Reprinted from the 'Transactions of the Pathological Society of London,' 1896.

A case of spontaneous fracture of uric acid calculi.

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The spontaneous fracture of calculi in the human bladder is not of very frequent occurrence, but cases every now and again present themselves, and are always interesting, since it seems so contrary to the ordinary sequence of events to find such hard intractable bodies as uric acid calculi falling, so to speak, in pieces of their own accord. Especially so does it strike us who are called upon to crush them artificially, for we know that even when they are caught between the jaws of the lithotrite a considerable amount of force has to be applied before they can be broken. On looking over a fairly extensive collection of calculi, various specimens will probably be found, and it will be evident that spontaneous fracture has not occurred in all cases in exactly the same way. Various explanations of the phenomena have been suggested, such as the concussion of two or more calculi in the bladder from violent exertion on the part of the patient or from blows or falls, the generation of gas in the interior of the stones, swelling of the nuclei, and the like. In the present case the patient was a man seventy-two years of age, who was admitted into the West Norfolk and Lynn Hospital in the year 1867 with symptoms of stone. He died in the month of April, and the specimens which form the basis of the present communication were removed *post mortem*. They consist of some 240 fragments, weighing 270 grains. Besides these fragments, there were four entire calculi about half an inch in diameter in the act of splitting. Three of these have been cut in halves with a fine saw and the cut surface rubbed smooth upon a hone. Amongst the fragments there are the nuclei of twenty-one calculi, so that each calculus would weigh when entire about 10 or 12 grains.

The reason these specimens have for so long escaped closer attention is a simple one, namely, that they were regarded as being the result of a case of incomplete lithotrity, and with a certain amount of reason, since upon one occasion a lithotrite was passed into the man's bladder and a stone was undoubtedly crushed. At that time I was a pupil of the hospital, and was present at the operation. It will be remembered that in 1867 the operative manipulation in lithotrity was strictly time-limited, two or three minutes being considered as long as it was safe to work with the lithotrite in the bladder for fear of setting up cystitis. Such was the course pursued in this case, but the patient succumbed shortly afterwards. Now, although the operator was skilful and experienced, yet he will hardly lay claim to the ability of crushing twenty-one stones in three or at most four minutes, nor would he be likely to have caught the four other stones, applied to each just enough force to crack them, and leave the fragments *in situ*. I was also present at the *post-mortem*, and distinctly remember the condition of the bladder. The base of the viscus was as unlike what the interior of a bladder usually is as can well be imagined. It was occupied by numerous—ten or twelve—small sacculi, from half to three-quarters of an inch across and about the same in depth. The opening of each sacculus into the bladder was slightly smaller than the body of the pocket, freely admitting the tip of the finger. They were evidently pouches produced by the mucous membrane bulging, hernia-like, between the reticulated muscular fibres of the bladder. Each pocket held several fragments, some had entire calculi in them, but all were filled to the level of the bladder with muco-purulent urine. Owing to the openings of the pockets being smaller than the pouches themselves, it was found necessary to remove the bladder and turn it inside out into a basin, in order to get all the calculi out. It is obvious that neither the operation of lateral lithotomy nor that of lithotrity would have freed the patient from his disease. His best chance would have been with the supra-pubic, when by turning him on his face and washing out the bladder with a stream of water directed upwards through the wound, many of the fragments might have been got away, but the process would have been tedious and difficult. It has been asserted that with our newly-constructed lithotrites it is hardly possible to catch the mucous membrane, but with such a sacculated bladder as this it would have been hardly possible to catch a stone at all without at the same time catching the delicate walls separating the sacculi.

Externally, the calculi and fragments are of a uniform colour, looking as if they were coated with a layer of pale grey whitewash. On the outside of the larger this is collected into nodular masses, some microscopic in size, others as large as a hemp-seed. These are solid, but there are other rounded elevations of greater dimensions which are hollow beneath. There are others, again, still larger, which are perforated in the centre like volcanic craters. The whitish-grey deposit is freely soluble in caustic potash and insoluble in hydrochloric acid,—at least a fragment kept in the strong acid for a week showed no tendency to disintegrate.

