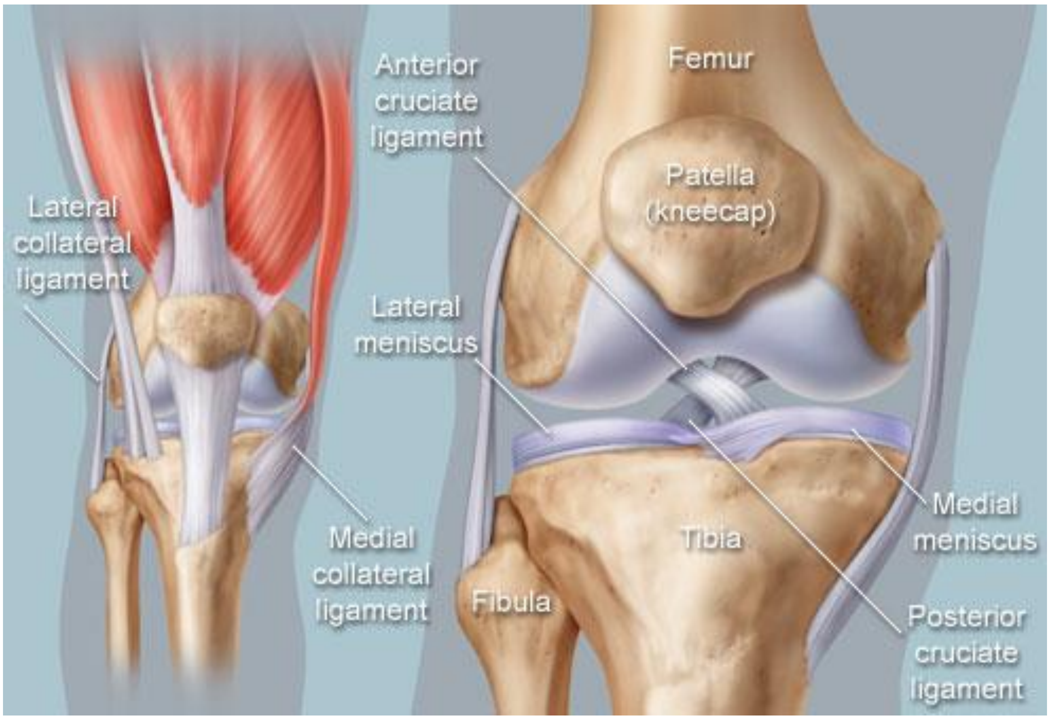
The Knee

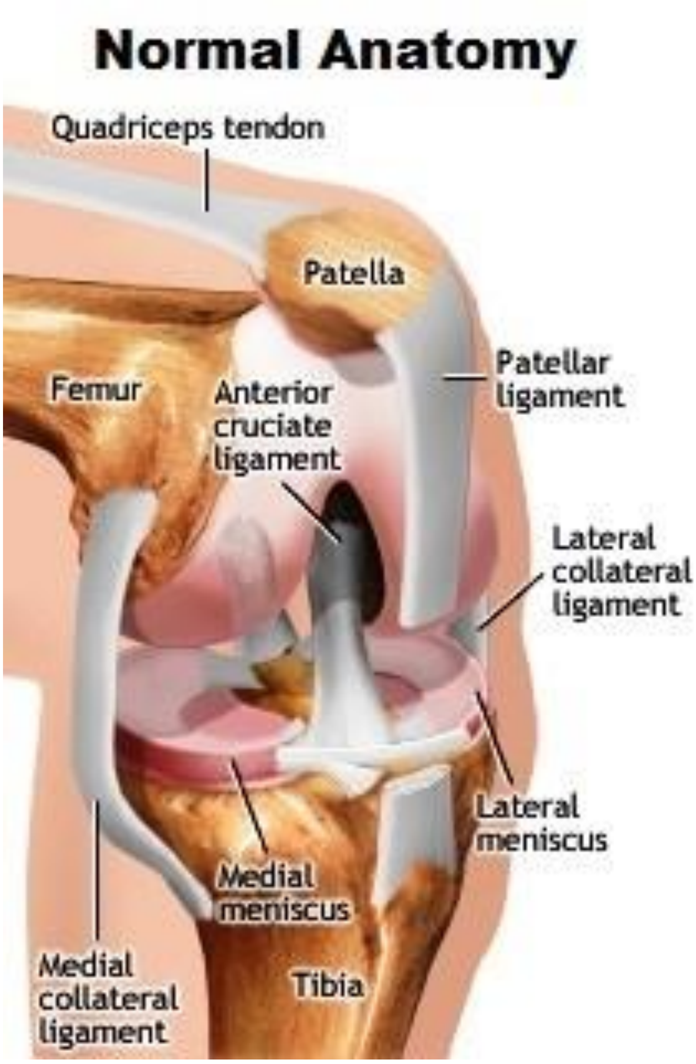
Structures, Movements, Disorders, Manipulations



Compiled by Laurence Hattersley
6/5/2014

Contents

The Knee



For such a major joint, the knee has very bad conditions of work:

1. The surface are ill-adapted
The femoral head is convex
The tibial head is flat with a slight concavity

2. The joint is very superficial
i.e. here is very little protection by the surrounding tissues. This probably makes it the most vulnerable of all the structures to stress and injury. The joint is not surrounded by thick muscle, but by terminal tendons. These have a reduced stabilising effect on the joint; therefore, its stability comes from:
   a. Powerful muscles
   b. A complex of tough ligaments

Figure 1 The Knee

The knee is formed by two joints:

1. Tibiofemoral Joint - between the femur and the tibia
2. Patellofemoral joint - between the patella and the femur

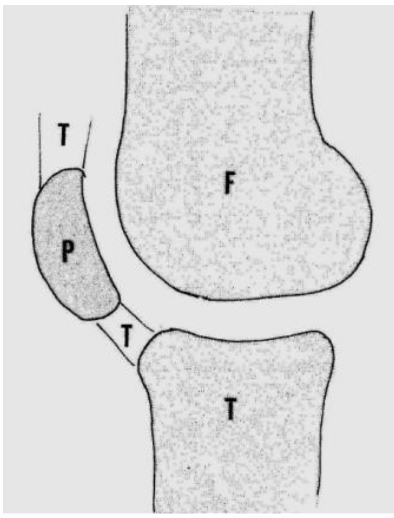


Figure 2 The Joints of the knee - here showing the patellofemoral and its tendons

Bony structures

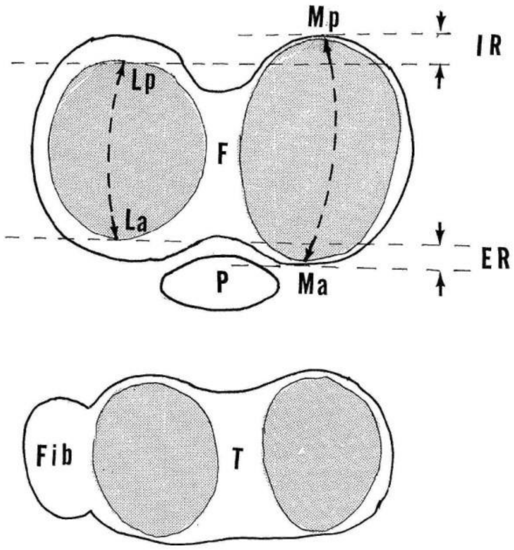


Figure 3 The femur and tibia seen from end-on

The tibiofemoral joint is made up of the lower end of the femur and the tibial plateau and the surface lengths of the femoral condyles is the basis of rotation of the tibia on the femur. The lower end of the tibia consists of two condyles, of which the medial is larger than the lateral, thus the movement of the knee is essentially a spiral (i.e. not a circle, but more like a cone lying on its side). Thus flexion at the joint is not pure, there being a slight lateral rotation of the femur on the tibia, as well as both sliding and rolling.
The upper diagram shows the difference in length of the condyles and the lower the tibial plateau. This shows a possible greater range of movement of the medial condyle. 'P' shows the patella and the anterior of the joint

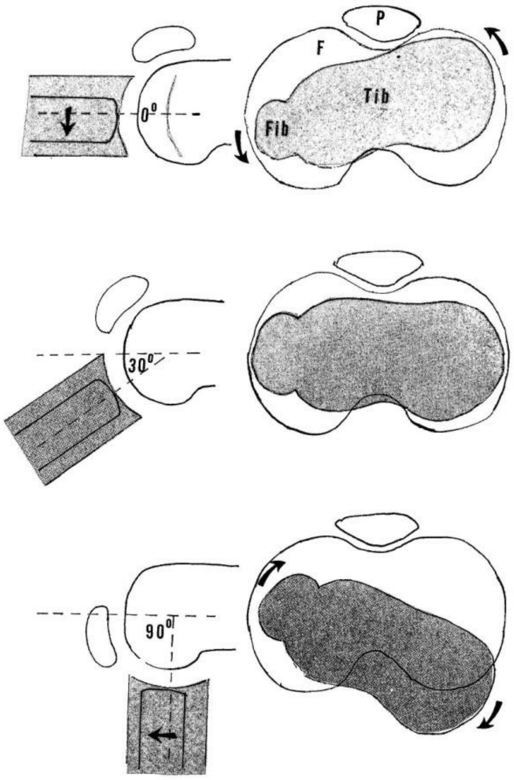


Figure 4 Rotation of the knee whilst in flexion and extension

In full extension the tibia has rotated laterally. At 30 degrees the tibia is neutral, and at 90 degrees is internally rotated

In flexion, the movements induced are both sliding and rolling:

- If it only rolls - the femur will roll off the back of the tibia
- If it only slides - the femur will hit the posterior edge of the tibial plateau

Hence, with its spiral shape:

Flexion:

10^0 - 20^0	- rolling back
Then	- begins to glide
End	- pure sliding

Glenoid surfaces of the tibia

The medial and lateral glenoid of the tibial plateau surfaces differ in that the medial is concave in all directions, thus there is very little A/P movement. The lateral, however, is concave in the lateral plane, but flat (or possibly convex) in the A/P plane. Therefore the lateral condyle can glide back further compared to the medial; this affects the movement of the femur on the tibia in flexion.

Ligaments

The knee has ligaments inside and outside of it:

1. Medial and lateral collaterals
2. Anterior and posterior cruciates

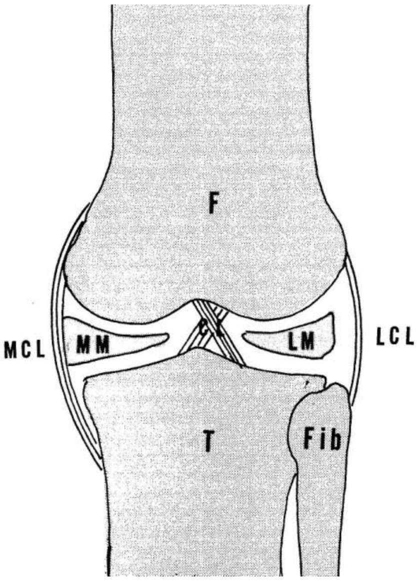


Figure 5 Schematic of the ligaments of the right knee

Note here that the medial collateral ligament (MCL) not only connects the medial aspects of the femur and tibia, but also is attached to the capsule of the medial aspect of the joint and through that to the medial meniscus (MM). The lateral collateral ligament (LCL) attaches the lateral aspect of the femur to the head of the fibula but is **not** attached to the capsule or meniscus.

The Medial Collateral Ligament (MCL)

The MCL is layered (see figure 5), the most superficial being the major medial ligament. The inner layers of this connect to the capsule and the medial meniscus; it is relaxed in flexion. The deep layer of the medial collateral ligament is divided into three sections:

- The inner - extending anteriorly to stabilise the extensor mechanism (the quads)
- The middle - extending laterally, stabilising the joint, and
- The posterior - extending to the posterior popliteal capsule

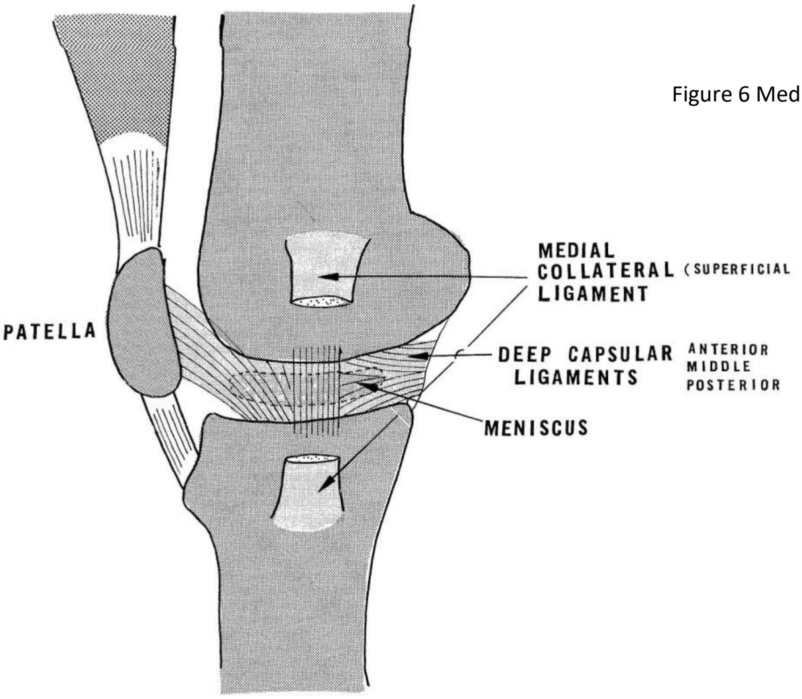


Figure 6 Medial collateral ligament

The Lateral Collateral Ligament (LCL)

The LCL passes from the lateral epicondyle of the femur down to the fibular head. The common peroneal nerve passes just inferior to this, around the neck of the fibula, behind the attachment of biceps femoris.

Movements between the femur and the tibia with Weight bearing

With flexion:

- The femur rock (rolls) from anterior to posterior
- The femur glides from posterior to anterior and rotates laterally

Range of movement:

- Flexion - 135 - 140^0
- Hyperextension - 5 - 10^0
- Rotation - 40 - 45^0 at 60^0 flexion (e.g. during skiing), but normally 20 - 25^0 from straight to full flexion

The knee has maximum stability when in full extension, as all the ligaments (especially the collaterals) are taught (see figure 6). They are most taut with full extension and relax immediately the knee flexes.

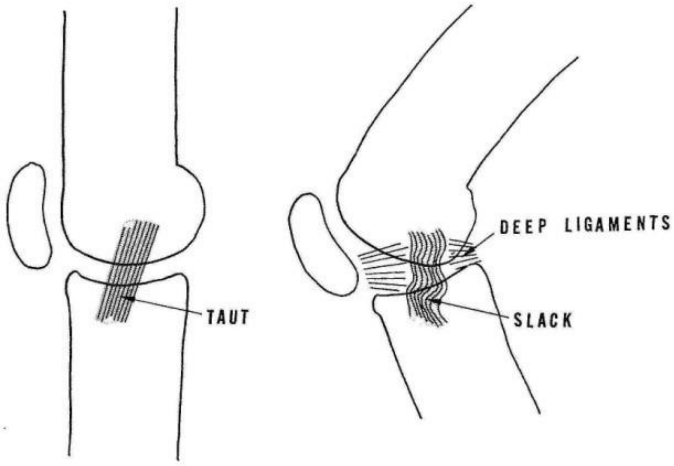
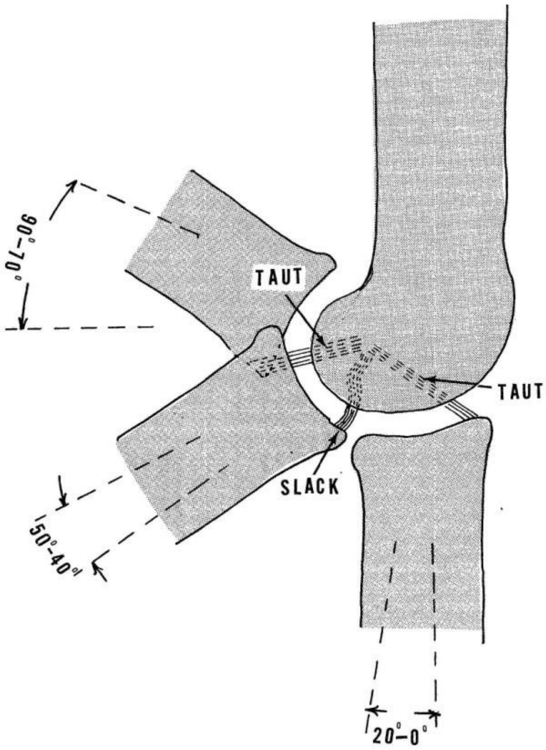


Figure 7 Collateral ligamentous tension

When the knee is straight and weight bearing,
the body's centre of gravity is slightly anterior to the middle of the knee, pushing it into hyperextension. When the knee is straight, the ligaments become taut and the quadriceps can relax, allowing the patella to become mobile.



When the knee flexes, the range of rotation increases with flexion. Now, also, the collaterals can relax; this allowing rotation to take place along with medial and lateral gapping (this can be of significance in certain activities that require a lot of external rotation of the hip. If it doesn't occur at the hip, it will occur at the knee with consequent recurrent sprains). When the knee is fully flexed, the collaterals and cruciates become taught once more.

Figure 8 Ligamentous laxity and tautness of the cruciate ligaments in flexion/extension

Cruciate ligaments

The cruciate ligaments are paired and named anterior or posterior as per their origin on the tibial plateau (figure 9)

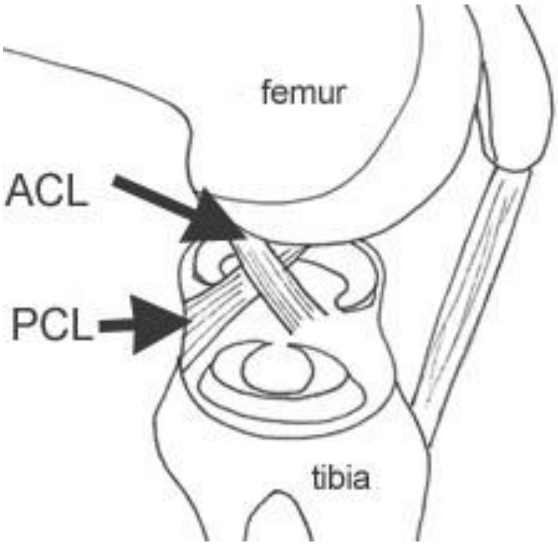


Figure 9 Cruciate ligaments

Anterior cruciate ligament (ACL)

This originates the anterior tibial plateau. It ascends, passing back and laterally to its insertion on the medial (non-articular) surface of the lateral femoral condyle. The ACL is taut when the knee in fully extended and does not relax during the first 20^0 of flexion. Then it becomes slack until 70^0 - 90^0 of flexion. In weight bearing it tenses to slow the rolling of the lateral epicondyle, producing a gliding within the joint.

