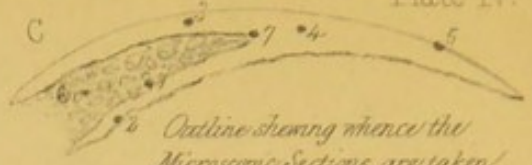
On the enlargement of articular extremities of bones in chronic rheumatic arthritis / by W. Adams.

ON

THE ENLARGEMENT OF ARTICULAR EXTREMITIES OF BONES

IN

CHRONIC RHEUMATIC ARTHRITIS.



Outline shewing whence the Microscopic Sections are taken.

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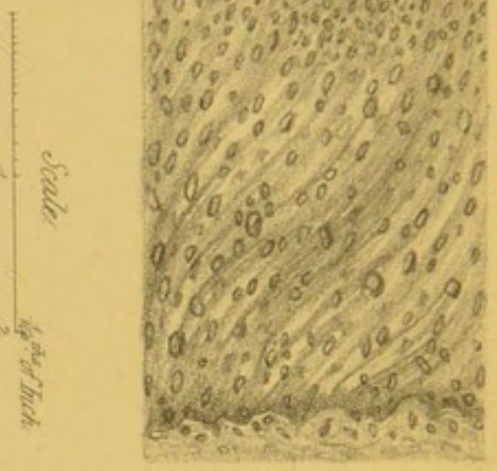

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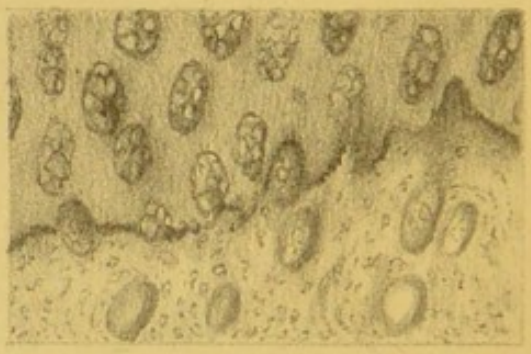

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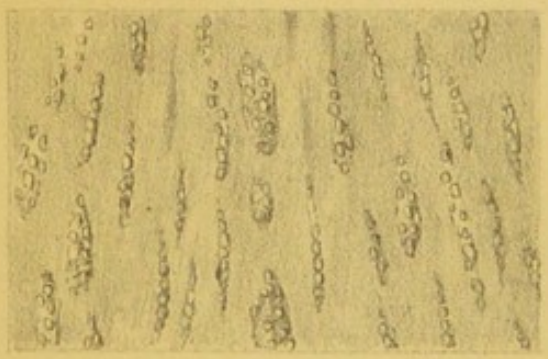

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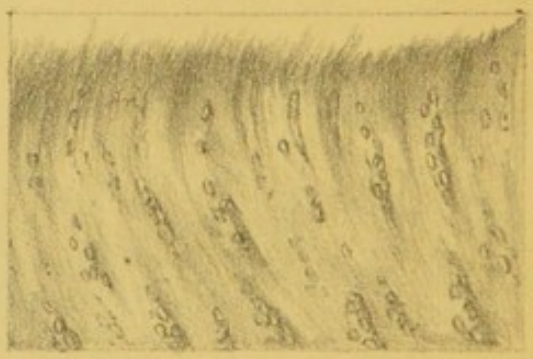

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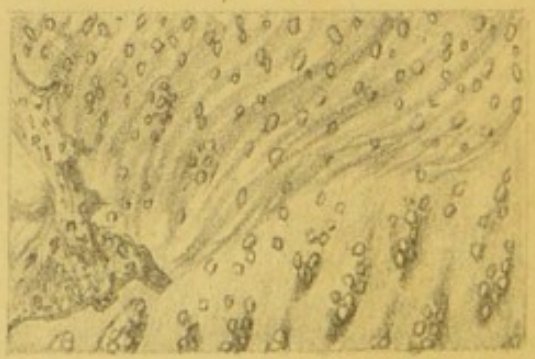

T. West. del. et lith. ad nat.

Ford & George, Imp. 54, Fetter Gate.

