

MORPHOLOGICAL AND CHEMICAL STUDY OF URINARY CALCULI

Pages with reference to book, From 300 To 303

F.D. Khan, M.S. Memon, A.F. Ansari (Department of Biochemistry, Institute of Chemistry, University of Sind, Jamshoro.)
J.M. Memon (Department of Surgery, Liaquat Medical College, Jamshoro.)

Abstract

Of 50 patients with urinary calculi, upper tract stones were common between 15-44 and lower tract stones between 0-14 and above 44 years of age. Urinary calculi contained calcium, phosphate, oxalate, urate/uric acid, ammonium, magnesium and carbonate. The frequency of occurrence of each of these radicals in sixty stones was 93.33, 83.33, 61.67, 51.67, 25.00 and 13.33% respectively. Five (27.78%) out of eighteen different combinations of acidic and basic radicals seen in the stones, analysed were of pure lithiasis and the rest were mixed.

The most frequent combination observed in upper urinary tract stones was calcium oxalate and calcium phosphate.

The cut surface of the stones revealed that 60% stones were featureless. Only vesical stones made of Ammonium urate, Ammonium urate + calcium phosphate and Ammonium urate + Calcium phosphate + Calcium oxalate were laminated and contained well defined nucleus (JPMA 36: 300. 1986).

INTRODUCTION

Despite the fact that Hyderabad region is considered as one of the areas in which urolithiasis constitutes a public health problem¹⁻³ little attention has been paid to the factors that are involved in, or lead to the formation of urinary stones in this area. Formation of stones within the urinary tract is a complication of varied metabolic disorder.⁴ Matrix and crystals are invariably the fundamental components of each stone and, morphologically are intimately associated⁵. Chemical analysis of urinary calculi is important for diagnosis, and therapy while knowledge of the composition of the stone is often the key to specific treatment.^{6,7} As the composition of the urinary calculi is known to differ from place to place⁸ the present work was, therefore, undertaken to investigate the common types of the stones and their possible etiological factors.

MATERIAL AND METHODS

Urinary tract calculi were obtained from the patients admitted in Surgical Unit IV, Ward 12, Liaquat Medical College Hospital Jamshoro and from patients themselves.

The stones received in the laboratory were washed (if necessary) with deionized water to remove any contaminations (dried blood or cellular debris), dried in air and weighed. After noting the external features such as surface appearance, colour and shape the smaller stones were ground to a fine powder in an agate mortar, while the larger stones were cut into two equal parts with a fine Jeweller's saw to study the general pattern of the internal structure. The powder obtained in either case was qualitatively analysed for the presence of various organic and inorganic constituents. The chemical methods used were wet chemical analysis as described by Reiner and Co-workers⁹ for the detection of Magnesium, Ammonium, Phosphate, Carbonate, Urate/Uric acid, Cystine and Xanthin,; Kaplan and Szabo¹⁰ for Calcium and Oxalate.

All reagents used were prepared with doubly distilled deionized water.

RESULTS

One hundred and five urinary stones from fifty patients were chemically analysed. Thirty four stones were from 7 female and 71 from 43 male patients. Forty five of these calculi were recurrences of the same qualitative composition, and hence have not been included in the analysis.

The results presented herein involve sixty calculi from 50 patients.

TABLE - I
Location of Stones and Sex Incidence.

Location	Sex		Total
	Male	Female	
Renal	22	05	27
Ureteric	01	—	01
Vesical	22	04	26
Passed in Urine	05	01	06
Total	50	10	60

Table-I Shows the location of the stones and sex frequency. Twenty six stones were from the lower urinary tract, while the rest were from the upper. With the exception of six stones which were spontaneously passed in the urine by the patients. all others were surgically removed.

Age and location of urinary calculi is shown in Table-II.

TABLE - II
Age and Site Occurrence.

Age group	Upper tract	Lower tract	Total	Percentage
0 — 14	03	08	11	18.33
15 — 29	18	05	23	38.33
30 — 44	08	05	13	21.67
45 and above	05	08	13	21.67

Upper tract stones were most common between 15-44, and lower tract stones between 0 to 14 and above 44 years of age. Urolithiasis was most frequent in 15 to 29 years age group. Chemical composition of stones is shown in table III.

TABLE - III
Frequency of Occurrence of the Various
Radicals in the Stones Analysed.

Radical	Upper Urinary tract 34	Urinary tract stones 36	Total 60	% occurrence
Calcium	32	24	56	93.33
Magnesium	03	12	15	25.00
Ammonium	04	21	25	41.67
Phosphate	27	23	50	83.33
Oxalate	25	12	37	61.67
Uric acid/Urate	10	21	31	51.67
Carbonate	01	06	08	13.33

Calcium (93.33%), Ammonium (41.67%), Magnesium (25.00%) and Carbonate (13.33%) were found in the decreasing order of frequency.

TABLE - IV

The Frequency of Occurrence of the Possible Combinations of Acidic and Basic Radicals in the Stones Analysed.

