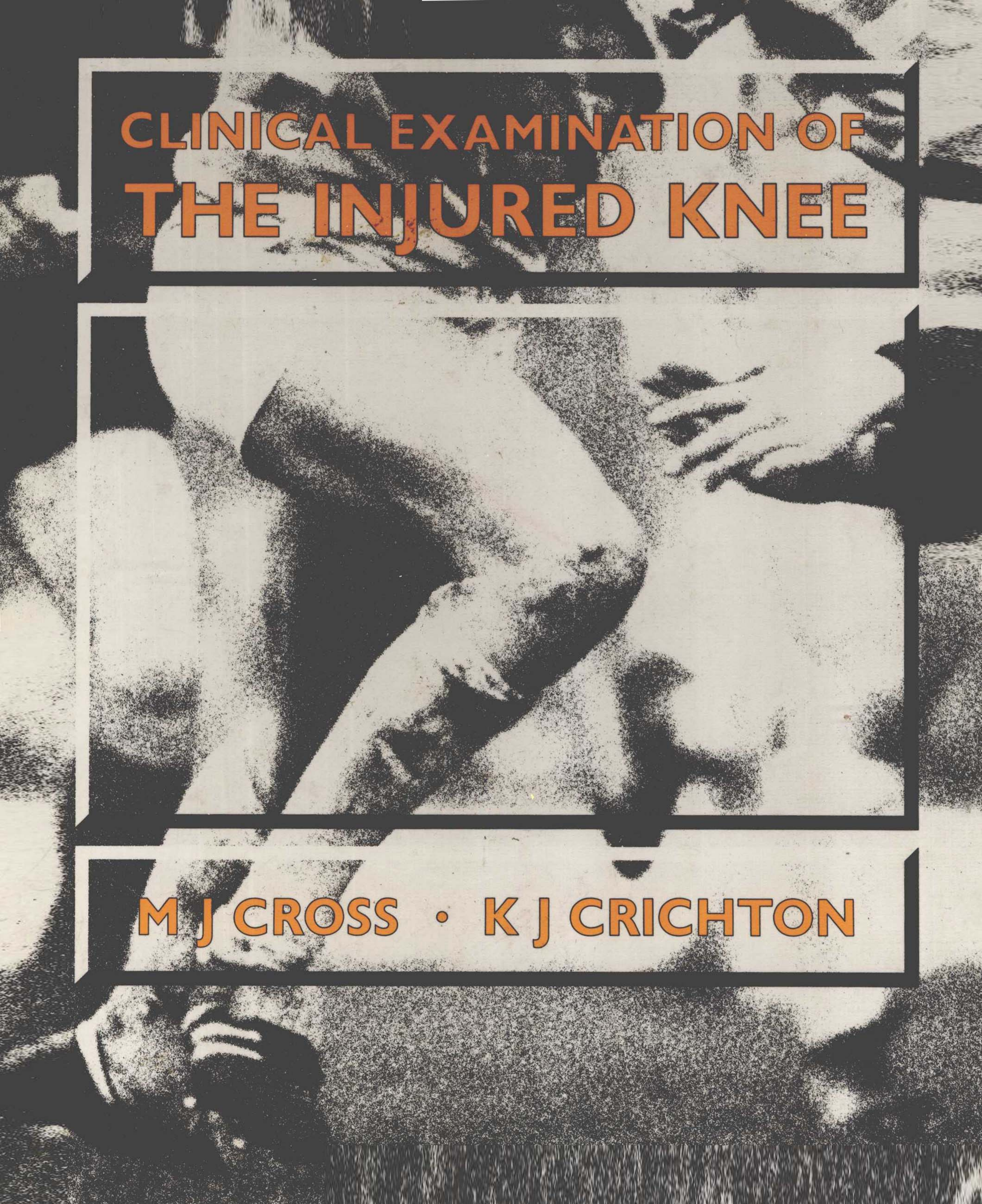

CLINICAL EXAMINATION OF THE INJURED KNEE

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FOREWORD

Surgery of the injured knee is passing through a period of great change. Many of the concepts on which knee surgery was based have been found unsound, new techniques have been introduced and the whole approach to the knee has been transformed in recent years.

Mr. Cross and Dr. Crichton have produced a lucid, clearly written and magnificently illustrated text which describes the fundamental principles of surgery in the injured knee, in a manner that leaves no doubt or ambiguity. This is not a theoretical text for academics, but a practical handbook based on great experience at the 'sharp end' of knee surgery. At a time when other textbooks have had to be rewritten, this overview provides a solid basis for surgery of the knee.

