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Original Article

Spectrum of Renal Stones Composition; Chemical Analysis of Renal Stones

Kashif Bangash*, Farwa Shigri*, Ahsan Jamal, Khursheed Anwar***
*Pakistan Institute of Medical Sciences Islamabad, **KRL Hospital Islamabad

Background: Pakistan has probably one of the highest incidences of renal stone disease.
Objective: The study aimed to qualitatively analyze the uroliths in Pakistani population and evaluate the predominant constituent present in them.
Materials & Methods: The study included 232 uroliths obtained by surgical intervention of Urolithiasis patients presenting to Pakistan Institute of Medical Sciences. The stones were analyzed by DiaSys analysis kit.
Results: Males were more prone to renal stone disease (M:F is 2.7:1) and mostly affected the working age group. All the stones contained oxalate (100%) and calcium was present in 99.5%. This was followed by uric acid (40.9%), phosphate (25%), ammonium (7.3%), magnesium (4.3%) and cystine (0.86%).
Conclusion: Calcium Oxalate was the most predominant chemical composition in stones of 203 patients (87.5%) followed by uric acid, struvite and calcium phosphate stones in 15 (6.5%), 10 (4.3%) and 3 (1.29%) respectively.
Key words: Uroliths, Kidney stones, Chemical composition, Calcium oxalate

Introduction

Urolithiasis is a common and a major cause of morbidity worldwide. The history of renal stones dates back to times of Egyptian mummies. [1] They are found in 1% of all autopsies. [2] The distribution of urolithiasis varies differently across the world. High incidence areas are Scandinavian countries, Mediterrenanian, British Isles, Northern Australia, and central Europe, parts of Malaysia, China, Pakistan, and Western India. In Asia the stone belt has been reported to stretch across Sudan, Saudi Arabia, UAE, Pakistan, India, Maynamar, Thailand, Indonesia and Phillipines[3]. In our region it is shown to comprise around 50% of all urological cases.[4] There are different types of calculi. Most stones, 75-80% are calcium containing, composed largely of calcium oxalate followed by calcium phosphate. Another 10-15% are struvite composed of magnesium ammonium and phosphate. 6% are uric acid stones and 1-2% are cystine stones[5] (Figure 3)

Male to female ratio is 2:1 and peak incidence is observed in 2nd or 3rd decade of life[6]. The fact that it mostly affects the working age group makes it a major socioeconomic burden on society[7].

Knowledge of chemical composition of renal stones may be of great importance both as a guide for the clinical management and also for better understanding of physicochemical principles underlying the formation of calculi that may help to give advice and suggestions for the people and patients to carry out preventive measures in reducing the risk of prevalence and recurrence of urolithiasis. A study was therefore done to perform chemical analysis of stone to know the pattern of stone type in patients presenting to our hospital.

Correspondence: Dr. Kashif Bangash

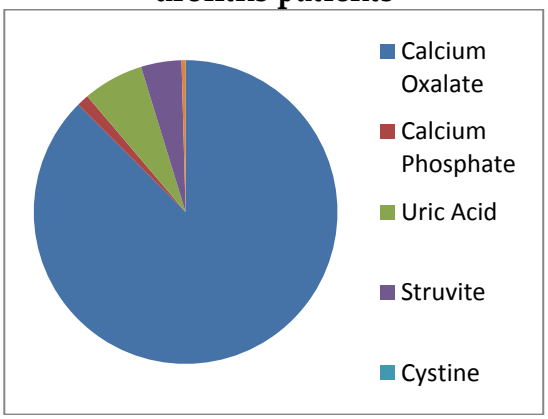
Material and Methods

The study included 232 uroliths obtained by surgical intervention of Urolithiasis patients presenting to Pakistan Institute of Medical Sciences (PIMS), Islamabad during a period of 2009 and 2010. The data of Urolithiasis cases was collected from the Ward and the Out Patient Department of Urology which is also entered in the Hospital Management Information System (HMIS). The stones obtained were sent to the chemical pathology laboratory at PIMS. These stones were washed with the distilled water to remove the debris, dried completely and weighed. The stones were triturated , the powdered form was mixed with distilled water in a graduated tube to make it upto 50ml. Then the sample is analyzed by using DiaSys analysis kit. This kit analyzes Calcium, Oxalate, Ammoniun, Phosphate, Magnesium, Uric Acid and Cystine