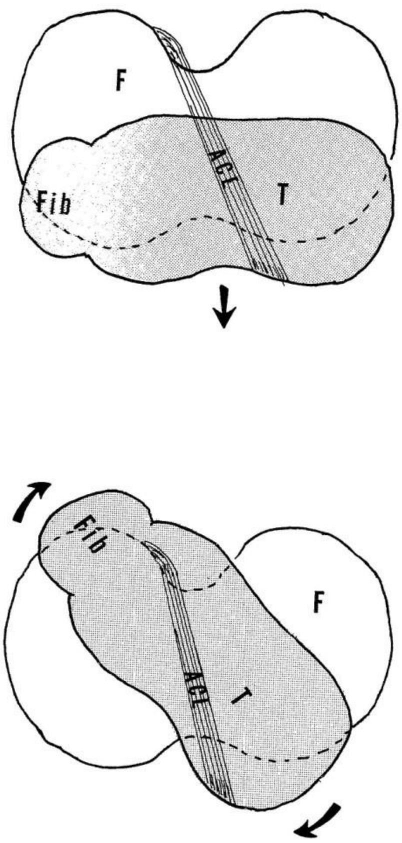


Figure 10 Restriction of movements by ligaments

Here the upper drawing shows the actions of the ACL on anterior shear of the tibia

The lower shows how the ACL restricts external rotation of the tibia on the femur

So, in flexion:

- The ACL guides the lateral epicondyle
- The medial collateral guides the medial epicondyle

In extension:

- The ACL prevents hyperextension (figure 11)

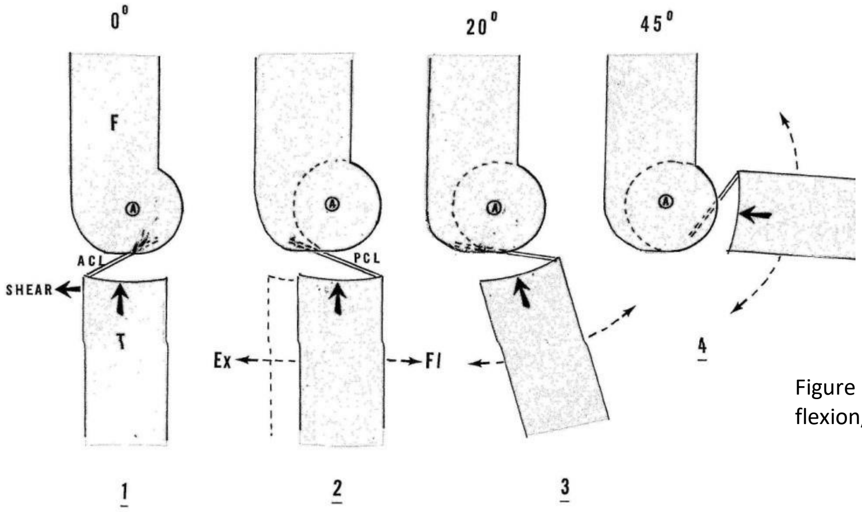


Figure 11 Effects of cruciates on flexion/extension

Posterior Cruciate Ligament (PCL)

This PCL (figure 11) originates from the posterior aspect of the tibial plateau passing up, anterior and medial to attach to the inner (non-articular) surface of the medial condyle. I becomes taut when the femur shears anteriorly, during early flexion, and becomes the fulcrum around which further flexion occurs.

The cruciates, therefore, primarily stabilise A/P shift in the knee as well as excess rotation (Figures 11 and 12)

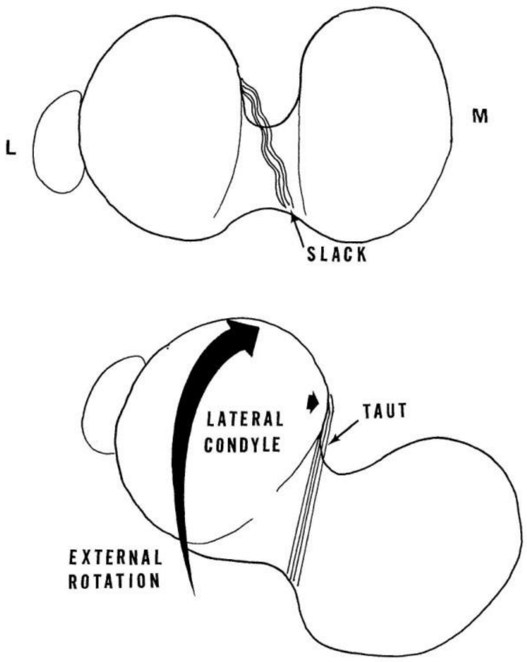


Figure 12 Cruciate restriction of tibial rotation, here only showing the femoral condyles

Full range of movement, especially hyperextension, is important in the person (in the clinic) in that the patient should have recovered their full range of hyperextension (5 - 10^0) before being discharged. If they are released prior to full extension being re-established, there may be the possibility of more problems. Why? Without hyperextension, the quads cannot relax and the patella would always be engaged, if not fixed, in the intercondylar groove. This would lead to soft tissues lesions in extension mechanics and later, cartilaginous problems of overuse.

Hyperextension can be normally found in:

- Young children
- Pregnant females
- Forced contraction of the quads

Besides giving mechanical support and limiting range of movement, the ligaments also supply proprioception to the patient. Proprioception of any joint (especially the knee) comes from actions of the: ligaments, capsule, muscle spindles and the skin with the ligaments providing the predominant sensory input. It depends upon the age of the person and the amplitude and the velocity applied to the joint. If it is impaired it can cause degenerative joint disease.

The medial collateral ligaments are densely innervated with free nerve endings and low-threshold mechanoreceptors, which have been considered to be activated as a ligamentomuscular reflex following injury (i.e. spasm following trauma). This thesis has now been refuted because these same reflexes contribute to reflex coordination to normal movements. Increased tension of the collaterals causes increased sensitivity in the α-muscle spindles afferents (i.e. information into the spinal cord) of the gastrocnaemuis, Soleus, and Semitendinosus muscle.

The collateral ligaments are supplied by free-nerve, Ruffini and Golgi endings. Ruffini endings have lower thresholds compared to Golgi endings. Forces generated in other knee structures (capsule and cruciates) are altered after ruptures of the collaterals. The proximal and distal ends of the ligaments are most densely supplied with sensory nerve endings, with few in the mid-portion (this could be because of here the tension normally expresses itself on cords that are stretched - at their ends).

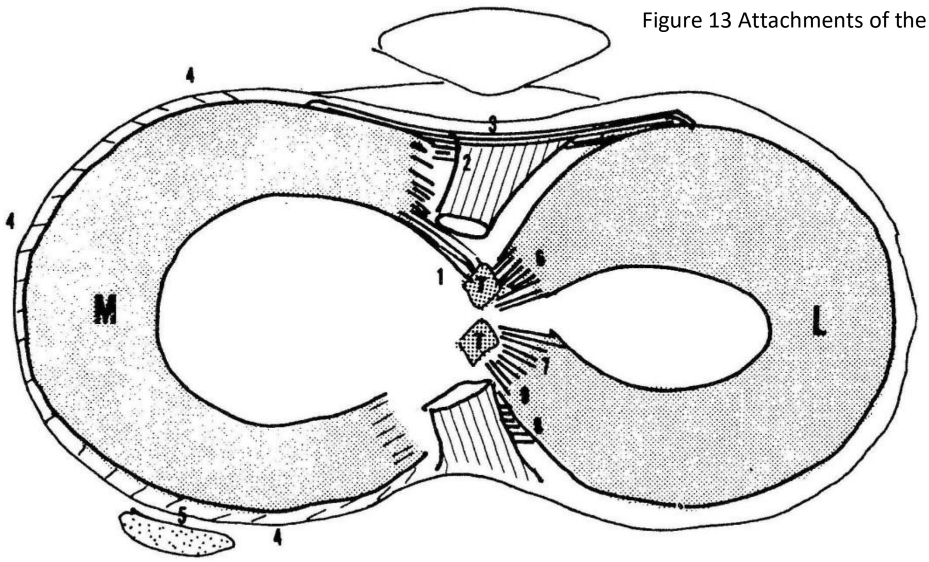
The MCL is the most commonly damaged ligament in the knee in sports-related injuries, but conservative (non-surgical) treatment delivers good results in all injuries bar avulsion fractures and traumatic amputations.

Menisci

The menisci are also known as:

- Semilunar cartilage
- Articular disc
- Ligamentous cartilage
- Enarthroidial cartilage
- Cartilagiform ligaments

Figure 13 Attachments of the menisci to the top of the tibia



This diagram shows the right tibial plateau viewed from above.

(1) - the fibrous attachment of the medial meniscus to the tibial tubercle
(2) - the connection to the anterior cruciate ligament
(3) - the transverse ligament that connects to the anterior horn of the lateral meniscus
(4) Shows the medial meniscus attached around its entire periphery to the joint capsule

(5) - the attachment of the capsule (and meniscus) to the semimembranosus tendon
(6) and (7) are the anterior and posterior horns of the lateral meniscus respectively and
(7) - the posterior horn of the lateral meniscus attached to the eminentia intercondylaris (T)
(8) - the attachment to the posterior cruciate ligament (9) is a fibrous band that attaches superiorly to the intercondylar region of the femur (ligaments of Humphry; 70 % of knees have either anterior meniscofemoral ligament of Humphrey or posterior meniscofemoral ligament of Wrisberg)

The lateral meniscus bears up to 70% of medial compartment contact pressure

The Menisci are attached to the tibial plateau via coronary ligaments:

Medial	4 - 5mm long	
Lateral	Anterior -	2cm attachment
	Posterior -	.3cm attachment

Thus, the lateral meniscus has a play of 10mm compared with 2mm for the medial (that, with its attachments to the capsule and the medial meniscus reduces its range of movement and increases its possibility of damage).

Their shape (including cross-section) reciprocally matches the line of the joint surfaces of the femur and the tibia i.e. concave superiorly and relatively flat inferiorly.

Their functions (because of their reciprocal shape to the joint surfaces) are:

1. Lubrication - increases ease of gliding and rolling, spreading synovial film between the two surfaces
2. Intercondylar wedge - tightens the cruciates and collaterals contributing to decreased lateral mobility i.e. reduced lateral gapping
3. Deepens the articular surfaces, so as to accommodate the femoral condyles and increase stability
4. Shock absorber - creates a cushioning effect in the joint. Also, the thickness of the cartilage stops the tibia hitting the posterior part of the femur in extreme flexion
5. Assists in joint mobility because they are mobile: moving anterior with extension and posterior with flexion. This movement also occurs in rotation of the knee, the menisci following the condyles

Medial Meniscus

This is about 10mm wide with the posterior horn wider than the anterior and middle portions. Generally, it is a 'C' shape and is attached around its entire periphery to the joint capsule and the MCL (figure 14). The anterior horn is attached to the anterior intercondylar eminence (on the tibial plateau), to the anterior cruciate and to the lateral meniscus via the ligamentum transversum.

Lateral Meniscus

This is about 12 - 13mm wide. The anterior and posterior horns are attached directly to the intercondylar eminence, the posterior cruciate and the medial meniscus via the ligamentum transversum.

Because of its attachments the medial meniscus moves directly with the femur and the tibia with motion. The lateral, though, rotates around its central attachments, hence (usually) avoiding mechanical entanglements.

The menisci have a unique blood supply (figure 14) via a blood vessel entering the periphery of the meniscus through a tortuous route from the popliteal artery. It supplies blood to the outer 1/3, whereas the inner 2/3 is avascular.

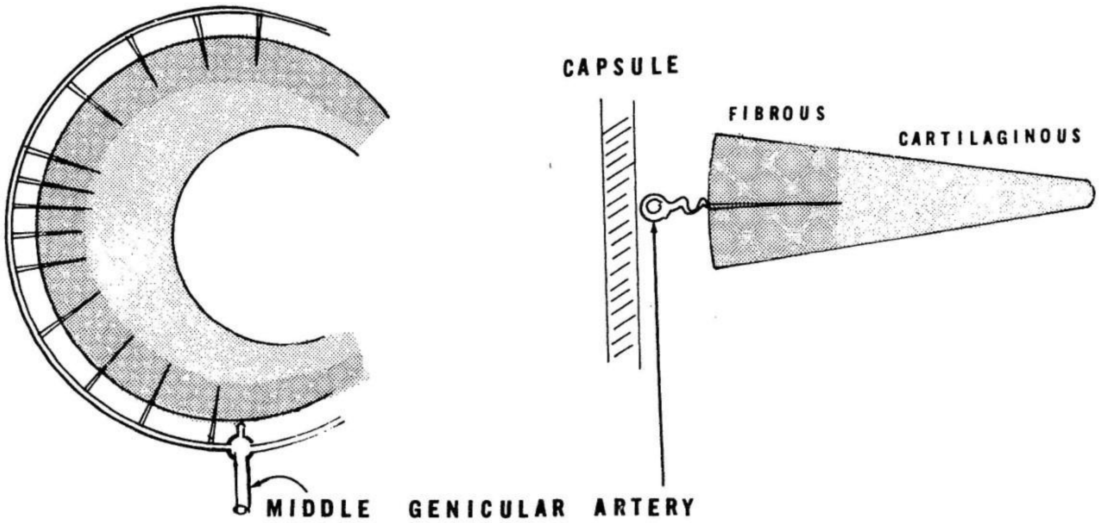


Figure 14 Intrinsic circulation of the menisci

This shows the middle genicular branch of the popliteal artery with it sending out branches around the periphery of the meniscus under the capsule. This arrangement allows movement of the meniscus.

The Patellofemoral Joint

The patella has an important role in the normal functioning of the knee and can be a major source of pain and impairment.

The patella is an ovoid sesamoid bone within the quadriceps tendon. It acts to enhance the extensor force of the quadriceps mechanics (figures 15 and 16)

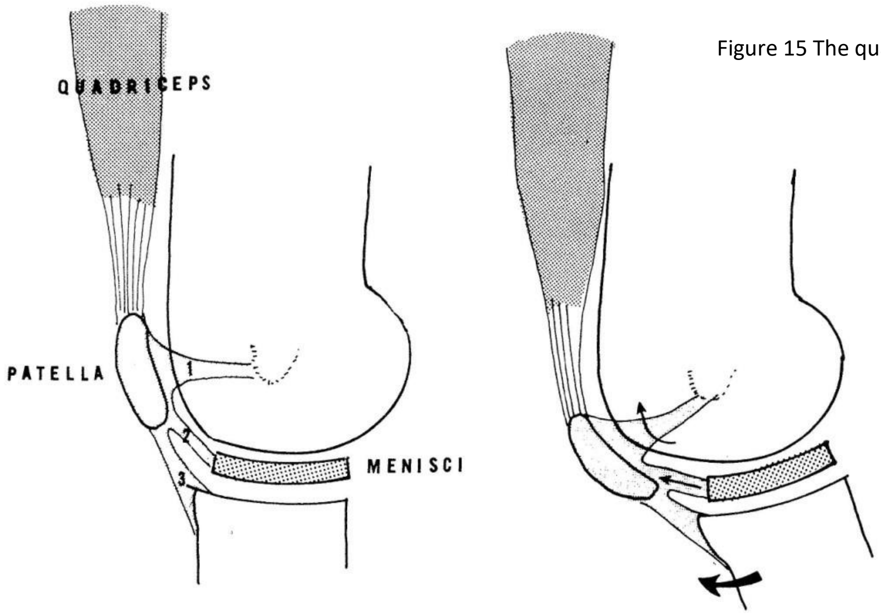


Figure 15 The quadriceps mechanism

The quadriceps muscle extends over the entire anterior knee joint through its tendon with three ligamentous extensions (1) the epicondylopatellar portion, which attaches to the epicondyle of the femur and guides the rotation of the patella (2) the meniscopatellar portion, which attaches to and pulls the meniscus anterior during knee extension, and (3) the infrapatellar tendon (the patellar ligament), which attaches to the tibial tubercle and extends the knee on the femur.

The patella (P) is attached to the tibia (T) through the angled ligamentum patellae (oblique arrow). The pull of the quadriceps (Q) elevates the patella (P) when it contracts (vertical arrow). Rotation around the axis (O) occurs at a distance (horizontal arrow), enhancing the force of the quadriceps.

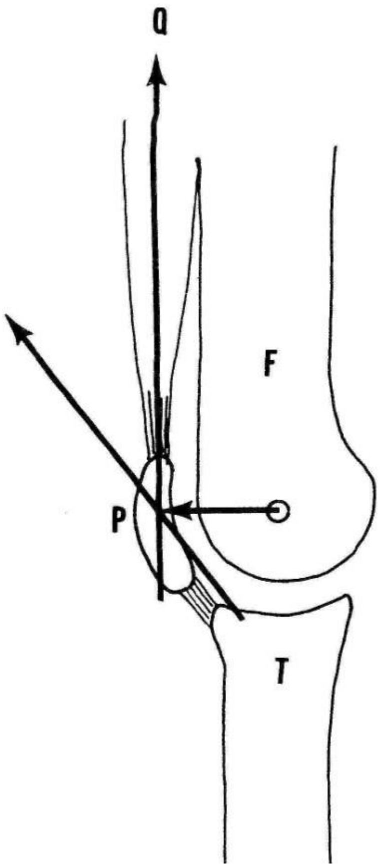


Figure 16 Parallelogram analysis of the quadriceps mechanism

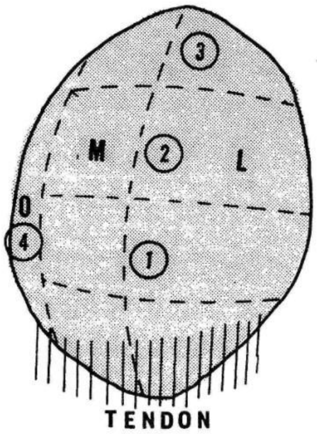
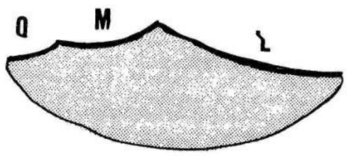


Figure 17 Articular facets of the patella



The patellofemoral joint is classified as a saddle joint, which isn't obvious at first. The patella rides in the concavity of the intercondylar groove and has biplanar concave surfaces on its underside. The facets are asymmetric with the lateral surface (L) being broader than the medial (M). Each half is further divided into three facets with the inferior facets attached to the patellar ligament.

It also has a 3rd facet, called the odd facet (O)

The lower picture shows the curved surfaces of the medial, lateral and odd surfaces

All the articular surfaces are coated with hyaline cartilage:

- Patella - 7mm thick
- Femur - 3mm thick

Functions of the patella:

1. Protection of the knee, especially from anterior impact
2. Stability of the knee i.e. ant/post via the quads
3. Increases the efficiency of the knee by way of forming a fulcrum or pulley for the quads. This is because muscles like to pull in straight lines. If the knee is flexed, the quads would effectively be 'pulling around a corner' and therefore would be inefficient. With the patella present, the quads can, largely, pull in straight lines with its forces being transmitted directly to the tibia via the ligamentum patellae. In addition to this the patellofemoral joint runs in a vertical plane, whereas the quads

pull along the course of the femur; here the patella acts as a 'straightener' to the oblique action of the quads, pulling the tibia in the vertical plane.

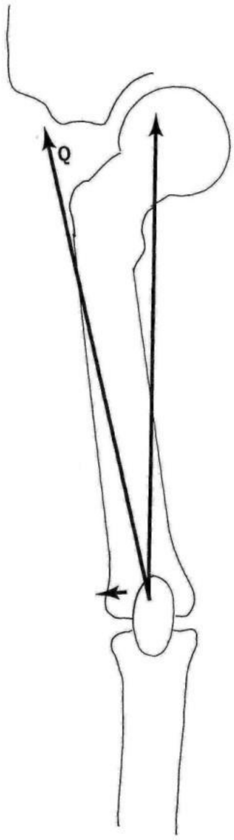


Figure 18 Diagram showing the direction of motion and direction of pull of the quadriceps

Because of this the capsule and subpatellar joint can be subjected to very high pressures. With a person of 60Kg:

- 145^0 flexion - 420Kg of pressure
- 130^0 flexion - 260Kg of pressure

As the articular surface of the patella is only mildly concave (i.e. flatter compared with the femoral condyles) the distribution of these forces is expressed over a very small surface (figure 17).

Hence with flexion:

20^0 - Inferior facet (1)
45^0 - Middle facet (2)
90^0 - Superior facet (3); here the quads is in contact with the femur via the Suprapatellar bursa.
135^0 - The patella rotates laterally and engages the additional odd facets (4), as the intercondylar groove gets deeper and the central portion is no longer in contact with the femur. Therefore, these additional facets are not in contact with the femur during standing, sitting, walking and running.