David J. Dandy FRCS

PREFACE

Great thanks are extended to the superb clinical teachers and operative surgeons of the knee, Dr. Jack C. Hughston in Columbus, Georgia and Dr. Richard Tooth in Sydney, Australia. Both these men have been Presidents of the International Society of the Knee, and through their tremendous efforts they have stimulated us in attempting to elucidate and describe systematically a clinical approach to the diagnosis of knee problems.

The knee joint is the most complicated and most fascinating joint in the human body. It is very accessible to clinical examination, and subject to most internal derangements. It should, therefore, be possible to ascertain a correct initial clinical diagnosis in the majority of cases by understanding its anatomy, biomechanics and function, together with a careful history-taking and a precise clinical examination.

Many misconceptions occur with respect to the knee. There is argument over the precise functions of the anterior cruciate ligament: is it possible to have a positive anterior draw with a normal anterior cruciate ligament, and a negative anterior draw with a ruptured anterior cruciate ligament? These seeming paradoxes will be explained in the following text. It was once taught that medial meniscal tears can present with pain on the lateral aspect of the knee, and lateral meniscal tears with pain on the medial aspect of the knee. This misconception is readily elucidated when one understands the functions of the knee with anterior cruciate insufficiency. It is possible to have the chief symptom occurring on the lateral aspect with subluxation, and to also have a resolving tear of the medial meniscus. Several orthopaedists in the past have thought that all internal derangements of the knee are due to meniscal lesions. It is this failure in the understanding and diagnosing of the anterior cruciate ligament tears that has led to mismanagement of many knee injuries.

Many normal X-rays of the knee are accepted as confirmation that no major problem exists. This further misconception is easily elucidated in the study of injuries to the knee, which in eighty to ninety percent of cases are soft tissue injuries, therefore X-rays are only relatively diagnostic.

For many team trainers, medical students, physiotherapists and general practitioners, we hope in the following text to describe a systematic and simple method of history-taking and physical examination, to show that an accurate diagnosis can be obtained even without the modern technology of arthroscopy. This is in no way an attempt to decry arthroscopy as a very vital and essential tool in the diagnosis and management of knee problems, but it is only an adjunct to follow the thorough history and clinical examination of the injured knee.

Finally, this book is dedicated to our wives, Virginia and Sandy.

M.J.C.
K.J.C.

CONTENTS

ACUTE KNEE INJURIES

ANTERIOR CRUCIATE LIGAMENT RUPTURES

The anterior cruciate ligament is an intracapsular extrasynovial ligament consisting of spiralled fascicles, which can be divided into three bundles: anteromedial, intermediate and posterolateral. Each bundle is taut in different degrees of flexion (*Arnoczky, 1983*).

The main function of the anterior cruciate ligament is to cause the tibia to rotate externally onto the femur when the leg comes to full extension. This is called 'screwing home' and starts from 30° flexion to full extension. Any force against this 'screwing home' into external rotation will tear the anterior cruciate ligament.

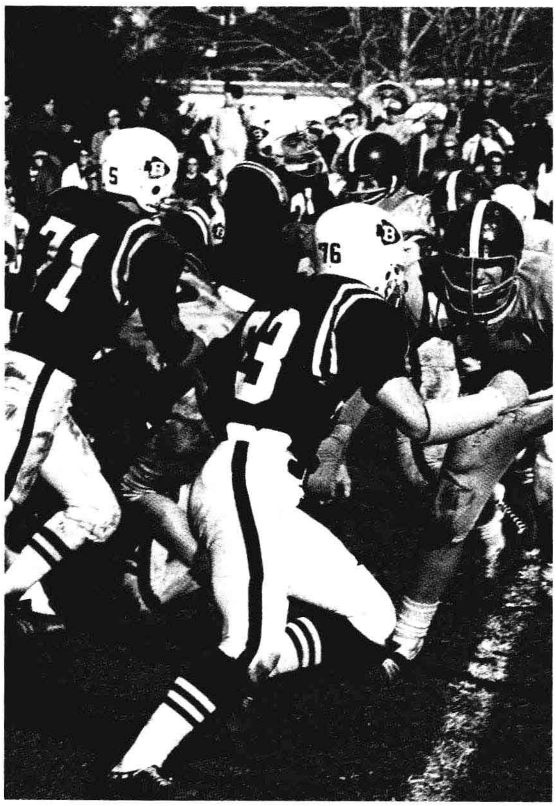


Fig.1 Sidestepping in football can lead to rupture of the anterior cruciate ligament.

This injury is often extremely debilitating, especially to the athlete, as it may result in chronic instability of the knee; early diagnosis of a ruptured anterior cruciate ligament is essential, particularly as early repair is becoming an increasingly accepted form of treatment.

