REMARKS

ON THE

CALCULI

IN ST. GEORGE'S HOSPITAL.

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The following paper is the result of an analysis of a collection of calculi, most of which were presented by Sir B. Brodie to St. George's Hospital. The collection now consists of 233 divided calculi, not including any duplicates, and 9 undivided, these last having some peculiarity in form. The analysis was begun in 1831 by Dr. Prout, who examined 24 specimens, and from these as well as from the remainder which I have analysed, I shall endeavour first to show that when the urates are deposited there is reason to suppose that little or no free acid can exist in the urine, and that consequently alkalies, however useful they may be in other respects, are not requisite in such cases to remove acidity. When we find an acid reaction on test paper, it is by no means a true conclusion that therefore free acids exist, and alkalies must be given to remedy this state of disordered secretion. As far as we yet know, the truth appears to be, that free acid is not usually present, and that consequently alkalies are generally not required to neutralize acidity in the urine.

I will secondly point out in what proportion of cases in this museum acid injections might have dissolved or partially removed the calculus.

Of those calculi which have been divided,

46 are simple, that is, consisting throughout of one substance.

40 are compound, consisting throughout of a mixture of two or more substances.

147 are alternating.

Of these alternating calculi,

83 have a simple nucleus.

58 have a compound nucleus.

If, instead of looking at the calculi from this point of view, we examine them for the purpose of seeing how often the same substance forms either a whole calculus, or occurs in a well-marked layer, we shall find that in this collection there are at least 450 distinct deposits. These I have arranged in the accompanying Table, from which it will be seen that

135 times uric acid occurs either alone or mixed with other substances.

222 — urate of ammonia, ditto.

163 — oxalate of lime, ditto.

139 — the phosphates, ditto.

80 — urate of ammonia with oxalate of lime.

TABLE of 233 Calculi examined. These consisted of at least 462 well-marked Layers, of which 450 may be thus arranged.

PROBABLE STATE OF SECRETION.	URIC ACID.	URIC ACID & OXALATE OF LIME.	OXALATE OF LIME.	PHOSPHATES.
1st. Urine acid to test paper.				
When enough free acid is passing to decompose all the urate of ammonia.	All Uric Acid = 89	Uric Acid and Oxalate of Lime = 8	Oxalate of Lime }	None
When little acid only passes, and the urate of ammonia is only partly decomposed.	Uric Acid & Urate of Ammonia = 31	Uric Acid, Urate of Ammonia and Oxalate of Lime = 7	Oxalate of Lime } =59	None
When there is no free acid passing, and hence none of the urate of ammonia is decomposed.	Urate of Ammonia = 61	Urate of Ammonia and Oxalate of Lime = 56	Oxalate of Lime }	None
2nd. Urine not acid to test paper.				
When there is an alkaline state of the urine from want of acid, or from excess of alkalies taken as medicines, or formed from urea.	Urate of Ammonia and Phosphates = 50 Fusible . . . . =47 Phosphate of Ammonia & Magnesia . . =2 Phosphate of Lime =1 — 50	Urate of Ammonia, Phosphates & Oxalate of Lime=17 Phosphates mixed . =9 Phosphate of Ammonia and Magnesia . . . =3 Phosphate of Lime . =5 — 17	Phosphates and Oxalate of Lime=16 Phosphates mixed . =7 Phosphate of Ammonia and Magnesia . . . =2 Phosphate of Lime . =7 — 16	Phosphates only=56 Phosphates mixed . =38 Phosphate of Ammonia and Magnesia . . =10 Phosphate of Lime = 8 — 56
	Nature of deposit on Calculus when there is a tendency to an excess of urates, in proportion to the water.	Nature of deposit on Calculus when Oxalate of Lime is formed, and the urates are in excess.	Deposit when Oxalate of Lime only is formed, and no urates in excess.	Deposit when no Oxalate of Lime is formed, and no urates are in excess, and no free acid is present.

Of Twelve Layers not included in the above Table,
10 contained Carbonates
2 Uric Acid and Phosphates (Dr. Prout).
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12

In order that a deposit of urate of ammonia or of uric acid, with urate of ammonia, may take place, it is necessary that an excess of urate of ammonia, as compared with the quantity of water, should exist in the urine; yet this is not the case as regards a deposit of uric acid alone. It will be shown that for uric acid to be precipitated, no other unnatural state need be present except that of some free acid passing in excess out of the system. In this, perhaps, we may find a partial explanation of the frequent occurrence of uric acid calculi.

