Ministry of Defence

Synopsis of Causation

Knee - Ligament Damage

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Disclaimer

This synopsis has been completed by medical practitioners. It is based on a literature search at the standard of a textbook of medicine and generalist review articles. It is not intended to be a meta-analysis of the literature on the condition specified.

Every effort has been taken to ensure that the information contained in the synopsis is accurate and consistent with current knowledge and practice and to do this the synopsis has been subject to an external validation process by consultants in a relevant specialty nominated by the Royal Society of Medicine.

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1. Definition

1.1. Knee ligament injuries consist of trauma to the major stabilisers (anterior cruciate ligament, posterior cruciate ligament, lateral collateral ligament, medial collateral ligament and combinations of these) of the knee. These injuries are characterised in the long-term with mild to quite severe symptomatic instability of the knee.

1.2. For the purpose of this Synopsis injuries to the menisci, which are often associated with knee ligament injuries, are also discussed. Meniscal tears are relatively common sporting injuries of the knee and often need surgical treatment.

1.3. Ligament injuries may vary in severity from partial tears to complete ruptures and, depending on the severity of trauma, may have differing combinations of ligaments involved.

1.4. These injuries occur frequently amongst the young and athletic population following sporting accidents and may lead to significant residual limitation of activity and morbidity. However, active older individuals and victims of motor vehicle injury of any age may also injure their knee ligaments.

1.5. The knee is the most common joint to be injured in sporting accidents. Meniscal tears account for about 11% of knee injuries, while ligament injuries occur in about 40 % of all knee injuries.[1] Amongst all knee ligament injuries the anterior cruciate ligament is most commonly injured (49%) and medial collateral ligament injury comprises 29% of these injuries.[2]

1.6. Complex disruptions of the knee involve injury to at least 2 of the major stabilisers and are associated with significant capsular injury. They are usually seen with high velocity trauma like motor vehicle injuries or sometimes in skiing accidents. The severity, clinical features and prognosis vary widely and depend on the particulars of the individual injury pattern. There is a risk of associated injury to the popliteal artery and the tibial and common peroneal nerves. With very few exceptions, these patients generally need surgical stabilisation (which is a specialised and complex procedure). Details of this type of injury are beyond the scope of this document and will not be discussed further.

1.7. Fractures, patellar dislocations, chondral injuries or disruption of extensor mechanism etc. may be associated with knee ligament injuries and indeed may sometimes go unrecognised, leading to ongoing symptoms which may worsen with time.

2. Anatomy

2.1. **Joint surfaces.** The knee contains the tibio-femoral joint and the patella-femoral joint. The tibio-femoral joint is a complex hinge joint formed by the distal end of the femur and the proximal end of the tibia. The patellar articular surface is in contact with the front of the femur. The knee joint is inherently unstable due to the non-congruous nature of the articulating surfaces. It depends on the ligaments between the femur and the tibia and fibula for its stability.

2.2. **Major intra-articular stabilisers.** There are two ligaments that cross each other while traversing the joint in the midline and help keep the two surfaces together (Figure 1). The anterior cruciate ligament (ACL) prevents forward translation of the tibia and the posterior cruciate ligament (PCL) prevents backward translation of the tibia. These ligaments do not heal well if ruptured.

2.3. **Major extra-articular stabilisers.** The tibia and fibula are joined to the femur by other ligaments which are outside a fibrous capsule delineating the outer boundary of the joint. These comprise the thickened bands of the medial and lateral collateral ligaments (MCL and LCL) on either side of the joint preventing the joint from opening out on the medial and lateral sides respectively (Figure 1). These ligaments can heal satisfactorily without the need for surgery, provided that any inadvertent stretching is avoided during the healing process.

2.4. The popliteal artery, sciatic nerve and branches pass very closely at the back of the knee joint (Figure 2) and are at risk of injury if the knee dislocates (usually with rupture of the major stabilisers).

2.5. **Medial and Lateral Menisci.** Medial and lateral cartilaginous semilunar discs (menisci) between the articular surfaces provide some stability but are essentially a load-sharing device (Figure 1) and convert the convex tibial articular surfaces into a slightly concave "socket".