The patient's history is of sudden pain and 'giving way' when the player is sidestepping (**Fig.1**), landing from a jump (**Fig.2**) or 'cutting' (**Fig.3**). There is often an audible 'pop' or 'crack' resulting in immediate effusion.

If a patient presents with this history, the injury is an anterior cruciate ligament tear until proven otherwise.

The main sports where this injury occurs are rugby, football and soccer for men, volleyball for women, and basketball for both. The most common cause of injury is internal tibial rotation on a flexed knee. A less common mechanism of anterior cruciate ligament tear is external tibial rotation associated with a valgus force (**Fig.4**).

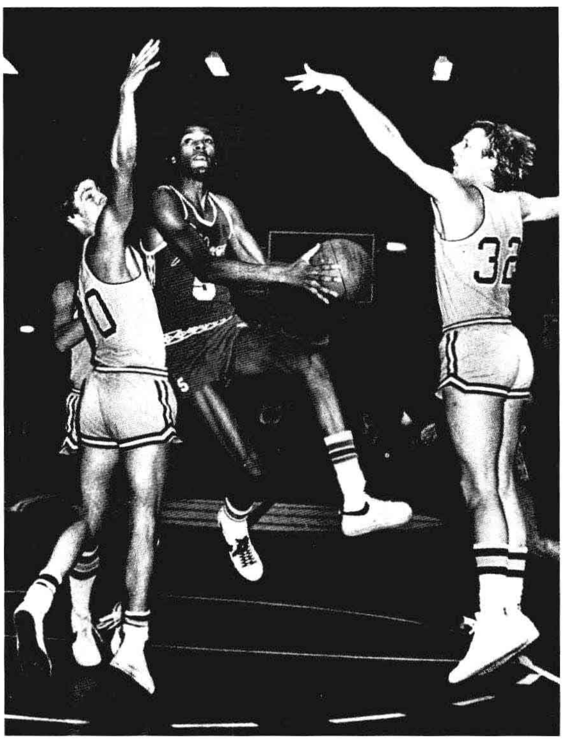


Fig.2 Landing from a jump in basketball can lead to rupture of the anterior cruciate ligament.

Fig.3 'Cutting' is responsible for the majority of anterior cruciate ligament ruptures.

With this injury there is usually an associated medial collateral ligament tear. It is often seen in footballers where, as they are turning, a tackler drives his shoulder into the player's knee, thus exercising a valgus force. Equally, downhill skiers may suffer a similar injury if the inside edge of their ski 'catches', causing the tibia to rotate externally. A fall forwards will add a valgus force which increases the tearing mechanism.

In a work published in 1980, O'Donoghue described a clinical triad which applies to this injury:

1. Anterior cruciate ligament tear;
2. Medial meniscal tear which, in fact, is not a tear in the meniscus but in the meniscotibial ligament, allowing the medial meniscus to sublux into the joint;
3. Medial collateral ligament tear.

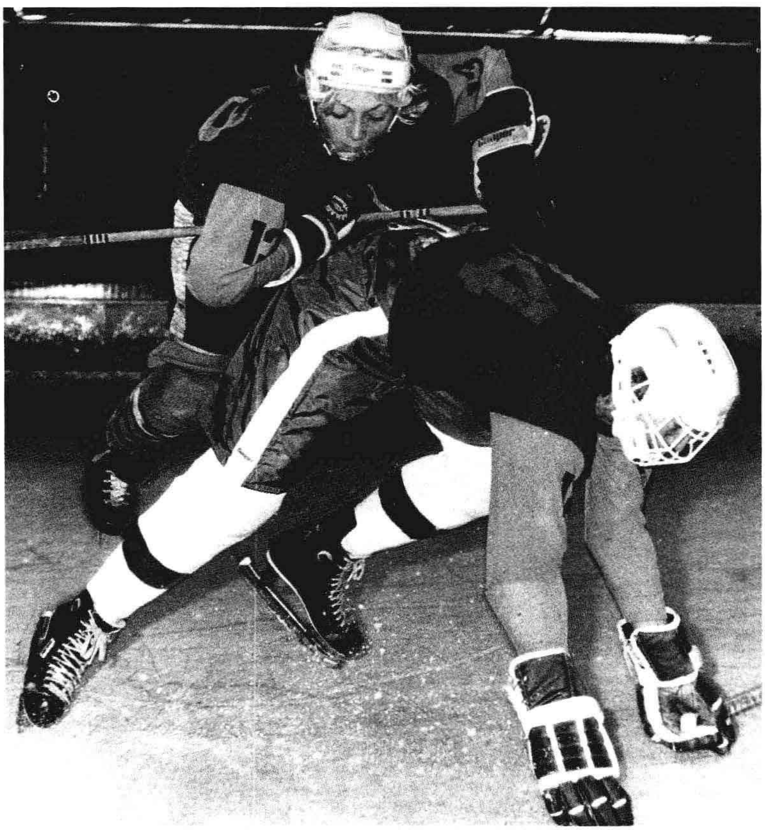


Fig.4 In ice hockey, a fall combining external tibial rotation and a valgus force causes a tear in the anterior cruciate ligament.

