NOTES ON DERANGEMENTS OF THE KNEE.

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A CLASSIFICATION of the mechanical conditions which give rise to derangements of the knee is difficult in the present stage of our knowledge. It is the more needful therefore to add our experiences and impressions to those already chronicled. Without including operations for disabilities arising from causes extra-articular, I have opened the knee joint over five hundred times, and in spite of this perhaps unique experience, I am quite prepared in cases even with classical symptoms to find my diagnosis wrong. A young woman dancing, a cricketer hitting to leg, an old lady removing the bed clothes with her foot, a direct blow on the knee, a trip, a twist, a jar, a miner working with fully flexed knee—in each case something gives way. The events following the sudden symptoms may be widely different. In one case the joint may have locked; in another acute pain is present; in another, obstinate effusion may occur; in another pain, effusion, and locking are absent, and despite these differences the diagnosis in each case may be the same. It is not my intention in this paper to statistically summarize my experiences, but rather to deal with the subject as it has affected me from the clinical side. On looking over my notes, I find a long list of affections upon which the disabilities depend, the most frequent of which are: *Injuries to the semilunars, synovial fringes, joint lipomata, loose bodies, exostoses, injuries to ligaments, bony separations, dislocation of the patellæ.* The most common of these is injuries to the semilunars.

Before proceeding to the discussion of these specific conditions, it will be well to restate certain anatomical points in reference to the mechanism of the knee and the attachment of the cartilages.

ANATOMY OF THE KNEE JOINT.

The knee is a modified hinge joint in which the articular surfaces of the bones are not closely adapted to one another, and in which there is never more than a small area of the femur in contact with the tibia in any position of the joint. This allows a slight degree of sliding movement and of rotation to take place in addition to the hinge movement.

The great strength of the joint is dependent on the integrity of the crucial ligaments and of the extrinsic ligaments and muscles. It is therefore necessary to give some account of the ligaments and of the semilunar cartilages so far as they have a direct bearing on internal derangements of the knee, especially displacements of the cartilages.

The external lateral ligament consists of two portions, a short inconstant posterior portion and a long anterior portion which, along with the tendon of the biceps, strengthens the joint on the outer side. It is a rounded cord extending from the external tuberosity of the femur to the head of the fibula, where it is attached between the two portions of the tendon of the biceps. It is entirely distinct from the capsule of the knee joint and is separated from the external semilunar cartilage by the tendon of the popliteus and the intervening bursa (Fig. 1).

The internal lateral ligament is a structure of great importance, for it plays a part in the production of the common displacements and injuries of the internal semilunar cartilage. Its superficial aspect is shown in Fig. 2, in which it appears as a long somewhat fan-shaped band. Its deep aspect, however, is intimately blended with the capsule of the joint and is firmly attached to the internal semilunar cartilage (Figs. 1 and 3). It is to be noticed that its deep fibres are really shorter[1] than those of the ext. lat. ligament, and consequently the internal semilunar is very closely moored to the internal condyle of the femur, a fact to which we shall refer again.

The semilunar cartilages are crescentic discs, thick at the convex border and thin at the concave margin, hence they are wedge-shaped in transverse section. Each cartilage assists the opposite lateral ligament in resisting lateral movements of the leg, for it acts as a wedge between the tibia and femur and helps to make the crucial ligaments tense.

The semilunar bodies consist of a core of fibrous tissue, arranged transversely and longitudinally, with a covering above and below of hyaline cartilage. The longitudinal fibres are continuous at the cornua with the fibres attaching them to the tibia, a few of these fibres sometimes are continuous in front from one cartilage to the other, forming the inconstant and unimportant transverse ligament.

At the convex border, fibres of the capsule blend with the transverse fibres of the matrix of the semilunar. The fibres coming from below are rather stronger and form the so-called " coronary ligaments," which are really only the portions of the capsule between the semilunars and the tibia.
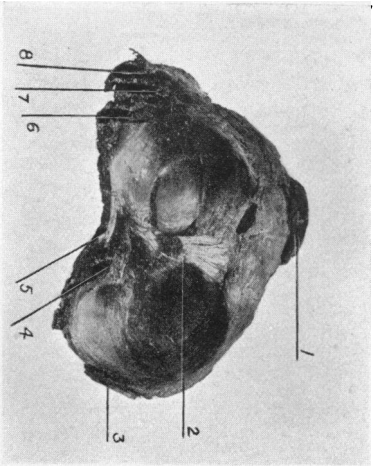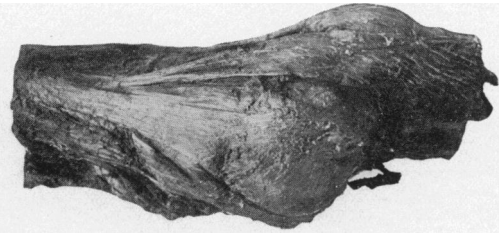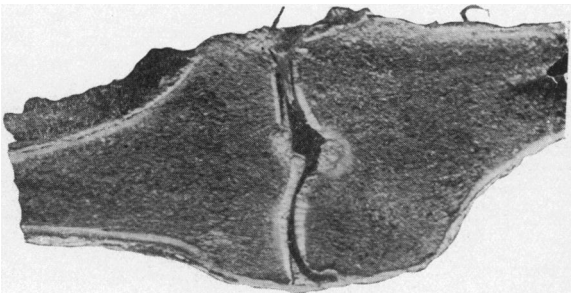
FIG. 1.

FIG. 2.

FIG. 3.

ANATOMY OF THE KNEE JOINT.

FIG. 1.—1, ligamentum patellæ; 2, anterior crucial ligament; 3, internal lateral ligament; 4, posterior crucial ligament; 5, fasciculus from posterior end of external semilunar; 6, tendon of popliteus; 7, external lateral ligament; 8, bifurcation of tendon of biceps.
FIG. 2.—Internal lateral ligament. The insertion of the vastus internus in exceptionally long.
FIG. 3.—Saggital section through internal lateral ligament, showing attachment to semilunar cartilage.

The external semilunar is separated from the capsule at the point where it is crossed by the tendons of the popliteus, while at its posterior horn a special slip of attachment runs up to be attached to the popliteal notch of the femur along with the posterior crucial ligament (Fig. 1).

On the other hand, as is shown by the accompanying figures, the internal semilunar cartilage is attached to the capsule along the whole of its convex margin, and is firmly attached to the strong internal lateral ligament as shown in the accompanying sections. The anterior cornu is always attenuated and its attachment to the tibia is never very strong and often very slender. It is easy to see that a sudden strain on the internal lateral ligament, especially if the femur is being rotated inward on the tibia, will tend either to detach the anterior cornu or split the cartilage longitudinally, or in rare cases cause a transverse rupture opposite the attachment to the internal lateral ligament.

FIG. 4.
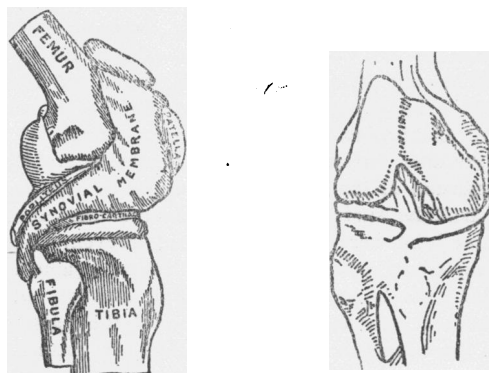
Structure of the knee joint.

It may be stated briefly that flexion of the knee takes place between the semilunars and the femur, the discs moving with the tibia; and that rotation occurs between the tibia and the discs, the latter moving with the femur.

The ligamentum mucosum is not a true ligament, but is the free upper border of the fold of synovial membrane which passes backwards to the anterior crucial ligament just below the patella. When the knee joint is opened above the patella, and the latter is turned forwards, two folds of synovial membrane are seen passing back on each side of the ligamentum mucosum. These are described in the text-books of anatomy as ligamenta alaria.

Tenney[1] has drawn our attention to the fact that the alar ligaments described by Morris and others cannot be found in joints hardened in formalin and from which the condyles of the femur have been removed subsequently; he states, however, that their apparent continuation as two fibrous folds of the extensor aponeurosis on each side of the patella can

always be seen. Pauzat traced these fibres down to the anterior ends of the semilunar discs, so that their effect would be to pull the discs upwards and forwards when the quadriceps contract. Tenney could not confirm this observation but traced the fibres into the infrapatellar pad of fat, and he considers that they pull up the synovial membrane and infrapatellar pad of fat and prevent the synovial membrane covering this pad from being nipped between the bones—an accident referred to by Hoffa[2] and others, which frequently occurs when the quadriceps extensor is atrophic and weak.

