NOTE ON THE CHEMICAL COMPOSITION AND PHYSICAL PROPERTIES OF RENAL CALCULI

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A series of twenty-two calculi in all was investigated, derived from a fairly wide distribution in South-west Lancashire and North Wales, the object of the study being chiefly to determine whether there was anything in the appearance of a calculus which would give a fairly reliable clue to its chemical composition.

The results are concisely recorded in the subjoined table, which shows that analysis alone can determine the nature of a calculus, the pigmentation, surface, and hardness which are usually relied upon for the classification of calculi being exceedingly untrustworthy.

An important result obtained as far as this series at least is concerned is that uric acid either free or as urates is an exceedingly rare constituent, for uric acid or urates were completely absent in nineteen out of the twenty-two stones, and only traces were found in the three cases where a faint positive result was obtained with the murexide test.

Of equal importance is the unexpected fact that oxalic acid, combined usually with calcium, was found in every one of the stones examined, although the previous literature places this as a very much rarer constituent than uric acid. Phosphates were also commonly present, although this is usually described as only an occasional constituent.

In two of the stones only were carbonates found, but in these two they were present in considerable quantity. These two stones also contained oxalates and phosphates.

In regard to the physical property of hardness, on which great

stress has been laid by earlier observers, in relationship to chemical composition, I have found as far as the simple test of crushing goes that the hardness is very little, if any, related to the chemical composition, and would suggest that the rate and process of formation of the stone is of much more importance, the compactly laid down glossy stone, probably of slower growth, being most difficult to crush, whatever its chemical composition.

In the previous literature—in addition to rarer forms of calculi which need not here be discussed, since none of them were found in the series—there were three chief forms of calculi recognised : (a) the pure uric acid calculus, usually described as of a yellowish or brownish colour, rough and crystalline on the surface, and brittle ; (b) the urate calculus, containing urates chiefly of magnesium and ammonium along with excess of uric acid, and oxalate of calcium and ammonium magnesium phosphate (these stones were supposed to grow larger than the pure uric acid stones, and were described as having a smooth surface and pale colour) ; (c) the oxalate calculus, which was described as having a brown colour and a spinous surface full of irregular projections of a rounded or club-like form (these are said to be much less frequent in occurrence).

The present series of analyses furnishes no experimental evidence to support this classification. As above stated, oxalates are the constituent *par excellence* in this series, being present in every one of the twenty-two calculi examined, and in the majority of the cases in preponderating amount above all the other constituents present. Further, the smoothness and pigmentation give no information as to chemical constitution in the series here examined, and these appear to me to depend much more on the rate of deposit and the natural amount of pigment present in the urine during the period that the stone is being deposited.

It would have been quite impossible for anyone not knowing the three stones in the series which contained uric acid to pick these out from the remainder from their physical appearance, and their pigmentation was very like that of the rest of the series, in which, as above stated, uric acid was entirely absent.

In conducting the analyses, the excellent table of Haller was followed as a routine. Since the amount of oxalates in nearly all the calculi examined was preponderating, it was thought that this might mask the presence of *small* amounts of uric acid, and in order to test this point the following experiment was carried out with an artificial mixture.

A solution of calcium chloride was added to one of oxalic acid, and the insoluble calcium oxalate was separated off. To this precipitated calcium oxalate the smallest trace of uric acid was then added, the proportion of uric acid in the mixture being not more than 1 in 1,000. This mixture was placed in a porcelain dish, a drop of nitric acid added as in the murexide test, and the whole evaporated to dryness.

The residue was quite white, and did not show the usual reddish brown residue of appreciable amounts of uric acid, so that the small trace of uric acid obviously was here concealed by the excess of oxalates.

However, on the addition of ammonia even this trace showed up positively. For a pink coloration could now be detected; this turned purple on the addition of caustic soda. The murexide test was hence here quite positive, and shown to be a very delicate test.

The delicacy of this control assured me that no appreciable amount of uric acid was present save in the three cases in which positive results were obtained.