The anterior cruciate ligament may also rupture due to hyperflexion, (**Fig.5**), hyperextension (see posterior cruciate ligament tear, page 6), and a forced anterior draw which may be related to sport, but is often due to mechanical trauma, as in a road accident.

If an acute anterior cruciate ligament tear is suspected, further history-taking may confirm the diagnosis.

Presentation and Diagnosis

A haemarthrosis occurs within half-an-hour, and represents haemorrhage from the rich vascular plexus surrounding the anterior cruciate ligament which arises from the middle genicular artery (a branch of the popliteal artery; *Arnoczky, 1983*).

In 1980, Noyes and DeHaven each carried out a study in which arthroscopies were performed on all knees presenting with haemarthrosis. It was found that approximately three-quarters of these had anterior cruciate ligament tears.

If a minor injury has caused this sudden swelling, the suspicion of a bleeding diathesis should be aroused.

Haemarthrosis means ruptured anterior cruciate ligament until proven otherwise.

Less common causes of haemarthrosis include:

Dislocated patella;
Peripheral meniscal tear involving the meniscal vascular plexus;
Capsular tears associated with collateral ligament tears;
Osteochondral fractures.

In a major injury, the lack of gross haemarthrosis is often due to associated capsular damage and the escape of blood into the surrounding soft tissues. Capsular damage is particularly relevant to the arthroscopic examination of the acutely injured knee, as difficulties have been encountered when fluid under pressure is introduced

Fig.5 This type of fall in soccer causes hyperflexion of the knee, leading to rupture of the anterior cruciate ligament.

into a knee joint with capsular damage. Large amounts of fluid are thereby introduced into the surrounding tissues, causing compartment pressure syndromes with possibility of deep venous thrombosis.

'Pop' or 'crack', often heard by bystanders, is reported in numerous studies as occurring in thirty to sixty percent of the cases presenting with ruptured anterior cruciate ligaments *(Fetto & Marshall, 1980)*.

In children, the possibility of avulsion of the tibial intercondylar eminence with an anterior cruciate ligament injury should always be borne in mind and excluded with radiographic examination. Avulsion also occasionally occurs in adults **(Fig.6)**.

On examination, the knee with an acute rupture of the anterior cruciate ligament typically has a gross effusion and diffuse joint line tenderness which may be more marked posterolaterally, indicating a lateral capsular tear. The joint may be pseudolocked due to the effusion, or locked by an anterior cruciate tag or associated meniscal (usually medial) tear. Ligament testing with dynamic extension is very reliable; the Lachman and jerk/pivot shift tests will confirm the diagnosis (see pages 50 and 53). The examination results obtained are:

Anterior draw: negative;
Dynamic extension test: positive;
Lachman test: lacking an endpoint;
Jerk/pivot shift: positive (in experienced hands).

Examination under anaesthesia, with or without arthroscopy, may be necessary in order to assess the extent of injury.

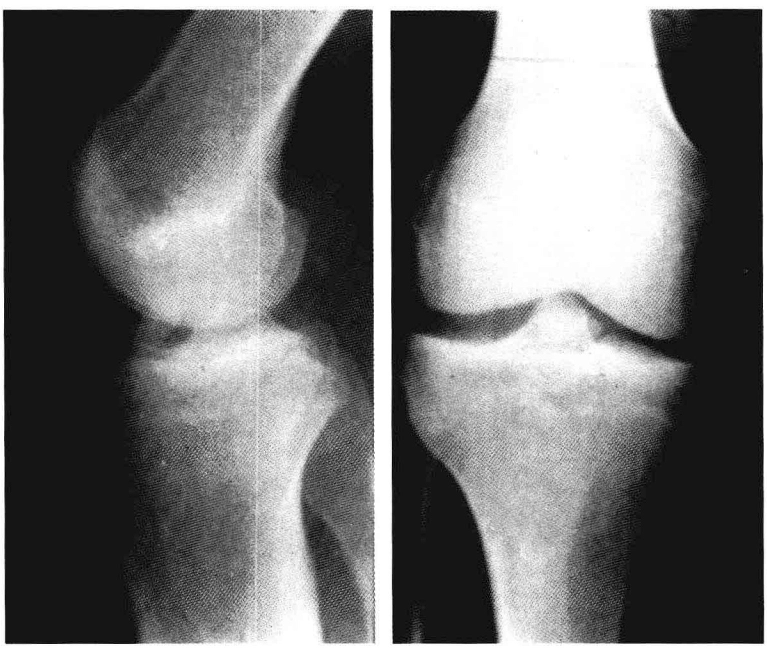
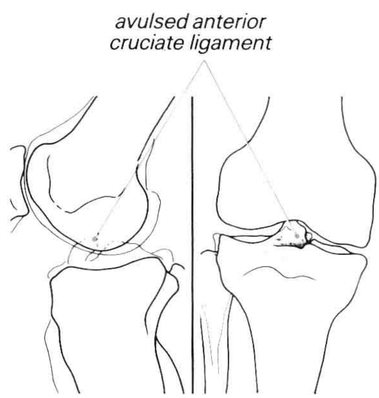


