A Paper

ON

DIAGNOSIS AND TREATMENT OF
COMMON INJURIES OF THE KNEE JOINT*

BY

NAUGHTON DUNN, M.A., M.B., CH.B.

LECTURER IN ORTHOPAEDIC SURGERY, BIRMINGHAM UNIVERSITY

Literature on injuries of the knee joint has been extensive, but to me accurate diagnosis in many cases becomes more difficult as my experience increases. There may be general agreement on the lines of treatment to be adopted for definite lesions, but not infrequently the accurate diagnosis is not possible. The reason for this seems to me to be that many of the ligaments, bursae, etc., described by the anatomists, are not directly palpable to the surgeon examining the joint. Before considering the question of diagnosis I think that it would make the subject clearer if I briefly refer to certain of the more important points which have been established with regard to the anatomy and physiology of the knee joint.

MECHANISM OF THE KNEE JOINT

The mechanism of the knee joint has evolved as a result of the function which it has been called upon to perform. It consists essentially of the broadened ends of the tibia and femur with a sesamoid bone—the patella—in the extensor tendon, and two intra-articular fibro-cartilaginous disks. It is the connecting link between the two longest bones in the body, so that body weight transmitted through these levers in movement of the joint subjects it to enormous strain. We therefore find that nature has provided it with powerful muscles for its control, and strong ligaments on which it largely depends for its stability.

Movements of the Knee Joint

Movements allowed at the knee joint are flexion, extension, and moderate rotation when the joint is flexed. These movements, except that of flexion, are limited by the ligaments. The fact that the articular surfaces of the condyles are not perfect arcs of a circle, and that that of the internal condyle is $\frac{1}{2}$ in. longer than that of the external condyle, allows the femur to twist or screw inwards on the head of the tibia on full extension of the joint.

In this position the lateral and the anterior crucial ligaments are taut and tense, and the femur and tibia become practically one continuous rigid support, no antero-posterior or lateral movement being possible. If internal rotation of the femur on the tibia is maintained, flexion of the joint cannot occur. Before flexion commences the knee must unlock, and muscle action is then necessary for its stability. We thus see that where full extension of the joint is impossible constant strain is thrown on the quadriceps muscle. We all recognize that joints and the muscles controlling them usually have a common nerve supply, so that muscle atrophy is an early sequela of joint injury; but is it not probable that fatigue resulting from constant strain may account for the very marked wasting of the quadriceps which is so frequently seen when the mechanical locking of the knee in extension is not possible? In flexion of the knee moderate internal and external rotation are allowed, but little if any lateral or antero-posterior movement.

* Read in opening a discussion in the Section of Orthopaedics at the Annual Meeting of the British Medical Association, Eastbourne, 1931.

ANATOMY OF KNEE JOINT

A knowledge of the relation of the intra-articular cartilages to the femur and tibia is essential to a proper understanding of common injuries of the knee joint. They are two crescent-shaped pieces of fibro-cartilage. They have at their extremities strong fibrous attachments to the rough areas in front of and behind the tibial spine. Both have weak attachments by means of the coronary ligaments to the peripheral margins of the tibial tuberosities. The internal meniscus is the less mobile because of its attachment to the internal lateral ligament, while the outer cartilage is separated from the external lateral ligament by the tendon of the popliteus muscle. The closer proximity of the corneal attachments of the external cartilage also anchors it less securely. The greater fixation of the internal cartilage probably accounts for the fact that it is more frequently damaged in cases of injury. It is also to be noted as a point of possible surgical importance that the anterior convex margins of the cartilages are frequently connected by a transverse ligament.

The behaviour of the intra-articular cartilages in movements of the knee joint is also of interest. It would appear that in flexion and extension they move with and on the tibia. In extension their anterior part is compressed by the femoral condyles—depressions normally present on the articular surfaces of these indicate this. In rotation the disks move with the femur on the tibia. Different parts of the meniscus come under special pressure during the various normal movements of the joint. One can therefore readily understand that undue strain may disturb the usual relations between the articular surfaces and the meniscus, so that a portion of the latter may become fixed and a tearing or displacement result. In any case rotation beyond normal limits is bound to strain or tear the attachments of the coronary ligaments to the head of the tibia. Rotation is only possible in flexion, and in my experience it is strain of the flexed knee which provides the very great majority of injuries to the intra-articular cartilages.

