or loss of the Kj. in man when the cord is injured at a high level. A dozen years ago Bastian called attention to the disappearance of the Kj. in such transverse lesions, not altogether unknown before, and since that time many such cases have been reported which seemed to justify the position that the removal of cranial or cerebro-spinal influences was the true explanation of the results. Out of these cases have grown extended discussions, some of which are almost painfully ingenious. The most interesting and important are perhaps those of Van Gehuchten (1897, with a modification in 1901), Koll (1898), and Brasch (1900). Nearly all the cases reported are defective because there is not a complete microscopic examination of the lumbar cord and the structures forming the reflex arc of the knee-jerk. Under these circumstances a single case of complete transverse destruction of the cord without loss of Kj. outweighs any number of uncertain cases and their incidental theories. Such seems to be the case reported by Kausch (1901) in which the cord was accidentally severed in an operation rendered necessary by tuberculous processes going on in the spinal column. At first there was a total disappearance of the reflexes and of muscle tonus. The tonus returned in about forty-eight hours, and is said to have persisted in an exaggerated form until death five months and a half later. The reflexes came back some twenty hours after the operation (*i.e.*, many hours *before* the tonus), both skin and tendon reflexes recurring at the same time. Most of the reflexes persisted and were exaggerated until death, but the Kj. as well as the Achilles tendon reflex grew feeble toward the end and finally disappeared before death, as also happens when the cord is intact.

This brings the human cord again into line with the cord of other mammals, and confirms the opinion that it is easier to believe that the functional activity of the cord is substantially the same in the higher mammals than to assume that the human cord is radically different. It has been shown again and again in the past twenty-five years that the knee-jerk returns when the cord is cut in the middorsal region in most laboratory mammals and persists for a long time. Applegarth experimented with the jerk of a dog nine months after such a section. Sherrington's monkeys regained their knee-jerks after section of the cord at the proper level and retained them for months. The evidence for other mammals is similar, but the observations have not been continued so long. The lumbar cord is the seat of all those spinal processes that are essential to the knee-jerk. By this is not meant that the jerk is necessarily the same after cord section as before, in fact it is generally larger and it may differ in form; there seem to be no exact measurements. Unquestionably there are influences flowing constantly from the various parts of the encephalon which profoundly affect the activities of the cord and may exalt or depress the knee-jerk, but that this permanently disappears when these influences are excluded it is not heresy to doubt. The temporary disappearance may be due to "shock," and this may mean nothing more than a more or less profound alteration of the circulation of the lower cord with incidental nutritive changes from which recovery is quite possible. The stimulation of inhibitory nerve fibres is also a plausible explanation, but this effect ought to pass away speedily in the absence of any irritating or inflammatory reactions. It may be the expression of a decentralization of spinal centres which have been strongly dominated by higher centres, as seems to be more markedly true of the higher vertebrates, and which require time to readjust themselves to a new and more independent condition. On the other hand, we may suppose that peripheral influences are equally constantly flowing into the higher centres to arouse them to participate more actively in the regulation of body movements.

For the participation of the cerebral lobes there is considerable evidence, and some have held the reinforcement of voluntary movements to be due to a diversion of "attention." Weinberg's results (1894) from stimulation or extirpation of motor areas, while in general favorable to the view that the cortex has influence on the Kj., are not so convincing as one could wish. The removal of a cerebral lobe increases the opposite knee-jerk (Russell, 1893). The effect of cerebral hemorrhages and of brain compression seems to show that the cerebrum does inhibit. Uncertain is the interpretation of the action of galvanization through the region of the temples (Mitchell and Lewis). Pándi (1895) seems to suppose the cortex to inhibit through the antagonistic muscles, while the commoner view is that some system of inhibitory fibres runs down the cord and directly affects the motor cells.

Van Gehuchten, although he makes the tendon reflex depend upon a rubro-spinal path (red nucleus, fascicle of von Monakow), and therefore mesencephalic in origin, considers that fibres of the cortico-spinal path have an inhibitory influence.

As to the action of the cerebellum, we have very definite experiments by Russell (1893) showing that the extirpation of a lateral lobe augments the Kj. of its own side and diminishes that of the other side, and a distinct but irregular increase is produced by extirpation of the posterior part of the vermis. The effect persists too well to be irritative; it is paralytic. Whether this is an influence through the cerebrum is unclear. Bechterew's views concerning the paths from the cerebellum to the cortex cerebri seem opposed to this view. The theory of Gowers concerning the cerebellum as a regulating centre for such centripetal impulses of the muscle sense as stand in some special relation to motor processes particularly concerned in equilibrium and in coördination of movements would seem also to become untenable.

