Chemical analysis of urinary tract stones

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The aim of present study is to reveal the chemical composition of urinary tract stones in patients ministering in Al-Sadir medical city/Al-Najaf. The study conducted from March 2010 - December 2012. Convenience sampling technique was employed. The study included patients of either sex (470 cases, 342 were males 128 were females) and all ages (from 1 to 60 year) were diagnosed with urinary stones. All patients were treated conservatively or by intervention (ESWL, ureteroscopy, PNL, or open surgical therapy). Chemical analysis was performed. Out of 470 patients, 342(72.7%) were males and 128(27.2%) were females. Age of the patients ranging from 1- 60 years. Location of the stones were from various parts of urinary system. Calcium oxalate stones were found in 126 (36.8%) male patients and in 42(32.8%) female patients. Uric acid stones were found in 64(18.7%) male patients and in 6(4.6%) female patients. Struvite stones were found in 6(1.7%) male patients and in 6 (4.6%) female patients. 146(42.6%) male patients and 74(57.8%) female patients were having mixed stones (calcium oxalate, calcium phosphate, uric acid and struvite stones). Mixed urinary stones (calcium containing and non-calcium containing stones) constitutes the commonest variety of any stones in our local population of Al-Najaf governorate, Iraq.

Keywords: Calcium oxalate stones, Mixed urinary stones, Uric acid, Struvite stones

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Introduction

The urinary stone disease is a common multifactorial disease, have a history from past ancient Egyptians mummies in 4000 BC. However, it was not until the end of the 18th century that the first reports were published on the chemical composition of urinary calculi. At that time, important chemical constituents of urinary calculi were discovered, such as uric acid (Scheele 1776) and cystine (Wollaston 1810). After the systematic studies by Heller (1847) and Ultzmann (1882) characterization of urinary calculi by chemical analyses was, in principle, an established routine. The diagnostic usefulness of information regarding the chemical composition of renal stones has been recognized since the 1950s and has improved so that it is now possible to correlate the results of an analysis with the appropriate diagnosis and therapeutic

regimen. Five to 15% of population is affected by urinary stones [1-3[. Stone disease varies with age, sex, ethnicity, and environment [4]. Forty to 50% of patients will have recurrent stone disease after the first attack, so it can be considered a disease of life [5].

Urine	Anatomy	Metabolic Abnormalities	Disease Status	Diet
Composition	Urinary Stasis	Hypercalciuria	Metabolic Acidosis	High Protein Diet
Volume	Urinary Obstructior	Hypocitraturia	Cystinuria	High Sodium Diet
Stone Inhibitors	Like Horse Shoe Kidney	Hyperoxaluria	Inflammatory Bowel Disease	High Oxalate Diet
		Hyperuricosuria	Medications	Low Fluid Intake

Table 1.
Some etiological agents for stone diseases.

Chemical constituents

The first step in stone formation is supersaturation of urine [6]. This results in crystallization of constituents and a nucleus for further stone aggregation. This step is usually inhibited by substances in our urine but in some patients these are absent or defective. Stones are of different constituents including calcium oxalate, uric acid, magnesium, phosphate, ammonium and cystine. Eight five percent of stones are calcium oxalate and calcium phosphate. Ten to 15% are struvite stones, 5-10% are uric acid stones, and rarely cystine stones. Incidence of calcium and non-calcium stones as showed in table 2.

Calcium based stone abnormalities	Non calcium based stone abnormalities
Hypercalciuria	Hyperuricosuria with PH < 5.5
Hypocitraturia	Cystinuria
Hyperuricosuria with urine PH > 6	Struvite / infection stones
Hyperoxaluria	
Hypocalcaemia	

Table 2.
Calcium and non-calcium stone abnormalities

More than 85% of urinary stones are radio-opaque and only uric acid indinavir stones are truly radio-lucent stones. There is a very broad variety in appearance, color, and consistency of the different urinary stones. Calcium oxalate stones usually have a dark-brown color. The surface is often mulberry-like. The stones are very hard. Apatite stones have a white or gray color, the surface is mostly smooth and the consistency ranges from solid to slackened. Struvite stones often forms with apatite mixed stones in the form of big staghorn stones, the color is mostly white to light gray, in most cases, they have a loose consistency. The color of the stones of uric acid varies from light-yellow to red-yellow, their surfaces are mostly very smooth.