The Patella

The patella is a sesamoid bone developed in the extensor apparatus of the knee joint. It is connected by the patellar ligament to the head of the tibia. Deep to the patellar tendon, but extra-synovial, lies the large infra-patellar pad of fat.

Capsule and Ligaments

The capsule of the knee joint is itself a thin membrane, but is reinforced by strong ligaments and expansions from the muscles controlling the joint. The main ligaments are the lateral, crucial and posterior. Their points of attachment are well known. The functions of the ligaments are to prevent slipping of the bones on one another in extension, to keep them in proper apposition during movement, and to limit movement. All are taut in extension of the joint except perhaps the posterior crucial ligament, which is made tense by movements backwards of the tibia, but it is doubtful if it limits flexion.

Muscles and Bursae

For weight bearing in any position except full extension, muscle action is necessary for stability. These muscles are numerous and have strong attachments to bony points in close proximity to the joint. In relation to the joint and the structures controlling it at least 12 bursae have been described. Four of these—the supra-patellar bursa, those lying under the heads of the gastrocnemius muscle, and that surrounding the popliteus tendon—usually communicate with the synovial cavity.

Articular Cartilage

The articular surfaces of the bones entering into the formation of the knee joint are covered with hyaline cartilage. It is to be noted that it is avascular and so has little or no power of repair.

Synovial Membrane

The synovial membrane supplies the oiling system which ensures free movement in healthy joints. The point to be remembered with regard to it is that it is richly supplied with sensory nerves. Any damage to this structure is therefore accompanied by pain. It lines the capsule of the joint but is reflected over the infra-patellar pad of fat and crucial ligaments, so that these structures are intra-capsular but extra-synovial. It also covers the intra-articular fibro-cartilages on their articular surfaces. It does not cover the articular cartilage but is attached to the margins. The synovial membrane covering the infra-patellar pad of fat is prolonged to form an attachment to the intercondyloid notch. This is named the ligamentum mucosum, the lateral expansions of which form the ligamenta alaria.

DIAGNOSIS AND TREATMENT

In all joints, disturbance of the normal mechanism is due usually either to trauma or to infection, although even in cases of injury the possibility of neoplasm or neuropathic degeneration must be borne in mind. Trauma may be mild or severe—blows, twists or fractures. Infection may reach a joint directly through an open wound, or by haematogenous implantation. We must realize that the majority of strains of the knee, as of other joints, make a natural and full recovery without special treatment. The knee joint however is particularly liable to more severe strain because it has to sustain body weight transmitted through long levers, and whilst doing so allows a wide range of movement. It therefore provides many cases of injury, but I would suggest that we should confine our discussion to cases of chronic or recurrent disability following common injuries of this joint.

For the purposes of this communication I have reviewed 522 consecutive cases of which I have detailed notes of the condition found when the case was first presented to me.

Diagnosis in 522 Cases of Injury of the Knee Joint

Lesions of internal semilunar cartilage	179
Lesions of external semilunar cartilage	71
Lesions of internal lateral ligament	34
Loose bodies	34
Lesions of exterior apparatus	11
(a) Transverse fracture of patella	6
(b) Rupture of quadriceps tendon	3
(c) Rupture of patellar tendon	1
(d) Avulsion of tibial tubercle	1
Neuroma on patellar branch of internal saphenous nerve	7
Rupture of crucial ligament including fracture of the tibial spine	7
Lesions of external lateral ligament including rupture of biceps and traction fracture of head of fibula	7
Fractures involving articular surfaces of femur or tibia	4
Traumatic exostosis	4
Direct infection	4
Strain of posterior ligament	3
Osgood-Schlatter's disease	2
Haemarthros-Haemophilia	2
Traumatic dislocation of patella	2
Others	4
(a) Myeloma in external condyle of femur	1
(b) Charcot's disease	2
(c) Fibro-lipoma in vastus externus	1
Indefinite lesions	147

These are cases of pain and limitation of movement following injury. Many of them were due to adhesions and responded to manipulative treatment. Others, where the history of injury did not entirely account for the con-

dition found on clinical examination, I believe were cases of subacute infective arthritis. There still, however, remains a large proportion of cases in which a definite diagnosis is not possible, because of the facts that the attachments of certain muscles and ligaments are not accessible to direct palpation. In support of this belief I would point out that while anatomists describe 12 bursae in relation to the knee, surgical reference is available with regard to only 3 or 4 of these, all of which are, or become, superficial.