TABLE OF ANALYSES WITH SHORT DESCRIPTION OF EACH CALCULUS

Initials	Percentage of Moisture	Percentage of Incom- bustible Material	Percentage of Com- bustible Material	Car- bonates	Oxal- ates	Phos- phates	Uric Acid
I.—Mrs. G. Brownish colour, spinous projections	6	43·6	56·4	Absent	Present	Present	Trace
II.—M. L. Shape-cast of kidney pelvis, chocolate colour, with whitish crystals on surface	2·89	26·7	73·3	Absent	Present	Present	Present
III.—E. B. Brownish, glossy, smooth	1·92	43·86	56·14	Present	Present	Absent	Absent
IV.—W. H. H. Greyish, spinous projections	9·7	62·2	37·8	Absent	Present	Present	Absent

TABLE OF ANALYSES WITH SHORT DESCRIPTION OF EACH CALCULUS—*Continued*

Initials	Percentage of Moisture	Percentage of Incombustible Material	Percentage of Combustible Material	Carbonates	Oxalates	Phosphates	Uric Acid
V.—A. E. Oval, greyish rind, cut surface brownish and glossy	3·3	34·5	65·5	Absent	Present	Present	Absent
VI.—E. H. Greyish, brittle	4·13	71·91	28·09	Absent	Present	Present	Absent
VII.—E. K. Shaped to renal pelvis, brittle, greyish-brown	3·8	72	28	Absent	Present	Present	Absent
VIII.—W. G. B. Greyish and spinous	2·09	55·94	41·16	Absent	Present	Present	Absent
IX.—W. E. P. Light brown and spinous	12·2	28·1	71·9	Absent	Present	Present	Absent
X.—Mrs. T. Brownish, irregular, brittle	2·32	59·07	40·93	Absent	Present	Present	Absent
XI.—P. J. H. Greyish and spinous	2·15	59·14	40·86	Absent	Present	Present	Absent
XII.—E. W. Whitish, irregular surface	5·92	75·6	24·4	Trace	Trace	Large quantity	Absent
XIII.—H. C. Chocolate colour, projections correspond to calyces, glossy	2·3	44·5	54·45	Absent	Present	Present	Present
XIV.—G. W. Large, whitish, brittle	7·6	65·5	34·5	Absent	Present	Present	Absent
XV.—J. D. Oval, greyish, spinous, brittle	5·4	62·8	37·2	Absent	Present	Present	Absent
XVI.—H. H. S. Oval, whitish, and smooth	4·7	76·2	23·8	Absent	Present	Present	Absent
XVII.—M. C. Greyish, irregular, brittle	5·5	66·9	33·1	Absent	Present	Present	Absent

TABLE OF ANALYSES WITH SHORT DESCRIPTION OF EACH CALCULUS—*Continued*

Initials	Percentage of Moisture	Percentage of Incom- bustible Material	Percentage of Com- bustible Material	Car- bonates	Oxal- ates	Phos- phates	Uric Acid
XVIII.—Dr. H. Brownish and spinous	5.67	47.73	52.27	Present	Present	Present	Absent
XIX.—A. L. Surface chocolate and smooth	2.02	40.6	59.4	Absent	Present	Present	Absent
XX.—Nurse D. Rind light brown and spinous, cut surface chocolate	3.07	38.5	61.5	Absent	Present	Present	Absent
XXI.—E. L. Oval, chocolate colour, glossy	2.27	43.3	56.7	Absent	Present	Present	Absent
XXII.—Mrs. W. Rind chocolate, cut surface greyish	1.6	32.8	67	Absent	Present	Present	Absent

NOTE.—Regarding other constituents present calcium and sodium were always found in every calculus of the series. Xanthin cystin and other rare constituents were usually tested for, but were invariably found absent.

The twenty-two samples examined were all from cases occurring in the practice of Mr. W. Thelwall Thomas, F.R.C.S., to whom my thanks are due for the suggestion of this work, as also for his kindness in placing the material at my disposal. My thanks are also due to Professor B. Moore for allowing me to work in his department, and for his help at all times.

CONCLUSIONS

1. The commonest constituent by far in this series of calculi is oxalate, present chiefly as the calcium salt.
2. Uric acid in any form was found to be extremely rare, and absent in nineteen out of twenty-two cases.
3. Neither pigmentation, hardness nor surface of the stone are any criterion of its chemical composition, and depend in all probability more upon the physical and physiological conditions while the stone is being deposited.