The three divided calculi consist of uric acid, yellowish circumferentially with a large darker nuclear portion. In structure they are very dense, hard, and compact. Many of the fragments are subangular segments of spheres, such as Dr. Ord has aptly likened to pieces of an exploded bomb-shell, being convex externally where they correspond to the exterior of the calculus, concave internally where they have been separated from the nucleus, angular laterally where they have been lifted from one another, so that they have a wedge-like or pyramidal contour. In some instances only a few such wedges have been split off from each calculus, leaving the nucleus as a little ball still *in situ;* in other cases the nucleus has fallen away, and remains as a free shot-like body. The outside of the unbroken calculi is mapped out by slightly elevated ridges indicating the segments into which they are in the process of separating. A section enables us to see how this is being brought about. If this passes through one of the blister-like elevations on the surface of the calculus above referred to, it will be seen that although the outer surface of the blister is smooth, yet the interior of the cavity is lined by an assemblage of rounded nodules or spheres standing side by side, the bases of which are continuous with a greyish white matrix, contrasting strongly in colour with the yellow concentric laminæ of the body of the calculus. In some instances it is evident that this grey matrix has been formed beneath the outer lamina, and as the grey deposit has increased in bulk it has broken away and lifted up the lamina itself, fragments of which rest imbedded in the grey material forming the upper wall of the blister. In fact, the calculus is undergoing a process of disintegration externally, brought about by the deposit of a substance of a very similar composition chemically as the calculus itself, but of a different molecular arrangement. The ridges on the exterior marking out the segments into which the calculi are splitting are also formed of the same grey material; they constitute comparatively thin bridges arching over fissures that extend downwards towards the centre. These bridges vary in height and in width, but on the surface of the calculus they are in all cases considerably wider than the fissure over which they stretch. The grey deposit extends downwards as a thin granular layer upon the fractured surface of the calculus, covering both sides but not filling up the fissure entirely, and it is here in the interior of the calculus that we find its spherical structure best developed. The thickness of this layer varies, but it is always greatest towards the exterior of the calculus just opposite the first or second or third external lamina, from which point it thins off so as to appear in section as a blunt wedge. On its free surface it presents an assemblage of spheres or of bluntly rounded cones or short cylinders, the bases of which become fused into an homogeneous layer applied to the fractured surface of each segment, so that the planes of the two deposits are at right angles to one another. In order to determine the composition of this granular deposit, a minute fragment was chipped off from the segment of the calculus, placed on a microscopic slide, and covered with a thin cover-glass; caustic potash was then run in, and the effect watched under a quarter-inch objective. The fragment dissolved in a few minutes. A similar fragment was kindly examined by Dr. Ord in the same manner, who used glacial acetic acid, when that very beautiful reaction took place in which the acetic acid gradually broke up the fragment and then caused the deposit of uric acid crystals with lancet-shaped ends, which he has shown[1] takes place when the uric acid is associated with ammonia, so that this grey granular deposit consists of an acid urate of ammonia.

The thick, wedge-shaped mass towards the periphery of the section is evidently the agent that is forcing apart the various segments, and it is here at the most external part of the fissures that the only attachment of the segments exists, in fact each hangs suspended by its external angles like Mahomet's coffin. Some of the fissures have obviously extended from the surface inwards towards the centre, while others have gone in the reverse direction from the centre outwards, as they are wider below than above. The fissures are narrow, and reach inwards as far as the dark nucleus, or, to

[1] Ord, W. M., 'Influence of Colloids upon Crystalline Form and Cohesion,' 1879, p. 99.

speak more correctly, the nuclear portion of the calculus from which each segment has been lifted up, the degree of upheaval varying according to the extent to which the disruptive process has gone, but sufficiently far in most cases to allow the insertion of the point of a penknife between the nucleus and the segment. The lower surface of the segments are also covered by the granular deposit, and it is to be found on the nucleus as well.