Surgical textbooks usually confine themselves to a description of commonly recognized lesions in relation to particular joints. The patient complains of pain, weakness, and/or limitation of movement in conditions such as tennis elbow, tenosynovitis, the presence of a ganglion, rupture of the plantaris tendon, etc. These cases are readily diagnosed when they occur in situations where the structures involved are accessible to direct palpation. This, however, is not possible in the case of many of the ligaments, bursae, etc., apt to be affected by strain of the knee joint.

There seems to me to be no reason why similar types of lesion should not occur in inaccessible portions of the knee, and I feel sure that this possibly accounts for much of the difficulty in accurate diagnosis. I propose to draw attention to points in diagnosis and treatment of the lesions of the knee joint in the order of frequency in which they occur in this series.

LESIONS OF THE INTRA-ARTICULAR CARTILAGES

To the lay mind the intra-articular cartilages alone are responsible for what is known as "football knee"; in fact, many patients will open their consultation with the statement that they have "slipped a cartilage," whereas close investigation reveals no such possibility. It is, however, on a correct diagnosis of the condition of these structures that successful treatment will frequently depend. The position of the joint and the exact strains to which it may be subjected at the time of injury are so problematical that they have ceased to interest me as a possible line of advance in treatment. My personal belief is that lesions of the intra-articular cartilages usually occur as a result of strain and protective muscular action when the joint is in a position of flexion. A lesion of an intra-articular cartilage may be readily diagnosed if there is a history of recurrent locking of the joint with pain and tenderness limited to the attachments of one of the cartilages, the joint being normal in function in the intervals between the acute attacks, and no x-ray evidence of any abnormality being present.

In this series of 522 cases, 250, or about half, were diagnosed as lesions of the intra-articular cartilages. In 179 the internal, and in 71 the external, cartilage appeared to be affected. Operation was advised in 160 of the internal cartilage cases and was performed in 139. The lesions found at operation were: detachment or fracture in the anterior half (19), detachment or fracture in the posterior half (64), bucket handle type (35), no definite lesion (21).

Of the 71 external cartilage cases 62 were advised to have operation, and this was performed in 46 cases. The conditions found at operation were: detachment or fracture in the anterior half (11), detachment or fracture in the posterior half (21), bucket handle type (4), cystic degeneration (3), no definite lesion (7).

Included in the series are 65 professional footballers. A consideration of these cases should be of special interest, since they afford examples of all the common injuries, and while giving rise to points for discussion as to diagnosis and treatment, the results establish the fact that a very high percentage of men return to the most strenuous

of games, after the removal of one or, in some cases, both cartilages. Further, my notes show that in the majority of the patients, manipulation by the bonesetter had failed to cure the condition.

Lesions Diagnosed in 65 Professional Footballers

Lesions of internal cartilage	29			
Operation advised in	29	..	Operation performed in	26
Lesions of external cartilage	18			
Operation advised in	18			
Strain of internal lateral ligament	6			0
Rupture of external lateral ligament (1 with rupture of biceps)	3			3
Loose bodies	2			2
Exostosis	2			2
Secondary infection of infra-patellar pad	1			0
Rupture of anterior crucial ligament	1			0
Indefinite	3			0

In one patient in whom the external cartilage was found fractured the *x*-ray showed very marked osteoarthritic changes, but after operation he continued to play for a First League team, although some temporary synovial thickening and a feeling of aching in the joint recurred after a strenuous game. In only two cases of football accidents did a loose body in the joint appear to be the cause of the disability. In one the lower outer quadrant of the articular surface of the patella was found detached—the history was a typical one of recurrent lesion of the internal cartilage, but the *x*-ray revealed the loose fragment of bone, and operation was confined to its removal.

In the second case the *x*-ray revealed a loose body exfoliated from the articular margin of the inner condyle. At operation we found that this body was obviously a portion of the normal articular cartilage, not completely detached but hinged at its anterior margin by a fibrous attachment. The history of this case differed from the preceding one in that the man had occasionally had some aching in the joint previous to the first attack of locking. That he was not able to satisfy me that the knee had always been absolutely as good as the other before the original accident is, I think, a most important point in helping to elucidate the differential diagnosis in lesions of the knee joint.