Urate of ammonia appears to be increased in the urine from very slight causes. The very frequent occurrence of this deposit in the state of health rendered it very probable that this substance would be often found as a constituent of calculi. Since Dr. Prout first proved its existence, other chemists have repeatedly recognized it, and this collection is not singular in the number of calculi which contain urate of ammonia.

Oxalate of lime appears from the above Table to exist with uric acid, with urate of ammonia and with the phosphates. It occurs 80 times in 450, with urate of ammonia forming a distinct deposit. As these substances occur together so often in calculi, so must they frequently be met with in the same sediment: that is, there must be a certain diathesis, in which urate of ammonia is formed at the same time with oxalate of lime. By means of the microscope this can be shown to be true. And in the red deposit of rheumatism and of indigestion

I have found octohedral crystals of oxalate of lime, sometimes in large quantities. This mixed diathesis I hope soon to bring again before this Society.

In order to arrive at the state of the secretion when the substances in the above Table were deposited, we must consider, with Dr. Prout, that urate of ammonia exists in the urine in the state of health. The rapid deposit of this substance when urine is evaporated under the air pump over sulphuric acid, and the change which ensues if even carbonic acid is first passed through the liquid, admits of no other conclusion than that uric acid exists in healthy urine combined with ammonia. And as we find by experiment that all acids, even down to carbonic acid, are capable of causing a deposit of uric acid, and that when acids are added in small quantities an equivalent quantity of uric acid is deposited, and if much acid is present, that all the uric acid is thrown down, and that no urate of ammonia is left undecomposed; it appears that free acid and urate of ammonia cannot exist for any length of time in the same solution. We find, moreover, that urine which reddens litmus, when cool, deposits urate of ammonia, and after being again heated and cooled, again deposits the same substance; and that however often this be repeated, no decomposition takes place, no uric acid crystals can be detected by the microscope; whence we must conclude that whilst urate of ammonia only is deposited, no free acid can be present, although litmus paper may be reddened.

We may make satisfactory experiments on this subject in the living body. To a patient who passes urate of ammonia, we may give acid medicines and cause a deposit of uric acid in its place, whilst litmus paper will be far more strongly reddened than it previously was.

For the above reasons, therefore, it seems most probable that when uric acid alone is deposited, much free acid must have been thrown out by the kidneys, and that thus all the urate of ammonia, which would otherwise have been present, must have been decomposed. If we wish to know how often in calculous complaints this highly acid state of secretion occurred, we must not only observe how often whole calculi consist of uric acid, but how often whole layers of this substance occur. This appears from the Table to have been 97 times in 450.

It was above stated that when little acid was added to urine or taken by a patient subject to a deposit of urate of ammonia, that substance was only partly decomposed; and the conclusion which must be drawn from this seems to be, that when urate of ammonia is found mixed with uric acid, but little free acid is secreted by the kidneys. Such a mixture was found to occur in 38 layers. Hence in 38 states out of 450, but little free acid was thrown off in the urine.

When we find urate of ammonia alone, without any uric acid, forming a calculus or layer, we must consider that no free acid was removed by the kidneys, although the secretion may have been acid to test paper.

The presence of the phosphates in a deposit generally implies a neutral or alkaline state of the urine. If such be the case, and the presence of uric acid implies an acid state from free acid, it would follow that uric acid and the phosphates must exist very rarely in the same deposit. When the calculus has consisted chiefly of the phosphates, I have not once found uric acid to exist with it. When traces of this acid have been present, careful examination showed it was in combination with some base. And when the calculus consisted chiefly of uric acid, the small ash which sometimes remains will rarely be found to consist of the phosphates.

In the above Table the phosphates occur 139 times. Hence 139 times in 450 the urine must have been neutral or alkaline to test paper.

If then phosphates indicate neutrality or alkalescence, and uric acid indicates free acid in the urine, we may conclude that the deposit of oxalate of lime, as it occurs in the above Table with uric acid, with urate of ammonia and with the phosphates, is independent of acidity and alkalescence, and that its presence in a layer does not indicate any particular state of the secretion.

Now, as such layer implies a certain state of the urinary secretion, the 450 layers may be taken to represent 450 states of the urine.

139 of these were neutral or alkaline, as so many times the phosphates are found to occur.

311 were feebly or strongly acid to test paper.

Of these 311, in 97 much free acid was passing from the system, as so often layers of uric acid occur.

38 but little free acid was thrown out, as so often mixed layers of urate of ammonia and uric acid appear in the Table.

117 no free acid passed, although litmus was reddened.

59 the state of the secretion is unknown, the oxalate of lime not offering any indication of it.

