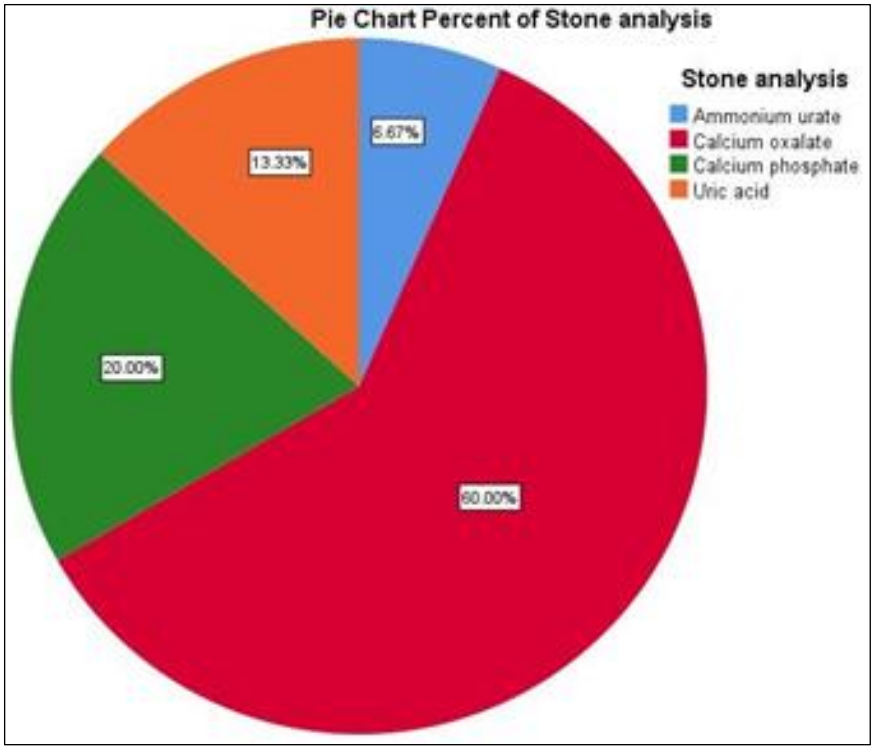
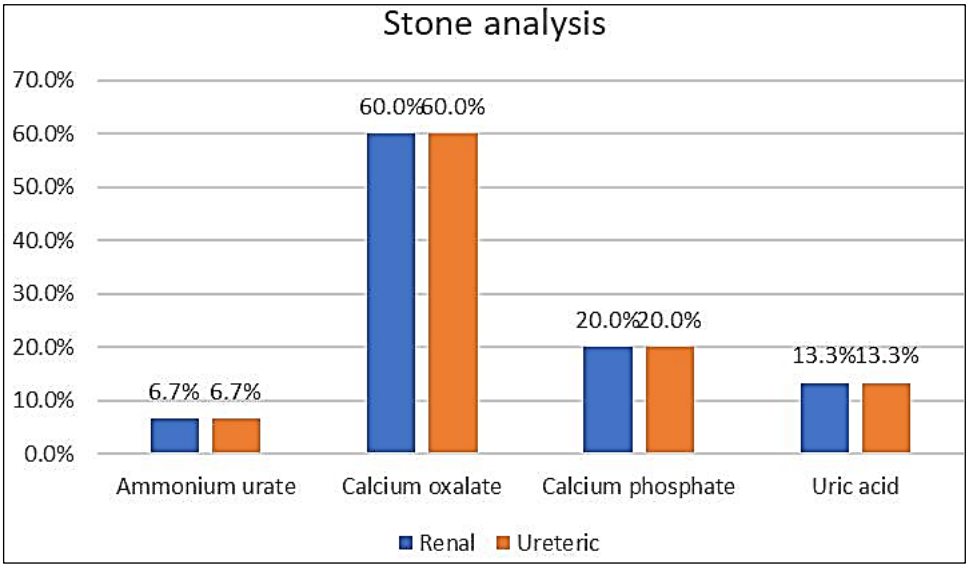


Fig 1: Pie chart representing the stone

Analysis of the study population.



Graph representing the analysis of the renal and ureteric stones.
It was observed that calcium oxalate stones (60%) were the most common type found in both the groups with renal and ureteric stones discretely.