Of the 9 cases of injury of the lateral ligaments none has been associated with lesions of the cartilages except one in which, in addition to damage to the internal lateral ligament, a rupture of the anterior crucial ligament had occurred. In this case operation was confined to the removal of the internal meniscus because in my hands the results of operation for replacement of a deficient anterior crucial ligament certainly do not suggest the possibility of the patient again playing first-class football. Removal of a cartilage which is obviously causing recurrent increase of disability in cases of crucial ligament injury is, however, advised.

I have not operated for repair of the crucial ligaments except in war injuries, the operation performed being that advised by Hey Groves and Alwyn Smith. My experience of the operation has been that stability of the joint was definitely increased, and for 6 months appeared to be almost a perfect success, but later examination always showed the presence of a degree of antero-posterior movement which did not justify the removal of splintage. If you read the history of the published cases you will usually find that a fractured cartilage was removed at the time of operation, and I have always had the feeling that the removal of a troublesome meniscus was not an unimportant factor in the patient's satisfaction with the result obtained. Even normal cartilages can be a source of trouble in knee joints in which rupture of the crucial

ligaments is complete. A displaced or fractured cartilage is subject to more frequent displacement, so that its removal gives patients a sense of stability which previously they had not known. The history of another of the cases is very interesting and instructive.

Having had an operation for removal of the internal cartilage, and being still unfit for play, the player was given a free transfer from one club and accepted by another. He was still unfit and was then referred to a well-known bonesetter in London. When I first saw him he still had definite signs of a recurrent displacement of something on the inner side of the joint, and as the *x*-ray was negative I advised further exploration. At operation it was obvious that only the anterior portion of the cartilage had been removed at the previous operation, while the true lesion was a detachment of the posterior half which was readily drawn into the centre of the joint. This man left the nursing home on the 12th day, played his first game for the club six weeks after operation, and has since scored many goals for his side.

This case opens some interesting points for discussion. It raises the question of what should be done if with a very definite history of recurrent trouble, pointing to lesion of a particular cartilage, one explores the joint. One may find a lesion of the anterior part, or a bucket handle displacement of a portion of the cartilage into the centre of the joint. In the former case I think it is sufficient to remove as much of the anterior two-thirds of the cartilage as is possible without strong traction, and in the latter to remove the obviously detached portion. If no definite lesion is seen, the condition of the posterior portion of the cartilage can only be known by its removal, and this, I am sure, is necessary. It will then usually be found that on further peripheral dissection and traction the main body of the meniscus becomes displaced into the centre of the joint. This would not occur with a normal cartilage, so we are satisfied with the operation, and expect and usually get a joint which gives no further trouble.

It is, however, to be noted that the portion displaced into the joint is not always the entire cartilage. In fact, I believe that it is commoner to have a longitudinal tear of the cartilage than a separation from its true attachments. This means that after the operation described, a portion of the periphery of the posterior segment of the cartilage is still present, and its attachments may have been loosened as a result of the original injury. Its removal would necessitate another incision, and, personally, I am inclined to be satisfied if I feel I have dealt with the main lesion. We must, however, remember that further trouble may occur as a result of the displacement of the remaining portion of the cartilage. I have myself experienced it in three cases of which the following history is typical.

Case A.—Definite history of recurrent displacement of internal cartilage. Knee had locked on previous occasions, but he had always been able to reduce it himself, and would play several games without trouble. On this occasion, while playing, the knee locked and his usual manipulations failed to allow extension. At operation the posterior two-thirds of the cartilage appeared to be detached and displaced in front of the point of contact between the inner condyle of the femur and the head of the tibia, while the attachment of the anterior portion of the cartilage was normal. As a matter of interest manipulative reduction with the structure exposed was tried and failed, but we deal with this point later in relation to manipulative surgery. Freeing of the anterior attachment allowed displacement of the obviously detached portion into the intercondylar space, and it was removed. The young man returned to full activity and played several matches without any recurrence of his old trouble. The following summer, i.e., 9 months later, he came to me complaining that he had had a recurrence of trouble on the inner side of the same knee, the history being that he had one leg in a punt and one on the bank, when the punt drifted out and the knee on the bank

in the flexed position was subjected to strain, gave way, and he felt something move in the joint. Examination revealed tenderness over the joint line on the inner side, and as he had had several definite sensations of something slipping in this region since this accident, I decided to re-explore the joint. The peripheral portion of the posterior half of the internal cartilage was found to be detached. Since its removal, 4 years ago, the man has played football regularly and has had no recurrence of trouble.