Plate to illustrate Mr Adams' observations on enlargement of articular extremities of bones.

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CHRONIC RHEUMATIC ARTHRITIS.

By W. ADAMS, F.R.C.S.,

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FROM THE THIRD VOLUME OF THE TRANSACTIONS OF THE PATHOLOGICAL SOCIETY OF LONDON.

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1851.

EXPLANATION OF PLATE.

Fig. A.—Section of an enlarged head of a femur. The mushroom-like form produced by flattening at the upper part, and a flattened ring-like layer of new bone surrounding and overhanging the margin of the articular surface. Articular cartilage between old and new bone absorbed except at the upper edge, and the continuity of cancellous tissue established.

Two-thirds the natural size.—In Museum of St. Thomas's Hospital.

Fig. B.—Section of an enlarged head of a femur.—A layer of articular cartilage distinctly traceable in its normal direction, external to which is the superadded new bone, by which the increased size is produced, covered by a layer of cartilage. Apex of wedge-shaped portion of new bone extending into hypertrophied articular cartilage.

Nearly the natural size.—In Museum of St. Thomas's Hospital.

Fig. C.—Outline diagram to fig. B, with numbers indicating the points from which the sections were taken.

Fig. 1.—Embedded articular cartilage in process of ossification, including edge of new bone. Ossification advancing from without inwards. Cartilaginous matrix studded with large compound cells. No appearance of fibres.

Fig. 2.—Embedded articular cartilage, including edge of advancing ossification from within outwards, or from head of femur. Changes in cartilage same as in preceding figure. Large compound cells partially and completely included within the line of advancing ossification well seen, and apparently forming permanent cavities.

Fig. 3.—Cartilage on articular surface of newly formed bone, including line of advancing ossification. Cartilaginous matrix thickly studded with small cells and nuclei of the smallest size, the latter more abundant towards the free surface. Matrix having a fibrillated appearance. No elongation of cells or nuclei. Cells included within the line of advancing ossification apparently persistent, forming lacunæ.

Fig. 4.—Articular cartilage from some distance beyond the point of new bone. Cartilage cells in elongated groups and clusters, apparently caused by gradual separation of the cells from each other in consequence of an increased development of the intercellular or hyaloid substance.

Fig. 5.—Articular cartilage near the eburnated bone, in a state of fibrous degeneration. Large and elongated cells at the lower part. Elongation increasing towards the free surface, together with disappearance of cell-walls, and wasting of nuclei or contained cells. Intercellular substance distinctly fibrous at and beneath the free surface, with shrivelled nuclei in this situation.

Fig. 6.—Articular cartilage close to angle of advancing ossification, which is included in section, showing the different appearances in the cartilage cells in the upper and lower portions, viz., in the upper half, the matrix studded with small cells and nuclei, as in fig. 3, with a tendency to form in groups; and a fibrillated appearance of matrix without elongation of nuclei; in the lower half, large solitary compound cells, the walls of which appear to undergo solution, and the nuclei or contained cells to become scattered in the hyaloid substance as they approached the border of the upper half.

Fig. 7.—Section of the newly-formed superadded layer of bone, causing the increase of size of the articular extremities, exhibiting well-formed lacunæ with and without canaliculi, in some parts irregularly scattered, and in others arranged concentrically round Haversian canals.

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SPECIMENS EXHIBITED 4TH FEBRUARY, 1851.

The specimens exhibited were from the hip and knee-joints, and showed the appearances ordinarily observed in the advanced stage of chronic rheumatic arthritis, viz :—

In the hip-joint :—1st. Great enlargement and irregularity of shape of the head of the femur, which assumes a mushroom-like form, in consequence of real or apparent flattening of its upper part, and nodulated masses and flattened ring-like layers of new bone surrounding the edge of its articular cartilage, and extending to a variable distance over its articular surface. To this mushroom-like form, the apparent shortening of the neck, in consequence of its upper part being concealed by the overhanging margin of new bone at the edge of the articular cartilage, also contributes. 2dly. Absence of articular cartilage to a greater or less extent, and the eburnation of the bony surface. 3rdly. Nodulated masses of new bone, from the size of a hemp-seed to that of a walnut, attached by thin peduncles to the synovial membrane on the neck of the bone, or to that of the capsular ligament,—more or less spherical when small, but flattened and irregular when of large size.

