BACK-KNEE, KNOCK-KNEE, BOW-KNEE

AND

OTHER DEFORMITIES RESULTING FROM DEFECT OF GROWTH AT THE EPIPHYSIAL LINES.

BY

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IN a paper "On the Influence of Paralysis and other morbid conditions upon the Growth of the Bones," published in vol. xlv of the 'Medico-Chirurgical Transactions,' 1862, p. 293, I gave a brief account, with a drawing, plate vii, fig. 1, of the leg of a girl, æt. 15, in which there was a marked backward curvature of the right tibia near the knee. It was said to have taken place during the six months preceding the date of my seeing her; and it remained in the same condition when I again saw her three years afterwards. The right tibia was shorter than the left; but the fibula had its proper length and rose above the level of the upper end of the tibia. I attributed the deformity to a want of proper growth at the fore part of the upper epiphysial line of the tibia, the articular part of the bone having, as a consequence,

become inclined forwards. The term "back-knee" seems an appropriate one for the condition.

Last winter my attention was drawn to a limb in the dissecting room so closely resembling the one above mentioned that I should have thought it to be the same had not age of the woman, above seventy, proved that it could not be so. Professor Macalister was good enough to place the limb at my disposal. The drawing (Pl. I, fig. 1), taken from a cast made by Mr. Griffiths, shows the sharp bend backwards of the leg near the knee and the great similarity of the case to that already alluded to; and figs. 2 and 3 show the tibia to be so much bent backwards near the upper end that its articular surface is at an angle of 40° with the shaft. The condyles of the femur, which are natural, are seen to be resting upon this sloping articular surface which is also natural. In the sharply retiring angle in front of the tibia there is a good deal of bone-formation which stands out boldly obscuring the tuber tibiæ. Behind, the outline is more rounded, resembling that of the anterior surface of a natural tibia, though it is more convex; and there is here no bony deposit. The section (fig. 3) shows the anterior wall thickened at the retiring angle, this being the part which corresponds with the line of junction of the epiphysis with the shaft; and the traces of the epiphysial line behind are seen a little below the articular surface and three quarters of an inch above the greatest convexity of the posterior curvature. The tibia is an inch shorter than that of the other limb; and the fibula extends to a little above the level of the topmost hinder border of the tibia. The rest of the tibia is natural, as also is the femur; and the movements of the knee-joint were free.

There can, I think, be little doubt that, as said in the passage quoted from my former paper, the deformity is due to a want of proper growth at the epiphysial line, and more particularly at its fore part, the upper surface of the bone being, in consequence, inclined forwards. The epiphysial line, as indicated by the remaining traces

of it, has acquired a similar slant, its relations to the articular surface being little altered because the growth at this line—and the same holds good with regard to other epiphysial lines—is almost confined to the side next the shaft; and an interference with it would be manifested only or chiefly on the lower, or shaft, side, that is to say, it is the growth of the shaft that would be arrested rather than that of the epiphysis by a suspension of activity in the epiphysial line.

The deformity, of which I have only seen these two examples, and which must have taken place during the growing period—it is stated to have done so in the first case—is, I think, attributable to undue pressure upon the fore part of the epiphysial line occasioned by the weight of the thigh and body falling in a disproportionate and excessive manner and extent upon this part, which may have taken place as follows. In the fully extended position of the knee the joint is bent a little backwards, all the ligaments, more particularly the posterior ligament, the posterior crucial ligament, and the lateral ligaments, which are placed nearer the back than the front of the joint in a plane behind the chief axis of motion, are put on the stretch, limiting further extension and causing a locking of the joint in such a manner that the position can be maintained without muscular effort, and is, accordingly, one of rest. In this position the line of weight falls through the fore part of the condyles of the femur, the *fore* part of the articular surface and epiphysis of the tibia, and the *fore* part of the epiphysial line of the tibia, while the drag upon the ligaments attached to the hinder part of the epiphysis acts still further to the disadvantage of the fore part of the epiphysial line. It thus tends to repress the growth and ossification of the cells in this situation and more or less along the epiphysial line, and the elongation of the shaft which should take place through their medium. Now, the attitude of resting with the whole weight thrown upon one fully extended limb, the other limb being used to preserve

balance, is frequently assumed by some persons. It is the stand-at-ease position of the soldier; and, if habitually maintained during youth, it would be not unlikely to induce the deformity in question. In accordance with this view, the osseous formation in front of the retiring angle may be compared with the bony ridges that form at the bulging edges of the epiphysial lines of the long bones often observed in rickets and also at the edges of the bodies of the vertebræ in lateral curvature of the spine, though it is in excess of what usually takes place in these instances. It is to be remarked that a similar bend, in the same situation but in the opposite direction, that is, with the convexity forwards, sometimes occurs in monkeys, as represented in fig. 4; and the direction of this bend accords with the fact that in the monkey the knees are commonly more or less bent, and the weight consequently falls more upon the hinder parts of the femoral condyles and of the articular part of the tibia and the epiphysial line. Full extension, indeed, of the joint, with the associated direction of weight upon its fore part, can scarcely be said to take place in any animal except man.