The next question that arises in surgery of the knee joint is: "What are we to do if we have an absolutely typical history of recurrent displacement of the internal cartilage, and, the x-ray being negative, we explore the inner side of the joint and remove what appears to be an absolutely normal cartilage?" My personal feeling is that if we are absolutely satisfied with our diagnosis of a recurrent displacement of a meniscus the outer side of the joint should be exposed, unless there is any particular reason why we should not do so. I remember particularly one case in which the history I got was so convincing that at the operation, at which I was assisting my colleague, Mr. F. G. Allan, after a perfectly normal internal cartilage was removed with the usual difficulty, I suggested that with a history such as we had, some definite lesion should be found, and on retracting the patellar tendon and infra-patellar pad of fat we were able to see that the external cartilage was abnormal. A small incision on the outer side of the joint allowed removal of the anterior two-thirds of the external cartilage which was attached in front, but a longitudinal split and fracture rendered a portion of the anterior two-thirds free in the joint cavity. Since removal of his normal internal cartilage and the detached portion of the external cartilage the man has had no further trouble. This case illustrates the surgeon's difficulty. Are we to be satisfied with finding no definite lesion of a particular cartilage when the history clearly indicates a recurrent locking of the joint as the result of injury, and the symptoms and physical signs point definitely to an injury of that cartilage? I will make the question more difficult by referring to another case.

Mr. H. asked me to see one of his house surgeons with regard to his knee joint. The patient was an exceptionally strongly built doctor, 28 years of age, and still actively interested in rugby football. As a result of examination, and from the history he gave, I felt quite sure that a portion of the internal meniscus had been detached or fractured, and that operation was necessary to restore his full activity. At operation no lesion of the internal cartilage was found, and I removed the greater part of the cartilage with difficulty. As he was a doctor, I decided to confine myself to what I had told him I should do, and asked Mr. H. to tell him that we had found nothing wrong with the internal cartilage, and if the trouble recurred we might consider exploration of the outer side of the joint. Mr. H. did not tell him anything of the apparent failure of our surgical effort, and the young man whose knee used to give way and lock when he was running to catch a bus, has to my knowledge played 15 games of rugby football without trouble in the knee from which we removed what appeared to me to be a normal meniscus.

Another case which complicates the question is the possibility of both cartilages having been torn as a result of one injury. We know that in taking our history of a recurrent case the patient is often indefinite about the side of the joint to which the pain was referred at the time of the injury, and with recurrent displacements it may also vary. In these cases I always make the diagnosis on the site of tenderness after a recent injury, but if sometime later a patient presents himself with a definite history of recurrent displacement of a cartilage with pain referred sometimes to the inner and sometimes to the outer side of the joint, I will not operate, but request that the

knee be tested and the patient referred to me for further examination as soon as possible after the next injury.

If after a recent injury, which the patient states is similar to previous ones, I find tenderness on the line of the inner or outer side of the joint, I advise operation accordingly. That this is not always a safe procedure is illustrated by the following case sent to me by the medical adviser of a certain well-known association football club, who suggested that the young man was suffering from an injury to his external cartilage. My examination, however, pointed definitely to a lesion on the inner side of the joint, and at operation I was particularly pleased to find a bucket handle displacement of the internal cartilage, and after its removal closed the joint. It was reported to me that the knee had given way and again locked when the patient was getting out of bed prior to discharge 14 days later. Pain and tenderness now were referred to the outer side of the joint, and exploration revealed a similar lesion of this cartilage. Since this occurrence the knee has resumed and retained normal function.

