

Chemical Composition of Upper Renal Tract Calculi in Multan

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Abstract

Objective: To study the chemical composition of upper renal tract (renal and ureteric) calculi in Multan.

Setting: Department of Urology, Nishtar Hospital, Multan.

Study period: September 1992 to February 1999.

Material and Methods: A total of 700 renal and ureteric calculi were analyzed by chemical method of Hodgkinson.

Results: The commonest were uric acid (28.1%) calculi, followed in frequency by calcium oxalate calculi (26.1%), mixed calculi containing calcium oxalate and uric acid (21.8%) and calculi containing calcium oxalate and calcium phosphate (10.4%). Other variety of calculi were less common.

Conclusion: Uric acid, calcium oxalate and mixed uric acid and calcium oxalate calculi are the main types in Multan region (JPMA 50:145, 2000).

Introduction

Renal stones are common in Pakistan. There is high prevalence of renal tract stones in Southern Punjab^{1,2}. The incidence of the different chemical types of stone depend on geographical * environmental and socio-economic factors as well as the incidence of urinary tract infections and chronic urinary tract obstruction³. The importance of the analysis of urinary stones cannot be overemphasized. A knowledge of the composition of urinary stone is important because urolithiasis is a recurrent disease in many people^{4,5}. Preventive measures, medical therapy and decision about proper procedures for treatment, require the knowledge of stone composition^{6,7}. Many studies have been performed in different parts of the country on the composition of the renal tract calculi and they have included smaller number of patients. We have studied the chemical composition of the upper renal tract calculi in 700 patients and to our knowledge this is the largest study ever reported in Pakistan. This study describes the composition of upper renal tract calculi in Multan, which is the largest city of Southern Punjab with an estimated population of around 2 million and compares it with other studies from Pakistan and some other countries.

Material and Methods

The study was carried out in the Department of Urology, Nishtar Hospital Multan. Upper urinary tract calculi (i.e., renal and ureteric) were obtained from the patients who had undergone operative treatment for their calculi in the urology, general surgical and paediatric surgical departments of the hospital. In addition stones were collected from some private hospitals of the city. The study period was from September 1992 to February 1999.

In all cases stones were washed with deionized water and then dried in an incubator. In each case, the size, appearance and hardness of the stone was noted. Then the sample was crushed into powder form and was analyzed by chemical method of Hodgkinson⁸. Two 10ml aliquots of homogenous stone powder were weighed. One of these was dissolved with 5 drops of concentrated hydrochloric acid (HCl) with application of heat. On cooling, the solution was transferred to a 25 ml flask and the contents were made up to the mark with deionized water. This acidic aliquot was used for quantitative estimation of calcium, oxalate, phosphorus, magnesium and ammonium. The second aliquot was

dissolved in 2ml of a decalcifying solution consisting of 5%(w/v) ethylene diamine tetra acetic acid (EDTA) and the pH was adjusted to 7.8 with sodium hydrochloride, the solution was completed by making the final volume to 10ml. This EDTA aliquot was used for the determination of uric acid contents. Carbonates were determined by effervescence test by exposing the stone powder to concentrated HCl. Cystine contents were also determined. Any compound which was less than 10% of the weight of the stone was disregarded.

Results

A total of 700 calculi (581 {83% } renal and 119 { 17% } ureteric) were obtained from similar number of patients. There were 532 male and 168 female patients and male to female ratio was 3:1. The average age was 31.3 years (range 1 .5 years to 85 years) and 50.7% of patients were between 21 and 40 years of age. (Table 1).

Table 1. Age and sex distribution.

		Total	Male	Female
0	10 years	71 (10.1%)	61	10
11	20 years	96 (13.7%)	72	24
21	30 years	179 (25.5%)	144	35
31	40 years	176 (25.1%)	129	47
41	50 years	102 (14.5%)	76	26
51	60 years	47 (6.7%)	29	18
61	70 years	25 (3.5%)	17	8
	Above 70 years	4 (0.5%)	4	nil

Total Patients = 700

MALE =532

FEMALE=168 (M:F=3:1)

Table 2. Chemical composition of upper renal tract calculi in Multan.

