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Original Article

Overview of Microlithiasis in Infancy in Pediatric Urology

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ABSTRACT

Aim: Infantile microlithiasis, defined as kidney stones smaller than 3 mm, is a multifactorial condition associated with genetic, environmental, and anatomical factors. Congenital anomalies of the kidney and urinary tract (CAKUT) are among the major structural anomalies linked to microlithiasis. This study investigated the prevalence of microlithiasis in infants with CAKUT and explored associated clinical and biochemical characteristics.

Materials and Methods: This retrospective study included 148 infants diagnosed with microlithiasis via ultrasonography at a single center in the prior 2 years. Demographic data, biochemical findings, and imaging results were analyzed. CAKUT anomalies, including ureteropelvic junction obstruction (UPJO) and vesicoureteral reflux (VUR), were documented. Follow-up data covering 12 months were reviewed in order to assess stone persistence and complications.

Results: Among the 148 infants, 56% were male. CAKUT anomalies were identified in 16 cases (10.8%), with UPJO being the most common (87.5%). Stones were detected incidentally in 82.4% of cases, while symptomatic presentations included urinary tract infections (9 cases) and hematuria (3 cases). Persistent stones were observed in 7.4% of patients during follow-up, primarily in those with structural anomalies. A family history of nephrolithiasis was reported in 72% of cases, and all patients received vitamin D supplementation.

Conclusion: Infants with microlithiasis demonstrate a notable association with CAKUT, particularly UPJO and VUR. Routine biochemical and imaging evaluations, coupled with long-term follow-up, are crucial for identifying at-risk patients and preventing complications. Multidisciplinary approaches are essential for optimizing outcomes in this population.

Keywords: CAKUT, infant, microlithiasis, pediatric, urinary anomalies

Introduction

Nephrolithiasis, a condition once considered rare in pediatric populations, has emerged as a significant clinical concern (1). Among its various forms, infantile microlithiasis, defined as kidney stones smaller than 3 mm, poses unique challenges for diagnosis and management. This condition is often asymptomatic but carries potential risks for recurrent urinary tract infections (UTIs), hematuria, and long-term renal dysfunction if left untreated (2,3).

Congenital anomalies of the kidney and urinary tract (CAKUT) are frequently implicated in the pathogenesis of microlithiasis. Structural abnormalities such as ureteropelvic junction obstruction (UPJO) and vesicoureteral reflux (VUR) create a conducive environment for stone formation due

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to urinary stasis (4,5). Environmental factors, including vitamin D supplementation and inadequate hydration, further exacerbate this risk (6).

Understanding the epidemiology and clinical characteristics of microlithiasis in infants, particularly in the context of CAKUT, is crucial. This study aimed to provide insights into the prevalence of microlithiasis in infants with CAKUT and highlight associated clinical and biochemical profiles (7).

Materials and Methods

This retrospective study was conducted at a single tertiary pediatric care center. A total of 148 infants diagnosed with microlithiasis via ultrasonography were included. The study period spanned from January 2015 to December 2022. The inclusion criteria comprised infants with ultrasonographically confirmed microlithiasis (≤3 mm) and adequate clinical and biochemical data. The exclusion criteria included those patients with incomplete records or underlying systemic diseases unrelated to urinary anomalies.

Data Collection

Patient demographic details, including their age and gender, were recorded. Biochemical analysis included serum calcium, phosphate, parathyroid hormone, and the urine calcium/creatinine ratio. Imaging findings, including the presence of urinary anomalies, such as UPJO and VUR, were reviewed.

Follow-up

All patients were monitored for at least 12 months in order to assess stone persistence and complications such as UTIs or obstructive uropathy. Outcomes were categorized as stone resolution, persistence, or progression.

