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UROLITHIASIS: ETIOLOGY AND DIAGNOSTIC APPROACHES

Bahromov Bekzod Shavkatovich
Asian International University, Bukhara, Uzbekistan

Abstract: Urolithiasis, or urinary stone disease, represents one of the most common and recurrent urological disorders worldwide. Its etiology is multifactorial, involving genetic, metabolic, anatomical, infectious, and environmental factors. Early diagnosis and etiological assessment are crucial to prevent complications, reduce recurrence, and optimize treatment strategies. This article reviews the principal etiological factors and modern diagnostic methods for urolithiasis.

Key words: Urolithiasis, urinary stones, etiology, diagnosis, imaging, urinary tract infection.

Introduction

Urolithiasis is defined as the formation of calculi in the kidneys or urinary tract due to supersaturation and crystallization of urinary solutes. It affects approximately 2–5% of the global population, with higher prevalence in hot climates and among sedentary individuals. The disease is characterized by high recurrence rates and significant morbidity, necessitating a comprehensive understanding of its pathogenesis and diagnostic evaluation.

Etiology

Metabolic Factors:Metabolic disturbances are the most common internal causes of stone formation. Hypercalciuria, hyperoxaluria, hyperuricosuria, and hypocitraturia disrupt the balance of calcium, phosphate, purine, and oxalate metabolism, leading to crystallization. Urinary pH plays a key role: acidic urine favors uric acid and cystine stones, while alkaline urine promotes calcium phosphate and struvite stones.

Anatomical and Functional Factors:Structural abnormalities, either congenital or acquired, predispose individuals to stone formation by impairing urine flow. Examples include ureteropelvic junction obstruction, ureteral strictures, and prostate enlargement. These conditions promote urinary stasis, which increases the risk of crystal precipitation and infection.

Infectious Factors:Recurrent urinary tract infections, especially by urease-producing bacteria such as Proteus, Klebsiella, and Pseudomonas, contribute to struvite stone formation. These organisms hydrolyze urea into ammonium, raising urinary pH and facilitating magnesium ammonium phosphate crystallization.

Environmental and Lifestyle Factors:Diet, hydration, climate, and occupation also influence risk. High intake of animal protein, sodium, and oxalate-rich foods increases stone risk. Low fluid intake and hot environments promote concentrated urine, while physical inactivity may increase calcium release from bone, contributing to hypercalciuria.

Diagnostic Methods

1. Clinical Assessment: Detailed history and examination are essential. Symptoms often include renal colic, hematuria, and urinary disturbances. Evaluating risk factors such as diet, family history, and past stones is important.

2. Laboratory Investigations

Urinalysis: Detects hematuria, pyuria, bacteriuria, and crystalluria.

Blood tests: Assess calcium, phosphate, uric acid, and creatinine.

24-hour urine collection: Quantifies calcium, oxalate, citrate, and uric acid.

Microbiology: Identifies infection-related stones.

3. Imaging Techniques

Ultrasound: Non-invasive and useful for kidney/bladder stones.

X-ray (KUB): Detects radiopaque stones but misses radiolucent ones.

Intravenous urography: Offers anatomical and functional details but less used now.

Non-contrast CT: Gold standard, highly accurate for all stone types.

MRI: Limited role, mainly for soft tissues and radiation-free assessment.

Conclusion

Urolithiasis is a complex disorder caused by metabolic, anatomical, infectious, and environmental factors. Accurate diagnosis requires a combination of history, lab tests, and imaging. Identifying the underlying cause is critical for effective treatment and prevention of recurrence. Personalized prevention and risk stratification remain future priorities.

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