Ca Oxalate	183 (26.1%)
Ca Phosphate	5 (0.7%)
Ca OX+ Ca P	73 (10.4%)
Ca OX+UA	153 (21.8%)
Uric Acid	197 (28.1%)
Ca OX+Ca P+UA	50 (7.1%)
Ca P+UA	18 (2.5%)
AMP	12 (1.7%)
Ca OX+CaP+Amm	9 (1.2%)

Abbreviations

Ca OX = Calcium oxalate.

Ca P = Calcium Phosphate.

UA = Uric Acid.

AMP = Ammonium Magnesium Phosphate.

Table 2 shows the composition of the analyzed. Calculi containing pure uric acid commonest (28.1%), followed in frequency by oxalate calculi (26.1%) and calculi containing oxalate plus uric acid (21.8%). Calculi containing oxalate plus calcium phosphate constituted 10.4% and those containing calcium oxalate, calcium phosphate plus uric acid accounted for 7.1% of the calculi. Other calculi, AMP (1.7%), calcium phosphate plus uric acid (2.5%), calcium oxalate plus phosphate and ammonium

(1.2%) were present in smaller numbers.

Discussion

The analysis of the renal calculi has become an important part in the management of the renal stone disease patients. There are different methods for the analysis of renal stones. Schneider and co workers⁹ compared chemical, x-ray diffraction, infra-red spectrophotometry and thermoanalytical procedures in the analysis of the urinary calculi and found that all these methods are accurate in detecting the composition of urinary calculi. Among these, chemical analysis is rapid and cheap and can be performed in any laboratory, although it does require adequate attention to the details of technique¹⁰.

In this study all calculi were analyzed by chemical methods and the commonest variety of calculi were uric acid (28.1%), followed in frequency by calcium oxalate calculi (26.1%) and calculi containing calcium oxalate plus uric acid (21.8%). Calculi containing calcium oxalate plus calcium phosphate constituted 10.4% and those containing calcium oxalate, calcium phosphate plus uric acid accounted for 7.1% of the calculi. Other calculi, Struvite (1.7%), calcium phosphate plus uric acid (2.5%), calcium oxalate plus phosphate and ammonium (1.2%) were present in smaller numbers.

Table 3. Comparison of the results of chemical composition of upper renal tract calculi in Pakistan.

	This study (n=700)	Zafar et al ² Multan (n=258)	Khalil et al ¹¹ Quetta (n=137)	Sia et al ¹² D.G. Khan (n=50)
Calcium oxalate	183 (26.1%)	87 (33.7%)	35 (25.5%)	5 (10%)
Calcium phosphate	5 (0.7%)	2 (0.77%)	2 (1.4%)	Nil
Ca OX + Ca P	73 (10.4%)	49 (18.9%)	19 (13.8%)	10 (20%)
Ca OX +UA	153 (21.8%)	58 (22.4%)	40 (29.1%)	10 (20%)
Ammonium urate	Nil	49 (18.9%)	12 (8.7%)	Nil
Uric acid	197 (28.1%)	Nil	4 (2.9%)	Nil
Ca OX +Ca P+UA	50 (7.1%)	5 (1.93%)	Nil	15 (30%)
Ca P +UA	18 (2.5%)	Nil	Nil	Nil
AMP	12 (1.7%)	6 (2.3%)	23 (16.7%)	Nil
Ca OX + Ca P +Amm	9 (1.2%)	Nil	Nil	5 (10%)
Ca OX +Ca P+ Mg	Nil	2 (0.77%)	Nil	Nil
Ca OX +Ca P+ Amm +UA	Nil	Nil	Nil	Nil
Ca OX + UA + Amm + Mg	Nil	Nil	Nil	5 (10%)
Ca OX + UA + Mg	Nil	Nil	Nil	Nil
Ca OX+Ca P+Mg	Nil	Nil	2 (1.4%)	Nil

Table 3 shows the comparison of composition of calculi with other studies from Pakistan. In all these studies the calculi were analyzed by chemical methods. Zafar et al² analyzed 258 upper renal tract calculi from this area and reported that pure calcium oxalate calculi were the commonest variety (33.7%) of calculi followed by mixed calculi containing calcium oxalate plus uric acid (22.4%) and calculi composed of ammonium urates and those of calcium oxalate plus calcium phosphate each

making up 18.9% of the total number.