The motions of the joint are anteroposterior gliding movements and rotation of tibia upon femur. The ligaments allow of no other movement. In no position of the knee is lateral movement allowed, but when flexion is partial considerable rotatory movement can take place, and every time the knee is fully extended a certain degree of outward rotation normally occurs. The ligaments which prevent side-to-side movement during extension and during slight flexion are the laterals, and during the more acute flexions the crucials. It is obvious, however, that in conditions of strain the muscles are valued accessories—the rectus in front and the hamstrings behind—but they are quite inefficient as substitutes for either the crucials or the lateral ligaments should they be put out of action.

Griffiths,[3] of Cambridge, who has written a thoughtful article on the mechanism of the knee, having severed the internal lateral ligament, found that during extension of the limb the tibia could be appreciably bent outwards and the articular surfaces of tibia and femur correspondingly separated. If the same joint were flexed the crucials prevented such movement. In a case of complete rupture of the internal lateral ligament in a wrestler, I confirmed this experiment clinically and in another patient, where a portion of bone accompanied the separation of the ligament, no lateral movement was permitted during acute flexion. A strain upon the ligament is much more severe when it is twisted as well as stretched. Now, how can such a twist be applied? It takes place when the knee is flexed, the foot abducted, and the femur rotated inward. It is, in fact, in this position that strain and rupture of the internal lateral ligament and displacement of the semilunar cartilage almost always occurs.

A study of the anatomy shows us that there is a very close association between injuries to the lateral ligaments and displacements of the semilunars. An important point to remember is that from the closer approximation of its ends the external cartilage is more movable than the internal, and this is made more pronounced by the laxity of the part of the capsule to which it is attached.

EXPERIMENTS ON THE CADAVER.—Experiments on the cadaver show that extension of the knee is limited: First, by the posterior crucial ligament; second, by the anterior crucial ligament; third, by the internal lateral ligament; fourth, by the external lateral ligament, and that an increased range of movement is obtained as each structure is divided in succession.

External rotation of the leg is limited by the two lateral ligaments and is increased if either be ruptured or cut.

Internal rotation of the leg is limited by the internal lateral and anterior crucial ligaments.

In external rotation the tibia may slip forward slightly on the femur but is stopped by the anterior crucial ligament.

In internal rotation the tibia may slip back a little but is stopped by the posterior crucial ligament.

In the cadaver when the joint is extended and weight put on it the external semilunar cartilage can be made to fit closely to the condyle, but in no other position. The internal semilunar cannot be snugly fitted to the internal condyle in any position (Tenney).

FUNCTION OF THE SEMILUNARS.—The function of the semilunar cartilages is to assist the opposite lateral ligaments to resist lateral movements of the knee. It acts as a wedge between the tibia and femur and makes the crucial ligaments more tense.

When the leg was forcibly abducted on the cadaver, Tenney found that the internal lateral ligament tore away from its femoral attachments. The femur then slipped over the posterior end of the cartilage and when replaced crumpled up the posterior half of the internal semilunar. He points out that this is different from Hoffa's operative experience in which he found the anterior half of the cartilage curled up.

Clinically, it is the lower attachment of the ligament which usually gives way; the semilunar is then drawn back by the condyle, its anterior end gets worn and pinched between the bones.

We have seen that bending inwards of the knee in the extended and semi-extended position is prevented by the internal lateral ligament. Bending inwards of the knee during the fully flexed position is prevented by the crucial ligaments. These two anatomical facts should be remembered in their relation to displacement of the internal semilunar. One can thus easily understand how it is that the internal lateral ligament so frequently suffers injury. It is subjected to strain whenever the foot is firmly planted and abducted and the knee either slightly bent or kept extended (Fig. 5). If, in addition to this, as in the stroke to leg in cricket, or the final act of the bowler, body weight with rotation of the femur is added, we have produced that stretching and strain which Griffiths has proved to be so harmful to the integrity of the ligament. Indeed, the strength of the knee joint can be well gauged by the resisting power of the internal lateral ligament. Circumferentially, the internal cartilage is attached to the tibia by structures which allow the cartilage to be lifted fully a quarter of an inch—a point which is of importance. If the internal lateral ligament be torn above the level of the joint the cartilage remains upon the tibia; if torn below the level of the joint it follows the rotary movement of the femur. If the ligament be ruptured above and below the level

FIG. 5.

of the cartilage, it becomes a very simple matter to push it within the joint, a not unusual position to find it in. It would appear, therefore (Griffiths), that displacement or fracture of the cartilage can only take place when the internal lateral ligament is stretched or ruptured. This allows a separation of the joint surfaces and a slipping inwards of the cartilage; as the separate bones snap back the cartilage is nipped, and the knee is fixed in a very painful manner. The pain and effusion can be ascribed to injury to the synovial membrane, with which, as I have already stated, the cartilages are covered.

INJURY TO CARTILAGES.

In practically all cases the cartilage is displaced inwards, and in those rare cases where a protrusion has been felt from the outside it is due either to bruising and hemorrhage or to a buckling of the cartilage which gives an irregular feel to the articular margin. When we consider the wedge-shape of the discs, a displacement outwards could not possibly produce a locking of the joint; this can only occur when the displaced cartilage, acting as a foreign body, gets jammed between the bones. It is this internal displacement which gives rise to the acuteness and painfulness of the attack. We must all have been struck with the absence of anything abnormal from an external examination of a knee subject to recurrent attacks.

Now, what are the symptoms of displacement of the semi-lunars? The most constant symptom is a sudden inability fully to extend the joint; the cause of the displacement is strain thrown on the internal lateral ligament while the knee is flexed and the femur rotated inwards (Fig. 5). The force necessary in a first injury is generally great, the pain acute, and the victim, if an athlete, hobbles laboriously off the field with flexed knee. He is afforded a certain degree of relief by his friends in the pavilion, who fully flex his limb and then extend. When he reaches home the practitioner finds a distended knee, painful to manipulate. The strain which is most painful is that caused by stretching the structures on the inner side of the knee, and this is most acutely felt over the site of injury. In a certain proportion of cases, even with the knee fully extended, a gap between the bones on the inner side can be obtained by manipulation. For several succeeding days

there will be pain on pressure over the articular edge of the tibia opposite the ligament, and, generally speaking, some pain between the bones on pressure to the inner side of the patella. In a fortnight or three weeks, and after rest and massage, the patient is by common consent allowed liberty to walk. As we shall see later, this liberty is a mistake and the outcome of very indifferent surgery. Days, weeks, or months may elapse when again a train of symptoms, similar in character, but generally milder in effect, occurs. Many successive attacks, some grave and followed by effusion, some so trivial as merely to incommode, mark retrogression. In nearly all cases there is a history of strain or injury, the initial displacement as a rule being the most severe, while in the constantly recurring case any eversion of the foot may give rise to the displacement. I have had occasion to operate but twenty-four times for an external semilunar, which in my personal work only represents a 7 per cent. proportion. The reason the internal cartilage is so frequently involved is dependent entirely on anatomical grounds. Being, as we have seen, more firmly fixed by ligamentous attachments than the external, there is not the give and take about it which is found in the less controlled external cartilage, especially in the rotatory movements of the joint. Again, in the normal relation of femur to tibia the line of force is carried through the inner side of the knee; this is further emphasized by the abducted position of the foot which, if exaggerated, produces outward rotation of the leg. Another reason may be found in the fact that owing to the shape of the internal articular surface of the tibia the internal condyle of the femur can glide backwards on the tibia; thus the range of internal rotation of the femur on the tibia, which is a direct strain on the semilunar, is greater than that of external rotation.

Out of 117 cases operated upon (1906, 1907, 1908) for injury to the cartilage in which a lesion of the disc was found—

53 were torn from their anterior attachment.
16 were split longitudinally.
8 were attached by the cornua and torn from the capsule.

7 were displacements of the posterior horns.

12 were fractured transversely opposite the internal lateral liga-
   ment.

8 were loosely bound circumferentially with no other appreci-
   able abnormality.

8 had undergone changes in the loose anterior extremity of the
   semilunar of a nodular type, some being as lumpy and large
   as a pea.

3 cases exhibited no trace of the cartilage.

2 cases showed the anterior part doubled and adherent to the
   posterior part.

In the remaining cases it was difficult to classify the in-
juries; some cartilages were so friable as to tear when grasped
with the forceps and others presented fringed edges.