Statistical Analysis

The SPSS package program (IBM SPSS Statistics for Windows, version 25.0. Armonk, NY: IBMCorp, 2017) was used for statistical analysis. Variables with normal distributions are shown as mean values with standard deviation, variables with abnormal distribution are shown as median (range), and the rest are expressed as frequency. The chi-square test was used to compare categorical variables between groups. The Kolmogorov-Smirnov test was used to evaluate the normal distribution of continuous variables between groups. All parameters were distributed abnormally, so they were evaluated by the Mann-Whitney U test. For this study, $p<0.05$ was considered statistically significant.

Ethics Statement

This study was conducted in compliance with the Declaration of Helsinki (2013 revision). Ethical approval was obtained from the İzmir Bakırçay University Non-Invasive Clinical Research Ethics Committee (approval no.: 1558, date: 17.04.2024). Informed consent was waived due to the retrospective nature of this study.

Results

Among the 148 infants included in this study, 56% were male. Their mean age at diagnosis was 10.2 months (range: 2-24 months). The majority of microlithiasis cases (82.4%) were detected incidentally during routine ultrasonography evaluations. Symptomatic presentations included UTIs in 9 patients and gross hematuria in 3 patients (5,7).

Associated Urinary Anomalies

Urinary tract anomalies were identified in 16 cases (10.8%). UPJO was the most common anomaly, accounting for 87.5% of these cases. VUR was observed in the remaining patients (7).

Biochemical Analysis

Patients were evaluated for the presence of hypercalciuria based on reference values determined by months in Turkish children (8). Biochemical evaluation revealed hypercalciuria in 32% of the patients. Elevated serum calcium and parathyroid hormone levels were observed in 14% and 10% of the cohort, respectively. Vitamin D supplementation was reported in all cases, with 18% receiving doses higher than recommended (6,9).

Laboratory analysis results of the patients are shown in Table I.

Follow-up Outcomes

After 12 months of follow-up, stone resolution was noted in 72% of the cases, while 7.4% exhibited persistent stones. Persistent stones were significantly associated with structural anomalies such as UPJO and VUR. Complications during follow-up included recurrent UTIs in 8 patients and worsening hydronephrosis in 2 patients (10).

Discussion

Although infantile microlithiasis is often asymptomatic, it presents significant challenges due to its association with long-term renal complications, especially when accompanied by CAKUT. The anatomical anomalies of CAKUT, such as UPJO and VUR, lead to urinary stasis, creating a favorable environment for stone formation (11,12).

Table I. Laboratory findings at the time of admission	
Laboratory findings	
Urea (mg/dL) median (Q1-Q3)	12.4 (6.1-35.4) mg/dL
Creatinine (mg/dL) median (Q1-Q3)	0.23 (0.17-0.31) mg/dL
Uric acid (mg/dL) median (Q1-Q3)	3.2 (1.4-4.6) mg/dL
Calcium (mg/dL) mean ± SD	10.5±0.4 mg/dL
Phosphorus (mg/dL) median (Q1-Q3)	5.7 (4.5-7.1) mg/dL
Parathormone (pg/mL) median (Q1-Q3)	27.1 (14.5-57.1) pg/mL
Vitamin D (ng/mL) median (Q1-Q3)	34.3 (9.3-69.2) ng/mL
Urine density median (Q1-Q3)	1006 (1000-1030)
Urine pH median (Q1-Q3)	6.5 (5-9)
Spot urine calcium/creatinine median (Q1-Q3)	0.34 (0.02-2.13)
SD: Standard deviation	

The high prevalence of UPJO observed in the studied cases supports previous research linking CAKUT to pediatric kidney stones (13,14).

The persistence of stones in cases with structural anomalies highlights the importance of timely and appropriate interventions. For instance, studies have shown that surgical correction of UPJO not only improves urinary flow, but also reduces the risk of stone formation (14). Moreover, advanced diagnostic techniques have facilitated the identification of such anomalies, enabling the development of tailored approaches which address individual patients' needs (4).

