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Lengthening of Bones
under
Disease
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ON LENGTHENING OF THE LIMB AS A RESULT OF KNEE-JOINT DISEASE.

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It has long been noticed that lengthening of a limb may follow disease, and cases of so-called hypertrophy have been recorded as resulting from disease somewhere in the limb itself, but I do not know of any careful observations upon any series of cases. Individual cases have been reported, and it was owing to such a case being brought before the Pathological Society by Mr. Sydney Jones in 1875[1] that I was led to inquire into the subject more carefully, and examine a class of cases likely to throw some light upon the prevalence of this condition. The result of a few observations at that time showed me that some lengthening of the limb was of rather common occurrence after disease of the knee-joint, but the observations were too few to be of much value, and the expression of opinion by surgeons of eminence and experience was so opposed to these results that only further inquiry could prove how far my first observations were exceptional or otherwise.

The following cases have been examined from time to time as opportunity offered, and may prove of interest in more ways than one, for they seem to show that in a certain class of cases of joint disease a careful measurement of the respective parts of a limb may help to determine the extent and locality

[1] 'Trans. Path. Soc.,' vol. xxvi, 1875, p. 159.

of the disease. It may be, and I think it is, possible to say after such measurements which bone is affected, whether femur, or tibia, or patella, and whether the disease is only synovial, or whether it is essentially bony. I do not, of course, mean to discard other means of observation, but I think much greater value should be attached to accurate measurement than is usually done.

And here I would premise that in the majority of cases such accuracy is obtainable by ready means—by repeated observations, and by only more than ordinary care, defining accurately any point of bone which is to be one's landmark, and paying especial attention to the normal position of the pelvis. The effect of overlooking this latter important item I have discussed at length in a former number of these 'Reports.'[1] In other cases, however, where much swelling or tenderness exists, such observations are by no means easy, and for such cases I have used a plain flat rule, or its equivalent, a long outside splint, after marking the bony points carefully, and making sure the skin does not shift. But neither this nor a special apparatus I had made answered as well in the majority of cases as careful measurement with the ordinary tape measure. When I could not ensure the accuracy of an observation the case was omitted, but this was comparatively rare.

The class of cases brought under observation was that of knee-joint disease in young persons—in those whose bones were growing fast—where from their age it might be assumed that the epiphyses were not yet united. Most of them occurred in the wards or out-patient room at St. Thomas's, but I am indebted to the kindness of Mr. W. K. Trevor for the opportunity of examining several cases in the Margate Infirmary, and adding these observations to the list. As far as I am able I have given the references to the cases rather fully, and while acknowledging the courtesy of my colleagues in affording me the means of making many of these observations, it may, I trust, be possible to trace some of the cases further, and where excision or amputation, or death and post-mortem examination has taken place, the seat and extent and nature of the disease may be verified.

[1] Vol. viii, 1878, "On a Possible Source of Fallacy in the Measurements of the Lower Limbs."

When disease occurs in a knee-joint in a young growing person, and that disease, whatever its cause, becomes chronic, it is evident that the nutrition of the joint and its surroundings must necessarily be modified. If the disease be originally in the bone itself the nutrition and growth of that bone would naturally be most affected, and affected in two quite opposite directions. Growth may be arrested or may be exaggerated. If arrested the disease would appear to be very extensive, involving a large area, as may be seen in Case 20, and it may, I think, be assumed that such a condition would be found after necrosis involving the line of the epiphysis. If exaggerated, then the disease giving rise to the elongation of the bone would appear to be more local, and therefore more amenable to treatment, operative or otherwise. Any cause giving rise to chronic hyperæmia of the growing line—of the junction of the epiphysis with the shaft—would almost necessarily tend to increased growth, and in perhaps the majority of cases such cause—secondary though it may be—is found in local necrosis.

If the disease be almost entirely limited to the synovial tissues, it would not be anticipated that the growth of the bone would be disturbed, and Case 6 would appear to show this. But it is so obvious that disease beginning in synovial tissues may extend to the cartilaginous surfaces and the bones themselves that one would certainly anticipate that in many cases the conditions for excessive growth of one or other bone would be found. And this is, I think, traceable in some of the following cases where I have noted that the origin of the disease was spontaneous. But a disease originally synovial and spreading through cartilage to the outer portion of the bone may not dip deep enough to affect the real line of growth. This especially might be expected to occur in more healthy constitutions, and, therefore, it is not surprising that occasionally no increase in growth would be found. Case 7 shows this to some extent, but it must be borne in mind that the patient was the oldest of the series, being twenty-eight years of age, but inasmuch as she had suffered from the mischief seven years I have included the case.