Muscles moving the knee

Hamstrings (figure 19)

The medial hamstrings are the semimembranosus (SM) and semitendinosus (ST). Laterally is the biceps femoris (B). All other posterior muscles are labelled. The right drawing indicates their origin (shaded circle) and their insertions (clear circle):

B_{LH} = Biceps long head

B_{SH}= Biceps short head

B = Biceps

S = Sartorius

Pl = Plantaris

Pop = Popliteus

G = Gastrocnaemius

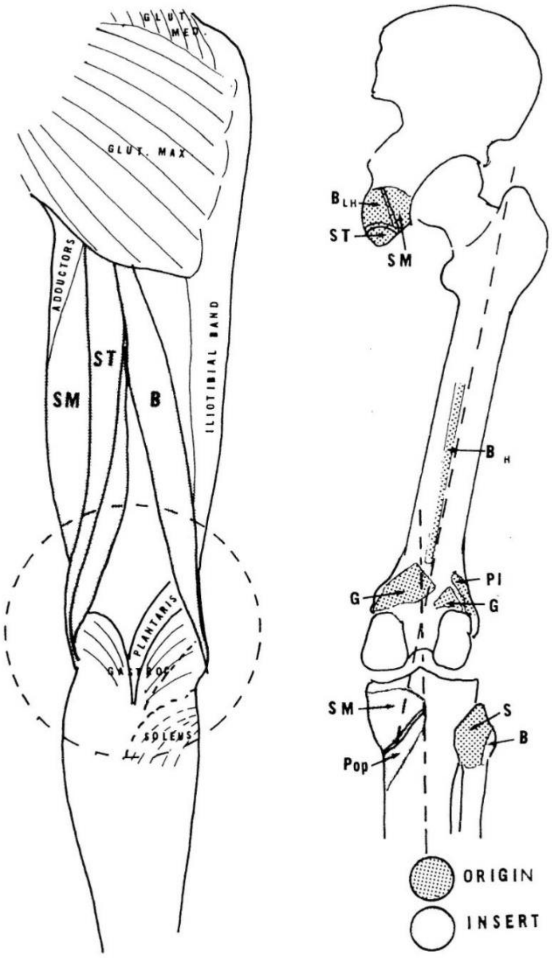


Figure 19 Posterior thigh muscles - hamstrings

Biceps femoris
O - Ischial tuberosity and linea aspera
I - Head of fibula
A - Flexes the knee, extends hip

Semimembranosus (figure 20)

O - Ischial tuberosity

I - 1) Posterior tibia with attachments to popliteus and medial meniscus
2) Tibia and capsule
3) Tibia and capsule

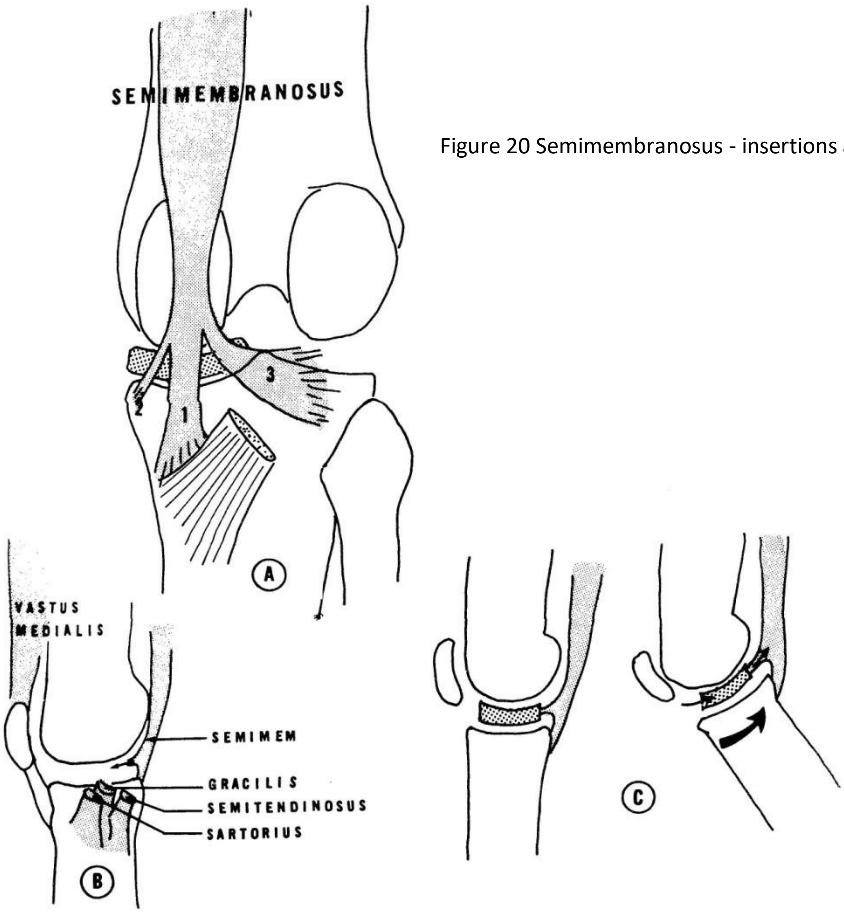


Figure 20 Semimembranosus - insertions and functions

A) Shows that the main branch attaches to the tibia and sends fibres to the popliteus muscle. In its path it has fibres that attaches to the medial meniscus. B) Shows the insertions of the hamstrings. Branches 2 and 3 attaches to both the tibia and the capsule. Semimembranosus flexes the knee and pulls the medial meniscus posteriorly, causing it to rotate with the tibia.

Semitendinosus
O - Ischial tuberosity
I - Pes Anserinus (medial tibia) with Sartorius and gracilis
A - Flexes knee and extends hip

Gracilis
O - Pubic bone
I - Pes Anserinus
A - Adduction of the thigh, weak flexor of knee

Sartorius

O – ASIS
I – Anteromedial upper tibia (pes anserinus)
A – Flexes hip
Flexes knee
Externally rotates knee

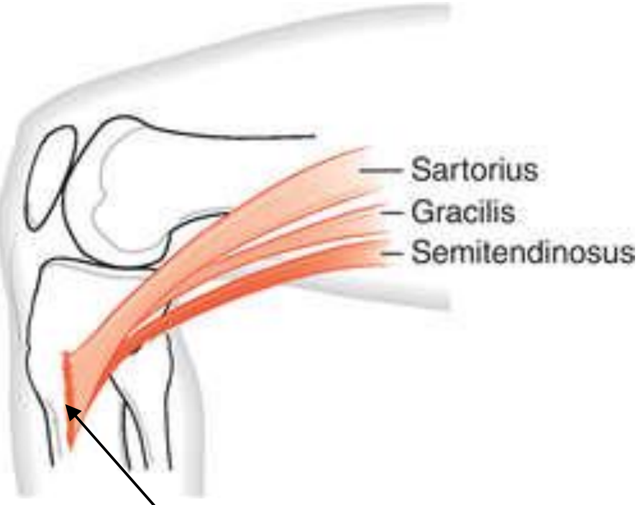
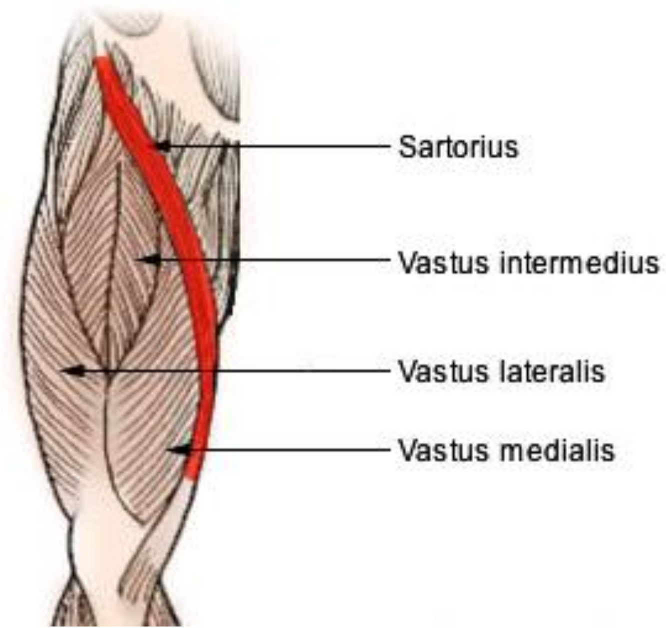


Figure 21 Pes Anserinus



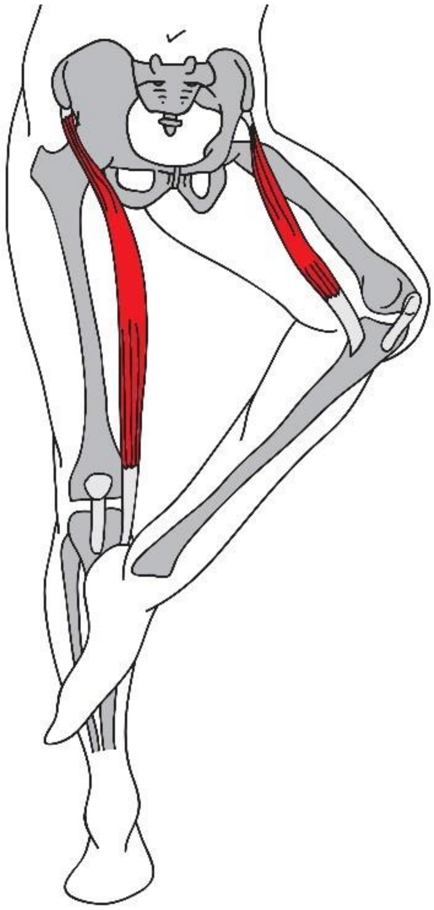


Figure 22 Sartorius

Popliteal fossa

The popliteal fossa is a diamond shaped concavity at the back of the knee and is bounded by muscles of the lower hamstrings and upper gastrocnaemius. Through it pass the major nerves and vessels passing into the lower leg. It is also the site of a Baker's cyst.

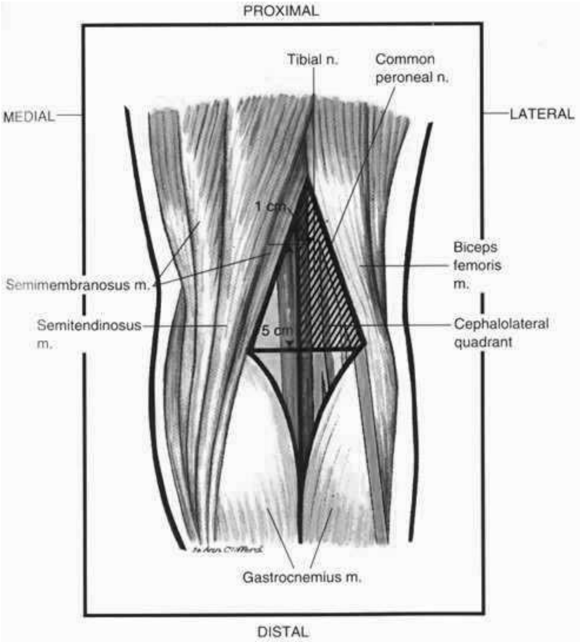


Figure 23 Popliteal fossa

Quadriceps

The quadriceps consist of the four heads of the three vasti muscles and rectus femoris

Vastus Lateralis (VL)

O - Posterior femur, lateral to linea aspera, and lateral side of femur

I - Lateral patella, ligamentum patellae

A - Extends knee, lateral displacement of patella

Vastus Medialis (VM)

O - Lower 2/3 of posterior femur medial to linea aspera, medial side of femur

A - Extends knee, Medial displacement (stabilisation) of patella

Vastus Intermedius

O - Anterior shaft of Femur
I - Patella
A - Extends knee

Rectus Femoris (RF)

O - Anterior Inferior Iliac Spine (AIIS)
I - Patella
A - Flexes hip, Extends knee

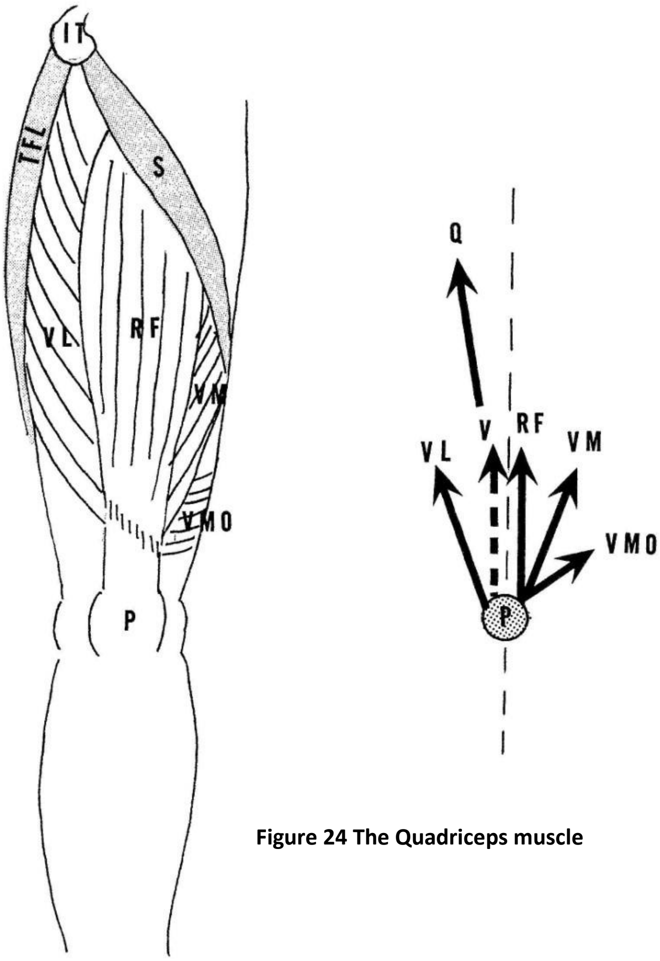


Figure 24 The Quadriceps muscle

The quadriceps mechanism comprises of the rectus femoris (RF), vastus lateralis (VL), vastus intermedius, vastus medialis (VM) and vastus medialis obliquus (VMO). The VMO does not essentially extend the knee but keeps the quads in proper alignment (Q). All the quads pull equally on the patella (P) to extend the knee. Vastus intermedius lies deep to rectus femoris. The sartorius (S) and tensor fascia lata (TFL) are not part of the quads but are included as they are located on the anterior thigh.

The Quadriceps Angle

The quadriceps angle, or Q angle, is the angle made between lines drawn down from the ASIS through the patella, and a vertical line through the patella

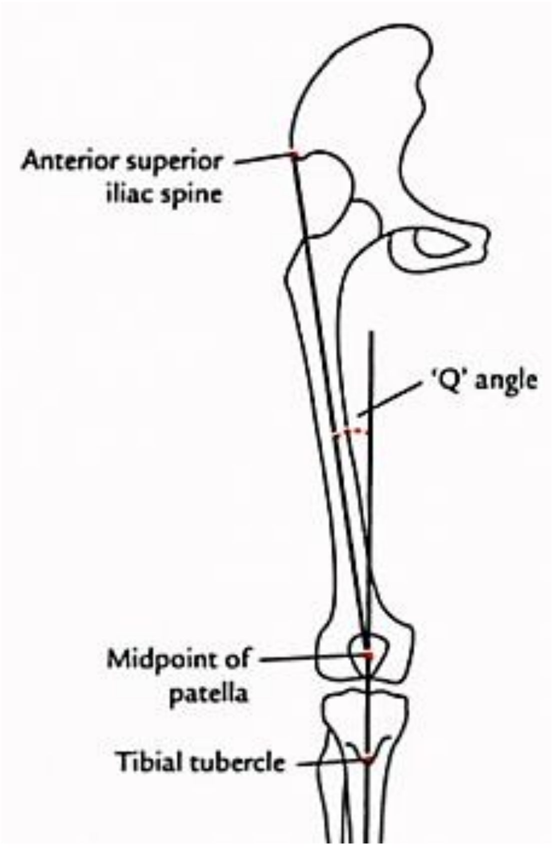


Figure 25 The Quadriceps angle

Another way of seeing this is to visualise the hips and legs. In a standing posture, the hips are a certain distance apart and the feet are closer together, but the legs do not go down in a straight line; the thighs come down medially and the tibias are vertical.

The patella rides vertically in the intercondylar groove of the patellofemoral joint, but the quadriceps muscle pull in the same direction as the femur. Because of the pull of the quads, the patella will tend to move laterally as well as vertically. This can cause greater stress on the lateral aspects of the joint.

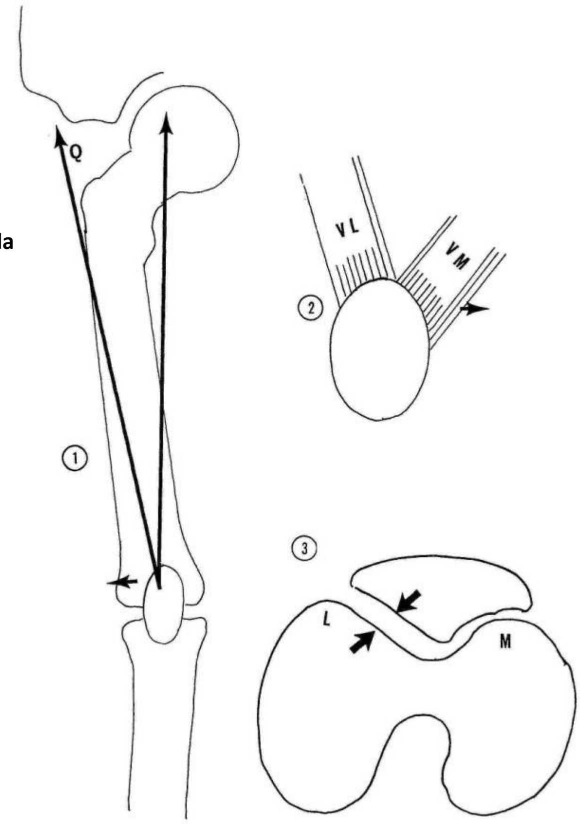


Figure 26 The effects of the Q-angle on the patella

(1) The Q angle is shown

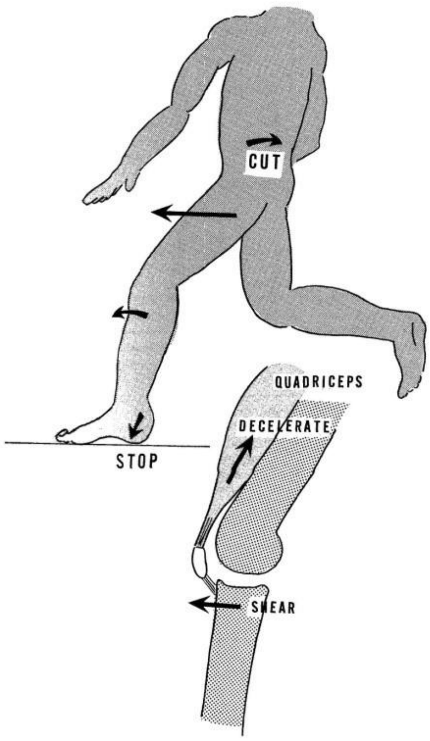
(2) The muscles that direct the quadriceps: vastus lateralis (VL) and vastus medialis (VM)

(3) Due to lateral pull, the lateral, the lateral facet receives maximum compression and friction (arrows) on the lateral condyle (L), as compared with the medial condyle (M)

The patella is kept in alignment (in normal circumstances) by the oblique fibres of the vastus medialis (fig 24)

Disorders

These may be due to direct trauma (which would be suspected from the case history) or from faulty musculoskeletal mechanics.