Stones of cystine have atypical yellow color, the consistency is very solid [1, 7-12]. No one method is sufficient to provide all the clinically useful information on the structure and composition of kidney stones. Methods which have been used include infrared spectroscopy, polarization microscopy, wet or dry chemical analysis, Roentgen–structural analysis, thermo-gravimetric analysis, porosity determination, pyrolysis gas chromatography, neutron activation analysis and solid phase NMR. A combination of refined morphological and structural examination of kidney stones with optical microscopy, complemented by compositional analysis via infrared spectroscopy of the core, cross-section and surface of calculi, provides a precise and reliable method for identifying the structure and crystalline composition, and permits quantification of stone components while being highly cost effective [13].

Materials and Methods

This prospective crossover study was conducted at Al-Sadir teaching hospital, Al-Najaf governorate from March 2010 to December 2012. Convenience sampling technique was employed. The study included patients of either sex (470 cases, 342 were males 128 were females) and all ages (from 1 to 60 years) were diagnosed with urinary stones. All patients who included in the study were treated conservatively or by intervention (ESWL, Ureteroscopy, PNL, or open surgical therapy). Chemical analysis was performed. The samples were washed with deionized water and dried in air. The stone powder was obtained by grinding it in container. Qualitative and quantitative analysis of this powder was done for various substances by treating the powder with the chemical agents provided for the diagnosis of various types of chemical stones.

Results

Out of 470 patients, 342(72.7%) were males and 128(27.2%) were females. Age of the patients ranging from 1-60 years. Location of the stones were from various parts of urinary system. Calcium oxalate stones were found in 126(36.8%) male patients and in 42 (32.8%) female patients. Uric acid stones were found in 64(18.7%) male patients and in 6(4.6%) female patients. Struvite stones were found in 6(1.7%) male patients and in 6(4.6%) female patients. One hundred forty-six (42.6%) male patients and 74(57.8%) female patients were having mixed stones (calcium oxalate, calcium phosphate, uric acid and struvite stones).

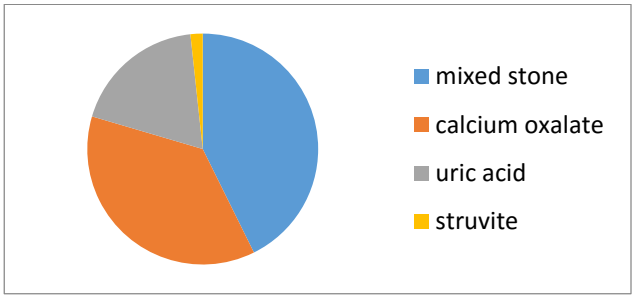

Figure 1.
Percent results for male.

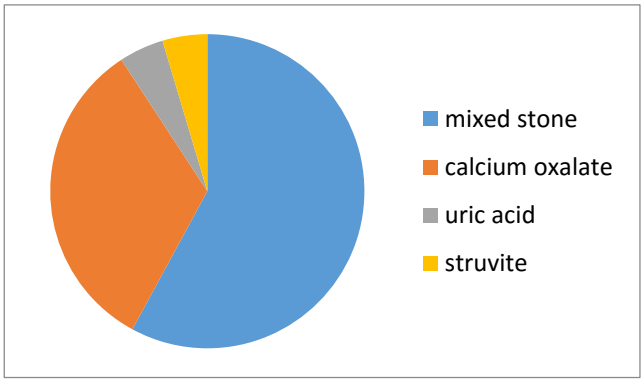

Figure 2.
Percent results for female.

