RESEARCH ARTICLE

The Mineral Composition of Urinary Tract Stones in Khost, Afghanistan

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Abstract

Background: The urinary tract stones include renal (nephrolithiasis), ureter (ureterolithiasis), and urinary bladder stones (cystolithiasis). The knowledge of the mineral composition of the urinary tract stone is important for the treatment, patient education, and to develop preventative strategies.

Aim: This study aims to characterize the proportion of different types of urinary tract stones and their chemical composition in Khost province.

Material and Methods: A retrospective, a hospital-based study design was used. The stones were analyzed using simple qualitative biochemical tests. A total of 63 patients were included in this study from Sept 2016 to Aug 2019. The stones were checked for the presence of calcium, magnesium, ammonium, oxalate, phosphate, uric acid, and cystine.

Results: The results obtained showed the incidence of the kidney (48 stones), ureteric (4 stones), urinary bladder (11 stones) at the age group of 18-75 years (mean 56.2). The incidence in men was higher than women, male to female ratio being 3:1. The chemical analysis of overall stones has shown that 88.21% had mixed compositions, and 11.79% presented a unique composition. The majority of stones obtained from women were cystine (70%) and oxalate (72%) stones, whereas the majority of stones in men were that of calcium oxalate (76%) and uric acid (74%) stones. Eight of the stones were pure of calcium oxalate, five were pure uric acid, 7 were pure cystine, and 43 were mixed stones. Among the mixed stones, oxalate was present in 32 samples (43 of total), calcium was present in 36 samples, uric acid was seen in 17, phosphate was present in 23, and cysteine was present in 14 stones.

Conclusion: This study showed that the most common type of mineral composition found in different urinary stones is calcium oxalate (81%), followed by cystine and uric acid. Further broader and large scale studies are required to assess the mineral base of the urinary tract stones in Afghanistan to develop preventive strategies and promote public awareness about dietary recommendations.

Keywords: Calcium Oxalate, Mineral Composition, Urinary Tract Stones.

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Introduction

The process of stones formation in the kidney, urethra, and bladder is a complex phenomenon, and the etiology is yet not clearly understood. It is not contributed to any single factor and may be due to metabolic disturbances, infections, hormonal influences, dietary conditions and habits, poor fluid intake which concentrates and decreases the urine volume, immobilization or lesions or obstructions in the bladder or kidney or increased excretion of stone-forming components such as calcium, magnesium, oxalate, carbonate, phosphate, urate, xanthine, cystine, etc.[1,2]

The evidence of urinary stones can be traced back to as early as 7000 years and perhaps earlier. The earliest recorded example is bladder and kidney stones detected in Egyptian mummies dating to 4800 years B.C. (a urinary stone belonging to a 16-year-old boy).[3] Urinary stones are products of the pathological biomineralization processes in the urinary system.[4] Many theories and studies have attempted to clarify the mechanisms of the formation and growth of calculi or stones. However, no satisfactory explanation has yet been put forward, and several questions remain unanswered.[5] The composition of urinary stones comprises two parts. The first part is an organic matrix containing mainly proteins, lipids, carbohydrates, and cellular components. The other part is the biomineral component.[6] Kidney stones may be present at any age, most commonly being encountered in adults with mean age, the prevalence being of 13 in men, and 7 in women.[7,8] If there is no appropriate treatment, recurrence may appear after five years after the occurrence of the initial event in up to 35-50% of cases.[9]

Certain factors have been noted to predispose to the development of urinary calculi. Metabolic conditions such as hypercalciuria, hyperoxaluria, hyperuricosuria, cystinuria, and hypocitraturia have been identified as a significant risk factors.[10,11] Age is another risk factor, with a significant rise in the incidence of urolithiasis noted after the age of 40 years.[12] Gender is yet another significant risk factor with men predisposed to developing urolithiasis compared to women.[13] Race has also been proposed to be significant with higher rates noted in Caucasians compared to African-Americans and Asians.[14] Aberrations in urinary pH, as well as the presence of urinary tract infections, are additional factors that have been implicated in urolithiasis. Accurate knowledge of the composition of the stone is critical to elucidating the underlying etiology of the clinical disorder that precipitated the stone disease.[15]

The commonest presenting clinical features in patients with urolithiasis were loin pain extending to the suprapubic region

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and haematuria while the commonest modes of imaging were ultrasonography and plain KUB radiographs.[16]

There are a number of different methods available for the mineral composition of stone analysis that include wet chemical analysis, thermogravimetry, scanning electron microscopy, optic polarizing microscopy, spectroscopy, infrared spectroscopy, X-ray powder diffraction and elementary distribution analysis.[17] Wet chemical analysis is still the most widely utilized technique for calculi analysis in routine clinical laboratories in Afghanistan. There are variety of treatment options for KSD, including open surgery, percutaneous nephrolithotomy, super-mini percutaneous nephrolithotomy, ureteroscopy, extracorporeal shock wave lithotripsy, and conservative intervention/measures.[18-23]

Patients and Methods

This study was a retrospective review of medical records and the analysis of urinary tract stones samples collected. The clinical and laboratory records for all patients during the period spanning from Sept. 2016 to Aug. 2019 formed the study that included sixty-three symptomatic patients with confirmed urinary tract stones. The demographic information, biochemical data, treatment methods, severity of hydronephrosis report, and stone chemical composition, were collected and analyzed.