A mechanism of knee injury is when the athletes comes to an abrupt stop with or without simultaneous rotation, thus placing severe stress forces on the ligaments

Figure 27 Stop and cut injury

With the left knee fixed on the ground, sudden rotation of the body causes severe rotational stress on the ligaments: femur and tibia

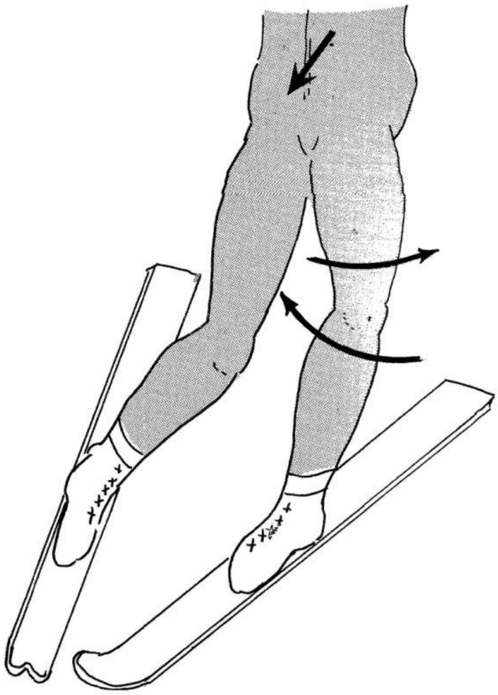


Figure 28 Mechanism of rotational injury

Collateral sprain

The most frequent site to be injured in the knee is the medial collateral ligament, but injuries are not exclusive to this.

Simple sprain- e.g. a grade 1 or 2, where the fibres remain intact or, at worst, stretched. Here stability is maintained with little effusion. With a moderate sprain, pain is elicited by passively gapping the joint on that side. Signs of meniscal and collateral damage must be negative.

Severe sprain (grade 3) ligamentous injury implies tearing of tissue, resulting in instability and massive effusion. If it swells up within ½ hour, haemarthrosis should be suspected and aspiration is indicated.

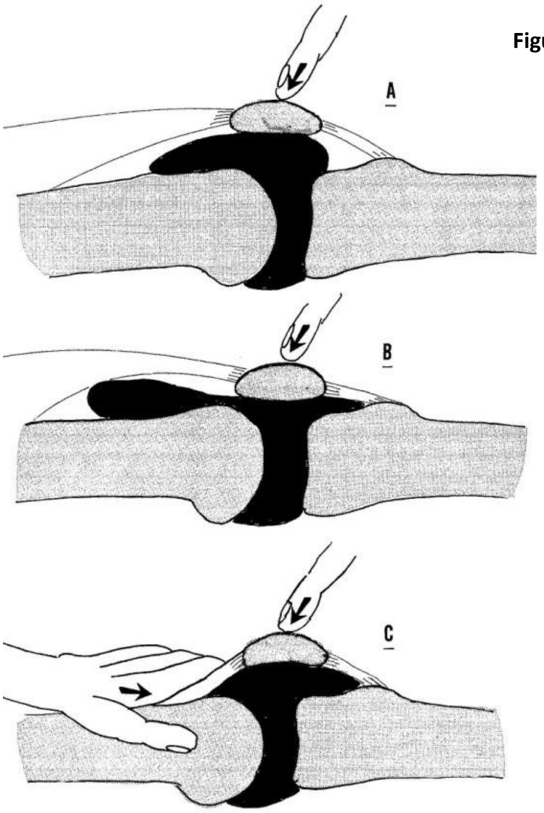


Figure 29 Ballottement test for knee effusion

The patellar tap

A) Fluid may not be visible and direct pressure on the patella causes no ballottement

B) Direct pressure disperses the fluid superiorly and inferiorly. With a small amount of fluid a negative ballottement test may result

C) Downward pressure on the suprapatellar tendon and direct pressure on the patella causes dispersal of the fluid medially and laterally (either side of the patella ligament): a positive ballottement test confirming the pressure of fluid or blood

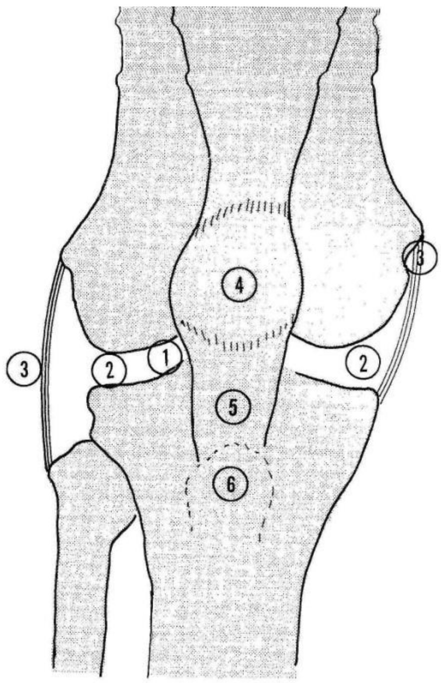


Figure 30 Tender sites for knee pathology

1) The site of painful fat pads
2) Meniscal sites of tenderness
3) Collateral ligament pain, medial and lateral
4) Patellar pain and tenderness usually from pressure and quadriceps contraction
5) Infrapatellar bursa pain
6) Tibial tubercle pain

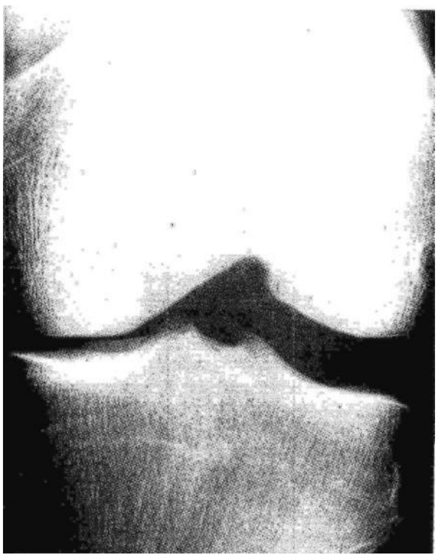


Figure 31 X-Ray of knee - A/P

Stress view of the knee of a 30-year-old hockey player who injured his knee some 6 months previously. When a valgus stress when applied to the knee, the joint 'opened' medially since the collateral ligament was ruptured

Medial collateral

Grade 3:

- Tender over medial surface of knee
- Possibility of pain (initially)
- Feeling of weakness

Here limiting the ROM of the knee temporarily, especially to the MCL, to limit medial gapping can be beneficial. The initial use of a robust hinged knee brace is advised and **large** doses of glucosamine, along with vitamin C, to assist ligamentous healing. Immobilising the joint entirely is not advised as it can lead to atrophy o the quads after several weeks and can cause extensive adhesions inside the joint, so allowing movement via a brace will help minimise these.

Lateral collateral

These are less common compared with the MCL, because they can often indicate dislocation at the superior tib/fib and have the potential to injure the peroneal nerve (due to its locality at the superior end of the fibula). Examination here will show excess varus (lateral gapping) with a joint gapping of 5mm or more. Pain on the lateral aspect may also indicate a lateral meniscus injury or displacement, but this would show on other testing.

Cruciate ligaments

Injuries to these may result in an unstable knee and can jeopardise further athletic activities. One of the functions of the cruciates is to limit A/P shift of the femur on the tibia, and it is via this function that the knee is tested.

The patient is placed in the **drawer** position (fig. 32). If there is a sever effusion, the test may be limited, but once is has subsided (via ice and arnica) a positive test is diagnostic.

Drawer test

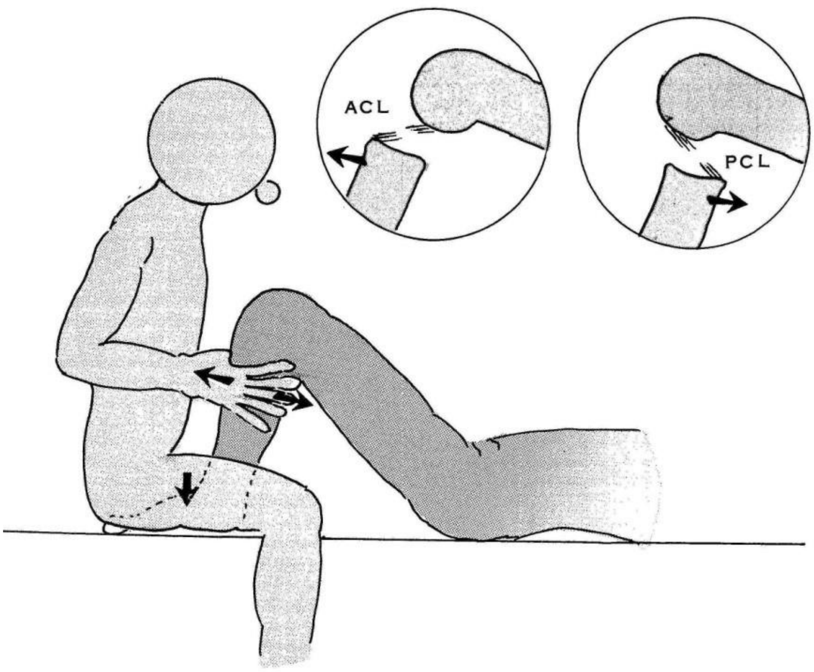
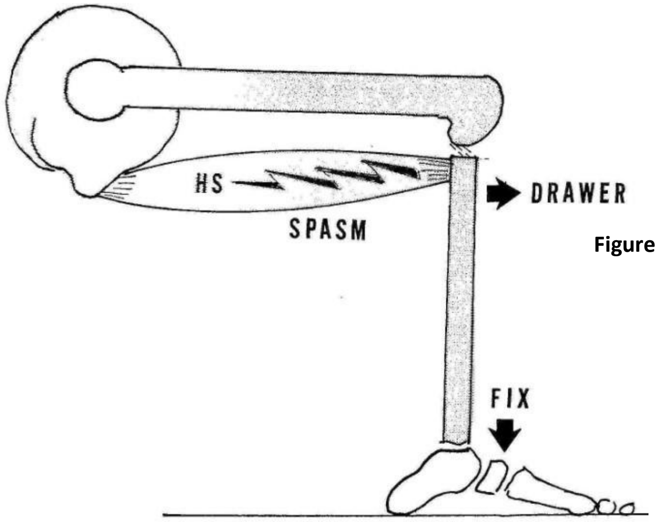


Figure 32 The drawer sign test

With the patient supine and the knee flexed to 90^o, the examiner holds the foot down (small vertical arrow) and passively shifts the lower leg forwards and backwards on the femur (small horizontal arrows). Bringing the leg towards the examiner tests the ACL and pushing the leg away tests the PCL.



A false negative test can result from excess tension in the hamstrings (Fig. 33)

Figure 33 False negative drawer sign from hamstring spasm

This prevents translation of the tibia on the femur, which prevents movement, implying an intact cruciate ligament that may be damaged

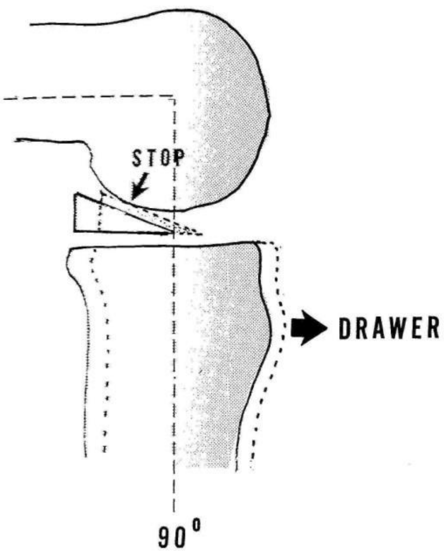


Figure 34 False negative from torn meniscus

A torn meniscus wedged between the femoral condyles and the tibial plateau may act to prevent anterior translation of the tibia, giving the idea that the ACL is intact, when it may be torn

A more specific test is the Lachman test (Fig 35). With the patient supine, the leg is flexed to 15° (from straight). The thigh is stabilised and an upward (anterior) shear is put through the upper end of the tibia; excess shift is diagnostic.

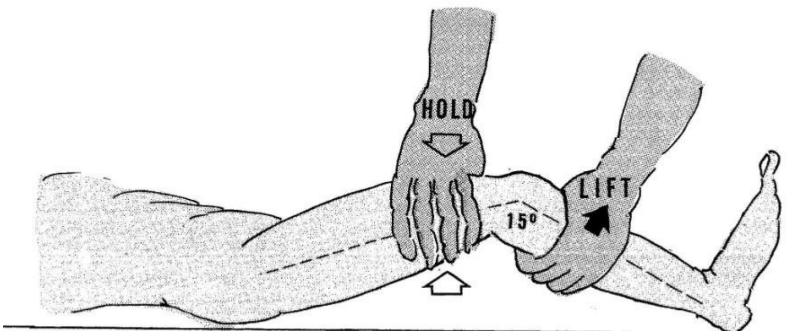


Figure 35 The Lachman test

The knee is flexed to about 15°. The thigh is stabilised, and the lower hand gently lifts the tibia. The distance is measured and compared with the good side, thus testing the anterior cruciate. Note the thumb of the lower hand is placed over the tibial tubercle, hence measuring the distance moved by the tibia more accurately.

This technique can be performed prone via the reverse Lachman (Fig. 36) and the rotator instability test (Fig 36)

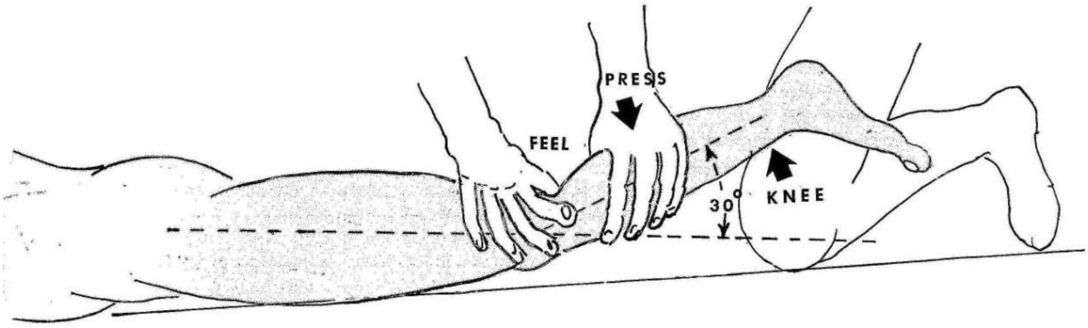


Figure 36 Reverse Lachman test

Here the patient is prone with the leg flexed to about 30°. The examiner's leg is placed under the ankle to hold that position. The lower thigh is stabilised in the popliteal space and the tibia pressed down towards the table, stressing the ACL.

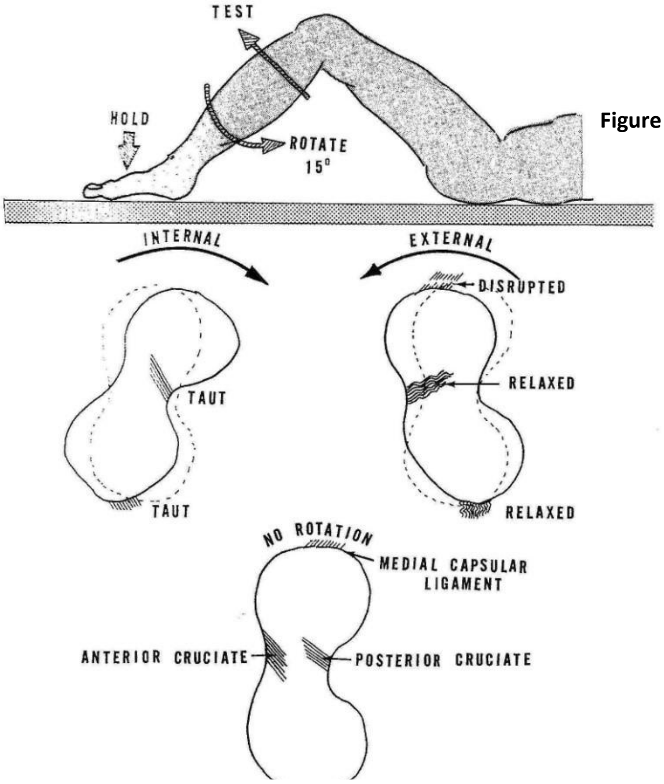


Figure 37 Rotation instability of cruciate ligaments

With the examiner holding the patient's leg, as in the drawer test, the examiner rotates the leg internally and externally 15° testing the cruciate ligament while also performing the drawer test. When the tibia is internally rotated, the posterior cruciate is taut. If it is externally rotated, the anterior cruciate is taut. Excessive motion indicates laxity or tear of a cruciate. The collaterals and capsule can also restrict movement.

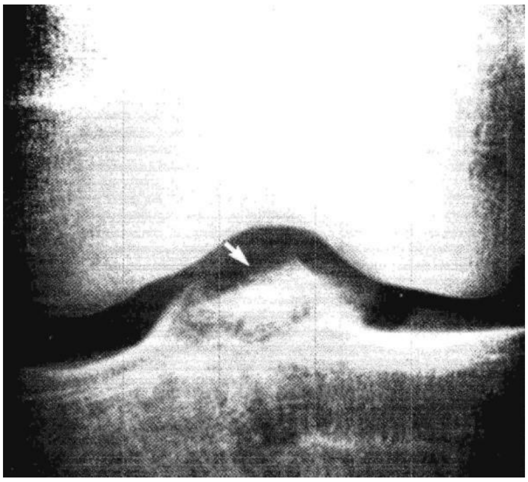


Figure 38 Avulsion of the tibial spine

Knee of a 27-year-old squash player showing avulsion tibia spine, where ACL attaches. At that moment he experienced extreme pain and heard a 'pop' in the joint; this is not uncommon in ACL disruption. If not recognised, it can lead to severe, chronic, instability. In that case the avulsed fragment was fixed back into place with a screw.

Treatment

Anterior Cruciate

Conservative treatment is preferred with strengthening of the hamstrings; however a complete tear can be repaired via autograft from the patellar ligament or an anterior reflection of a tendon from semimembranosus. Vitamin C and Glucosamine supplements can be of benefit here also.

Posterior Cruciate

This is stronger and less commonly injured. Here the increased tension in the hamstrings should be avoided.

Medial Collateral

This is tightest with the knee straight and, as was said above, is the most injured. Grade 1 and 2 sprains respond well to conservative treatment. Surgery, though, is controversial even for grade 3 sprains.

The MCL is densely innervated with both mechanoreceptors and free endings. These were previously assumed to prevent the knee from doing abnormal movements. Now, though, it has been shown that these reflexes are too slow to prevent injury in inadvertent movements; they contribute to normal coordination via the γ - muscle system.

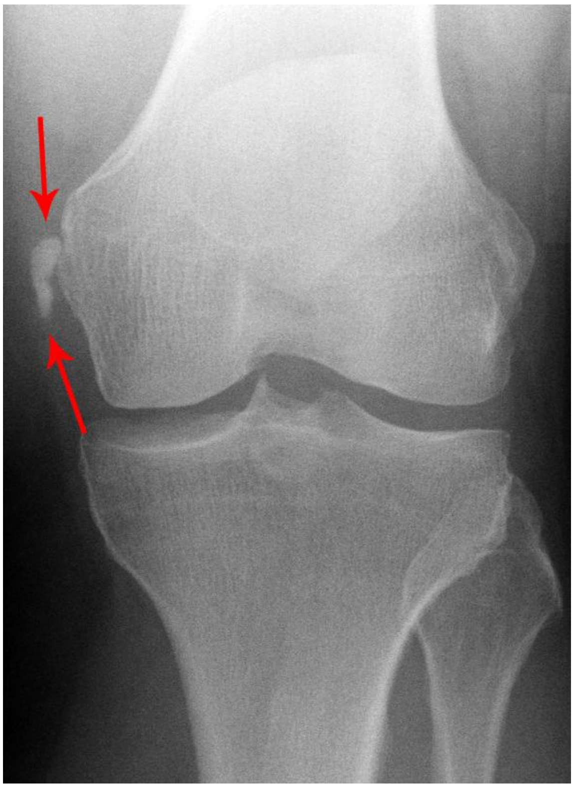
Here, therefore, a treatment scheme must include a sensory (proprioceptive) role of these ligaments in retaining normal knee functioning. If there is a severe sprain/rupture, there can be massive scar formation during healing which may affect its functional properties.