Discussion

Many intrinsic and extrinsic factors contribute to the formation of urinary tract stones. Urine is a complex solution and its pH changes frequently. Supersaturation of urine induces crystallization which leads to the formation of urinary stones. The presence of multiple inorganic and organic constituents and interactions between promoters and inhibitors, all modulate pathogenesis of stone formation. Crystalline material is nucleated somewhere inside the nephron that flow toward collecting ducts and serve as nidi for stone formation. These particles grow into the size range of, or even greater than, the inner diameter of the collecting ducts via crystal aggregation.

These particles will have chance to grow into clinically significant stones, which may be unable to pass through the urinary tract in a spontaneous fashion [7, 8].

Evidence from studies in industrialized countries suggests a significant change in the chemical composition of urinary stones during the second half of the twentieth century [20-22]. Calcium oxalate now account for more than 60% of all stones. This is likely a reflection of alterations in diet, in particular an increase in consumption of foods high in sodium and animal protein. While female patients are more likely to form phosphate stones, calcium oxalate stones are more common in male patients [23, 24].

In our study the stones were frequent among males than females. This finding conforms with what is reported by Tassaduqe et al [11], who found that 74.1% patients were males and 25.8% were females. Mshelia et al [25], reported that urinary stones were 12 times more common in males than females. In males, androgens play an important role in stone formation by increasing urinary oxalate excretion and deposition of calcium oxalate while in females, estrogens do the opposite effect [11]. In most of western and eastern studies which are in concerning with composition of urinary stones reflect that calcium containing stones were the commonest variety of stones as reported by Tassaduqe et al [11], Reynard J et al [9], they conclude that these may be due to variety of causes that include hypocalcaemia, hyper-parathyroidism, hypocitraturia, hyperoxaluria, can be caused by excess of oxalate containing food or excess absorption of oxalate due to various gut diseases. Struvite stones (17.4%) predict the presence of bacteriuria and urinary tract infections caused by urea splitting bacteria. [7, 8, 11].

Uric acid stones (9.4%) due to hyperuricosuria, gout this is due to increased non vegetarian diet, the uric acid contents of the body increases causing risk of hyperuricosuria and further formation of uric acid stones [26]. Farooq et al [27] in their 125 stone analysis showed calcium oxalate was frequent salt found (93.6%). Phosphate was present in 11.2% and uric acid was present in 6.4% stones.

Urinary biochemical profile of patients with urinary stones in Multan also reported predominance of calcium oxalate and uric acid in their stone analysis study [11].

A study conducted by Hashmi et al [28], reported calcium oxalate as the most common stone (60%). Rahman et al [29] observed that calcium is present in 92% stones. While Rafique et al [30], reported uric acid stones to be at the top with 28%, followed by calcium oxalate 26%, mixed stone 7%.

In our study, were we found there is no difference in distribution of urinary stones in relation to sex (72.7% males versus 27.2 % females) in comparison with other studies, but we found that difference in composition between males and females in addition to the distribution of mixed stones (calcium oxalate. Calcium phosphate, uric acid, struvite stones) were the commonest stones because in our study we found that mixed stones were 42.69% male, 57.8% female and this is the largest percentage of constituents of stones and we think this is due to increase all factors that cause all types of stones (calcium containing and non-calcium containing stones) in our locality such as increasing intake of tea, spinach, nuts, beet which are rich in oxalate, increase attacks of urinary tract infections that increase in

struvite stones, increase the factors which increase uric acid in urine (purine rich diet, low fluid intake), high risk of obesity which contribute in all factors of stone formation.
In our study we did not find the rare stones.
We recommend that the knowledge of the chemical composition of urinary stones helps in understanding their etiology, adequate management including prevention and recurrence. Hence such compositional studies should be regularly conducted. Further studies are suggested to confirm and improve up on our results.
In conclusion, mixed urinary stones (calcium containing and non-calcium containing stones) constitutes the commonest variety of any stones in our local population of Al-Najaf governorate, Iraq.

Competing interests

The author declares that there is no conflict of interest.

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