Apart from slipping, the most constant symptom of in-
jured semilunar, in over 400 cases operated upon where the
lesion was present, was localized pain on pressing over the
injured spot. This was felt for fully a month after injury.
It is best elicited while the knee is flexed, when pressure be-
tween the bones can be more effectively made. Locking was
found in less than half the cases. Effusion was present in
nearly all cases after the primary injury, and lessened or dis-
appeared in proportion to the ease and frequency with which
further displacements occurred. In one case where operation
was refused for a long time, and where the patient had for
three or four years slipped his knee several times a week, barely
any inconvenience was experienced beyond a sort of rocking
in the joint. He had no effusion, and consented to be operated
upon only because he was going abroad on a sporting expe-
dition. The anterior part of the internal semilunar was frac-
tured and displaced into the intercondyloid notch, while the
external cartilage was detached in front. In other cases where
the symptoms were often acute, barely any lesion except a
looseness of the moorings could be found. In five cases where
the symptoms—generally historical—pointed to injury of the
external cartilage, the lesion was found on the inner side. In
two cases operated upon since 1908, the internal cartilage was
found on the outer side of the joint.

As mentioned, during the years 1906–1908, I found 117

demonstrable lesions of the semilunar cartilages. During those years, however, I opened 190 joints with symptoms of derangement. In 30 I found thickening and irregularity of the structures about the ligamenta alaria. I found 9 cases of pedunculated fringes of a polypoid appearance. In 10 cases, I could find no lesion after careful search; in 3 of these cases— to be referred to later—I found on subsequent operation that the symptoms were due to the behavior of a tendon over an osteoma, and in 1 to a small fracture irregularity on the femoral condyle. In 8 cases the starting signs of hypertrophic arthritis were present; in 9 cases there were isolated loose bodies, and in 4 cases, loose bodies attached by pedicle to the synovial reflection. The remainder presented villous arthritis along the articular margin, lipoma arborescens and fibrous thickenings around the attachment of the anterior crucial ligament. In 20 of these additional 73 cases I expected to find injured semilunars, but was mistaken.

Many of the cartilages which I have removed at various periods had undergone changes which rendered them barely recognizable,—some were nodular and fibrous, some thin and frayed and some adherent to that part of the tibia on which they lay. The loose bodies are very interesting. They may be cartilaginous, bony, fibrous or fatty. When fibrous, they usually result from unabsorbed blood clot. The lipomata may be small or large, and develop in the synovial tissue, being attached usually by a pedicle. The larger lipomata are usually found to the side of the ligamentum patellæ. Hypertrophy of the synovial villi is frequently confused with a damaged semilunar. The condition is much more common than is usually expected, and I have frequently met with it in exploring joints. It is usually primarily the result of synovitis,— frequently later, the cause of. it. The whole joint may become papillomatous, or a few isolated fringes may be found generally where the synovial membrane meets the cartilage. They are often pedunculated, may be found anywhere along the articular margin, and are composed of fibrous tissue, fat and blood-vessels. In spite of the difficulty of an accurate diagnosis, effort should be made to differentiate.

DIFFERENTIAL DIAGNOSIS.—Injury of the internal semi-lunar is diagnosed by the acuteness of its onset, by the persistence of pain on pressure over the detached or injured area, by tenderness less pronounced over the inner side of the patella, and by a locking of the joint. The patient usually refers the pain to the front of the joint until pressure decides it for him. Irregularity is sometimes found along the articular margin and often a sense of discomfort when the tibia is abducted and rotated outwards, even when the toe lightly touches an obstacle. The history of the mode of production is helpful.

Injury to the external cartilage produces a similar train of symptoms occurring on the outer side of the knee.

Synovial Fringes.—The symptoms of the nipping of a synovial fringe are less acute in its primary occurrence than are those of a displaced cartilage. The pain is strictly local and is not participated in by the internal lateral ligament. Frequently a prominence may be found over the site of pain, and no matter how often the nipping occurs effusion follows, creaking in the joint is a frequent accompaniment, and often an obvious swelling occurs on each side of the ligamentum patellæ (due to the chronic thickening of the infrapatellar pad).

Loose Bodies.—Loose bodies can usually be found and isolated by the patient. They often lock the knee but only transitorily. The symptoms are sharp but not acute, and unless pedunculated they may be referred to different places. Effusions are common.

Lipomata will sometimes lock the joint. There is often swelling about the lower part of the patella and painless effusions. Exercise rather than accident produces the symptoms which are rarely acute, and pressure on the knee will produce no pain.

Osteomata can be found by manipulation and by radiography. They sometimes lock the joint when a muscle or tendon becomes entangled. Such cases I shall briefly relate.

Rupture of the crucials, of which I shall relate cases, is the accompaniment of so severe an injury that other structures

participate in the general strain. The tibia can be made to glide in a to-and-fro direction, and when the knee is flexed lateral movements are free. If the lateral ligaments are torn, lateral movements in the extended position are also free.

I am quite conscious that despite any amount of care in diagnosis, error is inevitable in a number of cases, and only exploration can give us accurate information. For some weird reason, on occasions all the symptoms may point to injury on the inner side and when an exploration is made no lesion can be found. One such case I shall relate.

CASE I.—A young man of firm muscular development received an injury in a football scrimmage. His knee locked and he was laid up in bed for three weeks. He complained of pain, as far he could recollect, both on the inside and on the outside of the patella. Five weeks later, when jumping over a ditch, his knee locked, but only very transitorily and he was able to reduce it. He complained of pain on the inner side of the joint over the lateral ligament. On three subsequent occasions something gave on the inner side of the knee, and when he consulted me, some weeks after his last attack, all tenderness had gone. I decided that the internal cartilage required removal, but when I explored it I quite failed to find any defect in its appearance or behavior. I examined for loose bodies or hypertrophied fringes, but quite without success. Thinking that perhaps a loose body might be found on the outer side, I explored that aspect of the articulation through a second incision. To my great astonishment, instead of a loose body I found that the posterior horn of the external cartilage was doubled over and displaced forwards. Complete removal of this cartilage resulted in recovery.

CASE II.—I shall relate another case to show how a displaced cartilage may not give rise to any typical symptoms. I saw a boy of 18 who periodically had effusions in his knee, accompanied by much creaking but no pain. Three years previously he fell, but gave no history of locking, and walked a mile home. Next day his knee was much swollen and for a fortnight he rested it. For three years this effusion continued, with short intervals. The knee felt stiff; it sometimes pained when fully extended, but never once did he feel anything give in the joint, nor was pain

ever referred to any localized spot. Every variety of treatment had been tried and discarded before I saw him—rest, splints, massage, exercises, electric baths—but all of no avail. I determined to evacuate the joint by lateral incisions, and if necessary inject the cavity with iodine and alcohol. On entering the articulation and peering around, I saw the anterior end of the internal cartilage thinned and detached and lying very flat to the inner side of the anterior crucial ligament. I removed the cartilage and evacuated the contents of the joint. Movement and massage were started in a fortnight, and the patient made a slow but uninterrupted recovery.

I mention these two cases as being of considerable clinical interest in order to emphasize difficulties of accurate diagnosis. It must not be thought, however, because of these very exceptional cases, that it is useless to attempt classification. On the contrary, the case where a diagnosis is difficult or impossible is the exceptional case.

The most common injury to the knee joint is a sprain or rupture of the internal lateral ligament. As we have seen, this should not be mistaken for a slipped cartilage. In the one case a derangement is experienced, in the other it is never so. Next to the injury of the internal lateral ligament— which is often commonly called a sprained knee—injury to the inner cartilage is most frequent, and the problem of treatment must be solved. I maintain that a great distinction should be made between a primary and a recurrent luxation. I never operate in any but recurrent cases, and I have no doubt that were the first offence intelligently dealt with and at once, the proportion of such recurrence would be materially diminished. This may not be quite orthodox, but I cannot help feeling that it is quite true. Surgeons point to the thinned and battered cartilage, fractured here, displaced there and ask, " What can mechanism do here? " It is quite true! A time comes when operative measures are inevitable, but that is only when cartilages inefficiently reduced or far too frequently nipped, show the evidences of their maltreatment. The first displacement will not be accompanied by any degenerative change, and the

knee will very often quite recover if appropriately approached. (*a*) Reduction must be absolute. (*b*) All movement of the cartilage must be checked until union of the torn structures is complete. (*c*) No lateral strain must be allowed until the torn or stretched internal lateral ligament has recovered its tone and strength.