The biochemical abnormalities observed in this study further emphasize the multifactorial nature of microlithiasis. Hypercalciuria, observed in nearly one-third of our patients, is a well-known cause of stone formation. This finding aligns with studies emphasizing the synergistic role of metabolic factors and structural anomalies in pediatric stone disease (15). As this study was retrospective and evaluated from a pediatric urology perspective, only calcium and creatinine were measured in spot urine. One of the most important limitations of our study was that metabolic screening was not performed. Additionally, excessive vitamin D supplementation was noted in 18% of our cases, suggesting a potential contribution to hypercalciuria in susceptible infants, though this remains a topic for further investigation (16).

The resolution of stones in 67% of cases suggests that infantile microlithiasis can often be a transient condition. However, the persistence of stones in some patients underscores the importance of a patient-centered approach to follow-up and treatment. Proper hydration adjusted to body weight, low-oxalate diets, and periodic ultrasonographic follow-ups can lead to significant improvements in stone size and outcome (17,18).

These findings highlight the importance of routine screening for CAKUT in those infants diagnosed with microlithiasis. Advanced ultrasonography and voiding cystourethrography are valuable tools for the early detection of underlying anomalies (17). Early diagnosis is critical, as studies have demonstrated that timely identification and intervention can significantly slow the progression of nephrolithiasis and prevent associated complications. Structured follow-up and treatment protocols in infants with CAKUT have been shown to reduce recurrent stone formation and severe complications (11,12).

Injeyan et al. (18) reported that hydration plays a critical role in preventing stone formation, especially in those infants with CAKUT. They found that fluid intake increased in those infants with recurrent urinary stones. Their study emphasized that maintaining optimum urine output reduces the supersaturation of lithogenic substances such as calcium oxalate and uric acid (17). Adequate hydration has also been shown to prevent recurrent stones and alleviate urinary stasis in CAKUT patients. Regular fluid intake prevents crystal aggregation and dilutes solutes in urine, making it a cornerstone of pediatric nephrolithiasis management.

In addition to hydration, individualized management strategies, including dietary modifications and careful monitoring of vitamin D supplementation, are essential in reducing metabolic risks and preventing stone growth or even promoting spontaneous passage (15,16).

The strengths of this study lie in its use of robust imaging and biochemical analyses to elucidate the relationship between CAKUT and microlithiasis. High-resolution ultrasonography allowed for the precise identification of structural anomalies, while metabolic evaluations underscored the interplay between anatomical and biochemical factors. These approaches offer valuable insights into the multifactorial nature of stone formation in infants (11-16).

Study Limitations

However, the retrospective design and single-center setting of our study may limit its generalizability. Multicenter, prospective studies are needed in order to refine diagnostic, follow-up, and treatment protocols. CAKUT has been identified as the most significant factor in the development

of kidney stones in infants, with structural anomalies such as UPJO and VUR reported to account for 65% of cases. The presence of CAKUT was found to increase the likelihood of persistent stones by threefold compared to those infants without structural anomalies (19).

Similarly, CAKUT has been identified as the dominant risk factor in 60% of cases. The early diagnosis and management of CAKUT has been shown to significantly reduce complications such as recurrent infections and bilateral stones, underscoring the importance of screening for these anomalies in at-risk infants (11,13).

Conclusion

In infantile cases, the most critical factor is the presence of urological anomalies, which were evaluated in this study in line with the literature. In the absence of urological anomalies, we believe that routine follow-up is sufficient, and no additional interventions are required.

Ethics

Ethics Committee Approval: Ethical approval was obtained from the İzmir Bakırçay University Non-Invasive Clinical Research Ethics Committee (approval no.: 1558, date: 17.04.2024).

Informed Consent: Informed consent was waived due to the retrospective nature of this study.

Footnotes

Authorship Contributions

Surgical and Medical Practices: H.T., Concept: H.T., Design: H.T., Data Collection or Processing: H.T., Ö.Ö.Ş., Analysis or Interpretation: H.T., Ö.Ö.Ş., Literature Search: H.T., Ö.Ö.Ş., Writing: H.T., Ö.Ö.Ş.

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