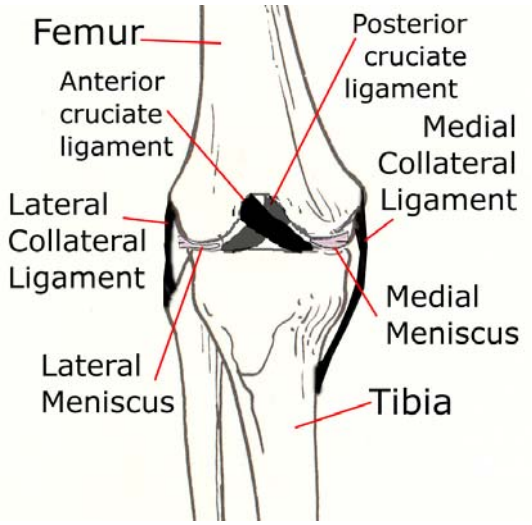

Figure 1: Knee anatomy (viewed from front)

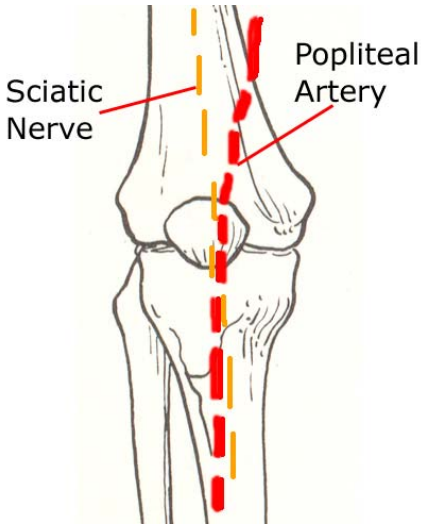

Figure 2: Popliteal artery and Sciatic nerve position behind the knee (viewed from front)

3. Clinical Features

3.1. Swelling, pain and varying degrees of inability to move the knee following the trauma are common early signs. The knee may swell quickly (due to bleeding) and become very painful and tense. This often indicates an intra-articular ligament rupture or intra-articular fracture. The knee may swell more slowly, over many hours (due to fluid in the joint) and this is usually indicative of a meniscal tear or traumatic synovitis.

3.2. **Knee ligament injuries.**

3.2.1. The extra-articular ligament (MCL and LCL) injuries are characterised by pain and tenderness over the involved ligament and are often associated with swelling and visible bruising of the area. Partial injuries to these structures are more common.

- The knee may exhibit limitation of movement and may be "locked"
- A clinical examination may reveal evidence of effusion, locking, areas of tenderness and any ligament laxity on stressing

3.2.2. **ACL Injuries.** ACL injuries are, probably, the most common devastating knee ligament injuries amongst sports persons, with a reported 90,000 ACL reconstructions performed annually, in the United States alone. Usually these injuries are isolated, mainly in non-contact sports, but may often be a part of more complex ligamentous injuries. They occur more often in contact sports, such as football, and road traffic accidents. These injuries are most likely to lead to the need for surgery and are therefore discussed in more detail here.

3.2.3. Injury usually occurs in athletic activities with both a contact and non-contact mode of trauma. Football, basketball and skiing are sports where ACL ruptures are common. There is often a history of a sudden deceleration injury with a "pop" and the knee usually swells up fairly quickly over an hour or so, with a tense painful haemarthrosis of the joint. Usually the patient is unable to continue playing following this injury.

3.2.4. Late symptoms include the feeling of sudden giving way of the knee, which may occur on any sudden twisting or turning movement. Intermittent symptoms are also associated with mild recurrent swelling, with giving way, and may be entirely pain free. If an ACL injury is associated with a concomitant meniscal tear or complex capsular disruption the symptoms may reflect that injury, with a locked knee or localised joint line pain.

3.2.5. In ACL injuries the knee demonstrates a positive Lachman's test and anterior drawer test. This is due to abnormal anterior translation of the tibia on stressing and can be quantified using the instruments like KT1000 Arthrometer (mainly used as a research tool).

3.2.6. An MRI scan is often helpful to evaluate the extent of associated pathology and to confirm the diagnosis.

3.2.7. **Epidemiology of ACL injury**. Studies, mainly from the United States, have reported that ACL ruptures are significantly more frequent amongst women. A study, from the United States Naval Academy, found that women had a relative injury risk of 3.96, as compared with men in college level sports and 9.74 as compared with men in military training.[3] The size of the cruciate ligament (narrower in women)[4] and width of the intercondylar notch (narrower in women)[5] are potential anatomical causes, while the impact of female sex hormones is a potential physiological cause of these variations.