Case 1.—Agnes Tanner, æt. 16. St. Thomas's Hospital, 1875. Disease of right knee since she was three years old.

Now joint disorganised. Length of right femur, measured from antero-superior spine to lower border of patella 2·5 cm. more than left; length of right fibula 1·25 cm. more than left.

Case 2.—Female, æt. 18. St. Thomas's Hospital, 1875. No note made of extent or duration of the disease. No difference in the lengths of the bones.

Case 3.—Wm. Boswothie, æt. 13. St. Thomas's Hospital, 1875. Disease of right knee four years. From antero-superior spine to lower edge of patella equal. Length of right tibia, 2·5 cm. less than left.

Case 4.—Alf. Walker, æt. 8. St. Thomas's Hospital, 1875. Disease of right knee six years; now chronic. From antero-superior spine to patella, right ·6 cm. more than left. Length of tibia, right ·9 c.m. more than left, but the right limb was rather atrophied, and the right foot shorter than left.

Case 5.—Frank Smith, æt. 9. St. Thomas's Hospital, 1875. Disease of left knee five years; now apparently sound. From antero-superior spine to patella on affected side 2·2 cm. more than on other side. Length of tibia to patella on affected side ·6 cm. more than on other side. But the circumference of the left thigh was 2·5 cm. less than right, the calf ·6 less, and the foot ·6 less in length than its fellow.

Case 6.—Maud White, æt. 17. St. Thomas's Hospital, 1875. Disease of knee-joint, of spontaneous origin, one year. Measurements equal. Excised subsequently, and disease found to be synovial, involving the ends of the bones secondarily.

Case 7.—Charlotte Andrews, æt. 28. St. Thomas's Hospital, 1875. Disease of left knee seven years; origin spontaneous. Measurements equal. Excised subsequently. Disease of surface of tibia and femur.

Case 8.—Stephen Amley, æt. 9. St. Thomas's Hospital, 1875. Disease of left knee five years. Measurement of femur on affected side 2·5 cm. longer than other. Fibulæ equal, but the foot of the affected side was 1·25 cm. shorter than the other, the calf 1·25 cm., and the thigh 2·5 cm. less in circumference.

Case 9.—George Rickets, æt. 13. St. Thomas's Hospital, 1876. Disease of left knee six years; spontaneous. From antero-superior spine to patella on affected side, 2·5 cm. more than other side. Fibulæ equal. Excised subsequently. Parts examined showed the femur to be almost entirely the seat of disease. Acute congestion of the bone, not opposite to the tibial articular surface, but more deeply along line of epiphysis, and especially opposite the patellar surface. Acute destruction of cartilage everywhere except opposite to the tibial area.

Case 10.—James Walder, æt. 8. St. Thomas's Hospital. Disease of right knee six years; spontaneous in origin. From antero-superior spine to patella, diseased side, ·75 cm. more than other side. Tibiæ and fibulæ equal.

Case 11.—Herbert Renton, æt. 8½. Disease of left knee three years; origin from injury to the femur. From antero-superior spine to internal malleolus, diseased side, 1·25 cm. more than other side. Tibiæ and fibulæ equal.

Case 12.—Ada Goldfinch, æt. 10. Disease of left knee four years; spontaneous origin. From antero-superior spine to patella on affected side, 2·5 cm. more than other side. Tibiæ and fibulæ equal.

Case 13.—Agnes Davis, æt. 6. Disease of right knee four years. From antero-superior spine to internal malleolus on affected side, 3· c.m. longer. In this case the record I have does not give the difference in length of the separate bones and is therefore nearly useless for my purpose. But it is a record of the difference in total length of the limb as the effect of disease, and I have therefore retained it.

Case 14.—Maria Martin, æt. 14. Disease of three years' standing. Measurements apparently equal, but difficulty to ensure, owing to the limb being bent.

Case 15.—Wm. A. Williams, æt. 11. 1876. Disease of knee three years; spontaneous; apparently synovial. Measurements equal.