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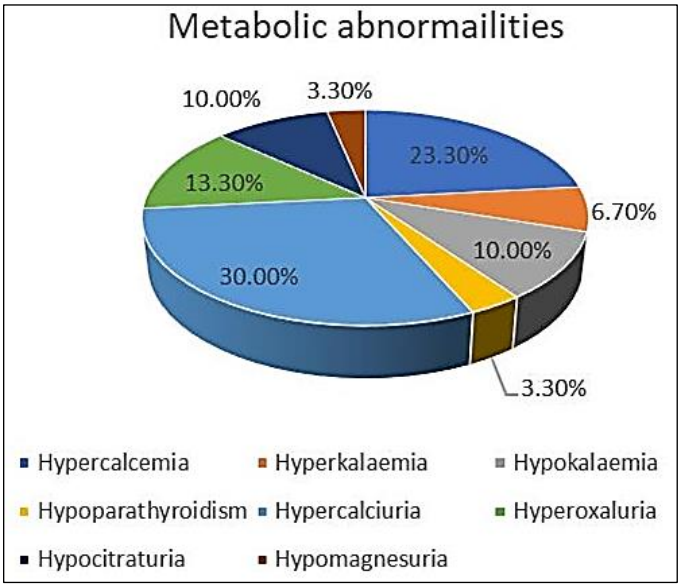
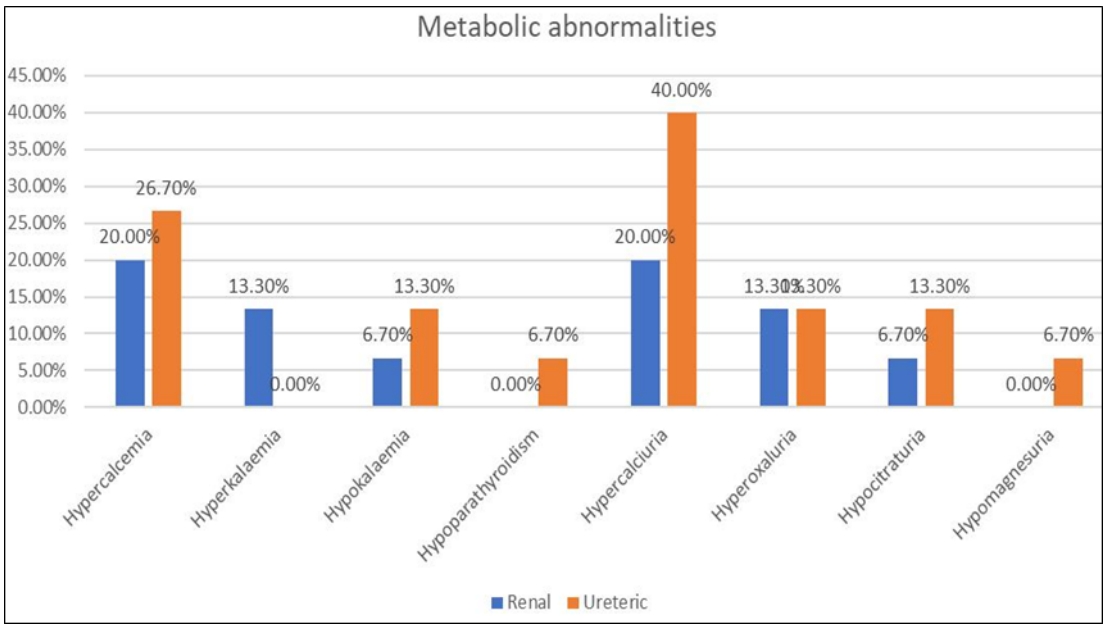
Chart representing metabolic abnormalities





Graph representing the metabolic abnormalities as observed in the study population.

It was observed that in the patients with renal stones, hypercalcemia (n = 3 (20%) was the most common metabolic abnormality. While, in the group of patients with ureteric stones, hypercalciuria (n = 6 (40%) was the most common metabolic abnormality.

Discussion

Urinary calculus disease has afflicted humankind for millennia. The rate of recurrent stones in childhood has been reported to be 6.5%-54% with a mean interval to recurrence of 3-6 years [5]. Only 1%-5% of children with urologic abnormalities develop calculi, suggesting a concomitant metabolic abnormality in patients that predisposes to calculi formation [4].

The evaluation of a child who presents with urolithiasis should be directed toward identifying physicochemical, anatomic, metabolic, and genetic factors predisposing to urolithiasis. Because of potential morbidity and risk of recurrence, metabolic evaluation is indicated in all children with urolithiasis [6].