The areas of the ligaments with which most innervation are the proximal and distal ends, with relatively few in the middle (this may be the body's 'knowledge' of physics that states that is a wire is stretched, the tension is expressed at the ends of the wire).

Decreased proprioception may predispose to further injury and possibly O/A changes in a mobile joint.

Pelligrini - Stieda lesion

This is heterotopic ossification of the MCL. It is an indication of a significant of previous injury, where calcification of the ligament occurs to help reinforce the chronic sprain. It can appear secondary to partial avulsion.



X-Ray of knee of a 19-year-old badminton player who had injured the joint eight months previously. The MCL was still slightly tender on firm palpation, and examination revealed a valgus instability of the joint due to the MCL damage. The lesion is arrowed is an area of calcification of the MCL

Figure 39 Pelligrini-Stieda syndrome

Meniscal Injuries

As was stated earlier, because of their shape, the menisci contribute to the stability of the joint and to the nutrition of the joint surfaces (fig 39). The hyaline cartilage covering the medial tibial plateau is three times thicker than that of the lateral; it is therefore more capable of absorbing impact.

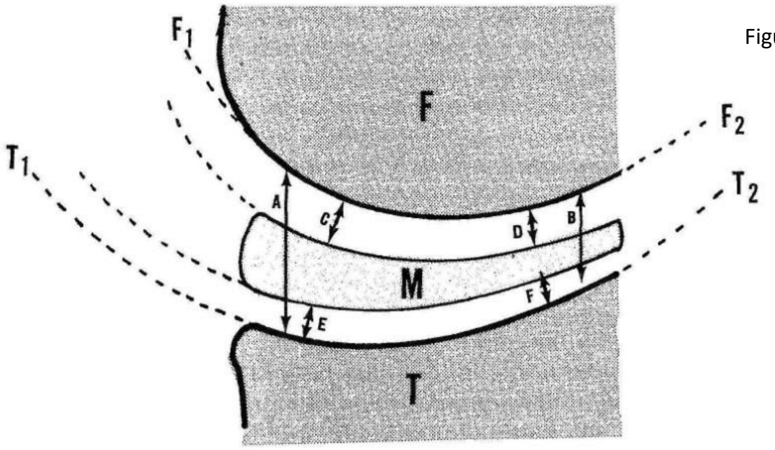
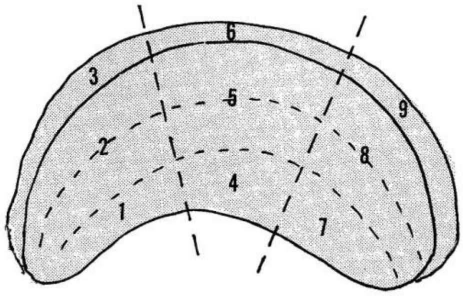


Figure 40 Hydrodynamic lubrication of the knee

The incongruous joint space between the femoral condyles (F1 - F2 on F) and the tibial plateau (T1 - T2 on T) is made more congruous by the insertion of the meniscus (M). The incongruous joint surfaces are unequal at A and B. The space between the meniscus and femur is more equal at C and D and at E and F, which is the now congruent joint space.



The diameter of the medial meniscus is larger compare with the lateral. The anterior horn is thinner and narrower than the posterior, and the meniscus is divided into three distinct zones (fig 41)

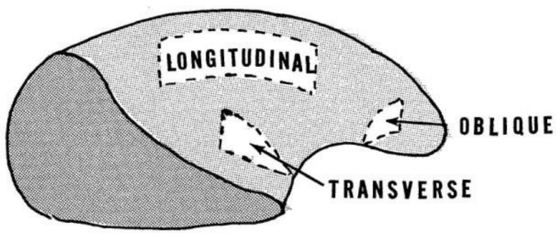
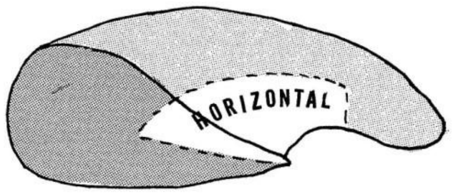


Figure 41 Primary meniscal tear patterns

This diagram shows the three distinct zones and the primary meniscal tear patterns. The upper drawing depicts a method to specify the zone of the site of the lesion. The two lower drawings depict the type of tear that occurs in any of the specific zones and their designations



The outer 1/3 is of circumferential fibres and is the only zone that receives a blood supply (Fig. 14). The inner 2/3 contains fibres that run transversely (radially; inner edge to outer edge) and are divided by thickened layers termed the **middle perforating bundle** (MPB). The direction of these layer bundles in important in understanding how the meniscus in injured when torn.

The menisci move with the femur on the tibia, moving posterior with flexion and anterior with extension.   During aberrant movement, the menisci may be get trapped between the opposite articulating surfaces. This can result in injury with torque/torsion/rotation, compression or traction. Various knee activities have been suggested, but faulty femur/tibia action is predominant. (fig 42 and 43)

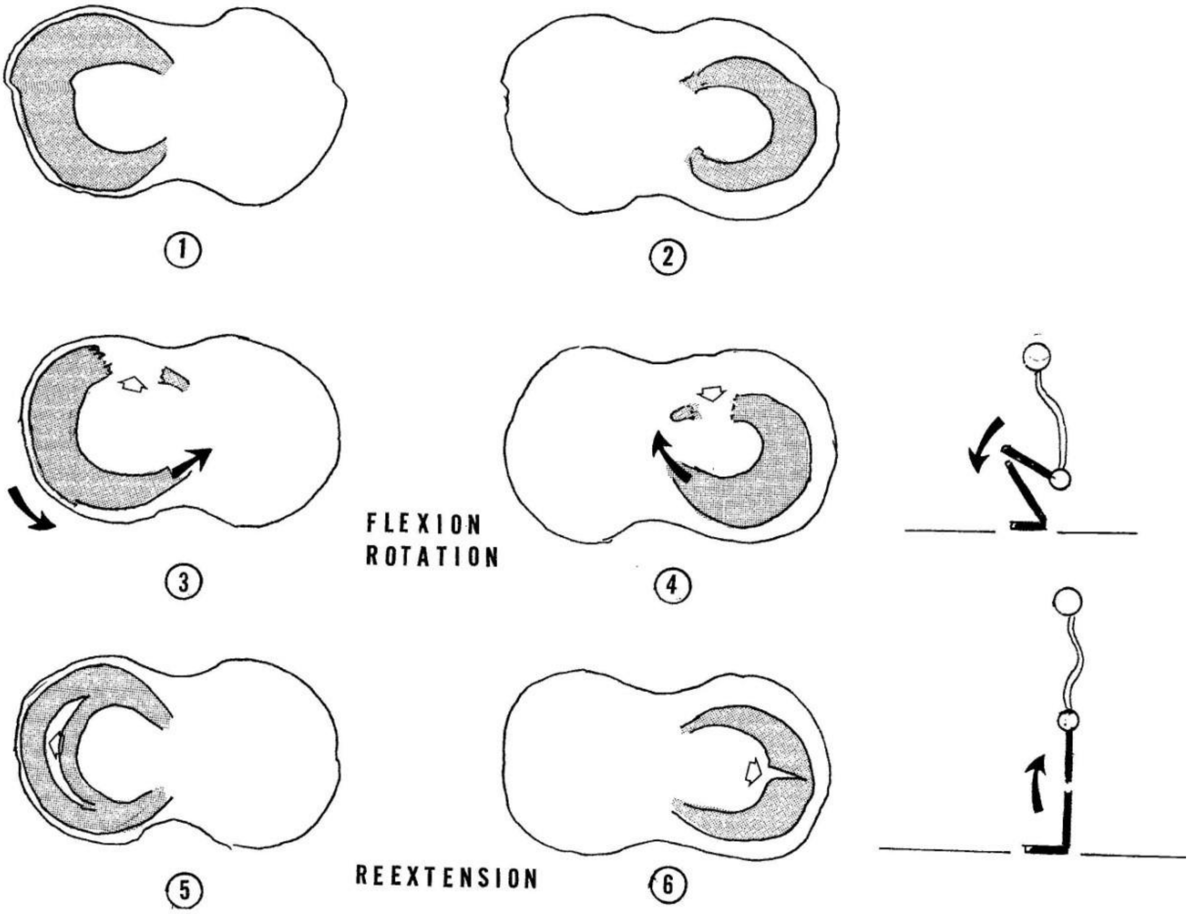
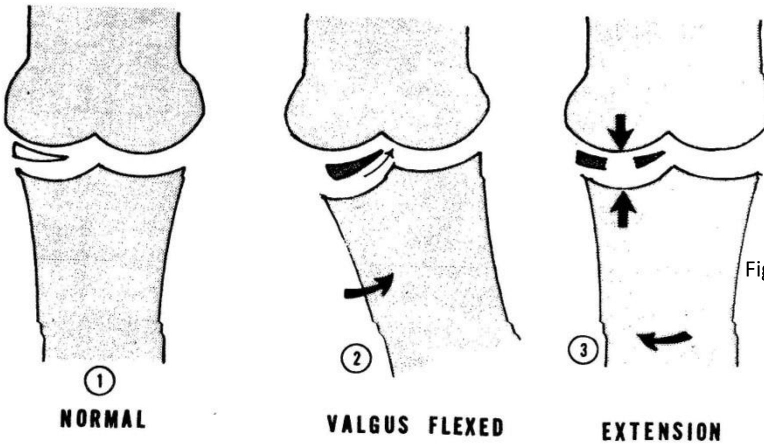


Figure 42 Mechanism of meniscal tear

There are a variety of meniscal tear.

1. Is the normal medial meniscus
2. Is the normal lateral meniscus
3. Is a tear (white arrow) of the anterior portion of the meniscus from internal rotation and flexion
4. Is an anterior lateral meniscal tear from flexion and external rotation
5. Is a 'bucket handle' tear, usually from re-extension and de-rotation
6. Is a radial tear. Rotation with flexion and extension must be in the unphysiological motion



A significant external force causing a severe valgus, may injury the meniscus on knee extension

Figure 43 External forces injuring a meniscus

With meniscal injuries tenderness is elicited along the entire medial meniscal line, whereas a ear of the lateral meniscus causes tenderness only above or below the joint line. Joint locking is rare until effusion increases, causing either gradual locking or significant limitation. Audible clicking may be noted. Subsequent to this, atrophy maybe noted in the quadriceps muscle.

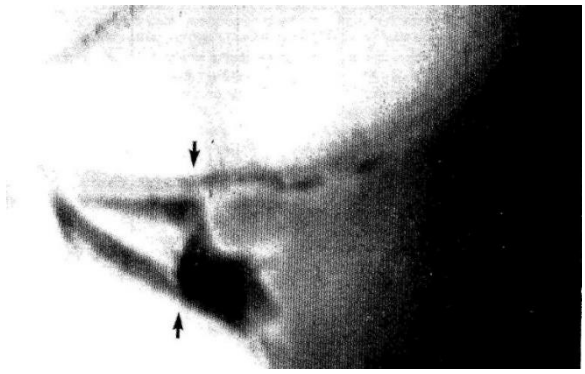


Figure 44 Medial meniscal tear

Arthrogram, showing a tear (arrowed) of the posterior horn of the medial meniscus of a 26-year-old cross-country runner.

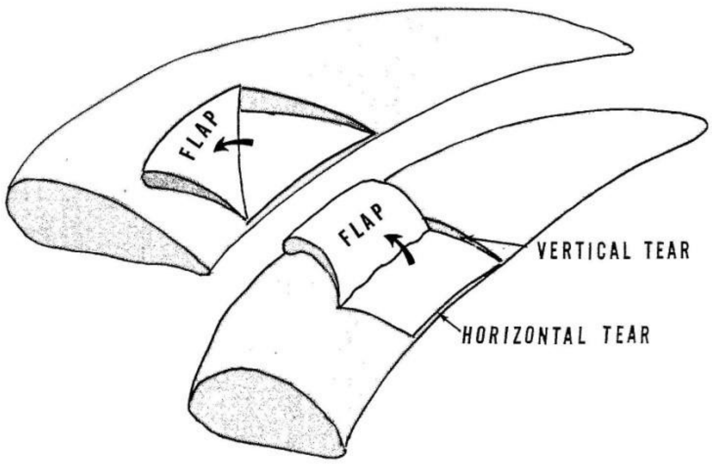


Figure 45 Flap tears of the meniscus

Longitudinal or vertical tears above the middle perforating bundle (MPB) may result in a superior flap, or an inferior one. These tears may be identified using arthroscopy or MRI

The tag can also fold back on itself; then the knee is in a real mess with gross locking and reduced range of movement. The transverse tear *probably* occurs more with age. If the meniscus tears completely, or is excised at surgery, the femoral condyle is now in contact with the tibia with no shock absorbing mechanism. This can predispose to O/A

Rotatory Forces - Generally:

- Medial rotation affects the medial meniscus
- Lateral rotation affects the lateral meniscus

Medial rotation

- Tends to force the inner part of the meniscus towards the centre (away from the periphery)
- Grinds the inferior surface of the meniscus on the superior platform of the tibia

This causes:

1. A damaged inferior surface of the meniscus, this possibly being asymptomatic, and can predispose meniscosis (degeneration of the meniscus). With repetition of the trauma, it may cause a longitudinal split, like a bucket handle, e.g. people who get up from crouching: coal miners, decorators, plumbers etc.
2. Overstretch or partial tear of the coronary ligaments. Here medial rotation can easily be associated with an increased valgus. With this, flexion is significant to localise the damage, i.e.
    a. Flexion - posterior ligaments
    b. Extension - anterior ligaments

Repetitive traumata can lead to a hypermobile meniscus, e.g. in cricket, football, squash, are all prone to this.

- Transverse tear - rare clinically, but more common in the medial meniscus in the region of the medial collateral ligament, and usually occurs in excess extension of the femur on the tibia.

Coronary ligament injury occurs in rotation associated with flexion. The patient will have pain immediately at the side of the knee and may fall to the ground but will then play on. There will be swelling that day, with the person limping the following day. On examination there will be swelling and warmth in the knee.

Range of movement:

- Active
    - Extension limited by 5^o
    - Flexion painful, but no real decrease in ROM
- Passive
    - Extension very painful, because the meniscus has moved anterior with a stretch of the coronary ligaments
    - Medial/lateral gapping should be normal
    - Progress - if untreated, the warmth and swelling will persist for several months

Unhappy triad of O'Donoghue
This is a combined injury to the three structures of the medial meniscus, the anterior cruciate and the medial collateral ligament.

Figure 46 Unhappy triad of O'Donoghue

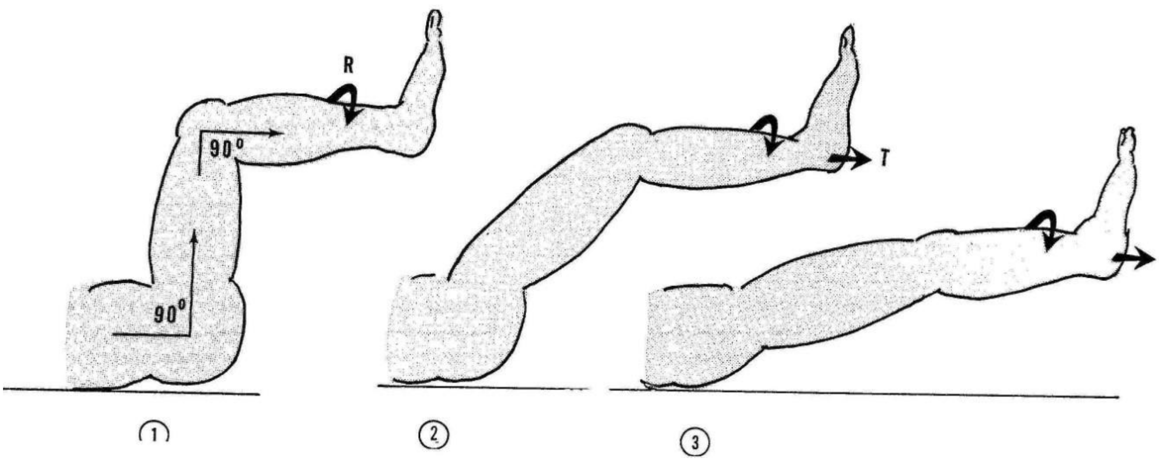
A rugby player's left leg is trapped with his tackler's leg is acting as a fulcrum. The tibia is being forced forwards (see arrow). Marked anterior displacement of the tibia has occurred and this has produced a tear of the anterior cruciate, the medial collateral and the medial meniscus.

Tests for meniscal damage

McMurray's (fig 47)

- Pt supine
- Hip and knee flexed to 90° (and dorsiflex ankle)
- Rotate leg internally of femur
- Slowly extend knee
- Any crepitation, pain or limitation of movement is positive for medial meniscus
- If a lateral meniscus is suspected, it is done with lateral rotation

Figure 47 McMurray's test



Appley's Test (fig 48)

Fig 1 (left)

- Pt prone
- Knee flexed to 90º
- Compression down along tibia
- Rotate leg on femur (here knee is **not** extended)
- Rotation medially tested for medial meniscus
- Rotation laterally for lateral meniscus

Fig 2 (right)

- With the patient in the same position, the leg is tractioned
- Rotating the tibia test the collaterals

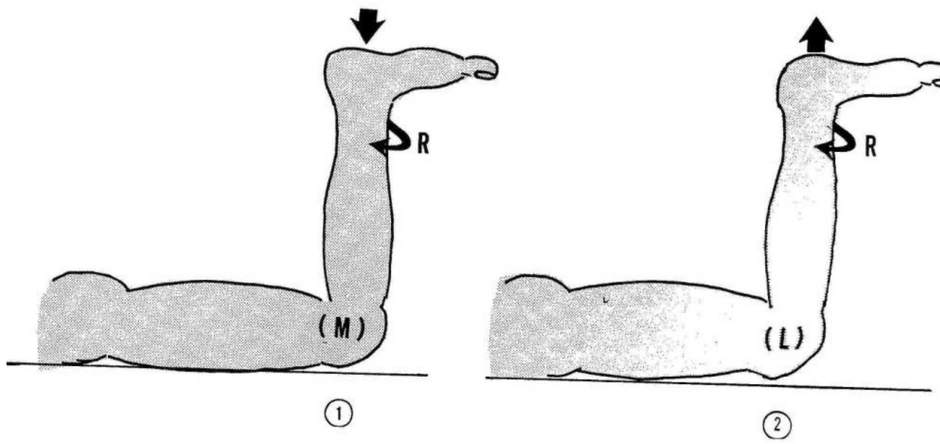


Figure 48 Appley's Test

The Appley's test is similar in method for testing meniscal tear, but is also considered differential diagnosis of collateral ligament tear.

Others

- Arthroscopy
- MRI

Of these two the MRI is less invasive, but with arthroscopy any damage can be addressed and repaired immediately with surgery.

Treatment

The healing process depends upon the site, type an extent of the injury. Tears within the inner, avascular, regions do not heal (or at least very slowly with the possibly of re-damaging with activity. Usually here only surgical intervention through removal or modification of the torn fragment decreases friction on the articular cartilage will allow recovery. A locked knee from a torn fragment should be reduced within 24 hours, because prolonged locking causes the meniscus to lose its elasticity (but not permanently) and slow its return to normal. The knee may also be manipulated; quads exercises should follow.