In the os innominatum—1st. Increased capacity of acetabulum. 2dly. Ossification of the fibro-cartilaginous rim, or cotyloid ligament. 3dly. Absence of articular cartilage to a greater or less extent, and eburnation of the exposed bony surface. 4thly. Irregular osseous growths (stalactitic osteophytes) on the surface of the bones external to and immediately surrounding the joint.

In the knee-joint :—the appearances were essentially similar to those in the hip, new osseous growths of irregular form surrounded the margins of the articular cartilages of the femur and tibia ; and pedunculated osseous growths, in considerable numbers and of all sizes, were attached to the synovial membrane, both in the notch and lining the capsule. In addition, however, the articular cartilage on the condyles of the femur presented a thickened nodulated appearance in their central parts.

With respect to the mode by which the enlargement of the head of the femur is effected, Rokitansky makes the following observations.

"*Expansion—Softening of the tissue of bone—and the consequent indurations.* Osteoporosis consists in an enlargement of the Haversian canals, and cells of bone.* Osteoporosis sometimes arises from an inflammation of the bone and medulla, which furnishes a product in the cavities of the bone differing in its nature from the ordinary ossific exudation. That very painful disease, the *malum coxæ senile,* (which by the way occurs in other joints also) appears to originate in a process of this kind. I hold it to be an inflammatory process of a gouty character, which gives rise to rarefaction, swelling, and a peculiar deformity of the head of the femur and acetabulum — an osteoporosis succeeded by induration."† And again, " The process by which the change is produced is a painful one, consisting without doubt in an inflammatory rarefaction, swelling, and softening of the bone. After furnishing an osseous exudation within the tissue of the bone and all around—an exudation which may be distinguished by its form and chemical composition—it terminates in consecutive induration."‡

* Rokitansky's Pathological Anatomy, Sydenham Society Translation, vol. iii., p. 171.

† Ibid. p. 173. ‡ Ibid. p. 200.

From the specimens exhibited, Mr. Adams drew the conclusion that the increased size of the head of the femur, and also of the articular extremities of other bones,—did not result from an inflammatory expansion of the osseous tissue, as stated by Rokitansky and other pathologists, but was produced by a growth of new bone external to the old, to the surface of which it afterwards became inseparably connected. The chief evidence in favour of this opinion consisted in the appearances observed in sections through the enlarged extremities.

The outline of the head of the bone was generally traceable in its normal direction, and indicated by the persistence, to a greater or less extent, of the thin shell of compact tissue, naturally limiting the head of the bone, and also of an imperfect layer of articular cartilage (plate 4, fig. *B*). External to this layer of cartilage, and extending from the circumference towards the centre, was a mass of finely cancellous new bone, which produced the irregular shape and enlargement.

This new bone is generally of an irregular wedge-like form; its base rounded, projecting beyond and overhanging the edge of the articular cartilage, and its apex directed towards the centre of the head of the bone lying on its articular surface, and being itself covered by a layer of cartilage; so that the mass of new bone is situated between two layers of cartilage, one belonging normally to the head of the bone, the other covering the articular surface of the new bone. In one specimen exhibited (fig. *B*,) the wedge-shaped portion of new bone measured an inch in length, and,—at its base,—more than a quarter of an inch in breadth; its apex corresponded to the centre of the articular cartilage, which at this point was somewhat thicker than natural, and had the appearance of being split into two layers by the advancing ossification; one layer passing over the articular surface of the new bone, and the other between the new and the old bone in its normal direction. In most sections the last described layer was thicker than the former.