Omitting these 59 oxalate of lime, there are then 117 states in which no free acid is passing from the system, and 135 in which little or much free acid was thrown out. From this it appears that in 252 cases of the uric acid diathesis, there were 187 in which no free acid was passing, and in these, alkalies would be of no benefit, so far as neutralising free acid in the urine is concerned: that is, in nearly every second case of the uric diathesis, there was but little if any free acid in the urine to be neutralised.

In only 97 cases out of 252 was there much free acid secreted, or only twice in five cases were alkalies very necessary to remove the acidity of the urine; though in other cases these medicines might have been beneficial in some other respect.

There are two points in my analysis which I have found difficult of determination, when only a small quantity of the calculus or layer could be spared.

The first, which is rare, is, to distinguish between a mixture of urate of ammonia with oxalate of lime, and urate of ammonia with urate of lime. The other is to recognise a mixture of uric acid with urate of ammonia. There is no difficulty in either case when a sufficient quantity of the calculus can be spared. The microscope, which in fresh sediments on the last question is most satisfactory, with the powder of calculi has afforded me no assistance.

In 40 cases the phosphates or the phosphates and carbonates form the last layer.

In 7 cases the whole calculus consisted of fusible deposit.

In 5 cases the whole calculus consisted of phosphate of ammonia and magnesia.

In these 52 cases out of 233, the calculus might have been lessened by the injection of dilute acids, and in 12 out of these the whole calculus might have been removed. This supposes however that in all these cases the calculi were in the bladder, and not in the kidneys, on which there is no satisfactory historical evidence.

In addition to these 52 cases there are 6 calculi which consist entirely of urate of ammonia and fusible deposit, and 19 in which fusible and urate of ammonia form the outside layer. In these cases, most probably, any acid injection would dissolve the fusible and decompose the urate of ammonia, and thus disintegrate the calculus. So that altogether in 75 out of 233 a solvent might have assisted in the removal, although in 18 only out of 233, or about 1 in 13, could the calculus have been entirely removed. For this Sir B. Brodie has shown dilute nitric acid sufficient. Perhaps at some future time lactic acid, which possesses a peculiar power of dissolving the phosphates, may be found even more rapidly efficacious.

APPENDIX.

Since the foregoing paper was written, I have been examining a small collection of between twenty and thirty calculi, chiefly removed by Mr. Cæsar Hawkins.

The first of these was a small calculus about the size of a large nut, which had been divided: the section showed a large nucleus with a few thin layers around it. The nucleus was dirty yellow, semitransparent, crystalline, irregularly radiated, and rather soft. The external layers were much harder, whiter, and less crystalline. The nucleus entirely disappeared with heat, giving a most disagreeable and peculiar smell; it dissolved with little difficulty in nitric acid with effervescence, and when evaporated afterwards to dryness, it left a black residue, which ammonia did not alter. A little of the powder from the nucleus was boiled with water in a test tube: to this a drop or two of a solution of acetate of lead was added, and then an excess of caustic potash.

On boiling, this mixture became in a few minutes jet black. This proof of the presence of sulphur was conclusive as to the nucleus of this calculus being cystine.

The layers exterior to this nucleus contained no cystine; when treated with nitric acid they gave evidence of uric acid, which was combined with ammonia, being soluble in water, and evolving ammonia when heated with liquor potassæ. By heat, a considerable residue was left, which dissolved with effervescence in dilute acids, and afterwards gave a larger precipitate of lime. By long-continued heat an alkaline ash remained. Hence the external part of the cut surface consisted of urate of ammonia and oxalate of lime.

The external surface of this calculus also appeared to consist of two substances, a white crystalline superficial part, and an inferior brownish yellow substance. The first consisted of crystals of oxalate of lime, the second of urate of ammonia and oxalate of lime.

Hence the cystine deposit continued for a considerable time, and was succeeded by urate of ammonia and oxalate of lime for a comparatively short time, and this was followed for a still shorter period by oxalate of lime alone.

Through the kindness of Mr. Hawkins I am able to give the history of this calculus, which he removed from James Roberts, 6¼ years old, at the Asylum for the Recovery of Health, in 1828. The boy had suffered from symptoms of calculus for four years. The pain occasionally was so great that he was held up by his feet to give him relief. The operation was performed on the 25th of October, and the wound healed on the 6th of December. He returned to Cornwall, and nothing has since been heard of him.

This case proves the existence of a deposit of cystine so early as two years of age. It has not as yet been found in a patient of more than 47 years. Of the ten cases recorded by Dr. Prout, eight occurred between 47 and puberty. One before 12 years of age, and one before the patient was five years old.