'Clicking knee', possibly with pain

1. Patellar engagement in intercondylar groove. This usually occurs at about 130^{o} of flexion, when it comes into contact with the additional facets. Here there is no pain.
2. Increased mobility of lateral meniscus
3. Children with discoid meniscus. This is a congenital abnormality. During early development, the menisci are circular. Then the inner section is reabsorbed, leaving the final semilunar shape. Below 10 years of age there may be an audible and palpable 'click' with flexion and extension.
4. Recurrent mild subluxations of the tibia under the femur with extension (i.e. exaggeration of movement in forward shift and lateral rotation). This is common in infants and people with hyperlaxity of the capsule
5. Meniscal tear. Here the patients are usually older, with irregularities of the articular surfaces
6. 'Snapping' of tendons around the joint, especially with biceps femoris and semimembranosus. It usually occurs after injury with resultant bony prominence or exostosis (after a blow or a tear)

Cyst on the meniscus

This usually occurs on the lateral meniscus. The patient complains of intermittent pain on the lateral aspect of the joint line or has attacks of internal derangement. The cyst creates a weakness in the meniscus, possibly imitating a tear, because of the decreased functioning/movement with weight bearing etc. Here there will possibly a history of trauma some months before.

On examination: there will show a small, hard swelling on the lateral joint line with the knee in full extension. Here, ask the patient to flex the knee. If it is a cyst on the meniscus, it will disappear. If the cyst is **outside** the joint, it will **not** disappear and will remain palpable. Treatment is by surgical excision.

Hypertensive hamstrings (semimembranosus)

Semimembranosus has several prints of attachment at the back of the knee.

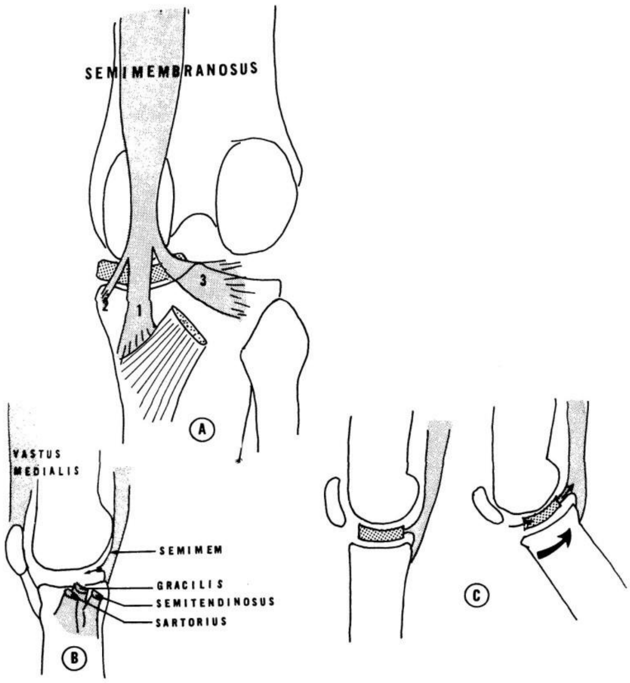


Figure 49 Semimembranosus

As the diagram shows, semimembranosus has several points of insertion at the back of the knee; one of these is on the joint capsule which is again attached to the medial meniscus. Contraction of the semimembranosus not only directly flexes the knee, but also pulls on the joint capsule and the medial meniscus, initiating it slide backwards on the tibial plateau.

If there is any residual tension in semimembranosus, it can cause a functional disorder. This will express itself in tension in the tendon of semimembranosus, in its persisting pulling action on the medial meniscus. This will deny the meniscus its full range of motion forwards, especially with full extension of the knee. The result of this is a dysfunction resulting in a 'pinching' on the medial meniscus, precipitating pain around the medial joint line of the knee.

This denial of full extension will consequently deny full ligamentous locking of the knee and the quadriceps will be forced to maintain some tension, possibly palpated as a restricted patella.

The patient may complain of:

- Pain on the medial joint line of the knee
- Hypertension in the quadriceps

Palpation may demonstrate

- Hypertension in the quadriceps, especially deep, like it is fixed down to the femur
- Reduced patellar mobility
- A small line of fascial tension on the medial joint line at the back of the knee
- Restriction in full extension of the knee, noted via pushing the joint towards hyperextension

It can be treated by

- Treatment of the relevant affected muscle groups
- Myofascial release to the affected tendon fibres at the back of the medial side of the knee
- Articulation of the knee and medial meniscus
    - Support the knee at the foot and the knee
    - Dorsiflex and externally rotate the foot (fixing the ankle and externally rotating the tibia)
    - Flex the knee fully
    - Push the knee medially (to medially gap the joint)
    - Using an oscillatory motion, articulate the knee, allowing it to fall gently into full extension; at the same time reducing the external rotation of the tibia
    - Repeat several time
    - Check the mobility of the medial meniscus via medial/lateral gapping
    - If there is still dysfunction, repeat until it feels normal

Anterior Knee Pain

Pain and disability in the patellofemoral joint is commonly known to be the most prevalent type of knee pain, especially in younger people.

Fracture of the patella

Here there would almost certainly be a history of trauma, like an impact injury (hitting something, or being hit); however routine radiological examination may reveal a bipartite patella, which may be confused with a fracture.

A 'sky-line' view. Here is seen a patella of a 20-year-old hockey player

Lateral Bipartite Patella - AP and Skyview

Patellar dislocation/subluxation

Total and partial dislocations of the kneecap generally occur because of a glancing blow to the front of the knee and are intensely painful. The kneecap is normally seen to lie on the lateral side of the knee and often has to be pushed back. Occasionally an anaesthetic may be required to achieve this. the traditional treatment was plaster for 6 weeks but now it is considered better to get the knee moving as soon as possible after the injury. A splint may be worn for the first week or so until the swelling subsides then early active movement is encouraged. If a second dislocation occurs surgery may be required to repair the structures around the kneecap. Sometimes a piece of bone and cartilage is knocked off the kneecap in the injury (osteochondral fracture) and may become a loose body.

Figure 50 Dislocation of the patella

In some people the joint behind the kneecap does not develop fully or the leg may develop with a twist in it. Such people may suffer from recurrent dislocations and the treatment of such people may be more problematic and require realignment procedures of the kneecap.

Patellar maltracking

As the name suggests, this is when the kneecap (patella) does not run properly in the groove on the front of the knee (trochlear). There are many causes for this including muscle imbalance in the quadriceps, maldevelopment of the trochlear or patella, malrotation of the femur and foot pathology. The main symptom of maltracking is pain but severe maltracking may be the underlying cause for recurrent patellar dislocation. Chronic maltracking over many years may lead to patello-femoral arthritis.

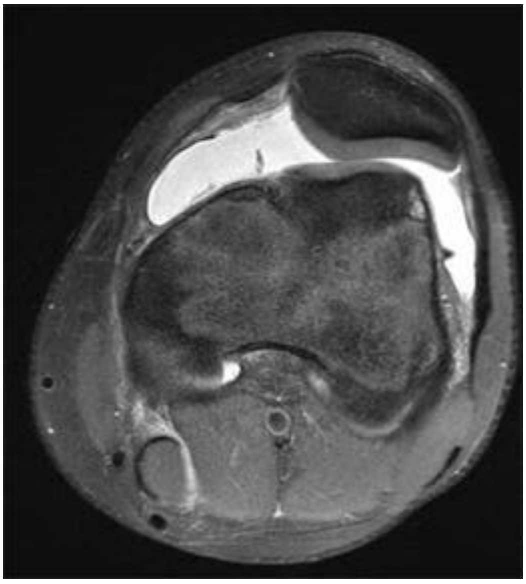


Figure 51 Patellar maltracking

The treatment for patellar maltracking is addressed to its underlying cause and treatments range from physiotherapy and insoles to major reconstructive surgery.

Plicas

Plicas are remnants of tissue from when the knee was developing and appear as crescenteric bands of tissue within the lining of the knee. Small plicas are normal within the knee, but large plicas can get pinched in the knee, normally in the patello-femoral joint. This causes inflammation and pain. The inflammation can lead to a thickening of the plica making it more likely to be pinched. Arthroscopic removal of the plica resolves the symptoms.

Figure 52 Plica in knee

Athletes that do repetitive deep flexion and extension movements of the knee, such as cyclists, and people who kneel at work are most likely to suffer from plicas.

Figure 53 Bipartite patella

Chondromalacia Patellae (CMP)

As the name suggests, it is a disease of the cartilage under the patella. There are four stages of this, determined by the level of cartilage damage:

1. Softening of cartilage
2. Blister formation
3. Ulceration
4. Crater formation and eburnation

Its causes can be anatomical and biomechanical. The common factors are:

a) Tightness of the lateral structures e.g. vastus lateralis, ITT and can be worse if associated with a weakness of vastus medialis. The end result of all these factors is the patella moving more laterally with knee flexion/extension
b) Increased Q-angle. The pull of the vastus intermedius from the anterior femur, and of the rectus femoris from the AIIS passes down to the patella, and thence to the tibial tubercle. Therefore, the patella acts as a 'straightener' of the pull of the quads. This can cause a 'bowstring' effect, which can cause, or predispose to, the patella dislocating laterally. The Q-angle is normally 10-15^{o} and an increased Q-angle is a predisposing factor to CMP
c) Patella Alta - (high patella). This could be:
    i. Congenital
    ii. Because of trauma, e.g. stretch of the ligamentum patellae, or strain/tear of the quads with consequent contraction/shortening from scar tissue
    iii. From tibial torsion; secondary to cruciate dysfunction

Clinical presentation of CMP

- Young adults: 25 - 26+
- Active in sport: running, jogging etc
- Young female doing keep fit
- Ballet
- Aerobics

Symptoms

- Pain, aches, soreness around or under the patella

Aggravating factors

- Going uphill/stairs
- Following excess sitting ('need' to get the leg straight)
- Deep knee bends
- Getting up from sitting

On examination

- Need to be able to reproduce the patients' pain
- Movement normally pain free, except with extreme flexion
- Joint crepitis with flexion/extension
- Sometimes mild effusion
- If severe, signs of apprehension with passive movement of the patella
- Active resisted extension from 90^{o} produces pain
- Restricted laterally, especially with gapping

- Check Q-angle

X-Ray

- A/P will show nothing, need tangential X-Ray

X-Rays can be beneficial, but diagnosis is primarily by clinical examination.

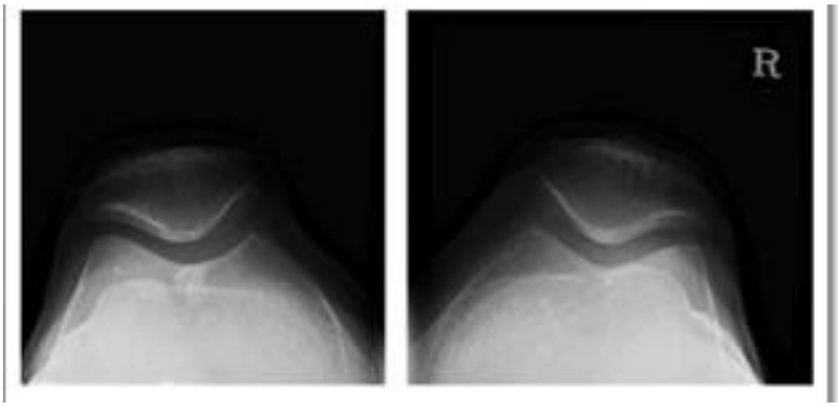


Figure 55 CMP - here note the lateral 'pull' on the patella, such that the articular surfaces are not 'parallel'

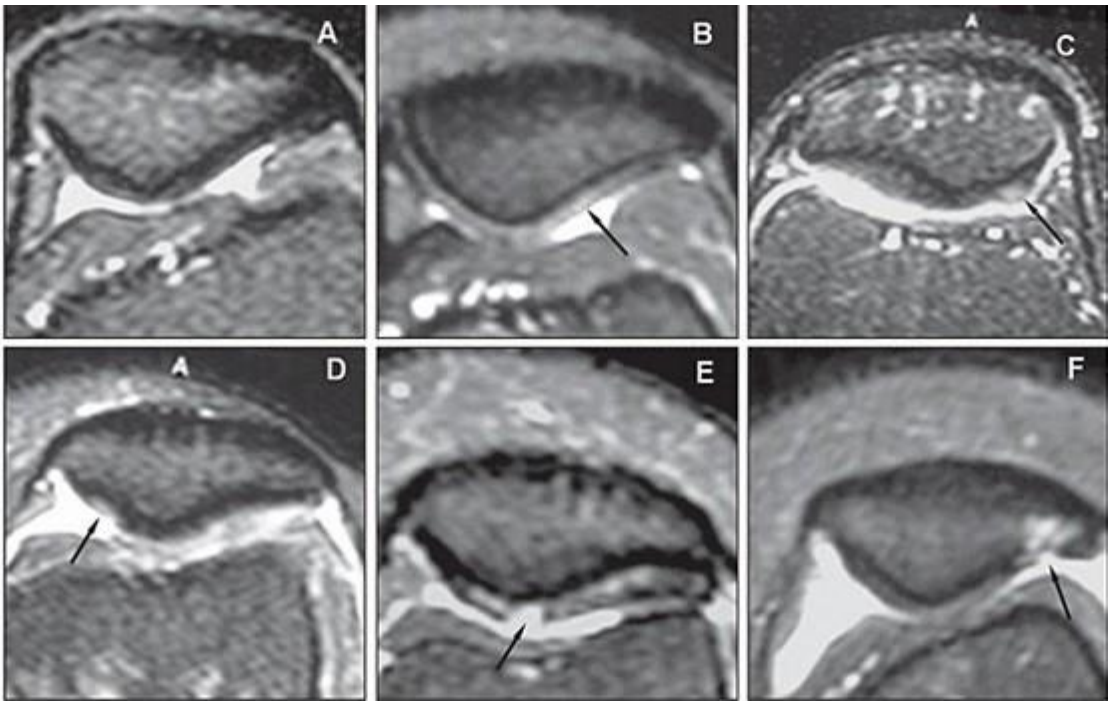


Figure 56 Chondromalacia patellae on

MRI

High field slices of CMP showing rating of CMP: A - Grade 1: cartilage presenting abnormal signal. B - or cartilage presenting abnormal signal and concave contour, without fissures or erosion. C - Grade 2: chondral fissure or erosion without subchondral bony exposure. D - Grade 3: chondral fissure with subchondral body exposure. E and F chondral fissure with subchondral body exposure or signal alteration

View of CMP with arthroscopy

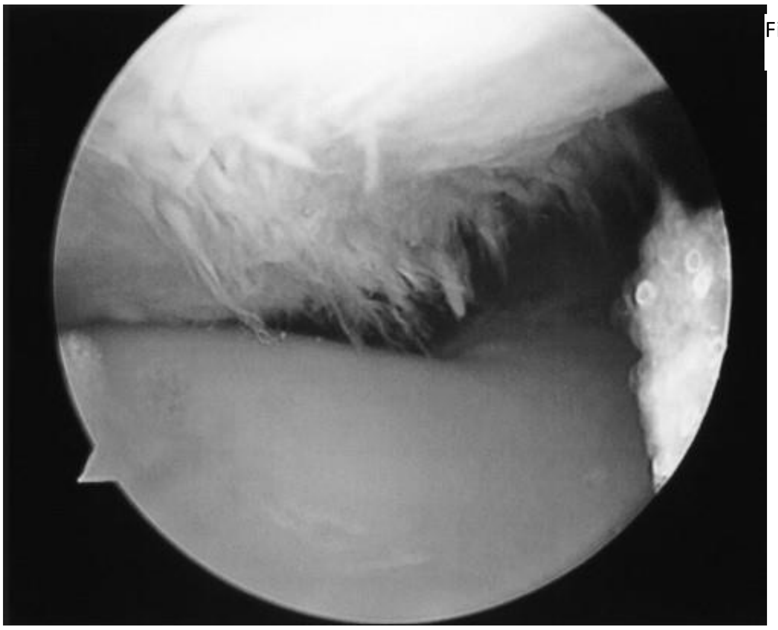


Figure 57 Chondromalacia patellae on arthroscopy

Arthroscopy shows the softening of the cartilage, with cartilage disruption and characteristic 'crabmeat' fraying

Differential diagnosis of CMP (other things that can produce similar symptoms):

- R/A
- Synovitis
- Referred pain from the S/I joint, via the femoral nerve or myofascial pull
- Osteochondritis dissecans

Pathology

With macroscopic examination, normal hyaline cartilage is a bluish-white. With CMP this becomes yellow, opaque and soft, with cracks and fissures appearing. Irregular wear and tear exposes bone in severe cases, with consequent osteophyte formation.

Treatment

Long conservative treatment should be the preferred option before any decision for surgical intervention is taken.

Avoidance of any or all of pain producing activities:

1) **Rest -** stop jogging etc., even though it seems to ease the pain. Such people tends to 'run through it', but it will make it worse each time. They may have found a 'trick' for themselves by turning the toes inwards; an action that reduces the Q-angle
2) **No kneeling** - avoid excess sitting with the legs bent, or straighten the legs under the desk. Use the arms to assist getting up from sitting. Avoid stairs.
3) **Ice** - in acute stages. 10 mins every 3 hours
4) **Moist heat** - hot wet towel, or hot gel pack/water bottle wrapped in wet towel for 15-20 mins at a time for as long as necessary
5) **NSAI's -** as required
6) **Hands - on treatment** - ASAP:

a. Massage to quads; knee to ASIS especially vastus lateralis
b. Massage to all lateral structures: ITT, hip abductors and capsuloligamentous structures of knee
c. Distraction of the patella, traction and articulation of the knee with the knee internally rotated, DLR, to reduce the Q-angle

7) Exercises - should start as soon as pain is diminishing:
   a. Straight leg raising - supine/sitting, with leg externally rotated. This will create a focus on vastus medialis.
   b. As it improves, continue with 8-10 lbs weights on the ankle; or as an isometric exercise lifting the leg to 30º from the horizontal (x10); once a day to start, increasing gradually and progressively and **always slowly**.
   c. As the patient becomes asymptomatic, a graduated programme of running can be established; the patient **must** apply ice **immediately** after each run and moist heat 2- 3 hours later
   d. Glucosamine treatment as treatment and prophylactic
      i. Anything between 5-10g per day, initially
      ii. Decreasing to 2g as they become pain free

Affecting factors of CMP

A. Broad pelvis - will increase the Q-angle and any genu-valgum, altering the tracking of the patella
B. Hip joint mobility - a significant lateral rotation with a reduced medial rotation may cause feet to turn out (increasing Q-angle)
C. Pes planus - can increase the medial gapping of the knee joint and therefore increase the Q-angle

Chronic knee pain

This can occur from degenerative arthritic changes or a neuroma in the retinaculum

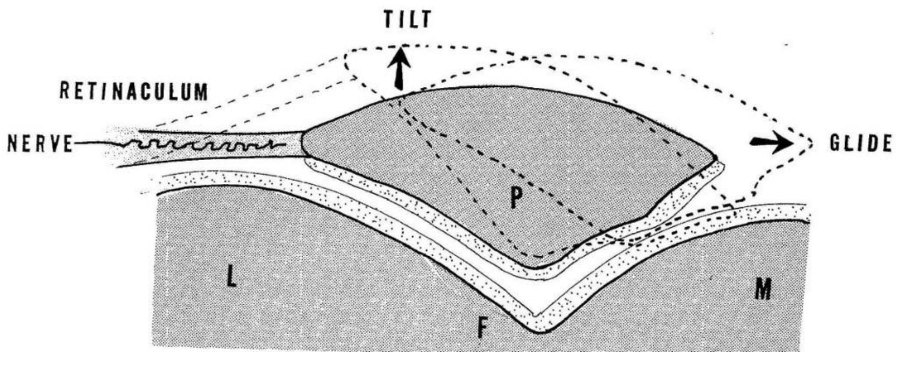


Figure 58 Degenerative arthritis with neuroma

Degenerative arthritis and neuroma in patellofemoral disease. The predominant wearing of the patellofemoral cartilage occurs more frequently on the lateral aspect (L) (small dark arrows). A neuroma can occur in the contracted retinaculum, especially if surgical intervention has occurred to realign the patella.
It could also be seen to be tension in the gluteus medius and minimus expressing itself through the iliotibial tract (on top of vastus lateralis)

Osgood-Schlatter's Disease

This is an inflammation of the epiphysis at the tibial tubercle, at the point of insertion of the ligamentum patellae (i.e. the quads). The tibial tubercle is enlarged and tender, with that pain being worse with exertion/physical activity. It only occurs during growth years and especially in teenagers (e.g. 13 years old). Their love of sport tends to involve them in a number of activities and sports, and it is entirely likely that they play in a number of different (running) sports.