3.3. **Meniscal tears.**

3.3.1. The common history is of a twisting injury on a knee that is bearing the body weight, while the foot is stable on the ground. A history of contact with another player is unusual. However, with the ageing process, degenerative tears of the meniscus may also occur and these might not give such a clear history of sporting trauma but rather may be associated with minor twisting injuries. The knee may often have a diffuse swelling, which develops overnight (effusion). Meniscal tears may sometimes be a part of a complex knee injury where other knee ligaments are also injured.

3.3.2. The torn meniscal fragment may be unstable resulting in displacement and entrapment between the articular surfaces of the tibia and femur; causing a "locked knee" (a mechanical block to full extension of the knee). Recurrent symptoms of locking and effusion in the joint may also be seen in knees with a loose body.

3.3.3. Examination of the knee often shows a small effusion, tenderness over the joint line localised to the site of the involved meniscus and often a springy block to full extension of the knee but with good (usually normal) flexion of the locked knee. This is due to a displaced fragment of meniscus between the articular surfaces. Other tests like the McMurray's and Apley's tests have a high incidence of false positives and are not very reliable.

3.3.4. Either the medial or lateral meniscus in isolation may be damaged but combined injuries with ligamentous ruptures are also well recognised.

3.3.5. Clinical assessment is commonly supplemented with an MRI scan which has a high success rate in detecting meniscal tears.

4. Aetiology

4.1. Ligament and meniscal injuries are usually of traumatic onset (sporting injuries or road traffic accidents).

4.2. A history of a sporting trauma is usual; otherwise, the traumatic event may be a direct injury to the front of the knee in a dashboard injury or motorcycle accident.

4.3. The trauma may be direct, as in rugby tackles, or indirect, such as twisting injuries in falls while skiing, with no other person involved.

4.4. Injuries may occur with a single ligament involvement or quite often involve multiple ligaments. Complex injuries are more common with severe high velocity trauma, for example, in road traffic accidents, motorcycle or quad bike injuries.

4.5. Meniscal injuries are usually secondary to a twisting force on a well planted stabilised foot while bearing weight. Degenerative meniscal tears may, however, occur with minimal trauma.

4.6. Some studies have suggested that female athletes are at a 6 times higher risk of developing ACL or MCL injury as compared to their male counterparts (see section 3.2.7. on ACL injuries) playing the same sports. Hormonal factors and ligament laxity have been suspected as potential contributory factors.

5. Prognosis

5.1. The long-term symptoms of knee ligament injuries may include true instability, with symptoms varying from a mild feeling of unsteadiness on sporting activities, to the knee giving way on simple activities like stepping off the kerb. This is quite a disabling symptom and frequently needs surgical stabilisation to allow normal functioning. The most common cause of persistent instability is ACL rupture, but it may be seen with any of the other ligament injuries.

5.2. Most minor injuries settle down with simple analgesia and progressive mobilisation. However, injuries to the ACL and meniscus often fail to heal, and may remain symptomatic requiring surgery.

5.3. **Investigations.**

5.3.1. A plain radiograph is initially required to identify any possible bony lesions and, in particular, any evidence of osteochondral defects or avulsions of ligaments from their bony attachments. Any loose bony body in the knee can be identified in this way.

5.3.2. An MRI scan of the knee is the most useful non-invasive test to identify any meniscal pathology, as well as ligament or bony injury.

5.3.3. Rarely more specialised scans and investigations may be required for assessment particularly if arterial or nerve injuries are suspected.

5.4. **Ligament injury – primary healing.**

5.4.1. Isolated MCL injuries heal well with non-operative treatment, including functional protective bracing. LCL injuries are often part of a complex injury and, therefore, may require special surgical attention although partial injuries to this ligament can heal with appropriate conservative measures.

5.4.2. Isolated ACL or PCL injuries, however, do not heal, even with direct repair. Indeed, the ligaments often need to be surgically reconstructed, using tendon grafts. Most ACL deficient patients, who are symptomatic after adequate rehabilitation, therefore, need surgical reconstruction.

5.4.3. PCL injuries, however, if isolated, may not always require surgical stabilisation. Up to half of all patients with isolated PCL injuries often return to their pre-injury level of sports and one third return to sport at a lower level.[6] Where there is a complex knee disruption PCL repair may need to be combined with surgical stabilisation of the rest of the knee.