Case 16.—Sarah Harris, æt. 13. 1876. Duration of disease not noted. Disease of right knee. Antero-superior spine to tibia or fibula equal. Tibia on affected side 1·6 cm. less than on healthy side. Patella enlarged in all directions, about 1·25 cm. in each diameter.

Case 17.—Arthur Sear, æt. 9. St. Thomas's Hospital, 1876. Disease of left knee-joint three years; diagnosed to be a case of necrosis. From antero-superior spine to tibia on affected side 3·1 cm. longer than on healthy side. Tibia on affected side 1·25 cm. shorter than on healthy side.

In this curious case, which finds a parallel in Cases 22 and 24, there appears to have been an arrest in the growth of the tibia with elongation of the femur. The patella in this case, as in 16, 18, and 19, was enlarged perceptibly.

Case 18.—Frank Manners, æt. 12. St. Thomas's Hospital, 1877. Disease of right knee nine years; now subacute. From antero-superior spine to tibia on affected side 1·25 cm. longer than on healthy side. Tibiæ and fibulæ equal. Patella enlarged apparently about ·6 cm. in two diameters.

Case 19.—Emma Cannon, æt. 10. St. Thomas's Hospital, 1877. Disease of right knee five years. From antero-superior spine to tibia on affected side ·9 cm. longer. Tibiæ equal.

Case 20.—Wm. Stopps, æt. 14. Margate Infirmary, 1877. Disease of right knee reported to have been existing only one year. Much thickening in the lower half of femur. Small sequestra escaping occasionally. Patella not fixed, but cannot bend knee. From antero-superior spine to tibia on

affected side 6·6 cm. shorter. Tibia on affected side ·6 cm. longer.

Case 21.—Robert Parfit, æt. 25. Margate Infirmary, 1877. Disease of right knee two years. Disease of spine. Right arm amputated. Measurements equal.

Case 22.—Ellen Chuter, æt. 15. Margate Infirmary, 1877. Disease of left knee rather more than one year, probably arising in bone. Patella fixed and painful on pressure. From antero-superior spine to tibia on affected side 2·5 cm. longer. Tibia and fibula on affected side 1·25 cm. shorter, but the foot on affected side was ·6 cm. shorter than its fellow.

Case 23.—Adelaide Green, æt. 11. Margate Infirmary, 1877. Disease of right knee five years. Patella not fixed. From antero-superior spine to tibia equal on both sides. Tibia on affected side 1·6 cm. longer than other.

Case 24.—Kate Hutchinson, æt. 14. St. Thomas's Hospital. Disease of right knee since she was four years old, attributed to injury. Family history of phthisis. From antero-superior spine to patella on affected side 2·0 cm. longer. Tibia on affected side 2·0 cm. shorter. Other measurements taken to ensure accuracy, and found to agree with the foregoing.

Case 25.—Agnes Davis, æt. 8. St. Thomas's Hospital, 1878. Disease of left knee three years. From antero-superior spine to tibia on affected side 2·5 cm. longer. Tibiæ and fibulæ equal. Excised subsequently, and showing on examination deep ulceration of the cartilaginous surface of the patella with corresponding disease on external condyle of femur. No disease on inner condyle or on tibia.

The cases may be conveniently arranged in a tabular form.

	Femur of diseased limb.	Tibia of diseased limb.	
	centimètres.	centimètres.	
Case 1	+2·5	+1·25	
2	=	=	
3	=	−2·5	
4	+ ·6	+ ·9	
5	+2·2	+ ·6	
6	=	=	Excised; disease essentially synovial.
7	=	=	„ necrosis in femur and tibia.
8	+2·5	=	
9	+2·5	=	„ disease essentially in femur.
10	+ ·75	=	
11	+1·25	=	
12	+2·5	=	
13	...	...	+3·0 for the whole limb.
14	=	=	
15	=	=	
16	=	−1·6	Patella enlarged.
17	+3·1	−1·25	Ditto.
18	+1·25	=	Ditto.
19	+ ·9	=	Ditto.
20	−6·6	+ ·6	
21	=	=	
22	+2·5	−1·25	
23	=	−1·6	
24	+2·0	−2·0	
25	+2·5	=	Excised; disease of femur and patella.