The study was conducted on 48 renal, 11 urinary bladders, and 4 ureteral stone samples. The patients were 47 males and 16 females ranging in age between 18 and 75 years.

The collected samples were placed in a labeled sterile container and sent for chemical analysis. The stones were washed with distilled water to remove any bloodstains, or contamination then dried at 60°C for about 5 hours. Each stone was weighed, its color and shape were recorded before being pulverized into a fine powder using mortar and pestle. The samples were then analyzed using biochemical technique and collagraphy.

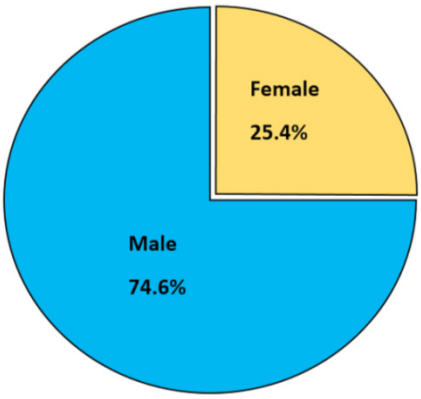

Figure 1: Gender Distribution

Table 1: Chemical composition of all stones

Chemical composition	*No. of stones*	*% of total*
Calcium oxalate	8	12.69%
Uric acid	5	7.93%
Cystine	7	11.11%
Mixed stones	43	68.25%
Magnesium	0	0%
Ammonium	0	0%
Total	**63**	100%

Results

A total of 63 stones were analyzed with the chemical composition of all stones shown in Table 1. Most of the stones were composed of a mixture of two or more than two of the tested chemicals shown in Table 2. The majority of the stones retrieved were that of renal stones (76.19%), followed by urinary bladder (22.22%) and ureteral stones (7.93%).

The most common stone contained a mixture of calcium oxalate (81.47%). The study included 18 female and 45 male patients, as shown in figure 1. The overall composition of different minerals found in our study is shown in Figure 2. There were no ammonium or magnesium-containing stones found in our study.

Conclusion

In this study, we retrospectively reviewed medical records with a stone mineral analysis of 63 cases from Sept 2016 to Aug 2019. Our study demonstrated that the majority of patients with urinary tract stones were male (3:1).

These findings are consistent with previous studies from various parts of the world.[24-26] It, therefore, seems advisable that male patients presenting with flank pain be properly evaluated for urinary tract stones, as various studies have alluded to underdiagnosis being of major concern.[27] The major constituents of the stones were calcium and oxalate, findings that are in keeping with previous studies conducted across various parts of the world.[12,19,25] This study is based on a simple qualitative biochemical study. This technique is simple and feasible for developing countries in terms of financial strength and available manpower.

The potential for a treatable cause of calculi production highlights the need for these patients to undergo at least a basic calculi workup and can be undertaken prior to urological or endocrinology review. This must include medical history, drug history, prior renal calculi or family history, urinalysis (especially pH) and blood for renal function, calcium, and uric acid.

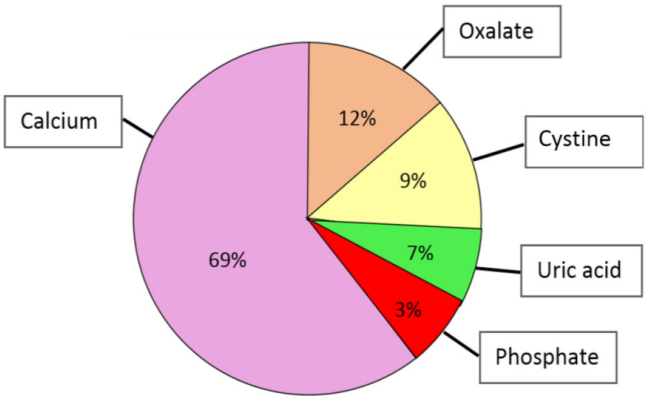

Figure 2.: The mineral composition of overall stones

Table 2: Chemical composition of Mixed stones

Chemical composition	*No. of stones*	*% of total*
Calcium oxalate, uric acid, phosphate	1	2.32%
Calcium, Uric acid	5	11.62%
Calcium, oxalate	26	60.46%
Calcium, phosphate, cysteine	6	13.95%
Cysteine, uric acid	3	6.97%
Total	**43**	100%

Patients can potentially reduce their risk of calculi formation by undertaking general preventative measures. Such as fluid intake of 2.5-3.0 l/d (litres a day), aiming for a urine output of 2.0-2.5 l/d, normal calcium intake (1-1.2g/d), low salt (NaCl 4-5g/d), reduced animal protein (0.8-1.0 g/kg/d).

The stone related burden is likely to increase, requiring an increase in surgery. A dramatic increase in the 60-year-old and beyond group could provide challenges to future surgery and increased risk to the patient with age related increase in co-morbidity. To limit the burden on the health care system, preventative measures should be undertaken at a population level, tackling adequate hydration and obesity.

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