With regard to reduction it does not matter what method is employed provided easy full extension is secured. Too often, more especially in badly displaced or protracted locking, the surgeon is content to acutely flex and extend the joint, and if at last, though full extension is not quite free, a back splint is applied and extension (which should be secured by manipulation) is brought about by pad and bandage, what probably happens is this: Reduction not being quite complete, there remains a slight obstruction to full extension, and the pad and bandage tightly compress the cartilage between the bones. Let us remember as we would an axiom, that we can only be assured of reduction when the knee can voluntarily be held in complete extension. It has been authoritatively stated that extension of the knee is often not possible because of bruising of the cartilage.[4] I would venture to insist on a reduction in every recent case of which easy extension is alone the proof. I learned this lesson some years ago. A youth, subject several times before to slipping in his knee, came to me straight to the pavilion from the cricket field. His joint was locked at an angle of 40 degrees. I put the limb through the orthodox manipulation, and it came nearly straight. I tried again with a similar result, and felt inclined to be content. "It is not in," he said, and, humiliated, I strove in public for five minutes, when, without any objective sign he cried, "Now I am right," and the knee could forthwith be held extended.

In reading text-books one would conclude that the reduction of a displaced semilunar is the easiest possible routine. This is a deduction based on very limited experience, for some cases are specially difficult to reduce. In the majority of instances, reduction is easily effected; in a few recent cases it is difficult; in some old cases it is extremely troublesome. What

is the best routine manipulation? Acute flexion, lateral devia-
tion and rotation inwards and full extension. Acute flexion is
always painful, but it is the only position where internal rota-
tion of the tibia is most free; lateral deviation separates the
bones which hold the cartilage, and full extension allows of
readjustment and places the limb in such a position as to permit
of accurate union of the internal lateral ligament.

RETENTION OF THE CARTILAGE IN A FIXED POSITION.—
This can only be secured when the limb is fully extended.
In all rotary and lateral movements of the joint the cartilages
participate. It follows, therefore, that both these movements
should be prevented if we are to strive for accurate union of
the torn attachment to the cartilage. Rest of the limb in a
fully extended position is therefore indicated, and rest should
be accomplished in bed so long as effusion lasts. Do not let
us forget that a joint distended with fluid relaxes by elongation
of all the protective soft structures of the joint, and the more
rapidly we attain absorption the more we avoid a prolonged
weakness. When all fluid is absorbed and the knee resumes
its normal aspect, we proceed to the next stage. It may be
days, it may be weeks; if slow, massage may help, but under
no conditions must flexion be allowed. Flexion, as we have
seen from the anatomical conditions, interferes with the moor-
ings of the cartilage and the integrity of the lateral ligaments,
both disturbances quite inimical to union of the torn struc-
tures. The third indication is to prevent for a prolonged
period lateral deviation of the joint. We have seen that in
derangements of the cartilage strain or rupture of the internal
lateral ligament is a necessary incident; it follows, therefore,
that during recovery no lateral strain should be thrown upon
the knee.

Sir William Bennett [4] and Mr. Whitelocke [5] in their inter-
esting monographs differ from me in my conclusions regard-
ing the prevention of lateral strain. Although the latter
author agrees that early rest, " from theoretical considerations
.   .   . would seem only reasonable and common sense," he
adds, " that the cases treated by shorter methods and with

movements from the first are to say the least no more liable to recurrence." In my opinion, a short splint, devised merely to prevent flexion and lateral deviation for the first few weeks, offers the only logical hope of recovery to the injured structures. Afterwards massage and exercises can be assiduously employed.

One of the simplest methods of preventing strain upon the internal lateral ligament is to walk upon an inverted foot with inturned toes. Seeing, as I do, a great number of cases of rickets, I am in the habit (when treating a genu valgum in an early stage) of insisting that the patient should walk with parallel feet, so aided by altered boots that the body weight is deviated from the inside to the outside of the tarsus. This throws a slight strain upon the external lateral ligament, and enforces pressure upon the inner articular surfaces of tibia and femur. So effective is this pressure that it generally suffices in a few months to correct the deformity. You can understand, therefore, what an important ally we have in so simple a measure to relieve the injured internal lateral ligament from strain.

In cases where the cartilage becomes displaced at frequent intervals I order an alteration in the heel and sole of the boots. The heel is elongated and raised on its inner side, and the inner side of the sole is fortified by a small wedge of leather. When the patient stands in such a boot the foot is inverted, and the lateral strain which is needed to displace the cartilage is avoided. If, in addition to this, the young athlete be told to walk with an inturned toe, and to run pigeon-toed, strain is inevitably thrown upon the external lateral ligament, while the internal lateral ligament is protected. Although immunity from displacement cannot be assured by this device, it materially lessens the tendency to its occurrence and becomes a valuable asset amongst our remedies. In addition, a splint must be employed.

In those cases where operation is not advised, or is rejected, a splint is indicated, so devised as to prevent lateral strain upon the knee, and to allow free movement. In all

recurrent cases which do not need operation, and in all cases of first displacement sufficiently recovered for flexion to be allowed, one orders a splint, alters the boot for the purpose of inverting the foot, and disallows walking except with parallel feet and running except with inturned toes.   In addition to this, the quadriceps, as the guardian muscle of the knee, must be energetically massaged and otherwise kept fit and strong.   May I once again emphasize the importance of adequately treating the first displacement, and of insisting that if the treatment is conducted on the lines I mention quite a large proportion of cases will make excellent and permanent recovery.   The recovery depends upon complete reduction and uninterrupted union and consolidation of both the internal lateral ligament and the ligamentous moorings of the cartilage.   In operating, as we so often do, on old injured cartilages, we are apt to be unduly biased when we see their thinned and battered edges.   This condition can only be the result of frequent injury, and should not discourage us in the mechanical management of a first slip.   I have at the present time many athletes playing tennis, football and cricket who have undergone a rigid mechanical treatment for undoubted displacement.

The question will be naturally asked: " What are the indications for operation? "   I shall try to define my attitude in regard to mechanical and operative treatment.

In the first place, I *refuse to operate* in any case I see early, the subject of a first derangement.   I *discourage operation* in those recurrent cases where the symptoms are transient and not followed by irritation of the joint.   I *strongly urge operation* in those cases where a recurrent displacement is at times followed by acute symptoms.   I advise it in all recurrent cases where a strenuous athletic life is a means of livelihood or a physical necessity.   I think operation absolutely imperative in the case of men who work or stand in dangerous places and where a yielding of the knee may lead to serious consequences.   Practically age has no influence over me if the indications I mention are present.   I have operated upon a boy of fifteen and a woman of fifty-four.

Is there any danger apart from periodic trouble in a slipping semilunar? I can clinically support Mr. Arbuthnot Lane ᵛ when he says it may prove the exciting cause of tubercle. Frequently I have examined patients with tubercular knees and patients with rheumatoid arthritis whose early history was associated with internal derangements of the knees and in several cases of badly recurring injuries I have found sometimes congestion and sometimes erosion of the bone and cartilage upon which they rested. One case to which I shall refer bears upon the point.

CASE III.—Some eight years ago, a youth, aged 19 years, consulted me concerning a cartilage which two years previously became detached. Several recurrences took place, some of them followed by synovitis and enforced rest in bed. I urged removal of the cartilage. The youth, however, persistently refused my overtures and only grudgingly and spasmodically wore the splint. In less than eighteen months I noticed that one of the attacks left him with a thickened and sensitive knee, which in time refused gradually to extend fully. At the present time he has recovered from a typical tubercular knee, firmly ankylosed.

This case is specially interesting to me as I have been able to watch the development from the beginning. Another case, a man aged twenty-five years, a boilermaker, sprained his knee. Later he became a frequent patient, with slipping internal semilunar. Three years after, creaking and swelling of the joint led to the suspicion of the hypertrophic variety of rheumatoid arthritis, which radiography fully confirmed. Of two cases, carefully watched, each refusing operation, one resulted in rheumatoid and the other in tubercular change. I would suggest, therefore, that this danger should be kept well in view, and that patients with either a tubercular or rheumatoid diathesis subject to recurring derangement should early be persuaded to have the exciting cause removed.

Is operative treatment invariably successful? In the great majority of cases a perfect recovery may be predicted; in a certain small percentage of cases the symptoms recur. The

recurrences were far more numerous some few years back, when the cartilages were sewn to the tibial attachments. The same causes which accounted for the initial displacements produced the recurrence. Since it is customary to exsect the cartilage other causes than a displacement must be searched for in answer to symptoms. It will then be discovered that the so-called recurrence is due to an overlooked accessory factor in the production of the symptoms of derangement. I shall illustrate this by very briefly referring to cases.