Van Gehuchten in his earlier article includes the cerebellum along with the mesencephalon and the rhombencephalon in the structures which constantly send exciting influences to the motor cells of the anterior horn by way of cerebello-spinal fibres and the longitudinal posterior fascicle. In his later article he seems inclined to limit this stimulation to the rubro-spinal path. For him the normal muscle tonus is only the external manifestation of the state of more or less permanent excitation in which these motor cells find themselves. As a condition of tonus exists in the isolated lumbar cord and may be constantly affected by the impulses of the muscles there innervated, as Sherrington's experiments show, this complex relation can only be of secondary importance.

A similar inference seems to be permitted concerning the reflex centre in the "*regio bulbocervicalis*" just below the tip of the calamus scriptorius (Rosenthal and Mendelsohn, 1897), which has been a source of comfort to many neurologists in recent years, a comfort which must be somewhat unreal until the doctrine is much more firmly established.

As to the nature of the reinforcement, both positive and negative, we are very much in the dark. We can hardly attribute them all to mere change of tonus, nor do there seem to be any experiments to show that tonus is thus changed. The theory that there is some sort of an "overflow" for every motor or sensory stimulus, or even emotion, and also the theory that every such stimulus in some way removes a check, does not fully account for the negative phase of reinforcement. The suggestion that a fatigue phase is in play is hardly plausible in view of the slightness of sensory stimulus found to be effective. The theory (Brunton) that nerve impulses may coincide or interfere like light waves, producing an augmentation or diminution according to the phase, is ingenious but difficult of interpretation.

While many of the reflexes are evidently protective, this is not the obvious purpose of the tendon reflexes. It seems reasonable to think, with Koll, that the knee-jerk is an extreme expression of a reflex stimulation constantly produced in a slight form by the tendons, periosteum, and joints and having an important regulatory influence on the entire mechanism of movement. Such tendon reflexes are perhaps of prime importance in certain particular kinds of movements and may have but a small share in the general coördination of body movements. There need then be no pronounced parallelism between the loss of a tendon reflex and ataxy, since the

tendon reflex is only a part of the coördination. A connection between the lumbar reflex arc concerned in the knee-jerk and the cerebellum by means of coördination pathways may be assumed, but there is no reason for postulating a direct pathway to the cerebellum, nor do the pathological observations demonstrate such.

Joseph W. Warren.

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KNEE-JOINT.—Whether considered from the anatomical or the surgical point of view, this is the most important joint in the body. It is at the same time the most complicated and the most difficult to understand. Its surfaces are necessarily large to support the weight of the body, and as there is not that close adaptation which is shown at the elbow and hip, its great strength depends upon the surrounding ligaments, fascia, and muscles, which are so effective that dislocation is rare. Its vast extent of synovial membrane predisposes it to inflammation, and its exposed situation renders it liable to injury. Its structure is more readily understood when it is regarded as an assemblage of three joints originally distinct, viz., a patello-femoral and two femoro-tibial. That this is a correct assumption is rendered probable by slight furrows upon the articular surface of the femur (not clearly shown in Fig. 3082) which separate a patellar surface from the two condyles, and the arrangement of the ligaments also amply confirms it; there being besides the capsular, investing the whole joint, certain internal ligaments which are vestiges of the original separate condition. From the middle of the joint, between the two condyles, pass downward and outward two folds of synovial membrane laid upon a thin connective tissue. These are the ligamenta alaria, and they indicate the line of separation into three cavities. Again, there are certain bands accessory to the capsule. Externally these are known as the lateral ligaments (Figs. 3082 and 3083), internally as the crucial ligaments (Figs. 3082 and 3083).