The manner in which the upheaval of the segments takes place is interesting. A uric acid calculus consists of concentric laminæ differing from one another in colour and varying somewhat in the degree of firmness by which they mutually cohere. But, besides this, there is a tendency to radial cleavage, so that we may regard a spherical calculus as being composed of an assemblage of cones or pyramids having their bases externally and their apices meeting at the nucleus. This is shown by the radial striation figured by Rainey,[1] as well as by the tendency to radial cracking, often seen in museum specimens, from drying. When a stone is crushed by the lithotrite its component parts are separated in both directions concentrically and radially, so that the larger fragments are more or less cuboid in form, but there is also a tendency to the pyramidal contour, most marked, of course, in the largest fragments. In the specimens under consideration the segments have been split off from the calculi by a separation between the pyramids, the force in the first instance acting from the exterior, the inter-pyramidal cleft passing inwards until it comes to a point where the adhesion between concentric laminæ is less strong than the adhesion between the pyramids, so that the force acting along the line of least resistance passes laterally between the concentric laminæ. The direction of the force is, however, influenced by the shape of the wedge, which is an exceedingly blunt one, and acting upon the periphery of the calculus separates the two margins of the fissure, forcing them asunder instead of driving the primary fissure onwards as a thin wedge would. The consequence of this is that after travelling a certain distance, generally less than one third round the calculus, the fissure turns outwards and so reaches the surface again; thus a segment is split off.

The whole process is exactly the same as that by which the trunk of a tree is riven by a hammer and wedge. In fact, the transverse

[1] Rainey, Geo., 'On the Mode of Formation of Shells of Animals by Molecular Cohesion,' 1858, p. 12, fig. 4; p. 58, fig. 4A.

section of an endogenous tree presents many points of similarity to the section of a calculus : the pith corresponds to the nucleus, the bark to the crust, the annular rings to the concentric laminæ, and the medullary rays to the planes of radial cleavage, so that a slice sawn from such a trunk may be employed as an illustration of the phenomenon under consideration. If a wedge be driven from the outside in the direction of the central pith, the log will be split into two halves, provided the wedge has been accurately applied; but if it be only driven in a short distance, it will open a crack wide above but a mere chink below, where it will terminate at one of the annular rings. If the wedge be now pressed sideways parallel to the bark, the crack, instead of increasing downwards, will turn at right angles and follow the direction of the annular rings on the side opposite to that to which the wedge is inclined. If the wedge be further depressed, it will, acting as a lever of the first order, lift out a wedge-shaped piece of wood, a secondary crack passing from the annular ring outwards. This crack will be the converse of the primary, being wider below than above, and is exactly what has happened in the calculus. In the calculus, however, the lateral pressure, by reason of the obtuseness of the wedge, is applied equally to both sides of the primary crack, so that the separation of the concentric laminæ below often takes place on both sides, although it is more pronounced upon one side than upon the other. When any of the secondary or extrusive fissures reach the surface of the calculus, the wedge-like deposition of the acid urate seems to take place at once, bridging over the crack. At any rate, there are none of the sections without it. Sometimes the granular layer becomes detached from the sides of the segment and remains as a free plate in the fissure. When this happens, the bared surface of the segment soon acquires a fresh coating of granular deposit.

It is evident that the disintegration of these specimens has been caused by pressure from without, by a process of wedging out of the segments, and that the acting agent has been this grey granular deposit of acid urate of ammonia. The same substance which has so evidently lifted up the outer zonal layers of the calculus is responsible for the opening up of the primary or intrusive cracks. In their beginning these were the merest rifts, but the continued aggregation of the deposit soon opened them into sensible fissures, which, by extending inwards in the manner above described, are ultimately responsible for the whole disruptive process. Rainey[1] long ago pointed out, in his work on 'Molecular Coalescence,' the radial striation of the artificial calculi he produced by the action of potassic carbonate on solutions of gum, but he further showed that these artificial calculi tended to disintegrate of their own accord when they were kept in solutions in which the colloid medium was denser than it was in the solution in which the spheres were first deposited.

We have here the probable clue to the case before us. In the man's bladder the pockets in which the calculi were placed were so situated that they never became completely emptied; hence the lower part of the calculi were constantly immersed in muco-purulent urine. The contents of the pouches were stagnant, so that the pus settled to their bottoms and the lower parts of the calculi were therefore bathed in fluid containing a large proportion of colloid, while their upper parts were washed by almost pure urine. Whatever the sacculi may have had to do with the fracture of these calculi, the association of the two conditions is sufficiently close to induce the practical lithotomist to be on his guard when he is called upon to operate on a case of spontaneously fractured calculi.

October 15*th*, 1895.

[1] Rainey, G., loc. cit., pp. 56—58.

PRINTED BY ADLARD AND SON, BARTHOLOMEW CLOSE, E.C.