Fig.6 Radiograph of the knee joint showing avulsion of the tibial attachment to the anterior cruciate ligament in a hyperextension injury.



Differential diagnosis

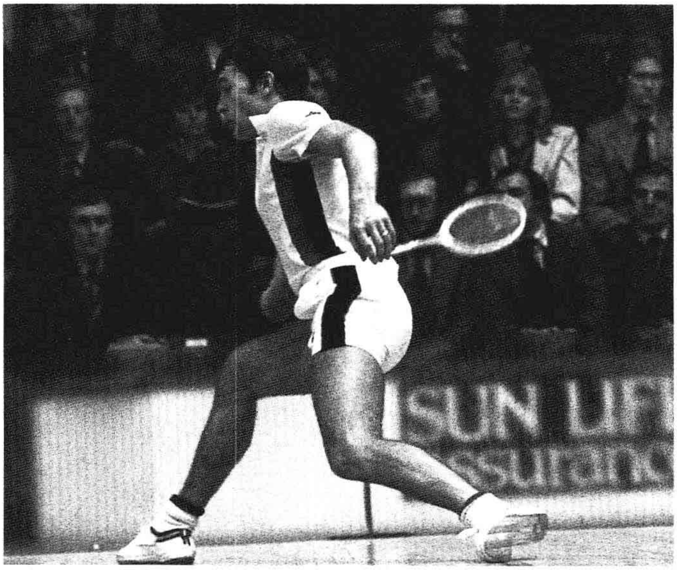
A similar history may be associated with subluxation and, in particular, dislocation of the patella. This may follow a direct valgus force or a twist (external tibial rotation on the femur), common in football and other sports (**Fig.7**). The injury may be ascertained by the presence of a large lump lateral to the knee, which reduces with extension. On examination the patella is pressed laterally, thus giving the sensation that it is once again dislocating (positive apprehension test, page 38).

POSTERIOR CRUCIATE LIGAMENT RUPTURES

A direct blow to the anterior tibia in a flexed knee resulting in popliteal pain with no swelling is characteristic of a posterior cruciate ligament tear (**Fig.8**). This injury often presents late, when the patient notices difficulty in stopping from a run and pain when running downhill. A patellofemoral pain syndrome may develop due to the increased patellofemoral stress from the tibia falling back on the femur because of posterior cruciate ligament laxity.

A posterior cruciate tear may also arise from a severe hyperextension injury (**Fig.9** left) and is usually associated with a tear of the anterior cruciate ligament. Avulsion of the ligament at its tibial attachment may occur (**Fig.9** right). Typically the results of initial examination are:

- No effusion, as any fluid tends to escape through an associated posterior capsular tear;
- Recurvatum, particularly when the cause of injury is hyperextension;
- Posterior sag/draw, which may not be present initially if the posterior capsule is intact, but tends to stretch later, unmasking the posterior draw.



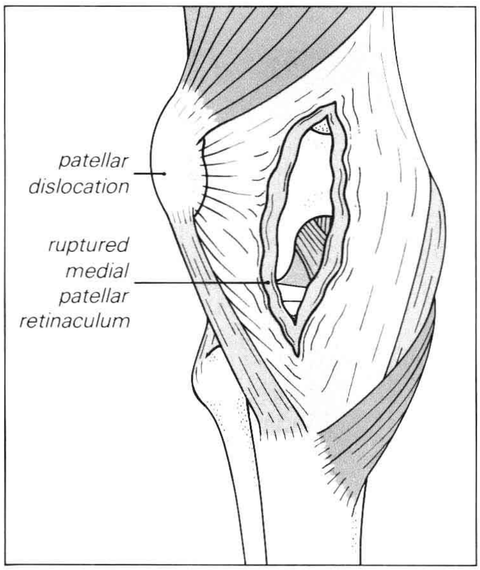


Fig.7 Squash player springing (left). His patella may dislocate laterally (right) with external rotation of the tibia on the femur, ripping the medial retinaculum.