The former pass from the tuberosities of the femur to the shaft of the tibia and the head of the fibula on either side; the latter are short bands arising from the femur,

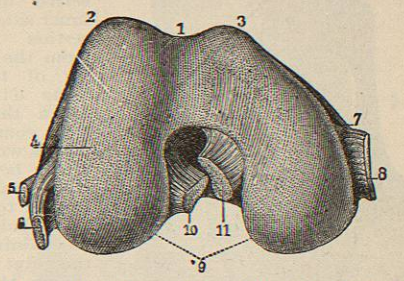

FIG. 3082.—Upper Articular Surface of the Knee-joint. (Sappey.) 1, The patellar groove; 2, outer edge; 3, inner edge, less elevated than the other; 4, outer condyle; 5, external lateral ligament, cut; 6, section of the popliteus muscle obliquely directed downward and inward, and covered by the external lateral ligament; 7, inner condyle; 8, internal lateral ligament, cut; 9, intercondylar notch; 10, section of the anterior crucial ligament inserted upon the posterior part of the inner surface of the external condyle; 11, section of the posterior crucial ligament inserted upon the anterior part of the outer surface of the internal condyle.

on either side of the condylar notch, to insertions in front and behind the spine of the tibia. These accessory bands limit and control the motion of the joint, as do similar structures elsewhere. On complete extension, the whole system is locked by the tension of the lateral and the anterior crucial ligaments, so that no muscular force is required to hold the knee firm in the erect position, the weight of the body falling in front of the joint and fixing it. When the joint is thus fixed and muscular action suspended, a slight blow from behind will throw the whole apparatus out of equilibrium, and occasion a sudden flexion of the limb.

This tripartite division of the joint corresponds to its condition in many lower animals, in which the three synovial cavities are either totally distinct, or communicate by small openings.

The irregular form of the joint surfaces is due mainly to the action of the muscles. While at the elbow the

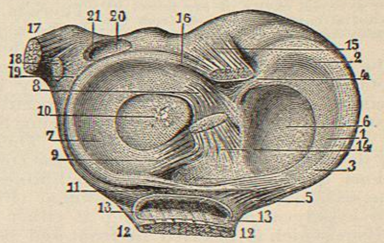

FIG. 3083.—Lower Articular Surface of the Knee-joint. (Sappey.) 1, 2, 3, Internal semilunar fibro-cartilage; 4, its attachment to the depression behind the spine of the tibia; 5, its anterior attachment; 6, that part of the internal glenoid cavity not covered by fibro-cartilage; 7, external semilunar fibro-cartilage; 8, 9, its attachments; 10, part of the external glenoid cavity not covered by fibro-cartilage; 11, transverse ligament; 12, ligamentum patellæ, cut; 13, bursa subpatellaris; 14, tibial insertion of the anterior crucial ligament; 15, of the posterior crucial ligament; 16, band of fibres which unites the external semilunar fibro-cartilage to the posterior crucial ligament; 17, tendon of the biceps, cut; 18, external lateral ligament, cut; 19, groove for the tendon of the popliteus; 20, bursa poplitea; 21, orifice occasionally found by which the cavity of the upper tibio-fibular articulation communicates with that of the knee-joint.

flexors, but two in number, come down and are inserted near the plane of movement, at the knee there is a series of flexors stretching over the joint from above, and inserted partly on the outside and partly on the inside of the leg; so that, when acting separately, they tend to twist the tibia upon its longitudinal axis. It will be observed also that while a single muscle, the biceps, is inserted on the outer side, there are four muscles (sartorius, gracilis, semitendinosus, and semimembranosus) Figs. 3084 and 3085), inserted upon the inner side, the insertion running from the tuberosity of the tibia some distance down the shaft. The consequence of this would naturally be to give more range of motion to the inner condyle, and an examination of the joint surfaces shows that they are correspondingly shaped to that end.

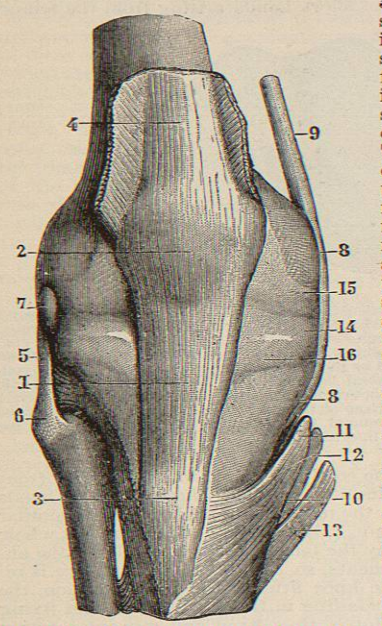

FIG. 3084.—Anterior Surface of the Knee-joint. (Sappey.) 1, Ligamentum patellæ; 2, its expansion over the patella; 3, its insertion upon the tibia; 4, tendon of the quadriceps extensor femoris; 5, external lateral ligament; 6, its insertion upon the head of the fibula; 7, tendon of the popliteus; 8, internal lateral ligament; 9, tendon of the adductor magnus; 10, fascial expansion of the internal hamstring tendons (*patte d'oie*); 11, tendon of the sartorius; 12, tendon of the gracilis; 13, tendon of the semitendinosus; 14, internal semilunar fibro-cartilage; 15, the upper synovial cavity of the joint; 16, lower synovial cavity, separated from the preceding by the fibro-cartilage.