In the deformity with an *inward* bend commonly called "Knock-knee" or "*genu valgum*" a similar condition may now and then be detected on the *outer* side of the upper end of the tibia; and there is, not unfrequently, a bend in the shaft of the femur or tibia of an obviously rickety nature. The chief and special feature of the deformity, however, is a deficiency in the length of the outer condyle—rather of the outer condyloid part of the shaft—of the femur, and a consequent obliquity of the lower articular surface of the femur, which are the resultant of an imperfect growth at the outer part of the epiphysial line. That this is the correct pathology of *genu valgum* I maintained as long ago as 1850 in my Lectures on Surgery published in the 'Provincial Medical and Surgical Journal' of that year, p. 91, and in my work on the 'Human Skeleton,' 1858, p. 476; and the view has been amply confirmed by Mikulicz in Langen-

beck's 'Archiv für klin. Chir.,' xxiii, Hefte 3 u. 4, and by Busch in 'Berlin. klin. Wochenschr.,' 1879, No. 38. Fig. 6 represents a femur and tibia, in the Cambridge Museum, in which this stunting of the outer condyle is very marked and there is nodular bony growth at the edge of the epiphysial line on its outer side such as is common near the ends of rickety bones where there has been giving or bulging of the epiphysial lines consequent on their delayed and imperfect ossification. The outline of the inner surface of the inner condyle is too curved; and the adjacent parts of the shafts of the tibia and femur are expanded and flattened out in the direction of the plane of the curve formed at the knee in the manner often seen in rickety bones. I have found similar specimens in certain German museums—Würzburg, Munich, Berlin, and Vienna, which, as well as the Musée Dupuytren in Paris, are rich in specimens of the so-called, but misnamed, "Englische Krankheit."

The frequency of the occurrence of this stunting of the outer condyloid part of the femur, and consequent knock-knee, is due to the fact of its being the weight-bearing portion of the lower end of the bone. A plumb-line falling from the uppermost part of the head of the femur passes through the outer condyle, which is provided for its function by its greater breadth as compared with that of the inner condyle, and by the greater thickness and vertical direction of the cancellous plates in its interior. The provisions, however, are scarcely sufficient to meet the requirements in young growing persons, especially those who are obliged to stand much or to carry burdens. Hence the cell growth and ossifying processes associated therewith are liable to be interfered with at this epiphysial line, where a greater amount of growth takes place than in any other part of the skeleton; and the failure is most likely to be evinced in the outer or more weight-bearing part of the line. The obliquity of the articular surface thus induced causes the slant of the leg outwards and the projection of the knee inwards

in the extended position of the joint; but, forasmuch as the condyle attains its normal antero-posterior diameter, and the full size of its hinder rounded surface, the leg acquires its proper direction with regard to the thigh during the flexion of the knee.

Knock-knee is still commonly attributed to *undue growth* of the *inner* condyloid part of the femur. The growth here is no doubt out of proportion to that on the outer side because the latter is defective, but there is not any sufficient reason for thinking that it is excessive or abnormally great. An excessive or disproportionate growth at an epiphysis, or at any part of an epiphysis, is very rare. I do not remember to have met with an instance, unless it be now and then on the convex side of the vertebral bodies in lateral curvature of the spine, whereas deficiencies are very common. They are the usual associates of rickets as evidenced by the shortness of the bones in this condition; and the deficiency is, as might be expected, very liable to manifest itself at the lower end of the femur on one or both sides. Illustrations of this, with bulging at the epiphysial line all round, from specimens in the Musée Dupuytren, are given in the plate accompanying my paper in vol. xlv of the 'Transactions' of this Society. I do not think that this view of the pathology of knock-knee—namely, that it depends upon *suppressed growth* in the *outer* condyloid part of the femur—has any especial bearing upon the operation of osteotomy for its relief.

With regard to the opposite deformity viz. "Bow-knee," or "*genu varum*," the only specimens I have seen of shortening of the *inner* condyloid part of the femur are in two otherwise rickety skeletons in the Museum at Vienna; and in both these there are traces of bulging at the *inner* part of the epiphysial line. We may sometimes recognise in the living limb, in cases of bow-knee, a slight prominence at this part, and more frequently a more or less distinctly projecting ridge on the *inner* side of the upper part of the tibia along the epiphysial line,

indicating a want of due growth at this part which would give rise to an obliquity of the upper articular surface of the tibia. In many instances, however, the curvature is not limited to the region of the epiphysial line but is diffused over the upper part of the tibia and in some also over the lower part of the femur. Indeed, the deformity in bow-knee, as well as in knock-knee, is, in some cases, entirely dependent upon curvature in the shafts of the femur and tibia.