The above cases have been examined as they came under notice, and may, therefore, be taken to represent average hospital cases of old-standing knee-joint disease in growing subjects. From a careful study of these it would appear that in a large proportion—as much as 76 per cent—some modification in the length of the limb is found. In 14, or 56 per cent., there was elongation; in 4, or 16 per cent., there was shortening; and in one there was no difference in the total length, but the femur was lengthened 2 cm. and the tibia equally diminished in length, compared with its fellow. In 6, or 24 per cent., there was no abnormality as to length, but as 2 of these cases were twenty-one and twenty-three years of age respectively at the time of the commencement of the disease they might be fairly excluded.

Besides the frequency with which some modification in the growth of the limb occurs in young subjects, some other points of importance present themselves as a result of this inquiry. The femur is much oftener the seat of disease than

the tibia, and far more frequently is elongated than shortened relatively. This occurred in 14 out of 18 cases, or 77 per cent. of the "lengthened" limbs, and 56 per cent. of the total number of cases.

That the femur should be the seat of greatest change in the class of cases here considered is not surprising when one takes into consideration its greater liability to injury from external violence, its large size and slight covering at many points, and especially the fact of its possessing so large a mass of epiphysis, and so rapidly growing an area. When, too, disease extends from the patella it is the femur, just by its quickly growing part, which is most liable to participate in the disease. What wonder, therefore, that in four out of five cases in which the patella indicated that it was the subject of disease the femur was found to be elongated, and the tibia not.

But if the femur is so often the seat of disease—for whether the elongation be the evidence or the result of disease does not materially signify—what is the concurrent condition of the tibia must be a question of interest and importance. As a matter of fact, the tibia was lengthened in only 4 out of the 25 cases, so that this condition was comparatively rare. But these 4 cases show that the increased length of the tibia, where it did occur, was accompanied by still greater lengthening of the femur in 2 cases, and nearly equal increase in a third.

When the femur was elongated it most commonly happened that the tibia retained its normal dimensions. This occurred in 8 cases out of 14. But it was not uncommon for the tibia to be diminished, while the femur was increased (3 cases); and, on the other hand, the tibia might be enlarged (3 cases). Some of the cases were rather remarkable, and I would call attention to Cases 18, 22, and 24. In Case 24 the increase in the length of the femur was exactly counterbalanced by the diminution of the tibia.

I am afraid it would be difficult to lay down any rules for these differences, but it is pathologically possible that increased vascularity of a part may be attended by either increased or diminished vascularity of a neighbouring part, or it may not modify it at all. So that either of the three conditions of increased, diminished, or normal growth in the tibia, may attend such disease in the femur as leads to its abnormal

increase of length. But, except by continuity, I do not think much influence in this respect would be looked for; for, much as the epiphyses are supplied with blood from the large vessels directly entering their outer surfaces, the addition to the length of the bone is much more active at the end of the shaft, and to this the large medullary artery mainly contributes, and this, in its origin, is far removed from the inflammatory area. Granting, therefore, that some active disease began in the end of a femur from some cause, and by its chronic character gave rise to increased vascularity and growth along the line of junction of shaft and epiphysis in that bone, it might, I think, be fairly assumed that similar increased vascularity and growth along the junction line of shaft and epiphysis of the tibia would not occur until the disease had extended deeply into that bone from the joint surface, and that would not be early in the progress of the case.

But disease so beginning in the femur may and does give rise to glandular irritation, and to swelling of the soft parts; and the more chronic the case the greater the induration of popliteal glands, and the greater the liability to interference with the circulation into the limb below. Here may, in great measure, be explained the fact of general atrophy of the limb below the knee, while the femur is lengthened, as in Case 22. I am sorry that I have note of only four cases in which I compared the feet (4, 5, 8, and 22), but these serve to show that even with a lengthened tibia and femur the foot may be undeveloped, no doubt in part by disuse. These considerations negative the careless use of the term "hypertrophy of the limb." There may be lengthening of various bones, but there is no hypertrophy of the limb in these cases.