The only other type of case in which no x-ray changes are shown which might simulate cartilage displacement is that of lateral displacement of the patella. Many times patients will describe the displacement of an internal cartilage as a displacement of the patella, but although the latter is rare it does occur. If in doubt, I would suggest that the best way of making sure whether displacement of the patella is the cause of recurrent disability is to have the knee tested in a gymnasium, and examined by someone sufficiently experienced immediately the trouble complained of occurs. If this is not practicable, then while the patient is anaesthetized, and just before the tourniquet is applied, test the mobility of the patella. If it is readily displaced laterally while that of the other knee does not allow of lateral displacement, the patient's diagnosis is possibly right.

LESIONS OF THE LATERAL LIGAMENTS

It is of interest to note that in this series, where strain or rupture of a lateral ligament was diagnosed, there appears to have been no case where a lesion of an intra-articular cartilage was also present. Furthermore, a complete rupture of the internal lateral ligament did not occur in any of the 34 cases in which a lesion of it was diagnosed, and recovery took place with conservative treatment. Of the 7 cases of injury to the external lateral ligament, complete rupture with laxity of the joint was present in 4, including 2 cases in which the biceps tendon was separated from its insertion. In these 4 cases operation was necessary to secure stability of the joint, and the results were excellent. One case in which there was a traction fracture of the head of the fibula made a perfect recovery without operation. This rather suggests that a complete rupture of a ligament is likely to be a more serious disability than a traction fracture of its attachment. The histories of two of this year's association football cup finalists are interesting.

Both patients indicated strain of internal lateral ligament of the knee joint, with possible displacement of the internal semilunar cartilage. Both were tender over the line of the joint on the inner side, but more tender over the femoral attachment of the internal lateral ligament. They were treated as strains of this ligament. The line of treatment advised and carried out was elevation of the heel of the boot, raising it on the inner side to prevent strain on the injured ligament, with electrical treatment of the quadriceps muscle, and a pad and strapping over the tender area on the internal condyle. One of the cases came under my care on September 3rd, 1927. He was discharged from treatment on October 7th, when local tenderness had subsided, and all forced movements were free and painless, and has since played regularly in a first division team. The other case was first referred to me on

March 31st, 1931, three weeks after the date of his original injury. I advised treatment on the aforementioned lines, and though there was still some tenderness of the femoral attachment of the internal lateral ligament, he played in the cup final four weeks later, with the knee tightly bandaged, and afterwards was playing for his club on a tour abroad.

These two cases alone satisfy me that although local tenderness on the line of the internal cartilage may be present, if tenderness of the attachments of the internal lateral ligament is also present it is wise to treat the lesion of the ligament, and wait for further evidence of true cartilage injury before advising operation.

LOOSE BODIES

Apart from diagnosis of the nature of gross lesions of the main articular surfaces, *x*-rays are particularly valuable in establishing the possibility of loose bodies or fracture of the tibial spine, as causes of recurrent or chronic disability following injury. Loose bodies are not infrequently present in the knee joint without giving rise to symptoms sufficiently severe to demand medical attention. There may be some "rheumatism" of the joint, and occasionally a feeling of something catching in a knee, or a sudden severe pain may cause the patient to seek medical advice. Until an *x*-ray is taken in these cases the true state of affairs is not likely to be recognized. The joint may then be found to contain many loose bodies, large and small; an *x*-ray of the other knee, of which no complaint is made, may show a similar picture. I do not propose to deal with the pathology and treatment of this type of case, but draw attention to them because they may either cause a very temporary locking of the joint, or a permanent locking may occur—i.e., persistent limitation of extension as a result of a moderately large body becoming wedged in the intercondyloid notch in front of the attachments of the crucial ligaments. In this case removal of the body is necessary to allow extension of the joint.

FRACTURES OF TIBIAL SPINE

With regard to fractures of the tibial spine, I am not satisfied that the *x*-ray appearance always justifies operation. It is usually possible to obtain full extension of the joint by manipulation or by gradual splintage, and although I realize that this position may not be the most favourable for the repair of a ruptured crucial ligament, it certainly allows repair of a fracture of the tibial spine, and a restoration of normal function.

EXOSTOSIS

X-rays may also reveal detached bone fragments or exostosis some weeks after injury to the lateral ligaments. If the stability of the joint is good as a result of conservative treatment, these should be dealt with surgically only if they give rise to trouble. In connexion with this question of ligaments and exostoses I must mention a case of particular interest.