CASE IV.—A young woman of 24 complained of a locking which was referred to the outside of her joint. It had recurred on several occasions, was sometimes accompanied by pain and sometimes followed by effusion. On occasions the slipping was not accompanied by locking. On opening her knee joint the external semilunar was found torn anteriorly, and I removed the anterior half. A month did not elapse before slipping again occurred, and on careful enquiry as to locality no reliable history could be obtained. I therefore opened the knee from the inner aspect, as I felt I should have seen any abnormality had it been present on the other side at my first operation. Floating by a thin pedicle a small fibrous nodule presented, which was removed with scissors, and the knee soon recovered its normal function.

CASE V.—A miner of about 30 complained of a slipping in his joint, sometimes accompanied by locking. There was always sensitiveness over the articular border, between the patella and the internal lateral ligament. There was often effusion. On opening the joint I found the anterior portion of the semilunar abnormally free, but apparently not detached. Having several times found a similar condition, for which I exsected the cartilage with restoration of normal functions, I exsected here, and for some months no symptoms were experienced. Later, however, quite similar symptoms were complained of, and pain, again referred to the inner side of the knee. I followed the line of the old scar and searched for a cause. I was almost closing the wound when internal rotation of the tibia dislodged a loose body which shot out of my wound.

Both these cases illustrate the danger that more than one

mechanical defect may exist in a joint, and the removal of merely a part of them will not cure the patient. We must therefore carefully inspect a joint when it is opened, to make sure that we have attacked all those elements likely to give trouble.

LOOSE BODIES.—As early as 1803, according to William Hey, successful removal of these bodies was performed, but one learns from the account of Larrey [7] how dangerous an operation it was. In 1861 he collected 169 operations from the time of Ambrose Paré for simple removal of these bodies, 131 by direct and 38 by indirect or subcutaneous incision. By the direct method 99 were cured—several with ankylosis, 5 failed and 30 died. By the operation in two stages 19 were cured, 15 failed and 5 died.

I have already referred to the similarity in symptoms between these cases and injured cartilages, and suggested points for differentiation.

One has met quite a large variety of loose bodies in joints, some derived from organic changes, sometimes in connection with the hypertrophic type of osteoarthritis, sometimes due to detachment of cartilaginous or bony structure, others introduced from without. For quite a long time a young woman puzzled all whom she consulted, for intermittent effusions, locking of the joint but hardly any local tenderness on pressure. She often walked a mile with barely appreciable discomfort. When we X-rayed her knee (Fig. 6) it was found to be full of needles, which I removed by a large flap incision. The patient, who was a wilful neurotic, delighted in surreptitiously introducing needles into her joints. She is now quite recovered and doing hard work.

The treatment of loose bodies of whatever kind is their removal. It is quite true that they sometimes become fixed in a harmless place, but it is hardly worth our while to wait for this. If the body can be localized and fixed this is a very simple matter, and the operation will be described later. If it cannot be localized it is probably pedunculated, and the surgeon generally finds it when the operation has been performed

in the expectation of finding slipping semilunar—indeed, the symptoms are identical. In such a case it will nearly always be evident, even by the small incision we make for a semilunar. Often large numbers of bodies pour out of the wound, some as small as millet seeds and others quite large and irregular.

DERANGEMENTS OF THE KNEE DUE TO EXOSTOSES.—I have many times operated upon joints that became locked or obstructed by the slipping of muscle or tendon over exostoses.

In one instance (Fig. 7) an athlete on several occasions was suddenly pulled up while running, with a pain at the upper part of his popliteal space with sometimes considerable swelling. An X-ray revealed a pedunculated exostosis which occasionally obstructed the vastus. It was surrounded by a bursa, inflamed and containing fibrous masses.

Fig. 8 is a type of one of four cases and will serve as a clinical picture of the rest. The patient, a youth, comes with the history of a knee which slips at the back. It nearly always occurs when active or unusual exercise is being performed. The knee sometimes completely locks, and in such a case is often difficult to reduce. Generally, however, it is as one would expect a sense of discomfort and slight slipping which prevents whole-hearted athleticism, and frequently the patient falls, gets up again, feels the back of his knee and off again he runs. Sometimes it is the biceps which is hampered, at other times the inner hamstrings, and in one instance I removed a pedunculated exostosis which constantly became entangled with the outer head of the gastrocnemius. Fig. 9 shows an osteoma which ceased to trouble when it fractured. The fracture never united and the osteoma is now considerably reduced in size. Fig. 10 shows a flattened osteoma which gave rise to symptoms suggestive of inner semilunar, really due to its contact with the sartorius and semitendinosus, and the osteoma shown in Fig. 11 also obstructed tendons. More rarely symptoms may arise from sharp exostoses over the adductor tubercle, as shown in Fig 12. Usually there
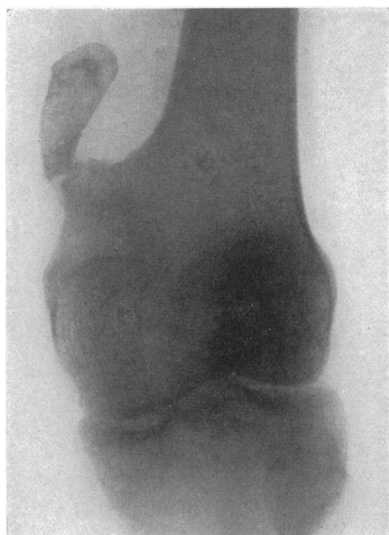
FIG. 6.
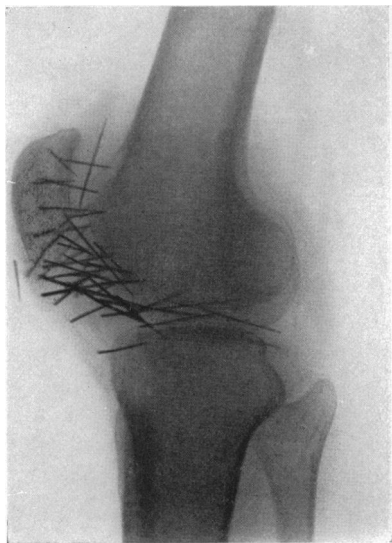
Knee joint filled with needles.

FIG. 7.

Exostosis of femur near the knee joint.

FIG. 8.

FIG. 9.

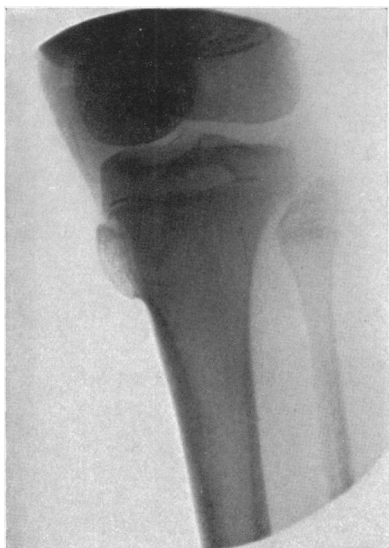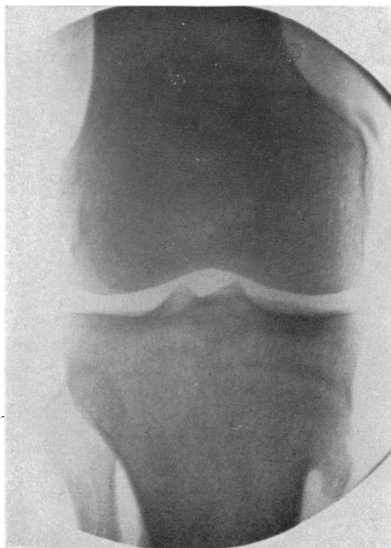Osteoma which fractured and then ceased to
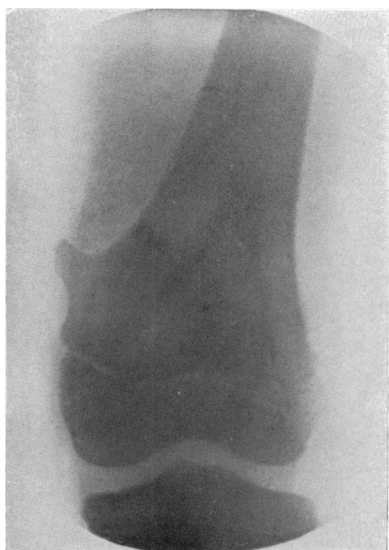give trouble.

FIG. 10.

FIG. 11.

a

Exostosis of tibia near the knee joint.

a

Exostosis of tibia near the knee joint.

FIG. 12.

FIG. 13.

Exostosis from the adductor tubercle of the femur.