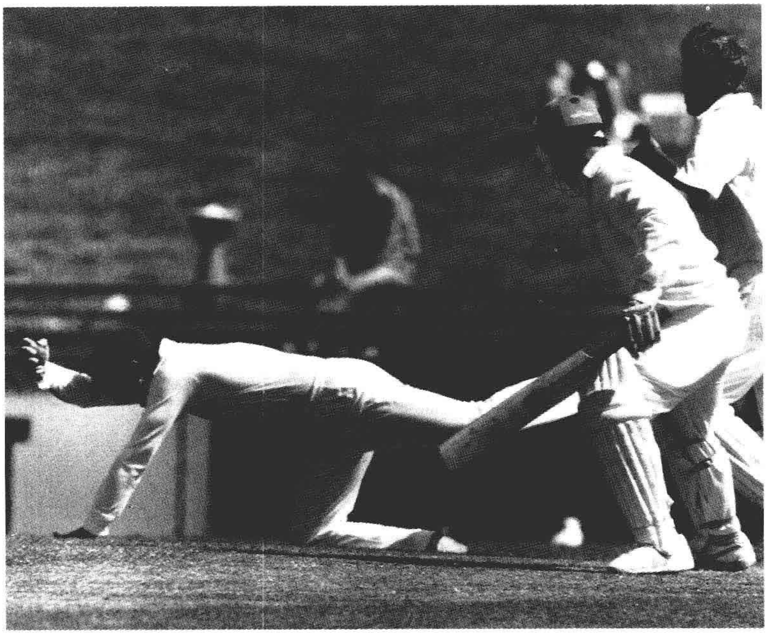
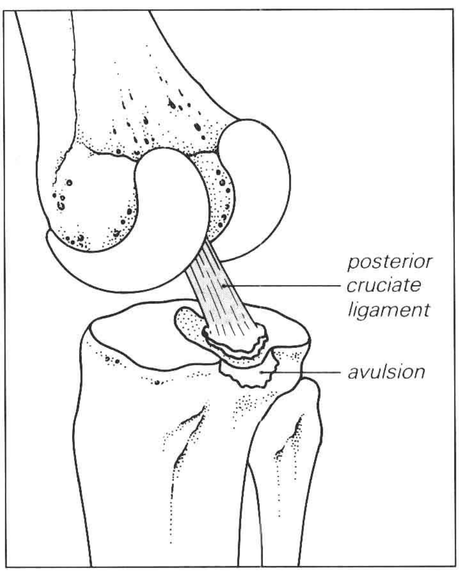


Fig.8 Cricket fielder. His fall may cause a direct blow to the anterior tibia of the flexed knee, resulting in rupture of the posterior cruciate ligament.



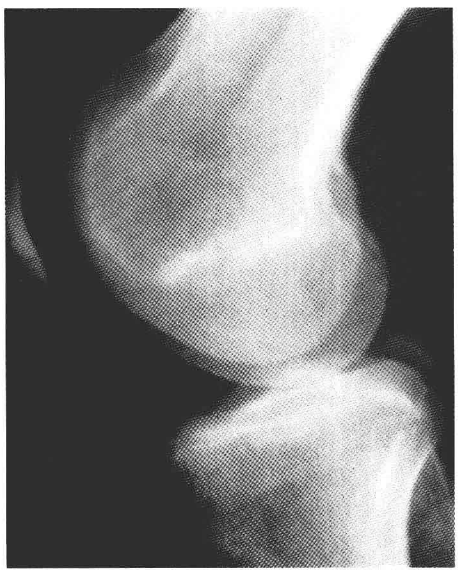


Fig.9 Avulsion of the posterior cruciate ligament due to hyperextension of the knee joint (left); the radiograph is showing ligament avulsion in a hyperextension injury (right).

MEDIAL COLLATERAL LIGAMENT RUPTURES

The player tackled from the side or two players kicking the ball simultaneously, the downhill skier 'catching' on the inside edge of the ski, the breaststroker in intensive training, are all likely to suffer a tear of the medial collateral ligament.

The two fundamental mechanisms of injury are a direct valgus force applied to the knee, as in the case of a rugby player tackled from the side (**Fig.10**), or external tibial rotation when two soccer players kick the ball simultaneously (**Fig.11** left); these two forces may also be exercised in combination (**Fig.11** right).