Results

Total 232 stones were analyzed during the years of 2009 and 2010. Patients above 13 years of age were included in the study. Out of them 169 patients, 106 were male and 63 were female with the ratio of 2.7:1.
The patients' age ranged from 13 to 79 years. Mean age was 43.9 years with S.D of 14.6. The age distribution has been shown in the Figure 1. Mean age was slightly different in male and female, 44.6 ± 15 and 42.2 ± 12.9 (mean ± S.D) (Figure 1)

Figure 1: Frequency of age distribution in uroliths patients



Calcium Oxalate (n 203) (% 87.5)
Calcium Phosphate (n 3) (% 1.29)
Uric Acid (n 15) (% 6.5)
Struvite (n 10) (% 4.31)
Cystine (Nil)
Others (n 1) (% 0.43)

Figure 2: Spectrum and frequency of chemical composition of stones

Out of 232 stones, pure stones were seen in 121 (52.1%) patients while the rest were mixed. Of them 120 stones were pure calcium oxalate and one was pure uric acid stone. (Figure 2)
The most common chemical component was oxalate, that was present in 100% of the stones while calcium was present in 99.5%. This was followed by uric acid (40.9%), phosphate (25%), ammonium (7.3%), magnesium (2.15%) and cystine (0.86%) (Figure 2).
Calcium Oxalate (Figure 3 & 4). was the most predominant chemical composition in stones of 203 patients (87.5%). Uric acid, struvite and calcium phosphate were predominant in 15 (6.5%), 10 (4.3%) and 3 (1.29%) of stones respectively

Table 1: Composition of Stones (n=232)

Composition of stone	# stones	%
Calcium Oxalate	89	38.36
Calcium Oxalate + Calcium Phosphate	37	15.9
Calcium Oxalate + Uric Acid	74	31.9
Uric Acid	1	0.43
Calcium Oxalate + Calcium Phosphate + Uric Acid	11	4.7
Calcium Oxalate + Ammonium Urate	7	3
Ammonium Magnesium Phosphate	4	1.72
Calcium Oxalate + Calcium Phosphate + Ammonium	6	2.5
Calcium Oxalate + Uric Acid + Cystine	2	0.86
Calcium Oxalate + Calcium Phosphate + Magnesium	1	0.43

Figure 3: A stag horn calculus

Figure 4: X-Ray of a patient showing bilateral multiple calculi that weighed 82 grams

Discussion

Pakistan being in the stone belt zone has a high incidence of renal stone disease. As our hospital lies in the centre of Punjab, Khyber Pakhtoonkhwa, Kashmir and Gilgit, there is a presentation of different casts of patients having the renal stone disease (Figure 4). Chemical analysis of the stones presented in the 2 years 2009 and 2010 has been discussed in the study.

The mean age was 43.9 years, with insignificant sex difference, 44.6 and 42.2 years in males and females respectively. Joual[8] reported mean age of 45 years, whereas Shokouhi[5] found the mean age to be 40.5 years. The male and female mean ages was also in close proximity to Shokouhi which he reported to be 42.2 and 39.8 for males and females respectively. In our study almost 69% of the patients were ranging between 20 to 50 years of age. This shows that renal calculi affect the working age group.

The M/F ratio was 2.7 : 1 which was consistent to that reported by Shokouhi et al[5] and Rayhan et al[9], both showing the ratio of 2.7: 1. Other workers also have shown it to be 2-4 times more common in males. Rafique et al[10] showed it to be 3 times more common in men than in women. This may be because of the larger muscle mass of men as compared to women or there could be other unknown gender related factors.

Thus, the daily breakdown of the tissue results in increased metabolic waste and a predisposition of stone formation. The other more significant cause may be because of the male urinary tract being more complicated than the female urinary tract[11].

Kidney stones result when urine becomes too concentrated and substances in the urine crystallize to form stones. Besides dietary factor, the most common cause of kidney stones is not drinking enough water. Excessive consumption of meat protein leads to a marked increase in kidney stones because meat causes the over acidification of urine causing the increased excretion of oxalate, calcium and uric acid, whereas the excretion of citrate - which provides protection against stone formation is decreased. Overly acidic urine is the main risk factor for the formation of uric acid stones.