Mrs. D. had for three years been unable to take part in sports because of a recurrent severe pain referred to the inner side of the knee if it was subjected to strain. Examination revealed a definitely tender point over the inner condyle of the femur, and pain was referred to this point on forced abduction and external rotation. The *x*-ray was negative. I decided eventually to force movements, but also to explore the tender area. I found there a tiny, sharp spicule of bone with a bursa around it, and have always felt that the removal of this rather than the manipulation was the cause of complete cure.

LESIONS OF EXTENSOR APPARATUS

I report 11 cases resulting from indirect injury to the extensor apparatus of the knee joint. Time does not allow of a full review of the possible causes and the detailed treatment of these lesions. The diagnosis is usually easy. The patient is unable to extend the limb voluntarily and

fully, while passive extension is possible, and the point of tenderness will indicate the site of the lesion. This would appear to me to depend on the relation of the patella to the condyles of the femur when the protective contraction of the quadriceps muscle comes into play. As a rule the more limited the degree of flexion the lower the lesion. The following lesions may occur: separation of the tibial tubercle; detachment of the ligament from the lower border of the patella; transverse fracture of the patella; separation of the quadriceps tendon from the upper border of the patella. As a result of the strong action of the quadriceps, considerable separation may occur at the site of rupture, so that surgical treatment is usually necessary.

These observations as to the site of lesion are based partly on experience of mobilization of knee joints in war surgery, but also on the fact that the three cases of rupture of the quadriceps attachment to the patella occurred in gentlemen late in the evening, at a time when their cerebral control of muscle action might have been somewhat delayed. I surmise that perhaps earlier in the evening the protective action of the quadriceps might have been more prompt, and no lesion, or perhaps fracture of the patella, occurred.

INDEFINITE LESIONS

These number 147 of the 522 cases reviewed. I feel that they should include several cases in which everything in the history appeared to suggest a definite lesion of a cartilage. The cases I have in my mind include the following histories.

(1) A girl aged 26, seen 10 weeks after her accident. Her doctor states that the knee was dislocated as the result of a twist while playing golf, and that he reduced the displacement under an anaesthetic. Since this, extension of the joint has been limited by 30 degrees.

(2) Mrs. W., aged 43, while being helped off a cliff three weeks previous to examination, had a feeling of something tearing inside the joint when it was acutely flexed. On examination I found tenderness on the line of the joint on the inner side, and pain on forcing extension.

In one of these cases manipulation failed to produce comfortable extension of the joint, and in neither was this possible after exploration and removal of apparently normal internal cartilages. Although I mention only two of the cases, I have come to realize that diagnosis of a true primary cartilage displacement is a very much more difficult problem than are cases in which there is a history of recurrent trouble. If the movement of flexion, as well as extension, is limited, and there is general tenderness of the joint margins, it is unlikely to be a simple cartilage lesion. A traumatic or subacute infective arthritis occurs in the knee as in other joints after a severe injury, so that limitation of extension does not necessarily mean that this is due to cartilage displacement, even although this probability is strongly suggested by the history.

MANIPULATIVE SURGERY

In other cases of indefinite lesions I include those in which the question arises whether the condition is likely to be relieved by manipulative surgery. This seems to me to be a branch of surgery which might with profit to the public be employed more frequently by the profession, and certainly less frequently by those whose record, as we know it, does not indicate that they have the fundamental knowledge necessary for its judicious use. It consists essentially of ensuring the normal range of movement of a joint in every position. In the knee joint attention must also be paid to securing normal lateral mobility of the patella and as far as possible of the intra-articular cartilages. There can be no mystery about this. The only question that arises is at what stage should

we apply it. It should always be utilized to ensure full extension of a joint where displacement of a cartilage is probable, except in cases of recurrent displacement, when the diagnosis is clear. In these cases the patient should be offered, or rather advised, to have the alternative—that is, operation—which will almost certainly prevent a recurrence of the trouble. The majority of cases which bonesetters cure are, however, cases of joint strain which have recovered from the usual reactions of a joint to trauma or mild arthritis, but the patient still complains of pain on certain movements. During the stage of active reaction forcing of movements can do nothing but harm, but there does come a time following joint injury at which forcing of movements, although painful at the moment, may be dramatically effective in its results.