Exostosis of tibia involving the quadriceps tendon.

should be no difficulty in making a diagnosis in these cases, more especially if an X-ray photograph be available. The fact is, however, that osteomata are not associated with knee derangements because they so often exist giving rise to no symptoms. Fig. 23 shows a most interesting osteoma which constantly became involved in the fibres of the quadriceps. Removal of these masses should be performed even in the growing epiphysis if they give rise to symptoms, and care should be taken to make the removal complete.

THE SNAPPING OR CLICKING KNEE.—A condition very puzzling, but one which most have probably encountered, is a loud click on acute flexion and sometimes on complete extension. This condition has been described as " trigger knee," because of its characteristic snap. It is most frequently experienced when extension is all but complete. You place your hand upon the patient's knee and ask him to extend his joint; this he does almost perfectly until about 170 degrees, when the remaining distance is performed suddenly accompanied by a click and usually an outward rotation of the tibia. The cause is difficult to explain and is generally ascribed to a disturbance of the movement of the external semilunar, which is successively caught and freed between the joints. Two cases I operated upon may throw some light upon what the surgeon may sometimes expect to find.

CASE VI.—A bank clerk not given to athletic sports presented such a knee. He complained of a sense of insecurity, more, he said, imaginary than real, and he told me that his health was undermined because of the nervous irritation it caused. The click, though most uncomfortable, was not accompanied by pain and never by effusion. He refused the suggestion of mechanical treatment, and I explored his joint. I was desirous of not opening his joint by a large anterior flap, and without any real reason I entered it from the inner instead of from the outer side. At once the cause was apparent. Tapering from the anterior portion of the cartilage and attached by a cartilaginous pedicle was a chrondrous structure the size and shape of a flattened pea. It lay loose just on the inner side of the anterior crucial ligament,

not so far back as the spine. On extending the joint the click was heard, but I could not, of course, see exactly what occurred. I removed the anterior portion of the cartilage, the tadpole ending, and I was able at once fully to extend the knee without the occurrence of the sound. There was a distinct wearing of the cartilage over the short track traversed by this nodule. The patient made a complete recovery. My second case very closely resembled the first. Clicking on extension of the joint was constant but not complained of. Periodically, however, the joint locked, and it was for this reason I was consulted. The locking was on the inner side, and I therefore approached the joint from this aspect. The anterior portion of the cartilage was thin and cordlike, quite detached and ended in a thickened extremity On removal of the cartilage, the clicking disappeared, and the patient also recovered the proper function of his joint.

I shall be very interested in future cases where this puzzling symptom is present. The mechanical treatment of such a condition consists in the application of a splint which, while allowing movement of the knee, prevents its full extension.

Some years ago I operated on two cases, where a clicking could be felt at the back of the knee. In both instances it was due to the slipping of the semimembranosus tendon over a small tibial exostosis. In both cases the disability was frequent but not constant, and at times weakness and soreness were present.

A third case was both interesting and instructive. A man, æt. 24 years, complained periodically of a locking knee. The locking was accompanied by scarcely any pain, and it seemed to take place in the popliteal space, never in front of the joint. Generally there was no great difficulty in releasing the leg; the patient by very rapidly flexing the limb at once freed it. On occasions, however, the locking was very complete, and the knee would remain flexed for some time until medical aid arrived. An exostosis could be felt just above the insertion of the biceps tendon, which when removed was found to be bicornate, like the letter Y, and the tendon sometimes slipped over the whole of it and at others was received between the horns. In each of these cases, removal of the exostosis remedied the defect.

FRINGES AND INFRAPATELLAR PADS OF FAT.

In 1906 to 1908 inclusive I operated upon 51 cases which would come under this division, in which I do not count early cases of rheumatoid arthritis. In 30 cases the condition was directly associated with the infrapatellar pads, and in none did I discover any connection with the suprapatellar pads. The condition has been described by several writers, including Hoffa[2] and Tenney.[8] The latter writer refers to two types— one occurs in the case of very fat folk where the thickening is due to the same causes as the general lipomatous condition. In this type the intra-articular masses shrink as the fat is absorbed in other parts of the body. In the second type the disability is associated with the young and athletic.

My experience of the condition is of long standing, and I will relate a case which will serve as an example.

CASE VII.—A young footballer lost his place in his team because of recurrent effusions after hard games. On the first two occasions the initial symptoms simulated dislocation of the semi-lunar without locking, but often no derangement could be noted and effusions were present without a knowledge of injury. At times he experienced a feeling of weakness in the quadriceps, which sometimes allowed him to fall when running down hill and restrained him from doing his best work. I saw him twice with the effusion and once during the recovered stage. At no time was pain complained of over the lateral ligaments nor tenderness over the articular margin, symptoms which are so characteristic of semilunar trouble. On pressing upon the patella while the knee was fully flexed and continuing the pressure during the act of extension a sense of discomfort hardly amounting to pain resulted. There was a marked thickening on each side of the patella. The recurrent effusions, the nodular firm swelling at the sides of the patella with the occasional yielding referred to the quadriceps suggested changes in the infrapatellar pads of fat. An operation revealed this condition and with a long curved scissors the pad was removed, when several small tabs compressed at their extremities revealed the mechanism of the lesion.

Fibrous hardening of the mass and the presence within it of

34

traces of old hemorrhage were found on making a section of the
fatty mass removed.

The patient was later able to resume first-class football with-
out discomfort or sense of weakness.

This case is typical of most of the others excepting that in
some cases where the tabs are elongated, more pronounced
symptoms of derangement predominate over those of synovial
irritation.   In most of my cases the pad presented remnants
of old hemorrhages, doubtless the records of separate previous
injuries.

Frequently one finds in connection with this condition an
œdematous fibrous state of the synovial membrane, especially
in the pouches, and it may be necessary to enlarge the incisions
to remove the masses in the same way as one removes the pads.
An X-ray photograph will often reveal the fibrous changes in
the intrapatellar pads and also the semilunars (Figs. 26, 27,
28).

RUPTURE OF ONE OR BOTH CRUCIAL LIGAMENTS.

This is a very serious accident, and one includes the old
ununited rupture amongst derangements because it involves
the joint in abnormal movement.   When one considers the
excellent recovery which sometimes follows a complete dislo-
cation of the knee, one realizes that recovery of useful union
of the crucials should be expected.   Some years ago I was
called to the country to amputate a gangrenous limb resulting
from an unreduced backward dislocation of the femur.   On
opening the joint afterwards complete rupture of the crucials
was displayed.   I have had under my observation several cases
of dislocation of the knee.   It is usually a forward displace-
ment of the tibia due to forcible hyperextension.   Several
cases exhibited the opposite deformity, in some the head of the
tibia lay behind and above the articular line of the femoral
condyles.   I have met with one case of lateral displacement of
the knee, unaccompanied by fracture.   My recollection of most
of these cases is that useful recoveries resulted although rup-
ture of the crucials must have occurred in all.   At times, how-

ever, where union of the ligaments has not resulted an operation may be needed. Such cases have been reported by Mayo, Robson,[9] Battle [10] and by me.[11]

> Robson's case is interesting, being the case of a miner who met with a severe accident in 1902, being buried in earth, and sustaining, amongst other injuries, a fracture of the leg and of ribs. After many weeks in a country hospital he was admitted into the Leeds Infirmary with a swollen knee. When the muscles were braced up the bones were in good position, but as soon as the muscles were relaxed the tibia fell back until stopped by the ligament of the patella. By manipulation the head of the tibia could be brought forward in front of the femur, and there was also free lateral movement. It was decided that not only were the ligaments generally relaxed, but that the crucials had been ruptured. When operated upon both crucials were found completely torn from their upper attachments, the ends being somewhat shreddy. They were stitched in position by means of catgut ligatures, and some years afterwards when examined, the joint had almost wholly recovered its function.

Although I have seen several cases where the diagnosis of rupture of the crucials, either anterior or posterior, was suggested, I have had an opportunity of operating upon only one case.

CASE VIII.—A barman fell down some cellar steps and dislocated his knee and for three weeks was kept at rest. He was then allowed to move about the house, and consulted me some ten weeks later. He had some pain in the knee, a little effusion, and, as he described it, " no dependence " on the joint. It slipped about, creaked, and was only moderately useful, and that only when a splint was worn. On examining the knee, the leg could be rotated inwards, but not outwards. The patient complained of pain whenever the knee was hyperextended, this being possible to a very limited extent. The tibia could be slightly displaced forwards in extension. I opened the joint by a free anterior incision, dividing the patella ligament, and found a complete rupture of the anterior crucial and considerable reddening of the synovial membrane. I freshened the ends, which were very frayed, and as they could not be brought together I plaited some chromicized gut as in nerve-union. For six weeks the patient was kept in bed, and in eight months after the operation the stability and mobility of the articulation was secured. In the

early part of last year I examined a boy of 15 who fell in scaling railings and was caught by the foot and held head downwards. I detected a separation of a small piece of bone from the inner femoral condyle at the attachment of the internal lateral ligament, and there was free mobility in all directions. It was obvious that in addition to other lesions both the crucials were ruptured. Immobilization of the joint for two months and subsequent control of the lateral ligaments resulted in a good recovery.