How far the conditions here noticed are permanent I cannot say. But bone being so much less liable to change than other tissues it appears probable that the increase or diminution of length would be permanent if found after the age when the epiphyses may be expected to join. If found in young and growing subjects would not the question of permanency depend upon the removal or non-removal of the cause of the abnormal length? Would not, therefore, treatment of the disease give the best prospect of return to normal conditions? With the usual lengthening especially this might be expected,

and I would hazard the conjecture that such lengthening may be commonly only temporary in young subjects, and, therefore, not found in adults who have been sufferers from chronic knee-joint disease in early life. This is, however, only a surmise, for I have no means of examining into such questions properly.

What light do the cases in which excision was subsequently performed throw upon the subject? These cases are four in number (6, 7, 9, and 25). In two of these there was no increase or diminution in the length of either femur or tibia. In one of these two the disease was almost entirely synovial; in the other the bones were implicated on their surfaces. In the two other cases there was a peculiar similarity to one another in the pathological conditions. In each there was lengthening of the femur to the extent of 2·5 centimètres, and the tibia was not abnormal in length. In each it was found that the disease affected the femur with peculiar exclusiveness. In Case 9 the "femur was almost entirely the seat of disease; there was acute congestion of the bone, not opposite to the tibial articular surface, but more deeply along the line of the epiphysis, and especially opposite the patellar surface, and there was acute destruction of the articular cartilage (of the femur) everywhere except opposite the tibial areas." In Case 25 there was "deep ulceration of the cartilaginous surface of the patella, with corresponding disease on the external condyle of the femur; no disease on the inner condyle or on the tibia."

These four cases are perhaps the best answer to the question which must be put: Of what value in regard to diagnosis are the facts which have been here pointed out? Can the locality or character of the disease be in any degree determined by the careful measurement of the bones? To this question I think the answer must be decidedly "Yes," though a larger series of observations is still needed, and especially of cases where the measurements will be subjected to the test of pathological observation, by subsequent excision of the joint or amputation.

How far the age of the patient and the duration of the disease affect the tendency of the bones to this modification in their growth in the presence of knee-joint disease these

observations are not sufficient to show. Nearly all the cases were under eighteen years of age. Two only exceeded it (7 and 21), and these I left in because the time at which the disease was reported to have begun might have been before the epiphyses had joined, but in neither case had any modification in the length of the limbs occurred, so that their admission in the list is of doubtful value. The extent of the disease is only to be accurately determined by examination of the parts after removal, and, so far as the cases above given show, the extent and nature of the disease would appear to be the key to the whole question, whereas the duration of the disease in itself does not materially assist the inquiry.

The enlargement of the patella noticed in some of the cases (16, 17, 18, 19) is worthy of a passing reference, and points to the value of measurements here, but the subject is beyond the original scope of this paper and is fraught with considerable difficulty, owing to the absence of distinctness of outline to the bone, and the notes taken are too few to be of any practical value in themselves.

It will, I think, be obvious that if such changes as have been here described occur in the knee-joint, they must occur in other joints also, and that careful measurements may assist in determining the same questions of locality and character of joint disease as have been inquired into in the case of the knee.

The conclusions which I would submit as a result of these observations are the following:

1. Long-standing disease of the knee-joint in young and quickly growing subjects is frequently attended with some modification in the length of the limb.

2. Abnormal lengthening of either femur or tibia is more commonly found than deficiency in length of these bones.

3. The femur is most usually the seat of this abnormal increase in length.

4. Abnormal increase in length of one long bone at the knee-joint may be attended with some or no abnormality in the length of the other bone.

5. It is more usual to find only one bone affected.

6. The amount of lengthening of the femur varied from ·6 to 3·1 cm., and the average in the cases where lengthening

was found was nearly 2 cm. or 1·1 cm. in the total number of cases examined.

7. Marked abnormality in the length of a bone must be looked upon as presumptive evidence of disease or the effect of disease in that bone in this class of cases.

8. When marked increase in length has taken place in one bone. that bone is probably the seat of active inflammatory disease along the epiphysial line. Where the distal bone is diminished in length comparatively, such diminution may be due to destructive disease in the bone itself, or to interference in its nutrition, as a consequence of disease in the proximal bone or the joint.

9. Where after long-standing knee-joint disease in young subjects no abnormality in length is found it may be anticipated that the disease has been synovial rather than bony.

10. How far these abnormalities are permanent is only a matter of conjecture at present.

11. Careful measurements of the bones may be of great service in localising and indicating the character of chronic joint disease in young and growing subjects.