I feel quite safe in saying that at least 90 per cent. of the professional footballers on whom I have operated have previously had their joints manipulated by a bonesetter. We may agree that manipulative surgery is not adequately taught in our medical schools, but in spite of this it must be clear to all who deal with joint injuries that the popularity of the bonesetter is more largely due to the fact that, as in the case of many popular remedies, successes rather than failures are widely advertised in the lay press.

OPERATIVE APPROACH FOR INTERNAL DERANGEMENT OF THE KNEE JOINT

The surgical approach to the knee joint should ensure as little damage as possible to the joint structures. Incisions which divide the patella or disturb the normal attachments of muscles or ligaments should be avoided unless absolutely necessary. Personally, I use the split patellar route only for the repair of the crucial ligaments. It has the one great advantage in that while it allows free access to the joint it does not necessitate detachment of the tibial tubercle, so that after operation the joint can be treated in the position of flexion desired, without risk of subsequent separation of this structure. For removal of loose bodies which cannot be fixed and evacuated by direct incision, I prefer one or more small incisions supplemented by digital examination. Single incisions are usually sufficient for removal of the damaged portion of

A and B.—Incisions commonly used for exploration of the inner side of the knee-joint.

either the internal or external intra-articular cartilage. Occasionally a small supplementary posterior incision, as described by Alwyn Smith, is necessary to deal adequately with a lesion of the posterior segment of the cartilage.

It will be noted that in this series operation has been necessary in 7 cases for the removal of neuromata of the patellar branch of the internal saphenous nerve, which had been divided as a result of the incision used for

exploration of the inner side of the joint at a previous operation. In 1916 my attention was first drawn to the importance of the line of the incision for the removal of the internal meniscus. In that year an officer presented himself at the orthopaedic hospital at Shepherd's Bush and stated that since the removal of his cartilage he had had no recurrence of definite locking, but that he had a tender nodule in front of the joint, and that the slipping of this over the margin of the inner condyle on flexion of the knee gave him pain and a sense of weakness. I excised the scar and he returned to France. Three months later he reappeared, and said he had lost the old sensation of pain on flexing the knee, but that he had developed a tender nodule over the inner condyle which gave him pain when riding. I removed this nodule, which was obviously a nerve bulb, by avulsion. As far as I know he had no further trouble. It was obvious to me that this was a nerve bulb on the patella branch of the internal saphenous nerve, and that the possibility of the complication which might result from its division had not been fully recognized. Since 1916 I have adopted an incision which avoids the possibility of division of this nerve.

C.—Incision advised to obviate complications following division of the patellar branch of the internal saphenous nerve.

This has the advantages that we cannot get the sequela of a painful neuroma in the scar, or the anaesthesia commonly complained of in the area of distribution of the patellar branch of the internal saphenous nerve. Both are points of great importance with regard to the treatment of professional footballers especially, as unless the limb feels absolutely normal confidence in it is unduly delayed. The essential point of the incision which I employ is that it runs parallel with the patellar branch of the internal saphenous nerve, and allows of its retraction before the capsule is incised.

SUMMARY

- (1) It is not possible to discuss adequately common injuries of the knee joint in a paper limited to 5,000 words.
- (2) While the anatomy and physiology of the joint are well known, only lesions easily demonstrable clinically, or by x-ray examination, are described in surgical textbooks.
- (3) This investigation of 522 consecutive cases of injury to the knee joint demonstrates that almost 50 per cent. are lesions of the intra-articular cartilages.
- (4) While accurate diagnosis of an original injury may be difficult, the cause of recurrent lesions can usually be established as a result of a carefully taken history, together with the clinical and x-ray findings.
- (5) Indefinite lesions are common. I believe that they include conditions analogous to tennis elbow, tenosynovitis, etc., commonly referred to in relation to other joints. The inaccessibility to direct palpation of certain regions of the knee joint probably accounts for this.
- (6) While conservative treatment or manipulative surgery is successful in many cases, a surgical exploration of the joint will always be necessary for the cure of a large number.
- (7) In the surgical approach to the inner side of the joint, incisions which may divide the patellar branch of the internal saphenous nerve should be avoided.

I am grateful to my colleagues, Mr. A. M. Hendry and Mr. Maister, for their help in reviewing this series of cases, and to Dr. Brailsford for preparing the slides and photographs.