We may, I think, conclude that rupture of the crucials is not an uncommon incident in dislocations of the tibia and other grave lesions, and that it is amenable to mechanical treatment if such treatment be sufficiently protracted. In old, neglected cases the gliding tibia is the characteristic derangement. If the anterior crucial alone be ruptured or elongated, the leg can be displaced anteriorly, it may be hyperextended, and it can be rotated inwards.

If the posterior or stronger ligament be similarly injured, the tibia can be displaced posteriorly. If both are ruptured, the tibia can be moved backwards and forwards, and if the knee be flexed outward rotation of the tibia is increased.

DERANGEMENTS DUE TO SMALL BONY SEPARATIONS.

On six occasions I have removed small portions of bone which have remained prominent after injuries to the femoral condyles. Three of these pieces were found lying in front of the anterior crucial firmly attached—two were attached to the internal condyle and one piece embedded in the centre of the infrapatellar pad (Fig. 14). I have frequently met with fracture of a small portion of the adductor tubercle and old standing ununited fracture of the tubercle of the tibia (Fig. 15), while of separation of part of the bony attachment of the internal lateral ligament both at its femoral and tibial extremities I have several radiographs. At times these pieces of bone give rise to derangement, more especially separations from the adductor tubercle. Removal is obviously the only treatment. In recent separation of the adductor tubercle, it is well to nail it in position. The same may be said of fracture of the

tibial tubercle, which of course must not be confounded with Schlatter's disease, or partial separation at the epiphysis so common in boys. This fracture is sometimes followed by a thickening round about the insertion of the ligament (Fig. 13) painful to the touch. It is an osteitis which remains local and is most effectively treated by entering a chisel to the depth of half an inch.

FRACTURE OF THE SPINE OF TIBIA.

A rare and interesting derangement caused by fracture of the tibial spine came before me recently (Fig. 16).

CASE IX.—A man of about 40 years was thrown off a bicycle six months previously. He was laid up with severe effusion and was not able to fully extend his knee. When he consulted me, three months later, walking was difficult and recurring effusion took place, although attempts had been made under anæsthesia to straighten the limb by means of manipulation, splint and bandage, but with no success. The knee remained unable to extend by about 15°. An X-ray (Fig. 16) showed a mass of bone in the centre of the joint.

On opening the knee by the incision which I adopt for semilunars I came down upon the tibial spine which was displaced backwards, carrying with it the anterior crucial ligament, but surrounded by a mass of fibrous tissue. I removed the bone, leaving enough adherent fibrous tissue to enable me to fix the anterior crucial. The result is a much stronger and more useful knee, which even yet cannot be fully extended. I have had no opportunity to search the literature for such an injury, but I cannot remember ever seeing a reference to it.

RECURRENT DISLOCATION OF THE PATELLA.

During the last two years I have operated upon twelve cases of this most troublesome affection which appears to the patient the most alarming of all derangements. Practically it always occurs on the outer side.

The etiology of the displacement is suggested by the anatomical fact that the line of action of the quadriceps in the axis of the thigh differs from that of the patella ligament in

the axis of the leg (Fig. 17). When the leg is extended by
contraction of the quadriceps the patella lying at the angle of
the meeting of these two axes must be pulled outwards as the
muscle and ligament attempt to form a sharp line. Indeed,
there can be little doubt that displacement would be very fre-
quent were it not for a second anatomical fact, viz. that the
outer margin of the trochlear surface of the femur is so
placed as to offer resistance to the outer deviation of the knee-
cap (Fig. 4 b). In a series of cases published by Goldthwaite [12]
he drew attention to what I have frequently observed, that the
tibial tubercle is displaced too much to the outer side, and in
this way there is an increase in the angle of axis of the leg
and thigh. If we alternately extend and relax the quadriceps,
this lateral movement of the patella becomes obvious and we
at once note the manner in which the trochlear surface of the
femur checks displacement outward of the patella. As Gold-
thwaite well says, " If for any reason the line of pull becomes
less direct or the articular ridge less perfectly formed; if the
capsule be weakened by the distention following some acute
injury; if the patella tendon be abnormally long, so that the
patella is drawn above the outer edge of the trochlear surface
of the femur; or if the joint can be hyperextended so that
during the muscular pull the patella is lifted away from the
femur—in any one of these conditions, the stability of the
joint so far as the patella is concerned must be materially
lessened."

The symptoms of slipping patella are obvious and fairly
constant. The patient, perhaps rising from a chair, feels an
excruciating pain in the knee and often falls. He is unable
to move. The patella is found usually on the outside of the
joint; effusion of fluid follows. In the recurrent case, if of
long duration, no pain accompanies the displacement and no
fluid is secreted. The reduction is easily accomplished. The
leg should be first extended, the inner edge of the patella be
elevated and passed back to its place. Patients nearly always
complain of weakness of the knees, and operative measures
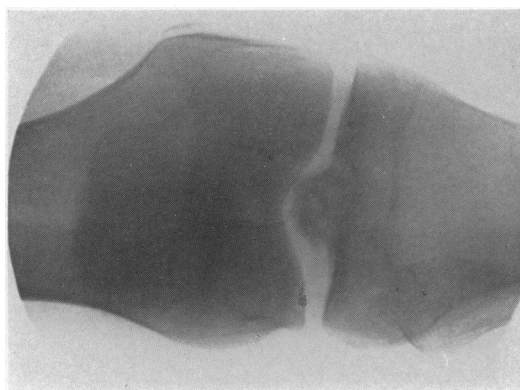are sometimes needed to correct the disability. I have trans-

FIG. 14.   FIG. 15.

Spicule of bone separated from condyle of femur imbedded in the centre of the infra-patellar pad.

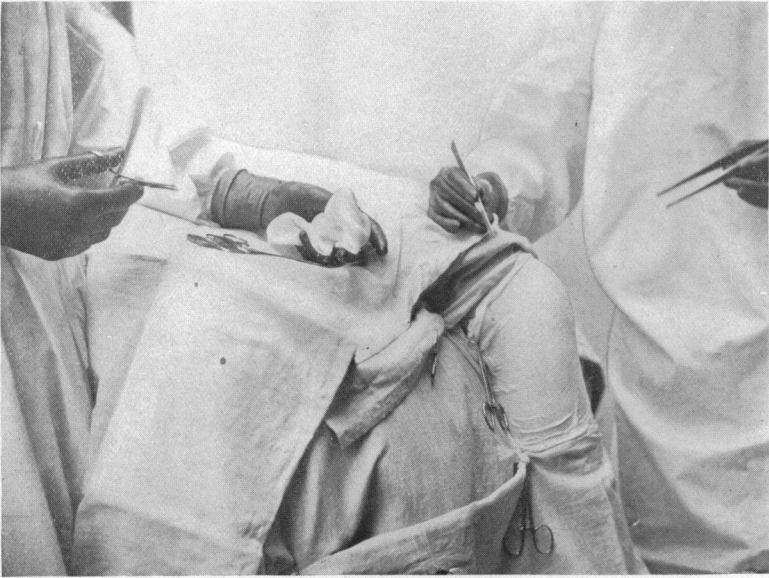Old ununited fracture of the tubercle of the tibia.

FIG. 16.

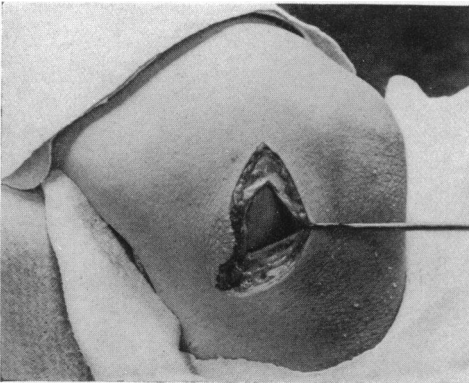Fracture of the spine of the tibia.

Fig. 19.

Illustrating preparations for opening the knee joint.

Fig. 20.