The inner condyle (Fig. 3082) is bent not only from before backward, but also from side to side like the half of a horseshoe, and roughly corresponds to a cone whose apex is at the insertion of the posterior crucial ligament. The outer condyle is bent only in one direction, but its surface corresponds in a similar way to a cone whose apex is somewhere within the anterior crucial ligament. There is thus seen to be a provision for a double motion of the inner condyle, a back-and-forth hinge action, and a rotation around the outer, while only the hinge motion has shaped the outer condyle. The peculiar action of these surfaces does not admit of their being fitted into a socket, regular and invariable in form. There are accordingly developed around the edge of the corresponding portions of the tibial surface two fibro-cartilages, called the external and internal semilunar (Fig. 3083). These are loosely attached, running at either end into fibrous tissue which is inserted in front and behind the tibial spine, and along their circumference being comparatively loose, merely united with the capsule. Synovial membrane covers both their upper and their lower surfaces, so that they are freely movable. They correspond in a general way to the impression made by the heads of the condyles, but their elasticity is such that, whenever the condyles move and twist, they follow their movements.

The general capsule of the joint (Figs. 3084 and 3085) is very extensive, reaching above and below beyond the articular surfaces of the femur and tibia, and blending with the tendons of the surrounding muscles and their fascial insertions. It is thinnest just above the patella on either side of the tendon of the quadriceps, and here it is that effusion is most likely to show. The extent of the joint cavity upward is here so great that the serious mistake has been made of opening a fluctuating tumor here, thereby entering the cavity and endangering the limb. The tendon of the quadriceps passes down in front to the patella (properly considered as a sesamoid bone, developed in its substance), and is continued on, beyond that bone, to the tuberosity of the tibia as the ligamentum patellæ (see Fig. 3084). The whole system answers the purpose of an anterior ligament to the joint.

Of the lateral ligaments (Figs. 3086 and 3087), the external is the shorter, and of the shape of a rounded cord, which may be felt on the outer side of the leg just above the head of the fibula; the inner is longer and flatter, giving more latitude of motion. The points of their origin from the femoral condyles are in the axis of the cones described by the surfaces. They are not, like the lateral ligaments of the elbow-joint, tense in every position, but allow the twisting motion of the tibia above mentioned. A second or short external lateral ligament is also described, passing from the condyle of the femur in connection with the head of the gastrocnemius, and inserted into the styloid process of the fibula. It is not constant. Behind, the capsule is broad and sheet-like (Fig. 3085), receiving fascial expansions from the tendons of the semimembranosus and popliteus. The band from the semimembranosus is sometimes described as the popliteal ligament, and the whole sheet as the posterior ligament of Winslow. It is everywhere of sufficient thickness to resist the irruption of abscesses from the popliteal space into the joint, but pus has been known to burrow from the synovial cavity outward below the popliteal ligament. This posterior sheet offers the principal obstacle in contracted knee, when associated with fibrous ankylosis. This is probably owing to the fact that it contains but little elastic tissue, and an increase of the white fibrous elements produces, as elsewhere in the body, a certain amount of contraction.