The medial support structures of the knee consist of two components: the deeper medial capsular ligament with its attachments to the medial meniscus, and the more superficial medial collateral ligament (**Fig.12**).

Remember that opening the medial side of the knee joint will compress the lateral side; the lateral meniscus must also be checked.

Fig.10 A direct valgus force applied to the knee, as in the case of the player on the right, may cause rupture of the medial collateral ligament.

Fig.11 The medial collateral ligament may rupture due to the force of external tibial rotation (left), or its combination with a direct valgus force (right).

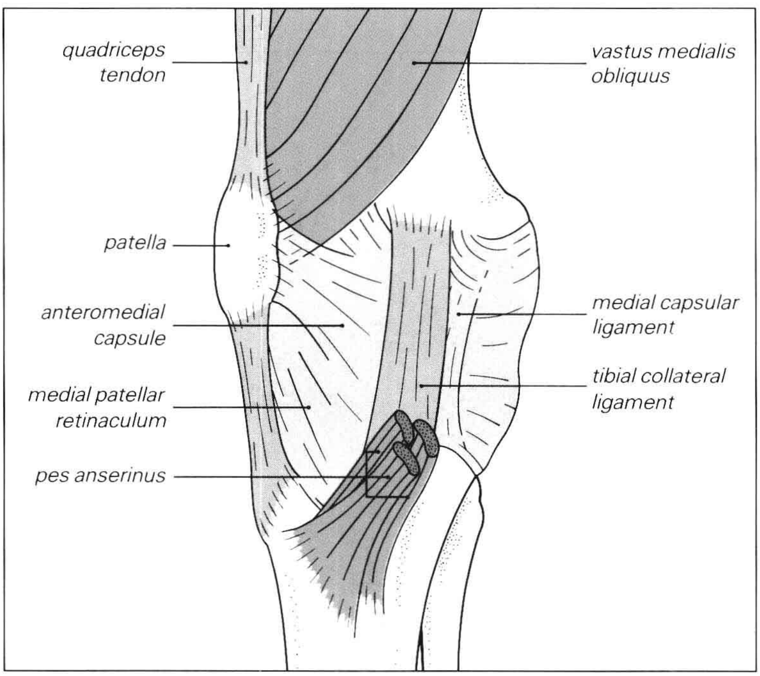


Fig.12 The medial support structures of the knee joint.

Tears of the medial collateral ligament can be divided into three degrees of severity (**Fig.13**).

First degree tear

This is the most common downhill skiing injury, but is also common in propping sports like rugby, football and squash.

The patient presents complaining of having twisted on the knee, with pain medially which is exacerbated by further twisting. Swelling, though usually not present, is localised over the medial side of the joint. Locking may occur, but is, in fact, a pseudolock due to hamstring spasm initiated by pain as the medial structures tighten with the knee coming to full extension. Later, adhesions at the femoral attachment may restrict movement and lead to chronic locking. 'Giving way' is not characteristic of this injury.

On presentation there is typically no effusion; there is mild pseudolocking and tenderness over the proximal medial collateral ligament. The valgus stress test shows no laxity but may produce pain (see page 46).

Breaststroker's knee

This injury is seen in breaststrokers, particularly if they are involved in intensive training programmes; it is a first degree medial collateral ligament tear resulting from the 'whip kick' (**Fig.14**).

Second degree tear

This injury may be produced by similar but larger valgus or external rotation forces, with disruption of fibres. A tear of the medial capsular ligament is followed by a tear of the medial collateral ligament: similar tenderness is elicited, but with more localised swelling and joint effusion due to capsular tearing. Valgus stress testing shows laxity with a definite endpoint.

Third degree tear

Under even greater forces, a complete tear of the medial structure may occur. Marked tenderness, gross effusion and localised swelling are characteristic of a third degree tear, with no endpoint on valgus stress testing. A ruptured anterior cruciate ligament is often also present.