Incision to expose internal semilunar, made with leg flexed to a right angle.

planted the tubercle of the tibia into such a position as to make the axis of the ligament and quadriceps one. In genu valgum accompanied by displacement of the patella I have performed a femoral osteotomy and maintained a strong extension in a small child. I have cut down upon the inner side of the
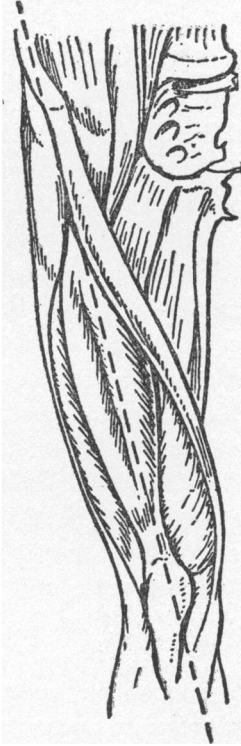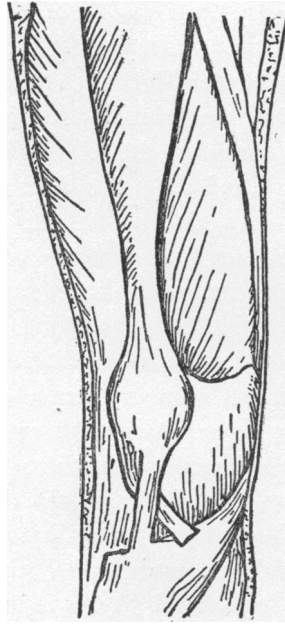
FIG. 17.

FIG. 18.

capsule and seized it above and below by a pair of Kocher forceps. The forceps are simultaneously twisted and a longitudinal strip of capsule is plicated which draws the patella inwards; this plication is freshened and stitched without opening the joint. In one obstinate case complicated by genu valgum I divided the femur above the joint, transplanted the tibial tubercle to the inner side, and plicated the capsule. The best operation, however, in the uncomplicated case, is that

devised by Goldthwaite, who splits the patella tendon, and after detaching the outer half, passes it behind the remaining portion and implants it to the inside of the patella tendon. The tendon is stitched to periosteum and to the expansion of the tendon of the sartorius muscle (Fig. 18), and in addition I plicate the capsule on the inner side. The operative treatment should only be advised in the really troublesome case.

OPERATIVE TREATMENT OF SEMILUNARS.

As I have said elsewhere, there can be no greater tragedy in surgery than to infect a knee joint in operating for a derangement. In my early days I experienced one such tragedy which ended in death. Although since then I have opened the knee for mechanical derangement in considerably over 500 cases, I always approach the operation with the most rigid care. Obviously the greatest precautions should be taken whatever operation be performed on any part of the body, still, the slightest error in technic in removing irritant bodies from the knee will almost surely end in disaster. As Edmund Owen says, " the knee joint leaves no margin for mistake,"— in this respect it is so different to the abdomen. Before our precautions were as careful as they are, I had several cases, perhaps five or six, with reddened skin which caused anxiety but ended well. In others I operated for tense and painful effusion. In no case was there any serious trouble nor any loss of subsequent mobility.

Whoever undertakes to operate should be scrupulously clean; he should pay, not homage merely, to asepticism, but allegiance. I prefer to have the knee cleaned with soap and water night and morning for a full week and compresses of sterile water covered with mackintosh applied. On the evening before operation the knee is washed with ethereal soap followed by methylated ether, and is finally rubbed with biniodide of mercury, water and alcohol, 1 in 1000, dried with sterile wool, and a dry sterile dressing applied. On the operating table in the morning I conduct a final scrub with mercury and alcohol 1 in 500, quickly followed by a rinsing with sterile
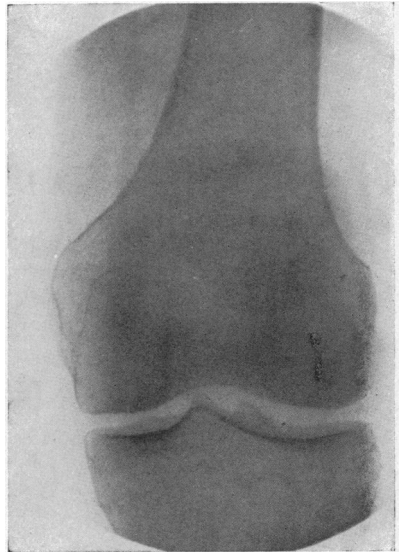
FIG. 21.

Osteoma of tibia invading joint.

FIG. 23.

FIG. 24.

Detachment of bone with rupture of internal
lateral ligament.

FIG. 25.

Detachment of portion of articular surface of femur, locking joint at angle of 45 degrees.

FIG. 26.

Knee distended with oxygen to show semilunar cartilages.

FIG. 27.

Joints distended with oxygen showing semilunars.

FIG. 28.

Joint distended with oxygen to show thickened infrapatellar pad.

water. The nurse, if she has to do with the sterilization of the knee, should be herself free from infected hands. She should not have touched a doubtful case for days. Both when the knee is washed and at a later stage, when chemically sterilized, the nurse must wear india-rubber gloves, boiled for each occasion; less than this is not enough. The surgeon's hands should be thoroughly prepared, first in running water and then with spirit lotion. Ten minutes at least should be spent in the rougher cleansing before a germicide is used. When the hands are as clean as water and lotion can make them, the antiseptic conscience will still distrust, and the surgeon must make assurance doubly sure by wearing boiled rubber gloves. Every one in the theatre should have head and mouth well covered, and a sterile gauze screen should be placed between the patient's face and the field of operation.

For some time I have given over operating with the knee in such a position that it has to be further flexed during the proceedings. Unless the greatest care is taken, the cloths get shifted or air is introduced into the joint. All surgeons of experience will have noted this. To avoid this risk I begin the operation with the patient's knee hanging at right angles over the foot of the table (Figs. 19, 20). To shift during the operation is to change the plane of the incision. The final cleaning of the knee takes place while the joint is flexed and the skin tense. Some thicknesses of sterile gauze squeezed out of 1 to 1000 biniodide of mercury is wrapped round the joint and the incision is made through the gauze, the cut edges of which are fixed to the wound. The length of incision which practically always suffices is three inches, the incision into the capsule is much smaller (Fig. 20). Long skin incisions obviously add to the risks, and are only very exceptionally needed. The incision should be slightly curved and extend from an inch within the lower angle of the patella to half an inch below the tibial margin, curving more acutely at this point towards the lateral ligament. The interior of the joint is then inspected with the aid of carefully applied retractors. No less authorities than Sir William Bennett [4] and Mr. Whitelocke [5] advocate

entering the finger for exploratory purposes. The finger should never enter the joint. Neither the surgeon nor the assistants should touch the wound with anything but sterile instruments. The sutures for the capsule should be handed on forceps and I usually make the stitches a blanket-stitch. In the flexed position, the best view is obtained of the interior of the joint and the cartilage can be well inspected. If the capsule plicates and hides the view, draw it outwards with a skeleton retractor which may be used to obtain a good view in any direction. The cartilage may be found in any position. It may be detached at its anterior extremity. It may be circumferentially split; it may be completely fractured; it may be completely twisted; it may be firmly fixed but with frayed inner border; it may be nodular; the posterior part may be in front; it may be attached at its extremities and free along the whole or part of its outer border; the anterior part may be ground away, or found quite loose as a separate body, or only the slightest movement may be possible, due to a loosening of its moorings. The examination, which should be gentle, is facilitated by a sharp or blunt hook. It is only necessary to remove the loose portion of cartilage, be it a frayed border, a circumferential tear or a detached anterior portion. Here I would offer a practical suggestion. Never pull upon the cartilage nor cut when pulling; this detaches more, and to my knowledge is a cause of recurrence. Note the degree of detachment and go a short distance further with a knife cutting the cartilage clean across, and then complete the incision along the outer border. Having removed the cartilage, look for fringes, tabs or other possible agencies which may cause trouble in the future, and remove them. Stitching the cartilage should be an obsolete operation. If the cartilage is only slightly mobile and the history characteristic, it should be removed forthwith.

During the operation, dabs taken directly from the sterile drum should cover the wound during any interval, and no dab should be used which has been exposed to the air.

I never tie vessels, always use a tourniquet until the dress-

ings are bandaged, and never drain. I used to drain, years ago, but I consider it quite unnecessary, and an additional communication between skin and joint. The synovial membrane capsule and skin should be separately sutured and the sutures should not pass through the whole thickness of the skin.

I now know no anxious moments, the skin never reddens, nor do I have trouble with effusion.

The stitches are left in position for eight days, the knee kept slightly bent in a splint for the same period, or a few days longer, and then passive movements and massage are started. Special attention should be paid to the weak quadriceps and in from three to four weeks normal exercise should be allowed.

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