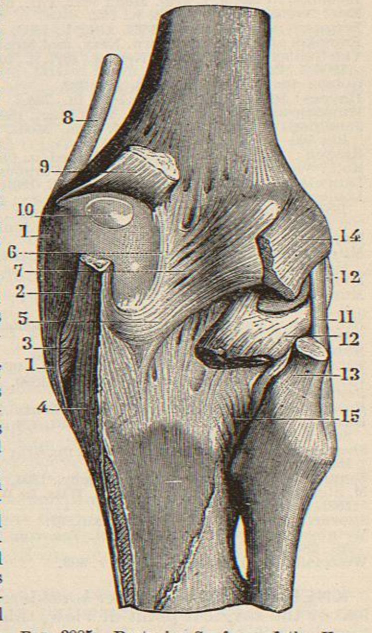

FIG. 3085.—Posterior Surface of the Knee-joint. (Sappey.) 1, 1, Internal lateral ligament; 2, tendon of the semimembranosus; 3, its anterior or reflected portion; 4, its middle portion attached to the posterior part of the internal tuberosity of the tibia. From this middle portion two expansions extend; one reaches the lower part of the internal tuberosity, the other is continuous with the aponeurosis of the popliteus; 5, posterior portion of the tendon of the semimembranosus. It forms a posterior ligament directed upward and outward, to be inserted upon the external condyle; 6, 7, fibres of this tendon directed vertically upward; 8, tendon of the adductor magnus; 9, tendon of the internal head of the gastrocnemius; 10, orifice often found in the fibrous capsule over the internal condyle; 11, external lateral ligament; 12, tendon of the popliteus; 13, tendon of the biceps; 14, tendon of the external head of the gastrocnemius; 15, the posterior superior tibio-fibular ligament.

The synovial membrane is very extensive, passing beyond the articular surfaces above, and traceable therefrom downward on either side to the semilunar cartilages forming the ligamenta alaria before mentioned. There is here, interposed between the membrane and the ligamentum patellæ, a large pad of fat, from which there passes backward to the intercondylar notch a process of connective tissue, the ligamentum mucosum (Fig. 3088). After covering the upper side of the semilunar cartilages the synovial membrane passes to their under surfaces, and from thence on to the upper surface of the tibia. There are several openings by which the synovial sac communicates with the neighboring bursæ. The principal one is above, where is a large orifice, nearly constant, opening into the bursa subcruralis (Figs. 3086 and 3087). Another, always found, communicates with the bursa under the tendon of the popliteus (Fig. 3083), and from this there is an occasional diverticulum connecting with the superior tibio-fibular articulation. A third communication is with the large bursa under the internal head of the gastrocnemius. Many other bursæ are found near the joint (see article on *Bursæ*, vol. II.), and some of them may occasionally connect, so that extreme care is always required in operations in this region, lest the opening of one of these sacs should involve the joint cavity.

The movements of the patella are not only gliding, but slightly rolling or coaptative. The bone is adapted to the shape of the hollow between the condyles by a ridge which divides it into two unequal, lateral portions. Each of these is again divided into facets, so that, taken from above downward, the contact of the bone with the femur is but slight, especially during flexion. It is this circumstance that causes the frequent fracture of the patella by muscular action. It forms a wedge-like body,

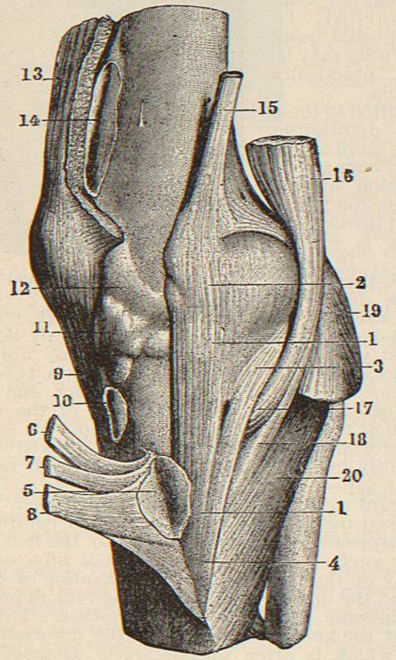

FIG. 3086.—View of the Knee-joint from the Inner Side. (Sappey.) 1, 1, Internal lateral ligament; 2, its insertion upon the tuberosity of the internal condyle; 3, its insertion upon the internal semilunar fibro-cartilage; 4, its insertion upon the upper end of the internal surface of the tibia; 5, bursa tibialis interna; 6, tendon of the sartorius; 7, tendon of the gracilis; 8, tendon of the semitendinosus; 9, ligamentum patellæ; 10, bursa subpatellaris; 11, adipose tissue near its upper part; 12, superior synovial cavity; 13, tendon of the quadriceps extensor; 14, bursa subcruralis; 15, tendon of the adductor longus; 16, 17, tendon of the semimembranosus; 18, its middle portion; 19, tendon of the internal head of the gastrocnemius; 20, the popliteus.

in contact with the articular surface only by a narrow edge, and the tendinous attachments are so arranged as to pull at right angles to each other directly over this edge. Any sudden jerk in this position has the same effect upon the bone as a sudden shock upon a stick over