5.4.4. **ACL injury.** A 5-10 year follow-up of ACL deficient knees showed that on average, 33% of patients had pain and "giving way" with activities of daily living (ADL), 33% had symptoms mainly on sporting activities and 33% had no symptoms in either sports or in ADL.

5.4.5. Sixty percent of ACL injured patients have an associated meniscal tear, 20% have other ligamentous injuries and 10-20% have associated osteochondral fractures.[7] Late development of degenerative osteoarthritis of the knee is more common after ACL injuries. The

factors that increase the risk of developing arthrosis include the following:[8,9]

- Number of hours involved in jumping, pivoting, hard cutting and lateral motion pre-injury
- Associated meniscal or osteochondral injury
- Patients refusing to consider activity modification
- More frequent incidence of the knee "giving way"
- Heavy manual work involving climbing, walking on uneven surfaces etc. post injury

5.4.6. An unreconstructed ACL injury, which remains symptomatically unstable, will have a greater incidence of meniscal tears and osteochondral injury due to the "secondary trauma".

5.4.7. No study has shown that ACL reconstruction protects against articular cartilage degeneration and secondary osteoarthritis. However, the incidence of secondary injury is reduced by a successful reconstruction and the return to previous level of sports is high amongst well-motivated athletes.

5.4.8. **Results of Surgical ACL Reconstruction.** The ideal successful ACL reconstruction is expected to provide a stable pain-free knee and the patient being able to return to full function, including sports at the pre-injury level. It should also prevent the subsequent development of secondary injury and arthritis. Most studies in the literature generally report a 90-95% success rate[10] in restoring stability, as tested by an arthrometer (KT 1000 or KT 2000).

5.4.9. Surgical reconstruction, however, is not without risks, which vary depending upon the specific techniques used. Commonly used reconstruction techniques include the use of autograft (bone-patella-bone or four strand hamstring grafts). These techniques are often performed arthroscopically.

5.4.10. Early complications include fracture of the patella, short graft, poor fixation, incorrect positioning of the graft, infection, knee stiffness and anterior knee pain. Later complications include knee stiffness, anterior knee pain or stretching of the graft. Re-rupture of the graft is usually due to a second trauma. The exact incidence of these complications is not clear from reports in the literature due to wide variations in reporting. About 10-25% of ACL reconstructions fail due to various reasons and may require revision surgery.[11]

5.4.11. Even though a number of case series have shown a clear clinical benefit in the symptoms of instability following surgery, doubts have been cast about the best way to treat these injuries. A recent large Cochrane review found no clear evidence that ACL injuries do better following reconstruction as compared to conservative treatment in the long run.[12]

5.5. **Meniscal Injury.**

5.5.1. There is some variation in the potential for healing of meniscal tears, depending on whether the tear is in the inner two thirds of the meniscus (where healing is unlikely), or if the tear is in the peripheral edge (which may heal if maintained in stable apposition). Therefore, isolated meniscal tears in the inner two thirds, with mechanical symptoms of locking or recurrent effusions, are treated with arthroscopic partial meniscectomy. Peripheral tears may be treated with meniscal repair.

5.5.2. Open menisectomy has been almost completely superseded by arthroscopic surgery usually by a partial arthroscopic menisectomy. In most of these cases a return to full previous activity level in a few weeks is often achieved.

5.5.3. A small number of meniscal tears (peripheral tears) may be treated more appropriately with newer techniques, like meniscal repair, thus salvaging the meniscus. This is a procedure that may be technically challenging. The rehabilitation period for these is about 3-6 months and with a reported complication rate of about 18% (as opposed to an overall complication rate of arthroscopic menisectomy of less than 2%).[17]

5.5.4. The techniques of meniscal repair are getting better and in experienced hands good results are reported in about 90% of cases.[10] Meniscal and cartilage transplantation are newer techniques that show promise but are currently still experimental.

5.5.5. Long-term results following open menisectomy have shown an increased incidence of degenerative osteoarthritis. It is still too early to say if current meniscal repair techniques lead to a significant decrease in the incidence of osteoarthritis in the future.