Fig. 5 (Pl. I) represents the upper end of an adult humerus, in the Cambridge Museum, in which the head of the humerus is placed at a lower level than natural owing to a sharp flexure at the upper end of the bone, the concavity of which is just beneath the articular surface of the head, and the convexity is on the outer side of the great tuberosity. The bone is in other respects normal. There is a similar flexure in the humerus of the other side, and also in two humeri, in the same museum, from an adult subject, which, together with the scapulæ (they are the only bones from that subject in the museum), are atrophic, being very thin as if from paralysis. These flexures I conceive to be due to an imperfect growth at the inner part of the epiphysial line; but to what cause that imperfection, or stunting, is to be attributed I cannot tell. The same cause must have been in operation on the two sides, and may have been congenital; or it may possibly have been due to the habit of supporting the weight of the body upon the arms during a period of confinement to bed in early life.

The most common examples of inequality of growth at the two sides of the epiphysial lines are furnished by the bodies of the vertebræ in cases of lateral curvature of the spine, which, on the concave sides of the curves, often do not acquire one half of the normal depth; and their upper and lower margins are so projected, or squeezed out, as to cover and sometimes become ankylosed over the intervertebral substances. This occurs most frequently during the later periods of growth, as a consequence of arrest of ossification at the upper and lower

epiphysial lines of the vertebral bodies caused by the weight of the superincumbent parts being thrown unduly upon one side ; and it sometimes goes on to absorption and further modification of form of the vertebral bodies. In the cases indeed which commence in still later life the lessening depth of the vertebral bodies on one side must be entirely due to absorption from pressure. In a few cases I have thought that the bodies of the vertebræ had acquired a slight increase of thickness on the convex side ; but this is rarely the case, the deformity being due almost entirely to a deficiency on the concave side. In the infantile curvature backwards the growth or epiphysial ossification is somewhat hindered in front but usually leaves no permanent deformity. In the senile curvature backwards, on the other hand, which usually commences in the dorsal region and involves the lumbar and cervical regions, the bodies of the vertebræ may become absorbed and flattened in front.

While speaking of growth at epiphysial lines—the growth of the cartilage layer and the ossification into it from the shaft—I may remark that the force of growth at these parts is usually sufficient to overcome the resistance offered by the pressure resulting from weight and muscular action and gives to the several bones and the surrounding soft parts, and so to the individual, a determined height ; the standard of height being therefore regulated by the amount and endurance of this force of growth and its ability to overcome the resistances offered, which vary in different persons. In rickets, however, this force, more particularly the ossifying element in it, which seems to be its most difficult and most easily disturbed feature, is deficient, and the bones are short. The epiphysial cartilages, though restricted in their growth, are still more restricted in their ossification. Hence they are unduly and irregularly thick, soft, and liable to bulge at the circumference. The deformity thus induced usually disappears as time goes on ; and, commonly as it is observed at the lower end of the radius and at

the junction of the cartilages with the ribs in rickety children, the traces of it become lost and are rarely to be detected at these parts in the bones of rickety adults. They are more frequently found to be persistent at the lower end of the femur and at the upper end of the humerus, those being the parts where epiphysial growth is greatest and most prolonged. The more localised and limited defects in epiphysial growth to which I have particularly referred in this paper as causing the deformities about the knee and the lateral curvature of the spine, though of the same nature as the other manifestations of rickets and often associated with them, usually show themselves somewhat later, during that period of accession of development and growth which is associated with and follows puberty; and they are very liable to be persistent.¹

¹ In the 'Transactions of the Pathological Society,' vol. xxiv, p. 179, is a short account by Mr. Nunn of the case of a girl, æt. 17, in whom there was curvature forwards in the lower part of the thigh, attributed to disease eight years previously which had interfered with the growth of the hinder part of the femur. That the deformity represented in Fig. 1 was not the result of fracture, as has been suggested, is shown, among other things, by the precise similarity of the appearances to those in the case of the young woman previously described by me in which the change took place gradually.

(For report of the discussion on this paper, see 'Proceedings of the Royal Medical and Chirurgical Society,' Third Series, vol. i, p. 60.)

DESCRIPTION OF PLATE I.

Back-knee, Knock-knee, Bow-knee, and other Deformities resulting from Defect of Growth at the Epiphysial Lines (Professor HUMPHRY, M.D.).

FIG. 1.—Outline of a limb with “back-knee,” showing the bend backwards of the leg close to the knee.

FIG. 2.—Bones from the same. The tibia is sharply bent backwards near the upper articular end, which presents an oblique surface upon which the femur rests. The upper end of the fibula extends above that of the tibia.

FIG. 3.—Section of the tibia on a larger scale, showing the sharp bend backwards and the trace of the epiphysial line, which is oblique—parallel, indeed, with the articular surface, indicating that the growth of the shaft in front (on the concavity) has fallen short of that behind (on the convexity).

FIG. 4.—The upper ends of the tibia and fibula of a monkey, showing a bend forwards.

FIG. 5.—The upper end of a humerus in which the head is much below its proper level, in consequence apparently of insufficient growth of the shaft at the inner part of the upper epiphysial line.

FIG. 6.—The bones from a case of “knock-knee,” showing the stunted condition of the outer condyle, or rather of the outer condyloid part of the shaft, with slight bulging and irregularity along the outer part of the epiphysial line.

Fig. 1.

Fig. 2.

Fig. 5.

Fig. 3.

Fig. 4.

Fig. 6.