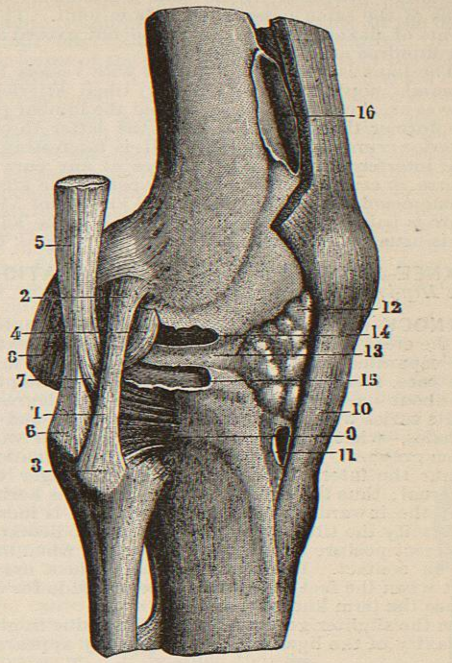

FIG. 3087.—View of the Knee-joint from the Outer Side. (Sappey.) 1, External lateral ligament; 2, its attachment to the external condyle; 3, its attachment to the external part of the head of the fibula; 4, tendon of the popliteus; 5, tendon of the biceps; 6, its attachment to the styloid process of the fibula; 7, the anterior or reflected part of this tendon, passing under the external lateral ligament, to be inserted upon the internal tuberosity of the tibia above the anterior ligament of the superior tibio-fibular articulation; 8, tendon of the external head of the gastrocnemius; 9, anterior ligaments of the superior tibio-fibular articulation; 10, ligamentum patellæ; 11, bursa subpatellaris; 12, collection of fat which fills the anterior part of the intercondylar notch. On each side it passes beyond the ligamentum patellæ; 13, external semilunar fibro-cartilage; 14, the superior synovial cavity, opened to show how it terminates upon the superior edge of the fibro-cartilage; 15, inferior synovial cavity, also opened to show its relation to the same fibro-cartilage; 16, bursa subcruralis.

the edge of a table. It is not strange, therefore, that it is more frequently broken by muscular action than any other bone in the body.

Atmospheric pressure is not without effect on the joint. In conditions of health it holds the patella firmly down and prevents its dislocation. In cases of opening the joint, or where there is effusion, the bone becomes much more movable laterally, and may be spontaneously dislocated.

The movement of the tibia upon the femur is such that, with flexion and extension, a slight degree of rotation always takes place. This is due to the peculiar shape of the condyles above mentioned, and to the pull of the muscles. The joint cannot, therefore, be said to be a perfect hinge, there being a considerable amount of lateral motion. This is most free in the semiflexed state, and may then amount to

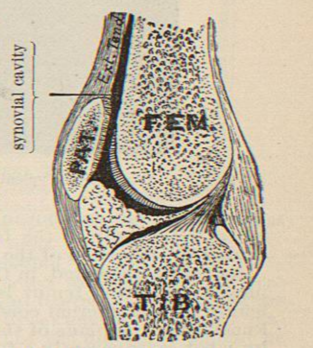

FIG. 3088.—Sagittal Section of the Knee-joint.

forty degrees. It is sometimes called pronation (which turns the toes in), and supination (turning them out), but is not produced by the same mechanism as the motions of the same name in the elbow-joint. The movements of flexion and extension do not exceed an arc of one hundred and sixty degrees.

The joint is copiously supplied with vessels from the femoral, popliteal, and anterior tibial arteries. The nerves are from both the sacral and the lumbar plexuses, the former through the sciatic, the latter through the anterior crural and obturator. It is interesting to note that interference with these nerves at any part of their course, or centrally, is followed by pain in the knee. The phenomenon known as "hysterical knee-joint," in which there is pain accompanied by no lesion in the joint proper, is usually thus explained. *Frank Baker.*

KNEE-JOINT, CONGENITAL DISLOCATIONS OF. See *Hip-joint, Congenital Dislocations of.*

KNOCK-KNEE.—(Synonyms: Genu Valgum, In-Knee.) In the erect posture the femora whose upper extremities are separated by the pelvis, incline slightly inward to the knee, forming angles at this point opening outward of about one-hundred and seventy-two degrees. The angle varies with the breadth of the pelvis, and in adult females, what may be called normal genu valgum, is often present. In compensation for the inclination of the femur the internal condyle is slightly longer than the external; thus the plane of the knee-joint is horizontal.

If the inward projection of the knees is increased to deformity the tibiæ are no longer perpendicular, and in the erect posture the feet are separated when the knees are in contact. In other words, the knees are in contact when the feet are in the proper attitude for walking, hence the term knock-knee.

