CHAPTER IV.

GENU VALGUM; ITS ETIOLOGY AND PATHOLOGY.

Definition.—A deformity at the knee joint in which a line drawn from the head of the femur to the middle of the ankle joint passes outside the center of the knee joint, and in which the internal malleoli can not be made to touch when the limbs are in an extended position.

In discussing the pathology and etiology of knock-knee, it will be necessary, in the first place, to clearly define what class of deformities belong to this category. Not all cases of separation of the feet and approximation of the internal condyles of the femur are to be classed as knock-knee. In other words, not all cases of in-knee are cases of true genu valgum. If we examine a case of true knock-knee we find that the anterior surface of the femur is directed forward; the feet point outward or forward to a greater or less degree, never directly inward. In uncomplicated cases, when the legs are *fully extended* on the thigh, the inner surface of the knees are in contact, while the internal malleoli are more or less separated, according to the degree of the deformity. And, on flexing the leg on the thigh, the knock-knee disappears. This is true genu valgum. A condition that at first sight resembles this is

seen in cases of spastic contraction, in some cases of disease of the knee joint, and in a few examples of coxalgia in its later stage. The whole limb from the hip joint is rotated inward, the knee is flexed more or less upon the thigh, and the feet are turned inward. In these cases it is often impossible to fully extend the leg on the thigh on account of the

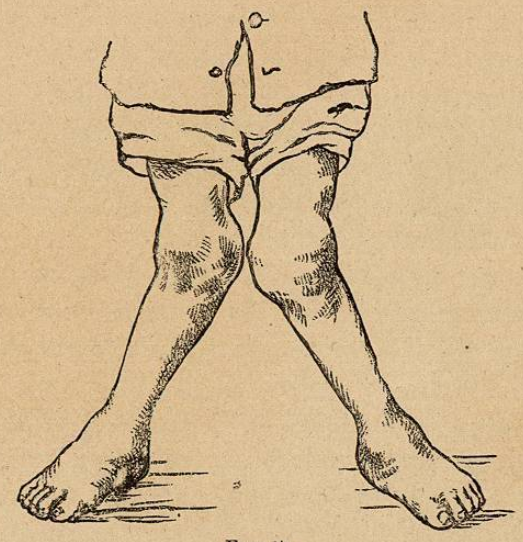

FIG. 17.

contraction of the muscles on the posterior aspect of the thigh and leg. They are no more cases of knock-knee than they are cases of talipes varus, simply because the toes point inward. They are often cured in a short time by tenotomy and appropriate apparatus. Patients with this deformity almost always walk on the toes. Any one can readily make his limbs assume such a position.

Fig. 17 is from a photograph of a patient with

genu valgum, and is a good illustration of an uncomplicated case.

If a perfectly normal adult femur be disarticulated and examined, it will be found that, when the bone is held perpendicularly, the internal condyle occupies a lower plane than the external, being about one half of an inch longer; but when the bone is articulated, the femur is found to slant inward so that the condyles are on the same level. This must needs be, as the plane of the articulating surface of the tibia is at right angles to the long axis of the body. Owing to this slanting of the femur, the knees are nearer together than the hips. This obliquity is greater in women than in men, on account of the greater breadth of their pelves. There is also an entering angle, the apex directed inward at the knee joint in the normal condition, more marked in women than in men. In a normal condition of the limb the inner aspect of the internal condyles and the inner malleoli can be brought together when the leg is fully extended on the thigh. In a case of genu valgum the malleoli can not be made to touch, while the inner condyles are in contact. In some few cases of genu valgum there is some flexion of the leg, due to contraction of the biceps. This is not a primary condition, but is secondary, and is due to the fact that the patient endeavors to stiffen and steady the knee joint by contraction of this muscle in walking.

The knee is the largest joint in the body, and yet it is the weakest. The strength of the joint lies not in the bones, but in the number and size and arrangement of the ligaments which unite the bones, and in

the powerful muscles and fascial expansion that pass over the articulation (Morris). It is a joint that is subjected to a great amount of strain; the bones of whose extremities it is formed exert, from their length, an immense leverage. This is a great element in the production of deformities, and, at the same time, the chief aid in their mechanical treatment.

Three theories have been advanced to explain the production of genu valgum, namely: the ligamentous, the muscular, and the osseous.