Khalil et al¹ analyzed 137 tippet' urinary calculi from Quetta valley and reported that most frequent calculi were those containing calcium oxalate and uric acid (29.1%) followed by calculi containing calcium oxalate (25.5%), AMP calculi (16.7%) and calcium oxalate and phosphate calculi (13.8%). Calculi containing uric acid or ammonium urate accounted for 11% of the calculi analyzed.

Sial et al¹² reported from D.G.Khan that the most frequent (30%) upper urinary calculi were mixed, made up of calcium oxalate, calcium phosphate plus uric acid.

In a study from Lahore by Khan¹³, most (48.5%) of the upper urinary calculi were of mixed composition containing calcium oxalate and uric acid. Next in frequency were calculi containing calcium oxalate and calcium phosphate (25.7%) followed by calcium oxalate calculi (22.8%). No urate calculi were reported. This study was small and 37 upper urinary calculi were analyzed.

In a study from Karachi by Rizvi¹⁴, 75 renal calculi were analyzed. The commonest were calcium oxalate calculi followed in frequency by calculi containing calcium oxalate plus uric acid and those containing calcium phosphate. No pure uric acid or ammonium urate calculi were reported. In this study 59.7% of the calculi contained uric acid while in studies reported by Zafar et al², Khalil et al³ and Sial et al¹² 43.3%, 40.8% and 60% of their calculi respectively contained uric acid. In another study reported from Karachi by Shah jehan and Rehman¹⁵ 52.8% of the upper urinary calculi contained uric acid.

Ammonium magnesium phosphate (AMP) calculi accounted for 1.7% in the present study. Zafar et al² and SJ Khan¹³ reported nearly same percentage i.e. 2.3% and 2.8% respectively. No AMP calculi were reported by Sial et al¹² while they Khalil et al¹¹ accounted for 16.7% of the calculi analyzed by.

No cystine stones were reported by Zafar et al², Khalil et al¹¹ and Sial et al¹² and no such stones were found in the present study too.

The composition of the renal calculi in other countries is different from ours (Table 4).

Table 4. Comparison of the composition of upper renal tract stones in Multan with some other countries.

	Present study	UK ³	USA ¹⁶	Sudan ¹⁷
Ca oxalate	26.1%	39%	58.8%	75%
Ca phosphate	0.7%	13%	8.9%	Nil
Ca OX + P	10.4%	14%	11.4%	12.5%
Ca OX+ UA	21.8%	Nil	Nil	Nil
Ca P + UA	2.5%	Nil	Nil	3.12%
Ca OX+P+UA	7.1%	Nil	Nil	Nil
Uric acid	28.1%	8%	10.1%	3.12%
AMP	1.7%	15%	9.3%	Nil
Cystine	Nil	3%	0.7%	Nil
Others	1.2%	6%	0.8%	6.25%

phosphate. No pure uric acid or ammonium urate calculi

Upper calculi made up of calcium oxalate are the commonest variety of calculi in USA 58.8%¹⁶, in UK 39%³ and Sudan 75%¹⁷, Next in frequency are mixed calculi composed of calcium oxalate and calcium phosphate in these countries. Uric acid calculi accounted for 10.1% in USA¹⁶, 8% in UK³ and 3.12% in Sudan¹⁷. Upper urinary calculi composed of uric acid tend to be more common in Israel¹⁸ and constitute 39.5% of the calculi¹⁹. There were no cystine stones in study reported from Sudan¹⁷ but they constituted 3% and 1.7% of the upper tract calculi in UK³ and USA¹⁶ respectively.

The present study has shown that uric acid calculi are the commonest variety of upper renal tract calculi in Multan. Three physiological and environmental factors responsible for uric acid lithiasis are i) persistent urine acidity, ii) hyperuricosuria and iii) decreased urine volume²⁰, Much of the population of this area cannot afford frequent intake of purine rich food such as meat, fish and poultry with resultant hyperuricosuria. Low urine volume and low pH is encountered in dehydration and dehydration has been considered as an independent risk factor for increased prevalence of uric acid stones in arid regions²⁰. In our opinion long summers with very high temperatures in this area leads to diminished urinary output, persistent urine acidity and supersaturation of urine with uric acid. Combination of all these in turn leads to uric acid crystallization and stone formation. Compared with all other types of renal calculi, effective chemolysis and prevention of the uric acid calculi can be achieved with increased fluid intake, decreased purine consumption and alkalization of urine.