In the slighter grades of knock-knee, due in great part to laxity of the ligaments, the deformity appears only in

Fig. 3089.—Typical Rachitic Knock-knees.

the upright posture, but in more marked cases it persists when the weight of the body is removed because it is caused by distortion of the bones.

As has been stated, in the normal subject the inward inclination of the femur is compensated by the greater length of the internal condyle; and in the deformity of knock-knee the plane of the knee-joint is still preserved by what is apparently a further elongation of this part of the bone. In fact, it was thought at one time that the cause of knock-knee was hypertrophy of the internal condyle, but it is now generally accepted that the apparent lengthening is caused by deformity of the lower extremity of the shaft of the femur. This is bent with the convexity inward, so that the epiphyseal line has an increased obliquity. Thus it is apparent that the internal condyle is lowered by a deformity of the shaft of the femur and not by a change in the epiphysis itself.

Fig. 3090.—Knock-knee and Bow-leg.

In most instances there is a similar, although usually slighter, deformity of the upper extremity of the tibia, so that when the bone is placed in the perpendicular position its internal condylar surface is higher than the external. In rather unusual cases the deformity may be confined practically to the tibia.

In addition to these direct deformities there is a more or less constant change in the relation of the two bones, the femur is rotated inward and the tibia is rotated outward. In some instances there is a certain degree of over-extension at the knee; this is more often observed in the adolescent type, which is more directly dependent upon laxity of ligaments. In the ordinary form of rachitic knock-knee in childhood, however, the typical attitude is one of slight flexion of the knees, and in well-marked cases there may be limitation of the range of extension at the knee and at the hip also.

The deformity of knock-knee is most marked when the limb is fully extended, because the shortened tissues on the outer aspect of the joint become tense and because the outward rotation of the tibia is increased. As the leg is flexed the deformity lessens, and in complete flexion it disappears. This is explained by the fact that the posterior surface of the condyles is not affected by the deformity of the shaft, while the relaxation of the ligaments and the outward rotation of the femora permit the tibiæ to become parallel with one another. Thus slight flexion at the knees, which lessens the deformity, is the attitude which is often unconsciously assumed by patients.

The outward inclination of the leg increases the strain upon the foot and tends to induce the attitude of valgus, and rachitic knock-knee in the progressive stage is almost always accompanied by flat-foot. After recovery from the local or constitutional weakness the efforts of the patient to restrain the abnormal separation of the feet may induce the opposite attitude of inversion. In fact, extreme knock-knee is usually accompanied by a slight degree of fixed varus, and in the mildest type of knock-knee this compensatory effort of nature, shown by the so called pigeon-toed walk, may be the most noticeable symptom of the deformity.

As a rule, genu valgum is bilateral, but not infrequently it is unilateral, and again unilateral knock-knee may be accompanied by outward bowing of its fellow. In the slighter degrees of rachitic deformity outward bowing of the tibia may accompany inward inclination at the knee. Thus, in-knee and bow-leg may be present in the same limb. In the marked distortions of the lower extremity that are the result of rachitis the bones may be bent and twisted in various directions. For example, the femora may be bent forward and outward, above and inward, and backward below; the tibiæ may be bent inward above and outward and forward below. This is sometimes called "cork-screw" distortion, of which the outward expression is knock-knee.

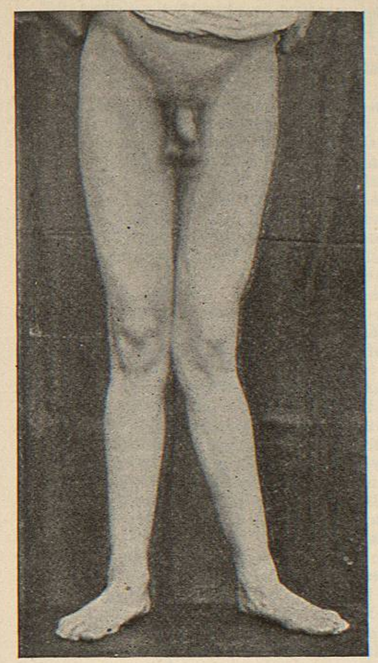

Fig. 3091.—Adolescent Knock-knee.

In the more extreme deformities caused by rachitis the shape as well as the contour of the bones is changed. For example, the internal border of the tibia may become very prominent at its upper extremity and project beneath the skin like an exostosis. A change in the contour of the fibula accompanies and corresponds to that of the tibia, but it is, as a rule, less marked.