Pediatric urolithiasis Etiology remains largely unknown. According to Several studies anatomical abnormalities, recurrent infection, lithogenic dietary habits, and metabolic factors predispose to stone formation. However, predisposing factors can be identified in 30%-80% of the patients [7]. An idiopathic cause is reported in up to 50% of cases in developing countries compared with <20% in developed nations [7, 8].

Anatomical abnormalities as a cause of calculus disease in a pediatric group were low in our series

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(3.6%, 1 ureterocele and 1 neurogenic bladder) [7, 9, 10]. Children with an identifiable metabolic disorder are nearly fivefold more likely to have recurrent stones than those with no identifiable metabolic disorder [7]. The study aims to identify the prevalence of metabolic abnormalities in children with urolithiasis.
In our study, 30 pediatric patients with urolithiasis were enrolled based on eligibility criteria. We found 15 pediatric patients having renal stones and the rest 15 children having ureteric stones.
Most of the children were in the age group of below 5 years. Male preponderance was found in our study. Nonspecific abdominal/flank pain occurs as the initial clinical feature in approximately 50% of children as reported in the literature and 90% of patients in our study [11].
The incidence of urinary tract infection (UTI) in children with urolithiasis has been reported to be 8%-70% in the literature [12, 13]. UTI was found in 2 cases with ureteric stones. Klebsiella growth was found in 1 case with renal stone and polymicrobial growth was found in 2 cases with renal stone. Bacteria, pyuria and positive urine culture are noted in 29%, 51% and 27.3%, respectively, in the study by Gouru *et al*. [14].
In our study; hypercalciuria was the most common metabolic derangement in children with urolithiasis. Biyikli *et al*. demonstrated a high incidence of hypercalciuria (43%) in patients with recurrent UTI [15].

Stone analysis
In our study, calcium oxalate stone is quite prevalent followed by calcium phosphate, uric acid, and ammonium urate stone.
Calcium oxalate is the most common type of upper urinary tract stone observed in this study. Calcium oxalate stones are found in many conditions, including hypercalciuria, hypocitraturia, hyperuricosuria, and hyperoxaluria [16]. Pak *et al*. showed that the most significant metabolic abnormality contributing to the development of calcium oxalate stones was hypocitraturia in their study [16].
In our study hypercalciuria (30%) was the commonest metabolic abnormality followed by hyperoxaluria (13.3%); Hypocitraturia (10%) and Hypomagnesuria (3%).
Gouru *et al*. [14] reported hypernatremia (65%) was the most common abnormality, hyperuricosuria in 57.5% of children. Hyperoxaluria and hypercalciuria were found in nearly 50% of the patients. Hypocitraturia and hypomagnesuria are found in 23% and 7.5% of patients, respectively. Our study group represents a pediatric population from a geographical region with a high incidence of calculus disease in both children and adults; the 24-h urinary excretion of lithogenic substances, such as calcium, and oxalate, was in higher amounts than inhibitory solutes such as citrate and magnesium in children promoting supersaturation, heterogeneous nucleation, crystallization, and finally stone formation.
Although our study has a small number of participants, which could be a limitation, we observed significant metabolic abnormalities in children with urolithiasis. Hence, we recommend the maintenance of calcium intake consistent with the recommended daily allowance for children. In addition, a high-potassium, low-oxalate diet is recommended for children. A low-calcium diet is not effective in reducing the risk of stone recurrence and poses a substantial risk to the maintenance of bone health.

Conclusion
Calcium oxalate is the most common primary composition of stones and Hypercalciuria was found to prevalent metabolic abnormality in our study. The 24- h urinary excretion of lithogenic substances, such as calcium, oxalate, sodium, and uric acid, were in higher concentration than inhibitory solutes such as citrate and magnesium in children promoting supersaturation, heterogeneous nucleation, crystallization, and finally stone formation.
Serum calcium, phosphorus, and uric acid are in the normal range despite having urinary abnormalities.
Because of the high prevalence of metabolic risk factors and the significant risk of lifelong recurrence in this population, all children with urolithiasis require a complete evaluation with metabolic workup.
Emphasis must be done on the importance of metabolic workup and adherence to treatment of any abnormality that is detected.
Adherence to modifications made after the detection of metabolic abnormality leads to a significant drop in recurrence rates.

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Conflict of interest: None.

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