Figure 59 Osgood Schlatter's Disease

With this there may be pressure from their individual teachers/trainers of those sporting activities to work hard in their particular sport, without taking into consideration the other activities in which the youth participates.

Fig 58 shows an X-Ray of Osgood-Schlatter. Note the wide epiphyseal space at the tibial tubercle. There appears to be increased density of the quads tendon and the ligamentum patellae, suggesting increased tonus of the quads.

Treatment

Osgood-Schlatter's is best treated conservatively.

- **Stop** the activity causing the pain (in acute phase)
- Massage the quads (and address any ongoing tension in the hamstrings contributing to this)
- Ice and homeopathic symphytum (comfrey) in acute phase

Most cases will settle (with treatment), although the condition may persist along up to skeletal maturity when the epiphyses fuse (about 20yoa)

Sinding-Larsen-Johansson Syndrome

Sinding-Larsen-Johansson syndrome is an injury affecting the proximal end of the ligamentum patellae at its attachment with the patella. It can also occur in young adolescents, especially if they participate in the sport basketball, or similar jumping sports. Being a fibro-cartilaginous injury, it can be slow healing.

Figure 60 Sinding-Larsen-Johansson syndrome

Treatment

- Stop the activity causing the pain
- Address any tension in the hamstrings
- Massage to the quads, gentle stretching
- Ice TTT in the acute phase, address gluteus medius and minimus
- Ruta
- Ultrasound

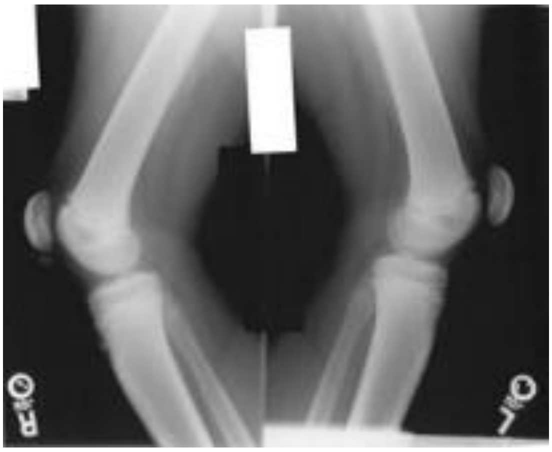


Figure 61 Sinding-Larsen-Johansson syndrome comparative X-ray

Loose body

Loose bodies are small pieces of bone or cartilage (or a combination of both) which float inside the cavity of the knee joint. They are most commonly the remnants of injuries to the knee such as cartilage tears, osteochondral fractures or of other conditions such as osteochondritis dissecans.

The main problems caused by loose bodies are instability and locking, that is an inability to move or straighten the knee joint. The locking is often painful and will require the sufferer to manipulate his or her knee to start the joint moving again. When this occurs, a click is often felt or heard.

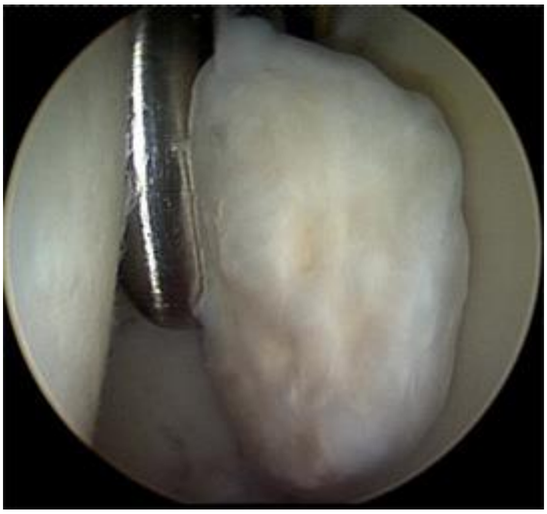


Figure 62 Loose body shown on arthroscopy

If loose bodies are problematic, they can be removed arthroscopically.

Osteochondritis Dissecans

Osteochondritis dissecans is a condition that can be confused with meniscal injury, as it manifests as a combination of pain, swelling. Locking and giving way. As the name suggests, it is an inflammation of the bone and cartilage and may have an intra-articular loose body, when fragments of bone break off from the knee joint surface. It occurs in younger people where the epiphyseal plate has not yet fused.

Unlike arthritis of the knee, the degeneration of the knee joint occurs quite quickly. It affects the articular cartilage and subchondral bone (bone underneath the cartilage), which becomes separated from the rest of the bone. The fragments may be smooth and still sitting in their normal position - called a stable lesion - or it may become loosely attached to its bony base or detach to become a loose body within the joint space - an unstable lesion.

At the present time, the cause of OCD remains uncertain but previous trauma and ischaemia (inadequate blood supply) have been implicated.

Figure 63 Osteochondritis dissecans

A loose fragment is arrowed

Osteochondritis Dissecans Signs & Symptoms

Patients with Osteochondritis Dissecans (OCD) of the knee usually have localised pain and swelling, which can also include the knee locking or giving way as the disease progresses. The knee pain can increase with strenuous activity and twisting motions and a form of OCD will exhibit a painful 'clunk' when bending or straightening the knee.

An X-ray should pick up the majority of OCD lesions if the correct views are taken (antero-posterior, lateral and tunnel views). An MRI scan is very useful in OCD management decisions because it helps determine the size and quality of the fragment and reveals information about fragment stability.

Osteochondritis Dissecans Treatment

The goals of treatment for Osteochondritis Dissecans are to reduce pain, restore the continuity of the articular surface, and decrease the likelihood of future degenerative joint disease (osteoarthritis).

Treatment options are largely dependent upon the age of the patient and the position and stability of the lesion:

- Patients with lesions of the Lateral Femoral Condyle, the Patella and the Medial Femoral Condyle usually require surgery, since these lesions are less stable and therefore difficult to manage.
- In the case of a juvenile or young adult patient with a lesion in the Medial Femoral Condyle, and no evidence of fragment instability on X-ray,

conservative treatment is indicated. This involves modification of activity for 6-12 weeks to promote bone healing. In those patients for whom conservative treatment is not successful, surgery will be required.

- Surgery is recommended for any adult with OCD.

Degenerative Changes

This can occur at the patellofemoral joint, or between the femur and the tibia; the former being the most common.

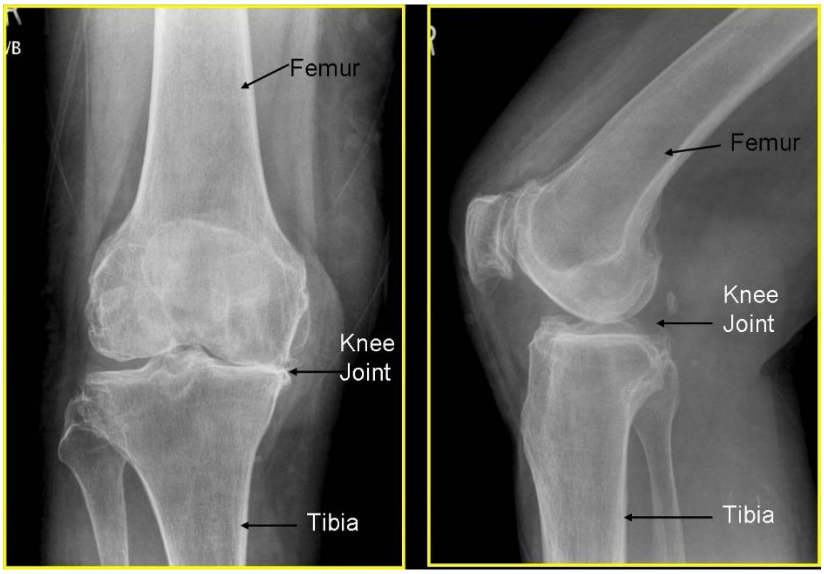


Figure 64 Osteoarthritis of the knee

O/A of knee. Note reduced joint space from 'wear and tear' and bony changes demonstrative of degeneration

In a normal knee, it *tends* towards extension. As the joint surfaces engage, the ligaments become tight and the joint locks, allowing the hamstrings and the quads to relax. This will allow the patella to become mobile.

If there is a mechanical problem within the knee, or a chronic tension pattern in the hamstring, full extension of the knee is denied. With this the quads will remain tight (to stabilise the knee with weight-bearing) and the patella will remain engaged in the intercondylar groove. As was mentioned earlier, the normal forces experienced by the patellofemoral joint can be 2-3 times the body's own weight, hence if there is a persistent tension in the quads there will be increased likelihood of degenerative changes at the patellofemoral joint.

On examination

What can be seen and felt depends upon how advanced the condition is. On palpation of the patella a lack of smoothness will be noted, possibly with an increase of depth of the joint, maybe even with crepitis.

Figure 65 Joint replacement in the knee

Treatment

- Massage to quads and hamstrings
- Distraction of patella
- Glucosamine and chondroitin supplements to help rebuild joint surfaces
- Flexiseq, if not too advanced
- Joint replacement, if advanced

This joint replacement is quite conservative with only the joint surfaces being removed and little bone replaced

Dysfunctions of muscles crossing the knee

Popliteus

In the normal knee, this muscle:

- Flexes the knee
- Laterally rotates the femur on the tibia, unlocking the knee such that it can flex
- Assists in stabilising the knee when going downstairs, crouching, skiing or hiking downhill, or walking in high heels

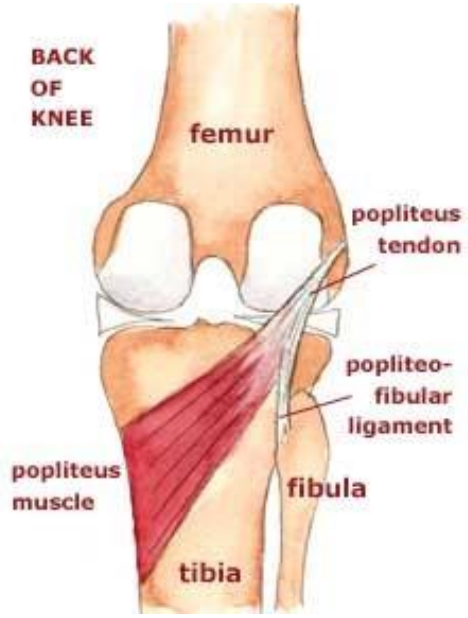


Figure 66 Popliteus

This muscle can be injured, frequently in an incident that the person cannot recall, but possibly from downhill running. Here popliteus acts as a 'brake', limiting the anterior shift of the lateral epicondyle of the femur on the tibia. This can cause a strain of the tendon or muscle, or as an overuse injury (RSI).

The pain is accurate and local to the lateral aspect of the joint. Palpate the joint just anterior to the LCL, at or above the joint line.

Diagnosis is via localisation of the pain

a) Patients squats - pain with full flexion and weight bearing, and at the end of flexion on the lateral side
b) Pain with active resisted - with flexion with medial rotation of the leg

Differential diagnosis

1. Inflammation and tear of the ITT
2. Hypertonic abductors, expressing itself down the ITT at the lateral knee
3. Lateral meniscus lesion or cyst
4. Biceps femoris tendon problem

Treatment

Friction to the belly of the tendon (not LCL) and check and correct any biomechanical problems (e.g. foot inversion, abductor muscles of hip)

Quadriceps

Quadriceps is especially important in walking etc., as it is 3 times more powerful than the flexors.

Haematoma

This is effectively a lump of blood in any of the quadriceps muscles, but most often occurring in

- Rectus femoris, when going to kick a ball and the foot kicking the ground instead. Here there is a forceful contraction against a fixed origin causing a tear in the muscle with consequent bleeding in the muscle
- A 'dead leg', when someone else knee comes in forceful contact with the outside of the thigh. The deep tissue bruising causes bleeding in the muscle

The injury consists of a well-defined sequence of events involving microscopic rupture and damage to muscle cells, macroscopic defects in muscle bellies, infiltrative bleeding, and inflammation. The repair of the tissue can be thought of as a race between remodelling and scar formation.

If the haematoma is small (i.e. an 'incomplete tear') it should not present too much of a problem. It can be treated with arnica, massage above and below the injury, until it heals by fibrosis. If the haematoma is large, it may need to drained via syringe.

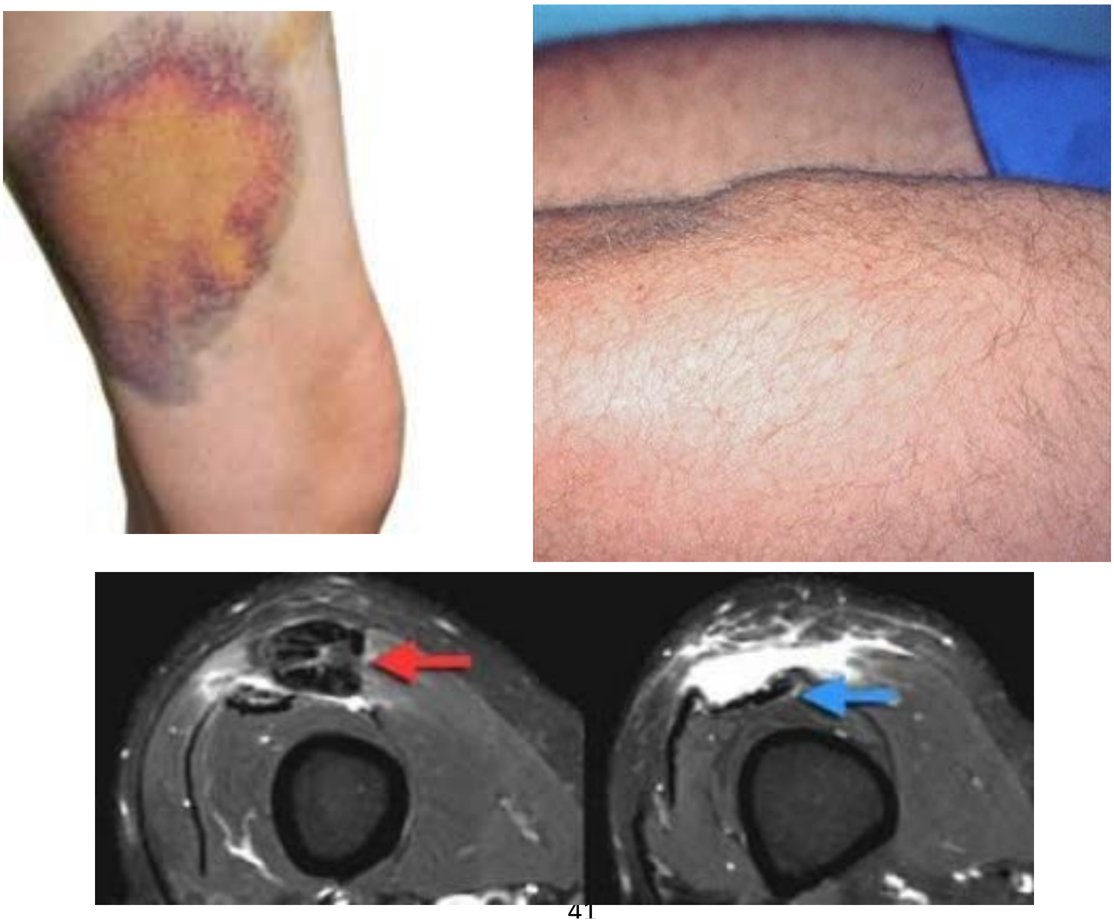


Figure 67 Various types of Haematoma

Adequate rest must be allowed before resuming full activity, else the body may try to heal any repetitive damage via calcification, leading to **myositis ossificans traumatica** (MOT)

MOT appears as a small mass, usually on the antero-lateral aspect of the thigh. It feels tender and warm (though not always) lump 2-3 weeks after the injury.

Osteosarcoma
These same symptoms can also manifest with Osteosarcoma (a virulent type of bone cancer) as MOT can also appear 10-12 months after the onset of the cancer.

It usually occurs in young adults (15 - 25 yoa) appearing at the ends of long bones, of these 60% appear at the lower end of the femur.

Symptoms

- Mass covered with shiny skin
- Occasional prominent veins
- Deep local pain, worse at night and with rest (this is because of local congestion and its increase in size)
- If it grows very quickly, it may even pulsate

It will be fixed (adherent to the bone, cf with MOT) and diagnosis is via X-ray

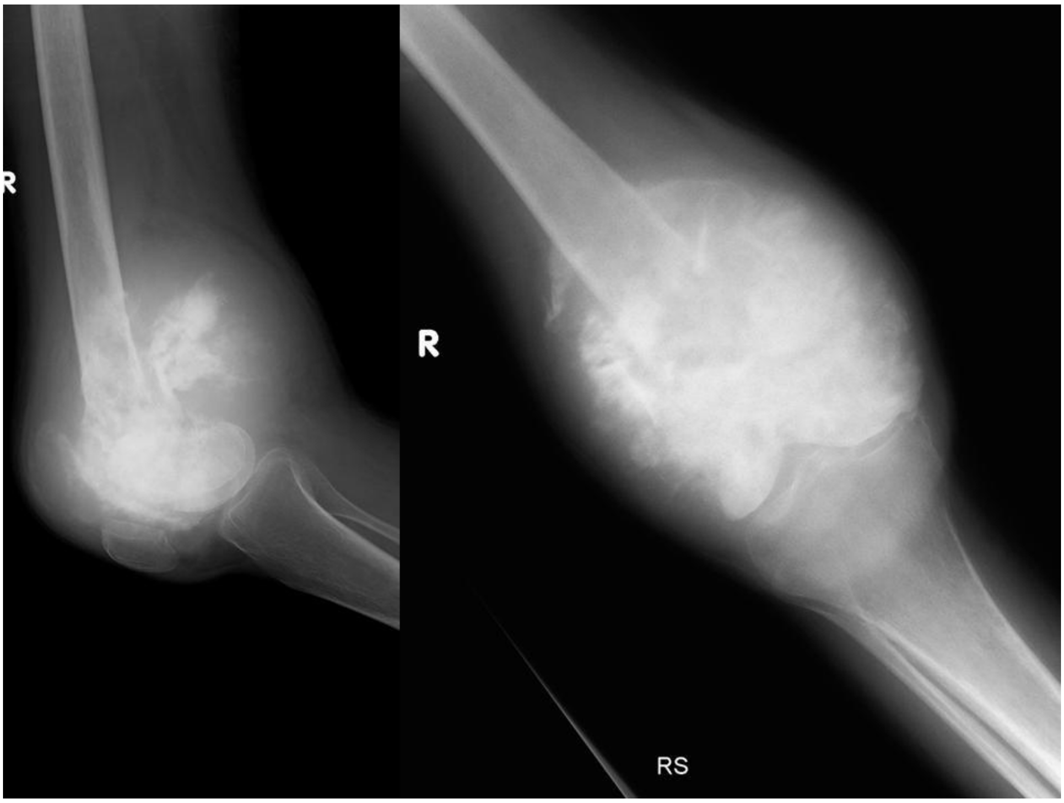


Figure 68 Osteosarcoma

This X-Ray shows its diagnostic characteristic of a 'sunray' appearance, with an ill-defined outline of bone with loss of trabeculae.