Allupurinol is recommended in cases of hyperuricaemia or hyperuricosuria²¹.

Present study has shown results different from all previous studies and similar large scale studies need

to be carried out in other parts of the country too so that true “textbook picture” on the composition of renal tract calculi can be presented to our medical students ,who all along have been fed with the European “textbook picture”. Better knowledge of the composition of urinary calculi will also improve results of the management of these calculi.

References

- 1.Khan FA, Khan JH. Stone survey of Punjab hospitals. Pak. Postgrad. Med. 1990;1:7-13.
- 2.Zafar MH, Khan MI, Malik NM. et al. Prevalence & type of renal stones in Multan region. Pak. J. Med. Res., 1992;31:13-17.
- 3.Watts RWE. Biochemical aspects and investigation of urinary stone disease in Textbook of genitourinary surgery” 1st ed: Ed. Whitfield FIN & Hendry WF. Edinburgh (UK) Churchill Livingstone, 1985, pp. 614-27.
- 4.Bangert SK. Renal tubular disorders and renal calculi in ‘Clinical biochemistry: metabolic and clinical aspects’. Editors, Marshall Wj, Bangert SK. 1st ed. Churchill Livingstone Edinburgh, 1995, pp. 163-73.
- 5.Menon M. Parulkar BG, Drach GW. (1998). Urinary lithiasis: etiology, diagnosis, and medical management In “ Campbell’s Urology”. Walsh PC, Retik AR, Vaughan EI and Wein AJ Editors. 7th Edition Washington. USA W.B. Saunders, 1998. PP 2661-2733
- 6.Prien EL, Prien EL Jr. Composition and structure of urinary stones. Am. J Med.. 1968;45:654-72.
- 7.Dretler SR I)reteral stone disease. options fir management. Urol . Clin. North. Am., 1990;17:217-30.
- 8.Hodgkinson A. A combined qualitative and qualitative procedure ‘or the analy sis of urmarv calculi. J Clin Pathol., 197 t :24: 147-51.
- 9.Schnieder HJ,. Berenvi M, H esse A, et at. Comparative urinary stone analy sea: Quantitative chemical, X-Ray diffraction infra red spectroscopy and thermoanalytical procedures. Int. Urol, Nephrol.. 1973.5:9-17.
- 10.Freeman tA. Beeler Mr. Urinary stone analy sis in “Laboratory medicine/urinalysis and medical microscopy”. 2nd cd Philadelphia Lea and Febiger, 983.
11. Khali NY, Nawaz H, Ahmad S. et at Urinary calculi prevalence, types and distri but on in urmary tract in Quetta valley and adjacent areas. ‘The Professional. 1998;2:197-202.
- 12.Sial SHJ, Khan ill, Iqbal S. ct at. Chemical analy sis of’ renal calculi front D.G.Khan. The Professionals. 1995;2:89-93.
- 13.Khan SI. Saeed M. Observations on the chemical profile of urinary calculi. The Professionals, 1997;2: 151-54.
- 14.Rizvi SAil. Calculous disease. A survey of 400 patients. JPMA. 1975;25:268-74.
- 5.Shahjchan S. Rehman MA, Studies on time etiology of urolithiasis in Karachi. Am. J Clin Nutr. 1971 .24:32-37.
- 16.Smith LH Urolithiasis in Schrier RW, Gottschelk CW. Eds “Diseases of the kidney. 4th edition. Boston, L ittle Brown. 988. pp. 785-813.
- 17.Kambal A. Wahab EMA. Khatab Al III. The chemical conipositioti of unitary stones in Sudan. Br. J, tJrol.. 1979;51,342-44.
- 18.Herbstein F H, Kleeberg 3, Shalitin V. ct al. Chemical aيتد X—Ray diffraction analysis of urinary stones in Israel. 1sr J, M, Sci., 1974;10:1493.
- 19.Colin l3itck A. Risk factors in idiopath ic stone dtsease. lit “ Scientific foundations of’ urology”: Eds -Chisholm GD. air WR .3rd ed Oxford. Heinmana Medical Books, 1990. pp. 176-92.
- 20.Riese R, Sakhaee K. Uric acid nephrolithiasis: pathogenesis and treatment. 3. Viol., 1992;148:765-71.
- 21.Malek RS. Renal fithiasis: A practical approach. J. lirol.. 1977;118:893-901.