

Metabolic Abnormalities and Stone Composition in Pediatric Urolithiasis: A Retrospective Analysis

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Abstract

Background: Pediatric urolithiasis is increasingly prevalent and is often associated with underlying metabolic abnormalities. The objective is to evaluate the prevalence of metabolic abnormalities and their association with stone composition in pediatric patients. **Material and Methods:** This retrospective observational study included 50 pediatric patients (<18 years) diagnosed with urolithiasis between April 2024 and March 2026. Clinical data, metabolic evaluation, and stone composition analysis using infrared spectroscopy/X-ray diffraction were reviewed. Associations between metabolic abnormalities and stone types were analyzed using the chi-square test, with $p < 0.05$ considered statistically significant. **Results:** The mean age was 12.4 ± 3.2 years, with male predominance (60%). Metabolic abnormalities were identified in 68% of patients. Hypercalciuria (36%) was the most common abnormality, followed by hyperoxaluria (22%) and hypocitraturia (18%). Calcium oxalate stones were most frequent (64%). A significant association was observed between hyperoxaluria and calcium oxalate stones ($p=0.01$). Recurrent stone disease was significantly associated with metabolic abnormalities ($p=0.03$). **Conclusion:** Metabolic abnormalities are highly prevalent in pediatric urolithiasis and significantly influence stone composition and recurrence. Routine metabolic evaluation is essential for targeted management and prevention.

Keywords: Pediatric urolithiasis; Hypercalciuria; Hyperoxaluria; Stone composition; Metabolic evaluation.

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INTRODUCTION

Pediatric urolithiasis is an increasingly recognized condition worldwide, with a rising incidence attributed to dietary, environmental and metabolic factors 1. Unlike adult stone disease, pediatric cases are frequently associated with underlying metabolic abnormalities and demonstrate a higher recurrence rate and potential for long-term renal damage 2. Common metabolic contributors include hypercalciuria, hyperoxaluria, and hypocitraturia. Early identification of these abnormalities is critical, as it enables targeted therapy and reduces recurrence risk 3. Stone composition analysis further enhances understanding of pathophysiology and guides individualized management strategies 4. Despite its importance, limited data exist correlating metabolic abnormalities with stone composition in pediatric populations, particularly in developing regions. This study aims to address this gap.

MATERIALS AND METHODS

Study Design and Setting: Retrospective observational study conducted at a tertiary care center.

Study Duration: April 2024 to March 2026 (18 months)

Study Population: A total of 50 pediatric patients (<18 years) with confirmed urolithiasis. Inclusion Criteria

- Age <18 years
- Radiological confirmation of urolithiasis
- Availability of metabolic evaluation Exclusion Criteria

- Incomplete medical records
- Active urinary tract infection during metabolic workup

Data Collection

The following variables were analyzed:

- Demographics: age, sex
- Clinical features: primary vs recurrent stone, family history
- Stone characteristics: size, location, laterality
- Metabolic abnormalities:
 - Hypercalciuria
 - Hyperoxaluria
 - Hypocitraturia
- Stone composition (infrared spectroscopy)

Statistical Analysis

- Descriptive statistics: mean \pm SD, percentages
- Chi-square test for association
- $p < 0.05$ considered statistically significant

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RESULTS

Table 1: Demographic and Clinical Characteristics

Variable	Value
Total patients	50
Mean age (years)	12.4 ± 3.2
Male	30 (60%)
Female	20 (40%)
Recurrent stones	18 (36%)
Family history	12 (24%)

Table 2: Metabolic Abnormalities

Abnormality	Number (%)
Hypercalciuria	18 (36%)
Hyperoxaluria	11 (22%)
Hypocitraturia	9 (18%)
No abnormality	16 (32%)

Table 3: Stone Composition

Stone Type	Number (%)
Calcium oxalate	32 (64%)
Calcium phosphate	8 (16%)
Uric acid	5 (10%)
Cystine	2 (4%)
Mixed	3 (6%)

Table 4: Association Analysis

Variable	p-value
Hyperoxaluria vs CaOx stones	0.01
Hypercalciuria vs Ca stones	0.07
Metabolic abnormality vs recurrence	0.03

DISCUSSION

This study demonstrates a high prevalence (68%) of metabolic abnormalities in pediatric urolithiasis, consistent with existing literature.^[5,6] Hypercalciuria was the most common abnormality, aligning with global findings.^[7]

Calcium oxalate stones were the predominant type, reflecting the metabolic basis of pediatric stone disease.^[8] A statistically significant association between hyperoxaluria and calcium oxalate stones reinforces the importance of metabolic evaluation.

Additionally, the strong association between metabolic abnormalities and recurrence highlights the need for early detection and preventive strategies. Pediatric urolithiasis should be viewed as a metabolic disorder rather than an isolated condition.

Limitations include the retrospective design and relatively small sample size. However, the study provides valuable clinicometabolic insights.

CONCLUSION

Metabolic abnormalities are highly prevalent in pediatric

urolithiasis and significantly influence both stone composition and recurrence. Routine metabolic workup should be an integral component of evaluation and management.

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Conflicts of interest

There are no conflicts of interest.

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