Dietary oxalate contributes to about half of the urinary oxalate. Spinach, rhubarb, beets, chocolate, nuts, tea, wheat bran, strawberries, and soya foods are known to increase urinary oxalate concentrations[12]. Vitamin C supplementation may increase urinary oxalate excretion and the risk of calcium oxalate crystallisation in patients who form calcium stones[13] as oxalate is the oxidized product of vitamin C.

The main risk factors for calcium stones are a low volume of urine, increased excretion of oxalic acid and calcium and a deficiency of citrate, which inhibits crystallization in the urine. Also the sodium contained in common salt can increase the risk of stone formation, probably by increasing the urinary excretion of calcium[14].

Calcium oxalate was the most common chemical composition in our study (87.5%). This was followed by uric acid (6.5%), struvite (4.3%) and calcium phosphate (1.29%). The findings somewhat differ from the textbooks[2] and other studies performed in the other areas of Pakistan and other countries.

Table 2: Comparison of our results with other countries

	Our Study	**Iran[5] 2008**	**KSA[6] 2004**	**Japan[9] 2003**
Calcium Oxalate	87.5	80.2	78	81.6
Calcium Phosphate	1.29	2.4	0	5.1
Uric Acid	6.5	16.2	19	9.6
Struvite	4.3	0.4	3	3.7
Cystine	Nil	0.6	0	0
Others	0.43	0.2	0	0

Rafique et al[10] noted the high incidence of uric acid stones (28.1%) in Multan, followed by calcium oxalate (26.1%), mixed calcium and uric acid stones (21.8%) and calculi containing calcium oxalate and calcium phosphate (10.4%). Struvite stones were seen to be in 1.7% of the patients. Hashmi[15] found calcium oxalate to be present in 60% of the cases, calcium phosphate in

5%, mixed calcium oxalate. (Table 3)

Table 3: Comparison of the results of chemical composition of renal calculi in Pakistan

Composition of Stones	Present Study (n=232)	Rafique et al[10] Multan (n=700)	Hashmi et al[15] D.I.Khan (n=200)	Khalil et al[16] Quetta (n = 137)
Ca OX	89 (38.4%)	183 (26.1%)	120 (60%)	35 (25.5%)
Ca P	Nil	5 (0.7%)	10 (5%)	2 (1.4%)
CaOX + Ca P	37 (15.9%)	73 (10.4%)	44 (22%)	19 (13.8%)
CaOx + UA	74 (31.9%)	153 (21.8%)	58 (22.4%)	40 (29.1%)
CaOX + Amm Urate	7 (3%)	Nil	Nil	Nil
Uric Acid	1 (0.43%)	197 (28.1%)	4 (2%)	4 (2.9%)
CaOx + CaP + UA	11 (4.7%)	50 (7.1%)	2 (1 %)	Nil
CaP + UA	Nil	18 (2.5%)	Nil	Nil
AMP	4 (1.72%)	12 (1.7%)	18 (9%)	23 (16.7%)
CaOx + CaP + Amm	6 (2.5%)	9 (1.2%)	Nil	Nil
CaOx + CaP + Mg	1 (0.43%)	Nil	Nil	2 (1.4%)
CaOx + UA + Cystine	2 (0.86%)	Nil	Nil	Nil
Amm Urate	Nil	Nil	Nil	12 (8.7%)

In a study conducted in Iran, it was seen that calcium oxalate was the most common composition (80.2%), while uric acid, calcium phosphate, cystine and struvite were predominant compositions in 16.2%, 2.4%, 0.6% and 0.4% respectively[5]. Khan et al saw calcium oxalate the most common stone component in 78%, uric acid in 19% and struvite in 3%[6]. No cystine and calcium phosphate was found in their study.

Comparing all these studies, it is seen that the incidence of calcium oxalate stones in our study was on the higher side. This might be due to increase intake of vegetables and cereals by the low socioeconomic status of the patients[11]. It is also seen that the uric acid stones were not very common and not single cystine stone was found. The reason could be less consumption of protein diet. The percentage of struvite stones (4.3%) in our study population was comparable with other studies[6,7]. The study could not find the living standard of urolithiasis patients.

Conclusion

Further extensive area-wise studies need to be carried out to assess the real picture of stone burden, its type, and its correlation with environmental, dietary and genetic factors. Better knowledge of stone composition and its etiology will also help in improving the management of stone disease. Dietary intervention on large scale and health education in this regard may be helpful as a preventive measure.

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