EXAMINATION OF THE KNEE JOINT

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This review article is intended to familiarize physicians with the methodology required for a systematic and logical examination of the knee joint. This article focuses on examination of the knee. However, keep in mind that knee pain may be the result of problems in the hip or spine and a screening examination of these areas should be performed prior to examining the knee.

° The knee needs to be examined systematically, since so much can go wrong with the knee, and so many signs and symptoms may be produced, that only a systematic technique will ensure that nothing of importance is missed.

° Equally, a logical approach is required, since the best way to remember a technique is to know why it is being applied. We will, therefore, attempt to explain what the various signs and symptoms mean in terms of knee pathology or pathophysiology.

The detailed examination of the knee will need to be preceded by taking the patient's history. This aspect of the clinical approach is vital, since it will often be found that a properly taken history will permit at least a presumptive diagnosis to be made. In fact, we might go so far as to say that good history-taking is "non-invasive arthroscopy."

HISTORY-TAKING

After establishing the nature of the principal complaint (or reason for consulting a doctor), a systematic history should be obtained, with questions grouped under three headings: History of present complaint; signs and symptoms; and life style (level of activity).

No. 1 HISTORY OF PRESENT COMPLAINT

As a rule, three questions should suffice to obtain all the information required under this heading. The first two concern the onset of the present complaint.

1.1 When?

This first question allows the examiner to distinguish between two patterns - complaints with an identifiable starting point, a known accident (traumatic or post-traumatic knee disorders); and complaints that appear to have come on more insidiously, which would be more suggestive of inflammatory or degenerative disease.

1.2 How?

The examiner should try to elicit the exact circumstances of how the disorder occurred - obtaining a description of how the accident happened or of how the problem has developed over time. Thus, in a trauma case, the examiner would seek to find out the nature of the contact (violent/non-violent; in valgus; in varus; in hyperextension) or whether the knee "went" after kicking a ball or "missing a kick." It would also be important to establish whether there was an audible "pop" in the joint, whether the knee swelled rapidly, and whether the athlete needed help to come off the pitch: - An affirmative answer to these questions would be highly suggestive of a torn ACL.

1.3 What happened after that?

This question needs to be asked in order to obtain information on any medical or surgical treatments already applied, on rehabilitation (if any), and on the course of the condition up to the time of consultation.

No. 2 SIGNS AND SYMPTOMS

A complete picture of the patient's signs and symptoms should be obtained, since anything elicited under this heading may be of diagnostic value.

There are four categories of cardinal signs and symptoms in the knee joint:-

2.1 Pain

The examiner should establish the way in which the pain developed, its character, and its severity; the patient should be asked to point to the site of the pain.

Pain at night suggests an inflammatory cause, while pain that gets worse towards evening, or during/after exercise, would be more likely to be mechanical in origin.

Pain when going up or down stairs, or aching in positions where the knee is kept flexed for prolonged periods of time (car journeys, visits to the cinema), are indicative of patellar problems, while pain that occurs when the knee is hyperflexed is usually caused by meniscal pathology.

The patient should also be questioned about pain in other parts of the body (low back pain, hip pain).

2.2 Laxity

° **"Going out"**: This is the term used by many lay persons to describe what will usually be found to be a torn ACL or a dislocation of the patella.

° **"Giving way"**: This term is used to describe the sensation of the knee suddenly failing to provide proper support, especially when walking on uneven ground. The symptom may be due to three mechanisms:

- Interposition: If, during weight-bearing, a third structure (meniscus, synovial membrane, cartilage, etc.) is placed between the opposing cartilage surfaces of the joint, a protective reflex will be triggered. This reflex will make the quadriceps relax and unlock the knee, to allow the joint to clear itself.

- Cartilage damage: If one or both of the cartilage surfaces are damaged, and the surfaces come into contact, the quadriceps may also be made to relax.

- Muscle weakness: This may occur in quadriceps wasting, in polio, after surgery, etc.

2.3 Locking

A proper knowledge of this clinical feature is vital, since patients have often been misdiagnosed because of the examining physician's imperfect understanding of this symptom. There are two types of locking, which must be carefully distinguished:

° **Meniscal locking (true locking)**: This is what a physician would consider to be locking. It is the impossibility fully to extend the knee for an appreciable period of time (more than a few minutes). This "passive flexion deformity" is brought on by a mechanical obstacle which makes the knee stop short of full extension. The cause may be a bucket-handle tear of the meniscus, or a bulky flap that has dislocated forwards in the joint; a loose body or an ACL stump may also be to blame.