These appearances seemed also to warrant the conclusion that the new bone had been developed in the centre of the articular cartilage. In some instances ossification had increased equally in every direction, so that rounded osseous-like growths were

formed ; and, in others, it extended as a ring-like layer over the articular surface, thick and rounded at the circumference, narrowing to a point towards the centre of the head.

The evidence of these new super-added osseous growths being developed in articular cartilage was equally conclusive in the specimen of the knee-joint above described. Sections through the prominent nodules in the central portions of the cartilage on the condyles of the femur, showed these prominences to depend upon irregular hypertrophy of the cartilage, the hypertrophied portions generally containing a central point of ossification. The process here could be traced from its commencement. As ossification of these nodules advances, a junction with the articular surface of the new bone is soon effected, and,—the thin limiting layer of compact bone becoming absorbed,—the appearance on section is that of a continuous mass of cancellated structure, as seen in the head of a femur exhibited (fig. *A*). The gradual disappearance of the articular cartilage between the central point of ossification and the articular surface of the bone may be traced in different sections. In consequence of this junction, which seems invariably to occur, though at different periods, these growths have uniformly, so far as Mr. Adam's observations have extended, a broad base, and therefore never become pedunculated, or form loose cartilages.

These new super-added osseous growths are at once distinguished, by their situation either at the margin or in the centre of the articular cartilage and, by their broad bases, from the pedunculated osseous growths above adverted to ; which, either solitary or in clusters, are so frequently found attached to the synovial membrane near the borders of the articular cartilage, on the neck of the bone, in the notch between the condyles of the femur, and in all parts removed from direct pressure.

The formation of these pedunculated osseous growths, which were unusually numerous in the knee-joint exhibited, and in which one had become detached, forming a loose cartilage, could be satisfactorily demonstrated to commence in the synovial fringes or glands first described by Mr. Rainey, and referred to by him in the 2nd Vol. of the Transactions of this Society, page 110, in connection with the microscopical examination of

some loose cartilages removed by Mr. Solly from the elbow-joint, which Mr. Rainey inferred had probably been formed in the synovial fringes.

On a microscopical examination of the different layers of cartilage, and the new bone in the enlarged head of the femur, the following changes could be traced. In the remaining portions of the layer of old articular cartilage embedded between the head of the bone, and the newly formed bone (See plate IV., figs. 1 and 2) ossification was actively advancing. The intercellular or hyaloid substance was impregnated with earthy salts terminating abruptly in an irregular, though well-defined and densely opaque line, immediately beyond which, and in all other parts, the hyaloid substance was clear and without the slightest indication of any fibrous development. Some of the irregularities in the line of advancing ossification, either at the upper or lower edge of this cartilage, (for the process was precisely identical whether extending from the super-added growth of new bone,—or from the head of the old bone,)—corresponded to the margins of the enlarged cartilage cells; these cells sometimes causing depressions in the osseous border by the earthy impregnation advancing between them, and at other times producing conical elevations by the earthy impregnation extending beyond—and including the cells, whilst it had advanced to a less extent between them.

The cells in this embedded articular cartilage were much altered; instead of elongated groups of cells, the cartilaginous matrix was irregularly studded with large solitary cells, generally of an oval shape, measuring from $\frac{1}{350}$th to $\frac{1}{750}$th of an inch in their long diameter, and having the appearance of compound cells, the contained cells or nuclei varying much in number and size, and generally having an irregular outline. Some of these large cells were filled with five or six globules of oil, and all of them contained more or less oil, either in molecules mixed with the granular contents, or in distinct globules occupying the place of the nuclei, from a conversion of which they probably resulted. The large solitary compound cells were probably formed by the solution of the adjoining cell-walls of the grouped cells, and an increased development of their contents,—a new cell-membrane being simultaneously formed. There was no appearance of

calcareous matter accumulating within the cell-walls; their contents, whether multiplied nuclei, granular matter, or oil, remained clear when half included in the osseous margin. When completely within the line of advancing ossification, these large cells remained without undergoing further change than the disappearance of their contents, and seemed to determine the permanent cavities or areolar spaces in the fully formed osseous tissue. Neither did these cells appear to act essentially as centres of attraction to the earthy matter, although it was frequently deposited to a variable extent immediately external to the cell-walls. The intercellular matrix was primarily, and perhaps exclusively, the seat of the osseous impregnation.