Those who adopt the ligamentous theory attribute knock-knee to contraction of the external and relaxation of the internal lateral ligaments of the knee joint. But the anatomical fact that ligaments are placed to limit motion, and have not the histological elements in their composition to enable them to undergo active contraction, militates against this theory. The condition of the ligaments in genu valgum varies. Sometimes they are relaxed. In some cases they retain their normal condition. In others the external will be relaxed while the internal hold the inner condyle and head of the tibia in close apposition—just the reverse of what the advocates of this theory assume to be the case. In some cases the external ligaments, as well as the crucial, are so much relaxed that the leg can be brought into a line with the axis of the femur without the use of any force. They therefore can not be an active agent in the production of genu valgum. Section of the ligament has been found to be useless in the treatment of this deformity.

Contraction of the biceps has been assigned as the cause of knock-knee. It is difficult to understand why this muscle alone should be contracted,

as it is supplied by the same nerve as the other muscles at the back of the thigh. In many cases it is found in the same condition as the semi-membranosus and semi-tendinosus, neither relaxed or contracted. Its division has not been followed by correction of the deformity. It is true that in some cases it is found contracted, together with the fascia; but it is a secondary, not a primary, condition.

In 1792, Büttcher[1] drew attention to the fact that in genu valgum the internal condyle occupied a lower plane than the external when the femur was in its normal position; and Mr. Bishop, in his work on deformities, states that "the inner condyle becomes disproportionately larger and altered in figure." Yet this fact seems to have been overlooked, or, from a feeling that it was impossible to remove it, was allowed to be forgotten.

The osseous theory of genu valgum is now universally adopted, namely, that all cases of knock-knee are due to alteration in the shape of the bone about the knee joint. There are three kinds of genu valgum: A femoral, in which the deformity is due to changes in the relation of the condyles of this bone; a tibial, in which the malposition of the leg is due to changes in the plane of the tibial heads; or the articular ends of both bones may be altered so that both contribute to produce the deformity.

Femoral Variety.—The plane of the femoral condyles can be changed only in three ways, namely:

1. By increased growth.
2. By the bending of the lower third of the shaft.
3. By atrophy of one of the condyles.

[1] "Brit. Med. Jour.," July 6, 1879, p. 1.

If the lower end of a perfectly normal femur be examined on a living subject, it will be found that, when the leg is strongly flexed on the thigh, the lowest portion of both condyles can be readily made out, and, if the thigh be held in its natural position, it is very easy to judge of the relative lengths of the two condyles. While the limb is held in this position a narrow piece of sheet lead can be molded across the joint, and from this a correct outline of the articular end of the bone can be obtained and traced on paper. That the internal is in some cases increased in length,

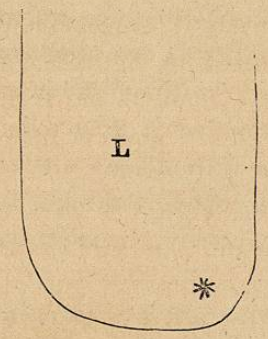

Fig. 18.

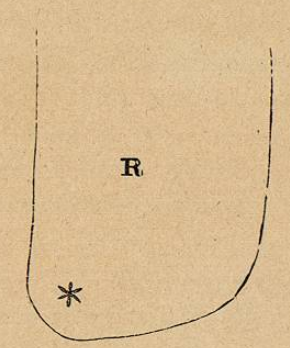

Fig. 19.

and thus occupying a lower plane than the external, has been demonstrated by post-mortem examinations and recorded by Delore, De Santi, Lannelongue, and others.

Figs. 18 and 19 are from a tracing of a case of unilateral genu valgum, showing the difference in the position of the internal condyles in the two limbs. The * indicating the position of the internal condyle.

Dr. Clark demonstrated the same fact in a careful measurement of one hundred and sixty-six limbs

(belonging to one hundred patients) affected with knock-knee, and, comparing them with one hundred measurements of normal limbs, in seventy per cent there was an abnormal increase of the internal over the external condyle. Allowing that in the normal limb the internal condyle averages about one quarter of an inch over the external condyle, all above this was considered abnormal. In persons under ten years of age there would be less difference between the length of the two condyles than one quarter of an inch. This would raise the percentage to over eighty-four. Of the one hundred and seventeen cases in which the internal condyle was over the normal length, the extent of the abnormality in fourteen cases was under a quarter of an inch. In fifty-four it was a quarter of an inch. In thirty-five it was over a quarter of an inch and not more than half an inch. In nine it was between a half and under an inch. In four it measured an inch, and in one it was an inch and a quarter.[1]

De Santi states that the hypertrophy is confined to the vertical diameter of the condyle. Guéniot found the same condition, but with an evident diminution in the antero-posterior diameter.