Treatment

- Surgery via amputation, is frequently immediate.
- X-ray treatment
- Chemotherapy

There is historical proof of Streptococcal Pyogenes infection acting to cure cancers of mesodermal origin (i.e. those in muscles and bones). This results from Tumour Necrosis Factor (TNF) being released as part of acute inflammation, but high fever (at least 104º F; 40º C) is essential as part of the healing crisis and orthodox medicine wouldn't allow that sort of fever.

Essiac or Floressence can also help healing

Running gait

In running there are two phases:

1. Support phase (when the foot is contact with the ground)
2. Airborne phase

Both of these are divided into three:

Support phase:

a) Heel strike
b) Mid-stance
c) Toe off

Airborne phase

a) Follow through
b) Forward swing
c) Foot descent

Generally, with running, there is a rhythmical, cyclical, movement. The foot hits the ground about 800-1000 times per mile (about 60-70 time per minute per foot) and hits the ground with about 3-8 times the body's weight. Ideally the shoe should absorb the force of this impact, though some athletes have demonstrated barefoot running (such as Abebe Bikila, Bruce Tulloh and Zola Budd). Insufficient shock absorption, or anatomical and biomechanical abnormality can lead to injury.

Hamstrings

These occupy the posterior compartment of the thigh and are frequently tight in active and sporty people. Muscles in this region are usually regarded as separate entities but should really be regarded as a continuum of the spinal and calf muscles; the hamstrings attach to the lower pelvis via the ischium, and the lumbar muscles attach to the top of the pelvis via the iliac crest.

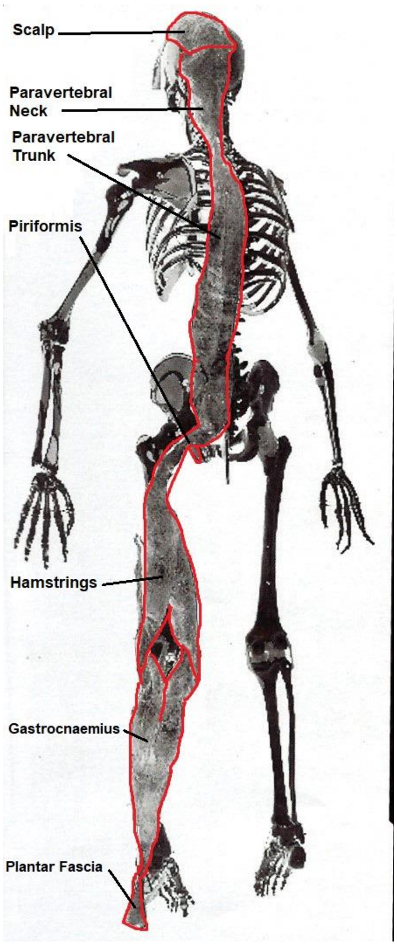


Figure 69 Hamstrings with low back and calf muscles

A dissection specimen, showing the continuity of the hamstrings with the gastrocnaemius and the back muscles

Hypertension in one group can thus express itself in the other group. Young people doing a lot of sport with very little warm up, warm down or stretching can develop tension such that normal function can be lost.

General lesions:

- Torn muscle - can occur at any part along its length, usually near the middle
- Avulsion fracture - a fracture at the point of attachment of a tendon from a forceful, sudden muscle contraction
- Cramp - an involuntary spasm in a muscle
- Chronic hypertension - causing a persistent pull at the attachments of the muscle and tendon. This can cause inflammation locally, or dysfunction of the knee via denial of full extension, with parallel tight quads and meniscal dysfunction

Biceps Femoris

This originates from two heads on the ischial tuberosity and linear aspera and inserts on the posterior head of the fibula.

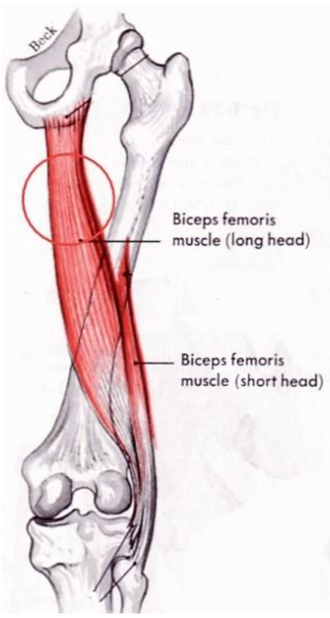


Figure 70 Biceps femoris

Hypertension in biceps femoris:

- Can cause pain on the lateral aspect of the knee
- Can mimic an LCL lesion pain
- Can cause irritation of the common peroneal nerve at the neck of the fibula, giving pain into the lateral and anterior compartments of the leg
- Will contribute to muscle fixation (stability) of the knee. If the muscle cannot relax fully, the knee cannot straighten fully in weight bearing. Thus, the quadriceps will have to maintain a state of tonus to stabilise the knee
- Can mimic anterior cruciate lesions, preventing anterior shift of the tibia

Semimembranosus

Semimembranosus originates at the ischial tuberosity and inserts on the medial side of the posterior tibia

It also has attachments on the posterior capsule, so assists the posterior movement of the medial meniscus in knee flexion

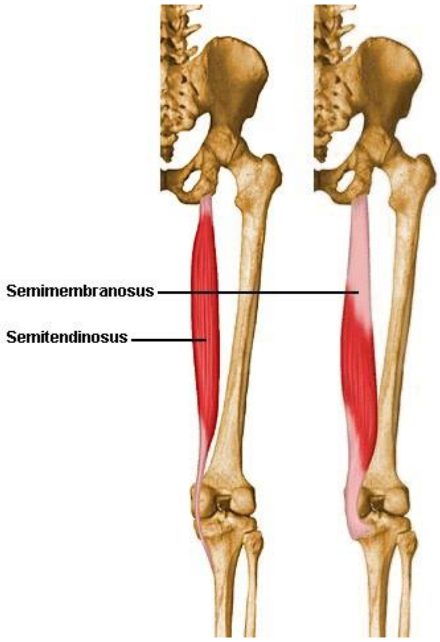


Figure 71 Semimembranosus and semitendinosus

Semimembranosus tension can cause:

- Can mimic medial meniscus or MCL problems
- Will prevent full extension of knee joint
- Will have associated tension of the quadriceps

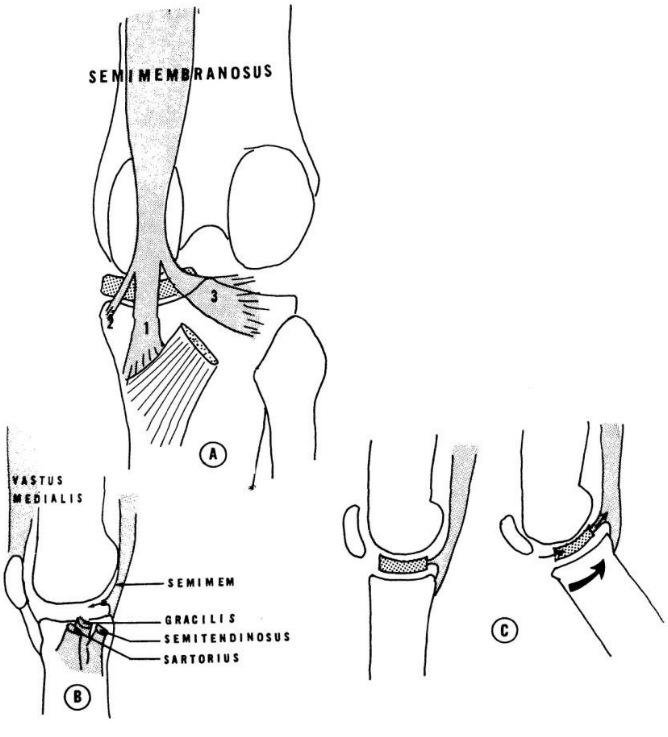


Figure 72 Semimembranosus and its various attachments

Semitendinosus

See fig 70

Semitendinosus originates at the ischial tuberosity and inserts on the pes anserinus with gracilis and sartorius

Hypertension here:

- Can mimic a medial meniscus and MCL problem
- Like biceps femoris I will contribute to knee stability with an anterior cruciate lesion
- Will have an associated tension in the quads

Adductor Magnus

Has origins on the ischiopubic ramus, ischial tuberosity and sacrotuberous ligament and inserts along the linear aspera and adductor tubercle; has a rotating fan shape

Tension here:

- Can cause pain in the posterior gluteal region
- Can cause pain on the medial aspect of the knee
- Can contribute to low back pain

Figure 73 Adductor Magnus

Treatment

- Massage or myofascial release to the affected muscles (also known as proprioceptive facilitation) find key areas of tension, fix them (local stretch) until they soften. This is a systematic release technique, working on small areas at a time
- Ultrasound to affected areas
- Prescribe relevant stretching techniques to be done regularly to prevent its recurrence

Bursae

A bursa is a synovial sheath or a pad. They are situated between tendons and bone, or tendons and other tendons and may even communicate with the joint. The synovial fluid they secrete reduces excess friction between these structures. Around the knee can be 12 of these:

- 2 - anterior
- 3 - medial
- 3 - lateral
- 4 - posterior

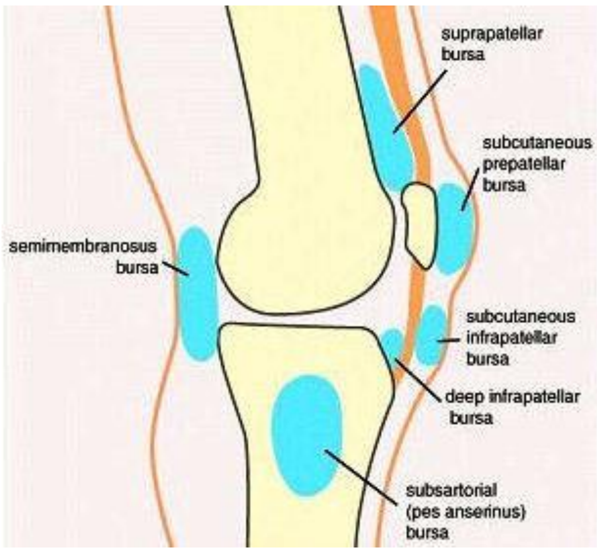


Figure 74 Bursae around the knee

Any of these can become inflamed, resulting in a bursitis. Of these there are two causes:

1. Traumatic
2. Infective

These may even become red and swollen, with pain on compression and movement

Posterior

There is one on each side of Gastrocnaemius, between the capsule and the tendon. These may even communicate with the joint. The medial one is important because it has a prolongation between gastrocnaemius and semimembranosus. This is commonly enlarged causing swelling on the medial side of the popliteal space.

Medial

These are positioned superficial to the MCL and deep to sartorius, gracilis and semimembranosus and around the latter's reflected head. These are easily inflamed and can be confused with MCL sprain or medial meniscus. Check for hypertension of the muscles to pes anserinus.

Lateral

Here there are three, in three layers:

1. Most superficial - between biceps tendon and the LCL
2. This is deeper than (1), between the LCL and the popliteus tendon
3. This is the deepest, between the tendon of popliteus and the lateral condyle of the femur. It forms a tube around popliteus with a synovial membrane and communicates with the joint.

Anterior

- **Suprapatellar** - This bursa is big and flat and is the size of the width of 3-4 fingers, immediately above the patella. It is positioned between the deep surface of the inferior end of the quads and the femur. It is important because it communicates directly with the joint and is involved in the extension of the knee.
- **Prepatellar** - This one is more superficial and is positioned anterior to the lower ½ of the patella and the upper ½ of the ligamentum patellae. This can be become inflamed kneeling on 'all fours' and is therefore known as 'housemaid's knee'. It can occur in professions like: tilers, carpet-layers and miners.
- **Infrapatellar** - There are two of these: superficial and deep. They are situated superficial and deep to the inferior end of the ligamentum patellae. They can become inflamed with excess kneeling in the upright position and is therefore called 'clergyman's knee'.

Other general pathologies of the knee

Polyneuritis - The symptoms are bilateral, symmetrical pins and needles (paraesthesia) and numbness (anaesthesia) from the feet up. There are also reduced reflexes (ankles then knees) with reduced vibration sense.

Causes for this are:

- Nutritional:
  - Lack of Vit B1 - beri-beri
  - Lack of Vit B12 - pernicious anaemia, which can lead, in time, to sub-acute degeneration of the spinal cord.
- Infection: TB, polio, mononucleosis, gonorrhoea

- Metabolic disturbances: diabetes mellitus - idiopathic, possibly associated with decreased blood supply leading to hypoxia.
- Alcoholic polyneuritis can:
    - Be caused by the excess of spirits leading to decreased B12 uptake
    - Connective tissue diseases: R/A, polyarteritis nodosa

Referred pain

Somatic

This originates from the capsuloligamentous apparatus or muscles of the hip

There are 4 types:

1. Knee pain - from spine, e.g. spondylosis, PID
2. Form O/A of the hip, referring down the ITT
3. Psoas muscle
4. Inguinal ligament, e.g. inguinal hernia, causing pain in the thighs

Visceral

The characteristic of this pain is that it is dull, boring, and continuous with frequent tenderness at the sire of reference. It can be recurrent in chronic diseases, irrespective or if the disease is apparent or not. It can be affected by increased work, tiredness, anaemia, periods and the weather.

It can also be from:

- Abdominal colic
- Uterine contractions
- Appendicitis
- Uterine fibroids

Cancer

Osteosarcoma was expanded upon above, but another source of referred pain could be a neoplasm at the level of L3

Baker's Cyst

A Baker's cyst manifests as a swelling at the back of the knee, in the popliteal space.

1. Benign synovioma - a benign swelling that can be big enough to compress the popliteal vein, causing leg oedema
2. Herniation of the synovial membrane, from a defect in the capsule. Shows as a painless lump in the midline on the back of the knee, low in the popliteal space. It can fluctuate in size. It is always indicative of an underlying condition: O/A, R/A

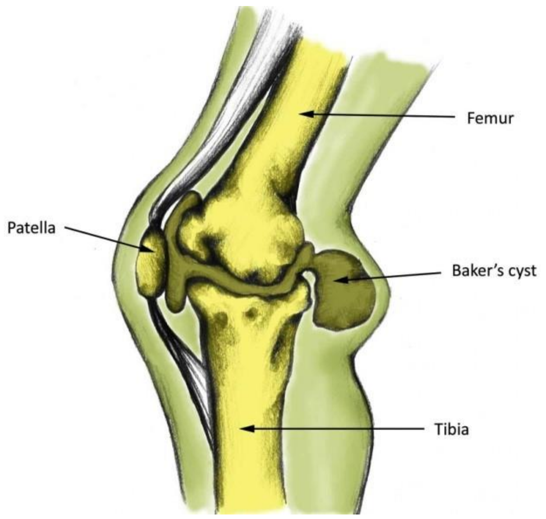


Figure 75 Baker's cyst

Bone bruise

Bone bruises are fractures of the micro-architecture of the bone without a fracture of the hard-outer layer of bone (cortex). They can occur following an injury to the knee and cause continued pain in the absence of any other finding. They are diagnosed by MR scanning

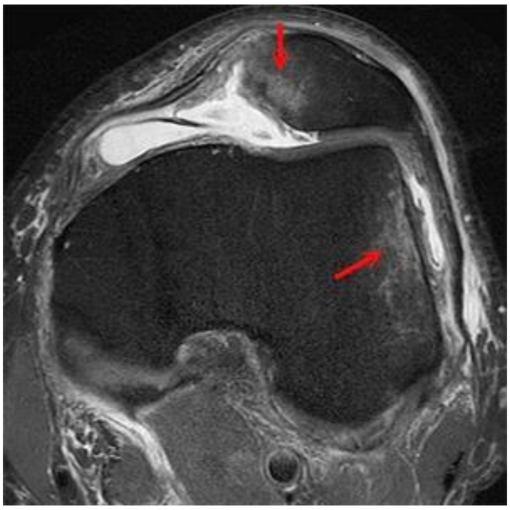


Figure 76 Bone bruise - here of medial patella and lateral femoral condyle

Bone bruises are self-limiting and require no treatment except limitation of activity. The condition generally resolves within 6 months but can last up to 2 years.

Avascular necrosis

Avascular necrosis is an uncommon condition in which an area of bone in the knee joint loses its blood supply and may die. The dead bone becomes weak and may collapse causing a fracture and collapse of the joint surface which may in turn lead to arthritis. Although there are recognised causes such as alcoholism and deep-sea diving, most patients with avascular necrosis have no apparent cause.

The main symptom with avascular necrosis is pain. It can be difficult to diagnose without special tests as x-ray changes only occur towards the terminal stages of this pathology. It is best diagnosed with a bone scan or an MRI scan.

Figure 77 Avascular necrosis of medial condyle of knee

Treatment is also difficult. If the condition is caught early enough decompression of the affected area may be successful but in most cases the treatment is addressed to treating the complications of the condition and may require a partial joint replacement in some cases.

Knee Manipulations

PCL adjustment

- Patient supine; knee flexed to 90º
- Point patient's knee toward **same** shoulder
- Take up the slack of the knee
- The thrust is at the **knee**

ACL adjustment

- Patient supine, flex knee to 90º
- Point knee towards **opposite** shoulder
- Take up slack in knee
- The thrust is at the **ankle or foot**

Non-specific thrust for adhesion in the knee

- Patient supine, knee flexed to 90º
- Hang the patient's leg over your forearm
- Traction the knee by pulling the leg along the axis of the thigh
- Take up the slack out of the knee by pulling on foot/ankle down
- The thrust is at the ankle or foot

Adductor stretch

- Patient supine
- Therapist starts at medial aspect of knee on inferior end of adductor magnus, rolling it off the bone. Continue up thigh towards pubic bone
- On reaching the pubic bone (and not before, as you the intent is to adjust a tendon and not a muscle), place the thumb of the adjusting hand on the inguinal area (of the groin muscles) and thrust towards the ipsilateral shoulder [the manipulation should be quick/sharp, due to the area and the tendon involved]

Figure of 8

A

- Patient supine
- Affected leg between thighs (at their ankle)
- Place both hands around the knee to support it
- Traction along the leg using your weight
- Move hands in a side-lying figure of 8

B

- Patient is sitting with affected leg over the side of the table
- Hold the patient's inferior thigh with static pressure
- Begin to move the foot/ankle in a side-lying figure of 8
- After a time, apply traction down the axis of the leg and repeat (here grip must be increased, and the pressure should remain even. The patient should not feel any discomfort

Medial meniscus adjustment

1

- Patient supine
- Flex knee to 90^o
- Place thumb of supporting hand on lateral side of knee
- Place other hand on the medial side of the foot, inducing dorsiflexion and external rotation of the leg, and push to create medial gapping of the knee
- Oscillate the knee around 90^0 to help the patient relax
- Quickly bring the knee into full extension, releasing the lateral rotation and the medial gapping
- Hold the joint in extension to allow the adjustment to settle
- Repeat as required

2

- Patient supine
- The affected leg is held between the therapist's thighs at the ankle
- The knee is supported a its sides by the therapist's hands
- With the knee in slight flexion, waggle the joint, medially and laterally
- There will be 'knocking' felt on the good side, and a 'dampened knock' on the affected side (usually medial); this indicates the joint being sufficiently open
- Quickly thrust the joint medially and into extension
- Keep the leg in full extension, allowing the joint to settle
- Check the function via medial/lateral gapping and full extension

Fibular Head

1

- Patient supine
- Flex affected knee to 90^o
- Knee is supported by examiners fingers
- Place thumb or M/P joint on posterior aspect of fibular head
- Rotate foot to laterally fix tibia
- Thrust the fibular head anterior along its joint line

2

- Patient side-lying affected knee uppermost
- Flex affected knee to 90^o
- Place affected leg in front of the other, such that it is flat on table
- One hand dorsiflexes the foot and laterally rotates ankle (fixing tibia)
- Thrust in the plane of the joint, anteriorly