The cartilage on the articular surface of the newly formed bone (fig. 3) differed remarkably from the embedded articular cartilage. Instead of the thinly scattered large solitary cells, last described, the cartilaginous matrix was here thickly studded with small irregularly shaped cells or nuclei, with clear, homogeneous contents, varying from $\frac{1}{1250}$th to $\frac{1}{5000}$th of an inch in diameter; nucleoli were not traceable in any of them. In a few places only was there any indication of the nuclei being clustered or grouped, and nowhere did they seem to be becoming elongated so as to form fibres. They were less numerous, and of larger size towards the margin of advancing ossification, than towards the articular surface; in the latter situation nuclei of the smallest size were remarkably abundant, and seemed to indicate an active process of cell-development proceeding at this part. This supposition derives support from the observations of Schwann on the development of cartilage. He does not consider that the multiplication of the cells generally results from an endogenous mode of generation, but that "the cartilage-cells originate in the first place by the formation of the nucleus in the cytoblastema," and states, that, "The formation of new cells takes place in certain situations only, on the surface of the cartilage for instance, or between the last formed cells. We have already seen that in the branchial rays of fishes, the least developed cells lay at the point and lateral margins."*

* Microscopical Researches, &c. by Schwann. Sydenham Society Translation, p. 33.

In all this layer of cartilage, the intercellular matrix had a fibrillated appearance to a greater or less extent, varying most towards the central and inferior portions in the neighbourhood of the line of advancing ossification, where it was sometimes distinct, and at others hardly traceable, the hyaloid substance having a faintly granular appearance. Towards the articular surface, this fibrillated character was distinct in all the sections, and the free surface presented a shreddy appearance, though to a much less extent than at the part from which fig. 5 was taken. The filaments were evidently formed in the hyaloid substance independently of the cells or nuclei, and appeared to result simply from a splitting of this material.

The terminal line of advancing ossification in this cartilage was very irregular, but abrupt and well defined. As the small cells or nuclei were gradually included, they appeared to remain permanently, and form the lacunæ of the new bone. The cells within the osseous margin, and in the adjacent cartilage, were to all appearance precisely identical.

In the articular cartilage at some distance beyond the advancing angle of the newly formed wedge-shaped portion of bone, (see fig. 4) the cartilage cells were disposed either in clusters or elongated groups, but the cells of which these clusters and elongated groups were composed appeared to be undergoing a process of gradual separation from each other by the increase of intercellular substance—the clusters gradually widening, and the elongated groups becoming more elongated, and the cells less flattened, somewhat resembling a string of beads.

In the articular cartilage towards the exposed and eburnated bone, where it was much attenuated (fig. 5) there were no clusters or groups of small cells; large solitary cells existed at the lower part, and these became more elongated, as they approached the articular surface; the cell-walls at the same time becoming less distinct, and the contained nuclei gradually wasting. Near to the free surface, elongated and very irregular groups of shrivelled nuclei were seen, occasionally having slight traces of the cell-walls, between the more distinctly marked bundles of filamentous tissue; the intercellular hyaloid substance became more distinctly fibrous towards the articular surface, where it had

a shreddy appearance. The cartilage in this situation gradually diminished in thickness to the edge of the enamelled bone at the upper part of the head, and was evidently in a state of fibrous degeneration by splitting of the hyaloid substance, the walls of the large compound cells at the same time undergoing a process of solution, and the nuclei disappearing.