I have also noticed, together with an evident increase in the length of the condyle, a spur-like growth from its inner surface, extending beyond the line of the tibia.

A curvature of the lower third of the femur with the convexity inward will cause a depression of the internal and an elevation of the external condyle. Or it may be looked upon as a tilting of the lower end of

[1] Macewen, "Osteotomy," p. 44.

the bone in a direction from within outward and upward. In the majority of cases in which the deformity appears early in life I have generally found it due to the bending of the bone; in addition to this there may be a change in the epiphysis. It is not placed squarely on the diaphysis, but is twisted more or less, the cartilage is thickened, may be, over the internal condyle, while that over the external portion of the bone may be flattened and crowded out over the epiphysis. The latter is due to the weight of the body acting upon the softened bone.

There is yet another change met with at post mortem, and which is a cause of this deformity, namely, a flattening of the external condyle; or it may undergo a true atrophy.[1]

From a plate in Delore, it is evident that the femur may be bent near its neck so as to throw the trochanteric and subtrochanteric portion of the shaft outward.

The femur often has an anterior bend.

In not a few cases of knock-knee a careful examination reveals nothing abnormal in the shaft of the femur or its condyles, the latter being in the same plane; but the articulating surfaces of the tibia are not on the same level, the inner head of the tibia being on a much higher level than its external, thus throwing the axis of the tibia outward, or the diaphysis of the bone may be united to the epiphysis at an angle.

Often the deformity in genu valgum is due to changes taking place in both the femur and tibia.

I have never met with a case of true genu valgum that was not due to osseous changes.

[1] Howse, "Guy's Hosp. Report," vol. xx, p. 531.

These changes in the shape of the bones are, in a certain class of cases, often accompanied by other curves of the long bones of the lower extremities. It is evident that in many cases of the deformity one factor can not be assigned as the sole cause of the the malposition of the tibia.

The condition of the ligaments about the knee joint in genu valgum varies. Often there is no change except such as is secondary to the deformity —namely, a lengthened internal lateral ligament, corresponding to the increased size of the condyle; but there is no relaxation. Sometimes the external ligament is very much relaxed, so that the tibia can be brought into a straight line with the long axis of the femur without the use of any more force than is necessary to move the limb, an interval being found between the external condyle and the corresponding point of the tibia. Both ligaments, together with the crucial, may be so much lengthened that the leg can be moved very freely in both lateral directions. Too much force applied during mechanical treatment has been the cause of this lengthening of the external ligament in some cases.

It is evident from this that the condition of these structures varies, and that they can have no direct cause in the production of the deformity.

Such being the changes found in the bones in genu valgum, the next inquiry is as to their cause.

There are two periods during which knock-knee is first developed: namely, in children between the first and fifth years of age, and in young persons between the twelfth and twentieth years, the first corresponding to the term during which diseases of

malnutrition are so common, the second to the period of rapid growth. Between these two dates—namely, from the sixth to the twelfth year—genu valgum is rarely developed. The etiology of the deformity in these two periods differs.

In genu valgum coming on before the fifth or sixth year, rickets is the predisposing cause. I have never seen a case of the deformity in a child under six years of age in which there was not unmistakable signs of this disease. In a perfectly healthy child—one who has been properly nourished and has breathed pure air—knock-knee will not be developed; at least I have never met with such a case, nor do I know of any recorded example of this deformity appearing. Normal bones do not become distorted.

The case is, however, different in children who have been improperly nourished and who have lived in bad hygienic surroundings. Those who have been brought up under such circumstances develop these deformities. At this age, and at the time of the greatest intensity of the rachitic changes in the bone (softening), any alterations in the shape of the shaft of the femur or in the articulating ends of the bone and the tibia may occur. Tripier advances the theory that the epiphyseal cartilage first becomes thickened and the limb lengthened, and later the weight of the body determines the bend, according as the intensity of the softening has fallen upon the epiphyseal cartilage or the shaft of the bone. The immediate cause is mechanical. In children who are too young to walk, the manner in which they are carried about has been assigned. In fact, any posi-

tion that can act on the soft bones may cause them to bend. Cases have been recorded of congenital genu valgum.