S.No.	Combination	Site of Occurrence		Total	Percentage of the total stones.
		Upper Urinary Tract	Lower Urinary Tract		
		34	26	60	
1.	UA	01	--	02	3.33
2.	AU	--	02	02	3.33
3.	Ca Ox	02	--	02	3.33
4.	Ca P	01	--	01	1.67
5.	Ca Carb	01	02	20	1.67
6.	Ca P + Ca Carb	18	--	01	33.33
7.	Ca Ox + Ca P	01	02	05	1.67
8.	Ca Ox + UA	03	--	01	8.33
9.	Ca Ox + Ca P + UA	01	01	01	1.67
10.	Ca P + Mg P	--	01	02	1.67
11.	Ca Ox + Ca P + Mg P	--	01	01	1.67
12.	Ca Ox + AU	01	01	02	3.33
13.	Ca P + AU	01	03	04	6.67
14.	Ca P + AU	--	03	04	6.67
15.	Ca P + Ca Carb + MAP	02	02	04	6.67
16.	Ca P + MAP+(UA/AU)	-	03	03	5.00
17.	Ca P + Ca Carb + MAP + (UA/AU)	-	04	04	6.67
18.	Ca Ox + Ca P + MAP + (UA/AU)	-	02	02	3.33

UA = Uric Acid

AU = Ammonium urate

Ca Ox = Calcium oxalate

Ca P = Calcium phosphate

Ca Carb = Calcium carbonate

Mg P = Magnesium phosphate

MAP = Magnesium Ammonium phosphate

Table IV presents 18 possible combinations of acidic and basic radicals seen in the stones analysed. Thirteen out of eighteen (72.22%) combinations were of mixed lithiasis, while the remaining five (27.78%) were of pure lithiasis.

Three radical combinations were more frequent in the upper urinary tract (61.8%) and more than three radical combinations in lower urinary tract stones (Table V).

TABLE - V
Percentage Occurrence of the Combinations Age and Tractwise.

Age group Location Combination	0 – 14		15 – 29		30 – 44		45 and above	
	UUT	LUT	UUT	LUT	UUT	LUT	UUT	LUT
	%	%	%	%	%	%	%	%
Ca oxalate	66.67	37.5	77.78	60.00	87.5	20.00	40.00	62.5
Ca phosphate	66.67	50.00	83.33	100.00	87.5	100.00	60.00	100.00
Uric acid	33.33	–	5.55	–	25.0	–	40.00	25.00
Amm. urate	33.33	100.00	5.55	80.00	–	60.00	–	50.00
MAP (Struvite)	–	25.00	5.55	60.00	–	60.00	20.00	37.5
Ca carbonate	–	12.5	16.67	–	–	60.00	20.00	25.00
Mg phosphate	–	–	5.55	20.00	–	–	–	–

Combination of calcium oxalate + calcium phosphate (52.94%) was maximally seen in upper tract stones. Individually calcium, Magnesium, Ammonium, Phosphate, Oxalate, Urate and Carbonate were involved in 88.89, 33.33, 44.44, 66.67, 44.44, 55.55 and 22.22 percent combinations respectively, while calcium phosphate, calcium oxalate ammonium urate and calcium phosphate ± oxalate were involved in 83.33, 61.67, 35.00 and 53.33% combinations respectively.

The occurrence of the possible combinations of acidic and basic radicals related to different age groups and locations is shown in table V. The frequency of Ammonium urate and Magnesium ammonium phosphate stones was significantly ($P < 0.01$) higher in the lower urinary and Calcium oxalate ($P < 0.05$) in upper urinary tract stones of patients between 0.44 years of age.

Morphologically upper urinary tract stones differed significantly in weight, shape and surface appearance from those of lower urinary tract. That is, 82.35% of the upper urinary tract stones weighed less than 2 grams, while 53.85% of lower urinary tract were about 5 grams. Upper urinary tract stones were mostly asymmetric in shape, having rough surface with numerous microcrystalline spiny projections, whereas, lower tract were mostly oval and had a smooth surface. The cut surface of the stones revealed that 79.41% upper urinary tract and 34.61% lower urinary tract stones were featureless with no definite or ill defined nucleus. Only bladder stones composed of Ammonium urate, Ammonium urate + Calcium phosphate and Ammonium urate + Calcium phosphate + Calcium oxalate were seen laminated and contained well defined nucleus.

DISCUSSION

The frequency of calcium, phosphate and oxalate, magnesium, ammonium and urate and pure lithiasis is similar to that reported by Rao et al.¹³ Das Revielland et al.¹⁵

High frequency of oxalate and a low frequency of Magnesium, Ammonium and Carbonate in upper urinary tract stones than in the lower suggest that latter are incompatible with oxalates as the Magnesium seems to oppose the crystallization of oxalates. Ammonium urate were also more common in vesical stones and oxalate in renal stones¹⁸ in this series.

Shahjehan et al.¹⁶ reported that 82.6% of vesical calculi contained a mixture of urate calcium, oxalate and phosphate, but our results show that only 13.33% of vesical stones were of this composition. On

the contrary 73.08% of the vesical calculi contained ammonium urate and 69.44% contained calcium phosphate + urate.

Greater incidence of phosphate containing stones in both upper and lower urinary tract may be attributed to alkaline pH of the urine in most cases. A significant increase in urinary pH is confined to patients preferably eating vegetables and fruits.¹⁷ The diet of the habitants of this area is far from ideal and is generally of a vegetarian nature. These facts suggest that diet could be one of the causative factors in this region. A periodic variation in the pH of urine and the possibility of epitaxial growth may be assumed as a possible cause of mixed lithiasis.

No definite correlation was observed between the gross appearance and the chemical composition of the stones analysed.

ACKNOWLEDGEMENT

The authors gratefully acknowledge the assistance and cooperation of the Registrars of Surgical Unit N, Ward 12 of Liaquat Medical College Hospital, Jamshoro and the authorities of University of Sind for granting financial assistance in this study.

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