5.6. **Knee injury and Osteoarthritis.**

5.6.1. It is generally reported that traumatised knees develop earlier osteoarthritic changes than those that have not suffered any injury. In one study, the risk of developing osteoarthritis of the knee by 65 years had been estimated to be about 14% in those who had a knee injury in adolescence, (this includes all knee injuries and does not just refer to specific ligamentous injuries) as compared to a risk of 6% in those that did not.[18]

5.6.2. It has been felt that the increased risk was due to the potential for secondary cartilaginous and meniscal injury in an unstable knee particularly in younger patients. Long-term case control studies and retrospective series suggest that some protection is gained if early surgical reconstruction was performed.

5.6.3. Prognosis following menisectomy is usually worse, with a reported relative risk of 14.0 of developing osteoarthritis after 21 years.[19]

5.6.4. Incontrovertible evidence from multiple long-term retrospective as well as prospective studies exist that knee osteoarthritis is significantly more common following knee injuries (this includes all knee injuries and

does not just refer to specific ligamentous injuries).[20] It also appears that the onset of osteoarthritis is earlier in these patients than those who have not injured their knees. The incidence of osteoarthritis does also depend on many other factors, as mentioned above. However, high quality evidence is still lacking regarding the potential reduction in the risk of developing osteoarthritis following surgery for knee ligament injury or meniscal pathology.

5.6.5. All of these studies provide generalisations and individual cases must, therefore, be assessed separately to identify the potential risk of future osteoarthritis. Osteoarthritis has a multifactorial aetiology and therefore individual factors such as height, weight, body mass index, activity levels and family history also have a contributory role.[21]

6. Summary

6.1. Knee ligament injuries are common in the athletic young population and may result in a chronic unstable knee. These need to be properly assessed and treatment should be dependent on the clinical presentation and pattern of ligament injuries.

6.2. Prognosis depends on the initial injury, associated damage to menisci or cartilaginous surface, pre-injury and post-injury level of sporting activity and the nature of treatment given.

6.3. Long-term arthritis is more common following trauma and may take 25-30 years to develop irrespective of the treatment given.

6.4. There is a higher incidence of ACL injury amongst women and some evidence exists that appropriate neuromuscular training may prevent some of this injury.

6.5. Surgical reconstruction can, usually, return the patient back to their pre-injury level of activity even though evidence is lacking as to any beneficial effects in relation to preventing the onset of late degenerative arthritis.

7. Related Synopses

Chrondromalacia Patellae

Internal Derangement of the Knee

Anterior Knee Pain

Osteoarthritis of the Knee

Osteochondritis Dissecans

8. Glossary

arthrometer	A calibrated device designed to measure the arc or range of motion of a joint.
arthroscopy (arthroscopic)	A procedure carried out with an arthroscope. An arthroscope is an instrument with a system of lenses and lights that enables a surgeon to view the inside of a joint. It is used most often to study the knee joint. Arthroscopy reveals abnormalities inside the joint.
articular surface	The bone end that forms the joint with the adjacent bone and is covered with a tough elastic tissue – the articular cartilage, which allows smooth movement between the bone ends.
effusion	Accumulation of fluid, or the fluid itself, in various spaces in the body. Commonly, the knee develops an effusion after an injury.
haemarthrosis	A condition where blood collects in a joint, resulting from broken blood vessels or capillaries.
ligaments	Tough, elastic, tensile tissue composed of bundles of a naturally occurring substance called collagen. The ligaments are attached at both ends to adjacent bones in a joint and thus help to keep the bones stable together while at the same time allowing some flexibility and movement.
meniscus	A "C" shaped cartilage in the knee which provides a stabilisation system for the knee and a measure of shock absorption.
MRI scan	A non-invasive, non-x-ray diagnostic technique based on the magnetic fields of hydrogen atoms in the body. MRI provides computer-generated images of the body's internal tissues and organs.
osteoarthritis	A type of arthritis that causes the cartilage in the joints to fray and wear. In extreme cases the cartilage may wear away completely.
osteochondral	Pertaining to both bone and cartilage (chondral = cartilaginous).
randomised controlled trials	A study involving 2 groups, one treatment group and one control group. The treatment group receives the treatment under investigation, and the control group receives either no treatment or some standard default treatment. Patients are randomly assigned to all groups.

relative risk	How a specified risk factor influences the risk of the outcome i.e. a relative risk of 10 means that the outcome is 10 times more likely to occur.

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