The cause of genu valgum coming on after the twelfth year has given rise to much discussion, and has received many explanations. Macewen, in his admirable work on osteotomy, considers that the deformity, as in the infantile variety, is due to rickets, and gives the histories of three cases in proof of his statement. In one, profuse perspiration about the head, curvature of the long bones of the lower extremities, swelling of the epiphyses of the forearm, and marked bow-legs, came on in a lad of fifteen years of age, who, previous to this attack, had been perfectly healthy. The other two cases are not given with sufficient detail. The author simply states that they developed knock-knee, preceded by a train of symptoms only referable to rickets. The history of the first case certainly corresponds to that of rickets. But whether all cases of genu valgum coming on after the twelfth year should be considered as due to this disease, I doubt. It is true that other writers have maintained the advent of rickets during adolescence, but these statements have been questioned by many able observers.

My own experience is limited to four cases, but, as they seemed to throw some light on this subject, it may be of interest to record them. For the use of these cases I am indebted to my friend, Dr. Gibney.

Case I.—F., fourteen years of age, has always been delicate; is now in fair condition; for the past year has been growing rapidly. No symptoms of rickets,

past or present, can be detected. Within the last eight months a double genu valgum has been developed. Both internal condyles are on a lower plane than the external. There is no abnormal bend of either femur or tibia, no tenderness over the line of the epiphyseal cartilage, and no enlargement of the ends of any of the long bones.

Case II.—M., seventeen years of age, has always been healthy. For the past year has been employed as a wagon driver for a groceryman. Has had to jump out of his wagon very often, and always coming down on his left foot. For the past year has been growing very rapidly. Two months ago he noticed that in walking his left knee bent inward. The patient is muscular and well developed. He has never had any perspiration about his head, nor any other rachitic symptoms.

On examination, he is found to have knock-knee in the left limb. There was no abnormal bending in either the femur or tibia, no enlargement of the ends of the long bones. The condyles of the left femur are on the same plane, but the inner head of the tibia is much higher than the outer, and is evidently the cause of the abnormal position of the leg. The ligaments are normal.

Case III.—M., sixteen years of age, is well developed and muscular. He has always been healthy. For the past two years has been employed in a factory where he has to stand all day and swing a heavy mallet. He is certain that his limbs were perfectly straight until three months ago, when they began to bend inward at the knee. This bending inward has been increasing. He has been free from pain until within

the last week. Since then has suffered considerably after standing or walking. The left limb is more deformed than the right.

Left Knee.—There are two spines—one two, the other three inches below the inner head of the tibia on the lateral aspect. They are quite tender upon pressure. The line of the epiphyseal cartilage of both the femur and tibia are tender on pressure. There is some lateral motion at the knee joint. There is effusion into the left knee joint, and it measures one inch more in circumference than the right.

Right Knee.—There are two spines in the same position as those in the left, but smaller and not so tender. The joint is not swollen; the epiphyseal line of both bones is tender. The condyles of both femora are on the same planes, while the inner heads of both tibiæ are higher than the external. There are no symptoms of rickets, either in bending of long bones or enlargement at their extremities. Patient states that he has increased six inches in height during the past year. He weighs 164 pounds.

Case IV.—M., nineteen years of age, baker, states that he has always been healthy. Is rather young-looking for his age. He first noticed that he was becoming knock-kneed nine months ago. Both limbs are œdematous, and feel flabby. The condyles of both femora are perfectly normal in position. The shafts of both tibiæ seem united to the epiphysis at an angle. The articular ends of these bones are on a level. There is no tenderness anywhere about the joints. There is slight lateral motion at both knees. The tarsal arch is flattened. The deformity is evidently

tibial. The patient has been growing rapidly during the past year. His work compels him to stand most of the night with his leg adducted and knees slightly flexed.

These four cases have one thing in common: that the deformity developed during rapid growth. In three it occurred in persons who gave no history of any illness, and, with the exception of the deformity, two of them would have been considered as types of healthy development. There were certainly no signs of rickets. In two cases the deformity was due to position—standing during long working-hours—in the other, jumping frequently from a wagon, and always alighting on the same limb.

It is a well-known fact that the increase in the length of the lower limbs takes place to a great degree by deposit of new material between the diaphyses and epiphyses of the femur and tibia. If the formation of new bone elements (cartilage-cells) is more rapid than the ability of the system to supply the earthy salts for their calcification, this new material would be liable to yield in any direction under persistent force. This, I believe, is the explanation of the advent of the deformity in the cases mentioned above. That this increased activity of formative process was great is evidenced in growth of spine over the tibia, and the effusion into the knee joint. Tenderness on pressure over the epiphyseal cartilage adds weight to the view.

In regard to tibial spines, Macewen states that they are a prominent feature in many cases of knock-knee; that they are more frequently found in infantile cases than in genu valgum adolescentium. He