Pathology.—In rachitic knock-knee, the changes in the bones and in the epiphyseal cartilages are characteristic of that disease. In the milder degrees of deformity, however, aside from the change in shape and the accompanying transformation of the internal structure of the bones, there is little that is noteworthy. The tissues on the internal aspect are relaxed, those on the outer side, the lateral ligaments, the capsule, and the biceps muscle, are contracted. Within the joint slight changes in the articulating surfaces of the bones and evidences of chronic irritation of the synovial membrane are sometimes seen.

Symptoms.—The deformity and the effects of the deformity on the gait and attitude are the most important symptoms, as they are of other distortions of similar origin. The gait of the patient with well-marked genu valgum is peculiarly awkward and shambling. The knees "interfere" and must be assisted, as it were, in the effort to pass one another in walking. In the slighter cases the thigh is abducted and rotated outward at the moment of passing its fellow, the movement being then reversed, as it, in its turn, supports the weight; but in the more severe type this voluntary effort of the muscles of the leg is not sufficient, and the body is swayed from side to side, the legs being alternately swung outward and lifted past one another.

In unilateral knock-knee, the leg being shortened by the distortion, a limp replaces the swaying gait.

Etiology.—Knock-knee is a deformity characteristic of weakness. The distortion is an exaggeration of the attitude of rest, and it may be assumed that in many instances the more or less constant assumption of the passive attitude, induced probably by weakness of the supporting muscles, is the cause of the deformity, the changes in the contour and in the internal structure of the bones being simply adaptations to the habitual posture. In the great majority of the cases the direct cause of the distortion is rachitis, and it develops therefore when the erect posture is assumed. In such instances a common attitude of the weak child is slight flexion at the three joints of the lower extremity, the knees being in contact with one another. To the habitual assumption of a somewhat similar attitude is ascribed the frequency of knock-knee among adolescent and adult bakers. It is probable also that postures assumed by the weak child in sitting and creeping before it begins to walk may determine the character of the subsequent distortion when weight is thrown upon the limb. One of the explanations of combined bow-leg and knock-knee is that the child has been habitually held upon the mother's arm in a manner to induce the deformity by direct pressure. Typical knock-knee is a deformity of childhood, but under favoring circumstances it may develop in adolescence. It is probable, however, that in many of these cases a slight degree of deformity was present in childhood, which later developed to noticeable distortion. Genu valgum may be induced directly by traumatism or by disease, and it may be a secondary or compensatory effect of deformity at the hip- or ankle-joint. These causes are, however, relatively insignificant.

Treatment.—Treatment of the deformity may be characterized as expectant, mechanical, and operative. During the expectant treatment the cause of the deformity, in most instances rachitis, should receive proper medicinal and dietetic treatment. If possible the direct exciting causes of the deformity should be removed; that is to say, the improper attitudes or the predisposing occupations should be discontinued.

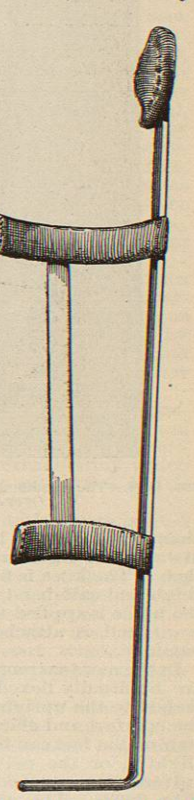

Fig. 3092.—The Thomas Knock-knee Brace.

In the slighter degrees of deformity, more particularly in weak or rachitic children, the limbs should be vigorously massaged at morning and at night, and forcibly straightened. The latter procedure is conducted as follows: The patient is seated in a chair; the leg is fully extended in order to make the deformity as extreme as possible; one hand then clasps the knee, the palm lying against its inner aspect; the calf is grasped firmly, and the limb is gently straightened over the fulcrum formed by the palm of the hand. This manipulation should be continued with gradually increasing force, although not to the extent of causing pain, for ten minutes, at least twice a day, and oftener if possible. This type of knock-knee, which is in itself an indication of weakness, is usually accompanied by flat-foot; thus the soles of the shoes should be made thicker on the inner border, as is described in the treatment of weak foot. If possible the patient should be instructed to walk with the feet parallel with one another, and tip-toe or other exercises in which the limbs are fully extended should be encouraged. A careful record of the deformity should be kept during this tentative treatment, and if there is some