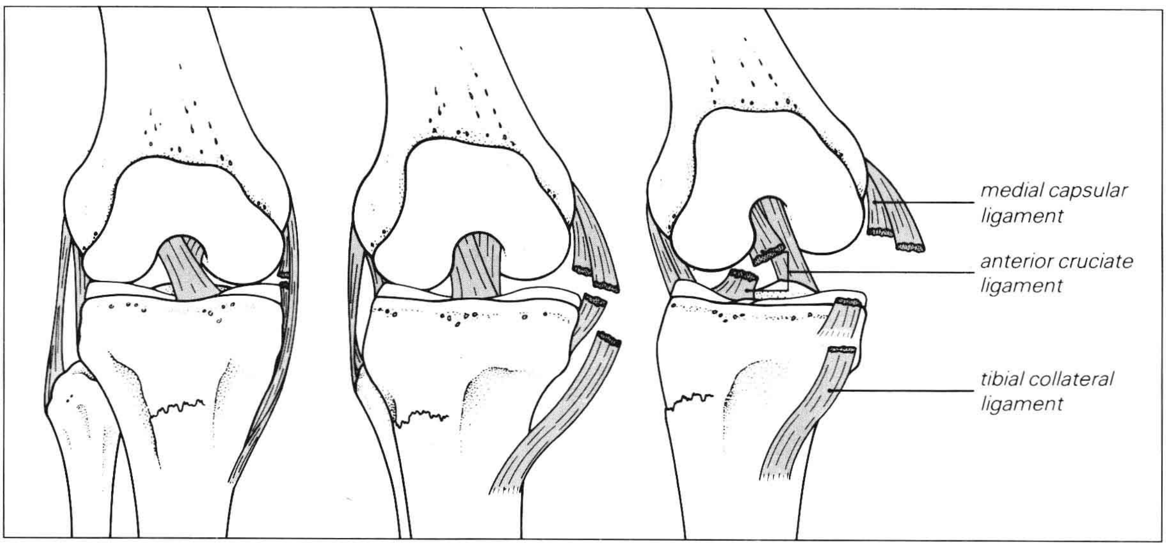


Fig.13 Tears of the medial collateral ligament are classified into first, second and third degrees.

Pellegrini-Stieda disease

Disruption of the femoral origin of the medial collateral ligament may lead to heterotopic ossification in the proximal fibres. The patient complains of persistent tenderness medially with pain on twisting (external tibial rotation). Occasionally the condition is florid, particularly if the patient has voluntarily immobilised his joint. In this case, often both flexion and extension are restricted and associated with marked medial pain. Radiological examination confirms the diagnosis and shows the characteristic changes (see page 39).

MENISCAL TEARS

The menisci are intracapsular structures which reduce the disparity between the femoral and tibial surfaces, thus stabilising the joint by a wedge effect *(Helfet, 1982; Kulund, 1983)*. In 1941, Brantigan and Voshell pointed out that the menisci also cushion hyperextension and hyperflexion, filling the space between the periphery of the femoral and tibial condyles and the capsule, synovium and ligaments. The menisci are attached at their anterior and posterior horns to the intercondylar eminence, and by the coronary ligaments to the tibial condyles. The medial meniscus is closely attached to the middle third of the joint capsule and is therefore less mobile than the lateral meniscus. The medial meniscus has the shape of a 'C', whereas the lateral meniscus is more of an 'O'.

Meniscal nutrition is derived peripherally from a vascular plexus and centrally from synovial fluid. The importance of surface pressure from adjacent structures to this nutrition is still not fully understood, but it is obviously significant particularly in the unstable knee, where often the normal structural apposition is lost. The vascular supply in relation to the site of a meniscal tear is also important when considering surgical repair.

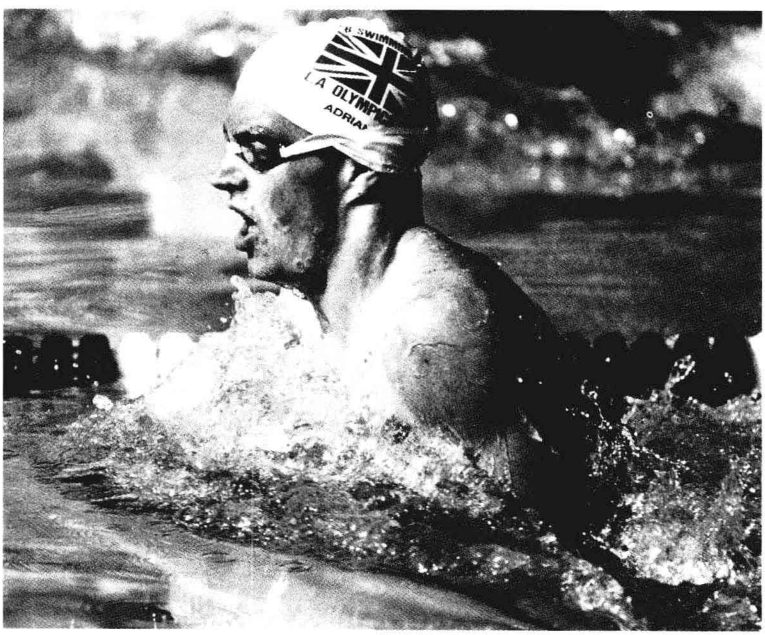


Fig.14 Breaststroker. His knee may suffer a first degree medial collateral ligament tear resulting from the 'whip kick'.