In the articular cartilage close to the angle of the advancing new bone (fig. 7), the cells presented different appearances in the upper and lower portions, with a tolerably well-marked line of separation. In the upper half, *i.e.*, towards the articular surface, the cartilaginous matrix was thickly studded with small cells as in fig. 3, intermixed with nuclei of much smaller size; these were grouped in places near the line above adverted to, and round some of the groups were traces of cell-walls, apparently in process of formation rather than disintegration. The filamentous appearance of the hyaloid substance was about as well marked as in fig. 3. The filaments frequently passed in a curvilinear direction round the groups of cells. In the lower half the cartilaginous matrix was studded with large solitary cells of an elongated and oviform shape; as they approached the line, the cell-wall became indistinct and disappeared in many instances, the contained nuclei then separating from each other, and being apparently scattered through the hyaloid substance.

The newly formed bone presented to the naked eye, and under the microscope, the ordinary appearances of healthy cancellous structure; numerous lacunæ existed in the thicker portions, and in many places were arranged in concentric layers round Haversian canals (fig. 6). The lacunæ were frequently destitute of canaliculi, but in many places, especially in the Haversian systems, these were present.

From these observations it appears that the process of enlargement of the articular extremities of bones affected with chronic rheumatic arthritis consists—

1st.—In hypertrophy of the articular cartilage, generally occurring at the circumferential margin, but occasionally taking place towards the central parts of the articular surfaces. The new growth of cartilage takes place principally, if not entirely, near to the articular surface. The propriety of the term, hyper-

trophy, may perhaps be questioned, since the new tissue is not precisely identical with perfectly formed articular cartilage; and Rokitansky, Henle, and other observers state, that articular cartilage is not liable to hypertrophy; the difference, however, between the newly-formed and original cartilage was, in some parts, extremely slight, for, near to the osseous border, in the new cartilage, the intercellular matrix was often free from any fibrous tissue, and in some places the nuclei appeared to be in process of aggregation. Generally, a fibrillated character of the matrix, and the scattered, solitary, or imperfectly grouped arrangement of the nuclei, distinguished it from normal articular cartilage.

2ndly.—In the development of true osseous tissue in the hypertrophied cartilage, ossification commencing either in the newly formed cartilage, or at the junction of the new with the old cartilage. Ossification proceeds more rapidly in the newly formed, and forming cartilage, for its growth is probably simultaneous with the advancing ossification, than in the old articular cartilage; so that considerable masses of new bone are formed, altering the configuration of the articular extremities, whilst a layer of articular cartilage remains in its normal position. More slowly, but as perfectly, ossification takes place in this embedded layer of articular cartilage. The process resembles the normal process of ossification in temporary cartilage in the intercellular matrix being the primary seat of earthy impregnation, and the enlargement of the cells in the immediate vicinity of the bone. The chief point of difference seems to be the absence of any definite arrangement of the cells near the line of advancing ossification, and the resemblance in the cells to those usually called compound cells.

The precise part played by the cells in the ossifying process was not more determinable than in the normal process of ossification. Generally, they appeared to be passive until included within the advancing line of ossification, when the large compound cells of the embedded articular cartilage seemed to form areolæ or spaces, and the nuclei in the new cartilage gradually to form perfect lacunæ with canaliculi; but in the embedded articular cartilage, there were no scattered nuclei from which lacunæ could be formed, yet they existed in the bone deve-

loped in this situation. With respect to ossification of articular cartilage, Henle, Sharpey, and other physiologists especially refer to an absence of a tendency to ossify as one of the characteristics of articular cartilage. Sharpey says, "the matrix of articular cartilage rarely, or perhaps never, becomes pervaded by fibres, nor is it prone to ossify."*

The view here taken of the formation of these osseous growths, not only explains the mode in which the articular extremities of bones become enlarged in chronic rheumatic arthritis, but it satisfactorily proves the expansion theory to be inapplicable to a large class of cases which have generally been adduced, especially by Rokitansky, in illustration of the expansion process. Mr. Adams indeed entertains considerable doubt of the soundness of the expansion theory as applied to the inflammatory process in bone generally.

* Quain's Anatomy, 5th edit. p. cxxviii.

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