° **Patellar catching (false locking)**: This is what the patient would consider to be locking. It is a momentary "sticking" of the knee, during a flexion-extension movement, with the knee incapable of flexing or extending beyond that particular point. Catching is relieved as soon as weight is transferred to the other side. Usually, patellar cartilage damage will be found to have caused this fleeting episode of "locking."

2.4 Effusion

**ASPIRATION IS RARELY WARRENTED IN A PRIMARY CARE SETTING AND SHOULD BE AVOIDED IF THERE IS A HISTORY OF TRAUMA

The knee swells up. Swelling of the knee is always indicative of a genuine lesion of the joint. Sometimes, its character will already have been established by aspirating the joint. The features of the aspirated fluid (colour, viscosity, protein content, cellularity) make it possible to ascertain whether the condition is

mechanical or inflammatory. The main indications for considering aspiration are to rule out a joint infection or crystal arthritis.

° Hydroarthrosis: The accumulation of clear, straw-coloured fluid is the result of irritation of the synovial membrane, which may be primary (inflammatory disease) or secondary to cartilage damage (osteoarthritis), meniscal lesions, or the presence of a loose body (osteochondritis dissecans; osteochondral fractures). Hydroarthrosis may also be seen following ligament lesions.

° Blood in the joint (haemarthrosis) is usually the result of trauma. If not, it could mean two things: haemophilic arthropathy, or pigmented villonodular synovitis. In the latter condition, the fluid may be amber-coloured rather than frankly bloody**.**

2.5 Other clinical features

° Subjective sensation of internal derangement: The patient feels that there is something moving in the knee (joint mouse); something "funny"; "a lump." This feature suggests a meniscal lesion or a loose body.

° Noises in the joint: Crepitus is a faintly audible and often palpable sensation of grating during flexion-extension. Clunks and clicks are much louder, and usually suggestive of patellar maltracking or a large meniscal tear.

No. 3 LEVEL OF ACTIVITY

History-taking also involves obtaining information on the patient's present and desired levels of activity. This information is important for two reasons: Firstly, it gives an idea of the degree of disability produced by the knee disorder; and, secondly, it shows what the patient would like to be able to do with his or her knee.

The questions to be asked will be a function of the patient's age:

° Young, active, or athletic patients should be questioned about the sports they practise, and about their ability to run, jump, or cut.

° Elderly or sedentary subjects should be asked about the use of walking aids, their walking distance, ability to go up and down stairs without holding on to a handrail, and whether they can get up from a sitting position without using their hands.

2 - EXAMINATION

The patient should be examined standing up, walking, and lying supine. It is essential that a comparison be made throughout with the unaffected side.

1 - In the STANDING PATIENT, a study should be made of

° Lower limb pattern: The lower limb is said to be in normal alignment if, when seen head-on, with the patellae pointing forwards, the medial malleoli and the femoral condyles touch. Genu varum describes a condition in which the femoral condyles are apart when the feet are together, while in genu valgum the ankles are separated when the knees touch. The distances should be measured; they may be expressed in centimetres (or in fingerbreadths), with the knees in extension **(Figs. 9-10)**. With the knees in hyperextension, a varus deformity may be seen to worsen. Genu varum and genu valgum are not, in themselves, abnormal conditions. This is why "normally aligned" is not synonymous with "normal."

Figure 9

Figure 10

° **Muscle wasting**: With the patient standing "to attention",. the muscle bulk is checked. Quadriceps wasting shows up as wasting of the vastus medialis. Looking at the vastus medialis will give an immediate idea of whether the quadriceps is wasted. Wasting may be the result of under-use of the knee joint and may be due to chronic pain or effusion. It may be quantified by measuring the circumference of the thigh.

2 - In the WALKING PATIENT, the following features are checked:-

° **The toeing angle** is the angle between the axis of the foot and the direction in which the subject is walking. Normally, the axis will be seen to point in a slightly lateral direction, enclosing an angle of 10° to 15°. In the normal postural pattern, this angle will be the same on both sides.

° **Tilting of the knee with single-leg stance**: This is seen where bone wear has occurred as a result of osteoarthritis (OA). The feature does not manifest itself until several years have elapsed. Where the tilt is due to ligamentous problems, it will be seen early on.

(a) With wear in the medial compartment, the tilt will chiefly be into varus, in a position of near-extension. It is best seen from behind the patient **(Fig. 11)**.

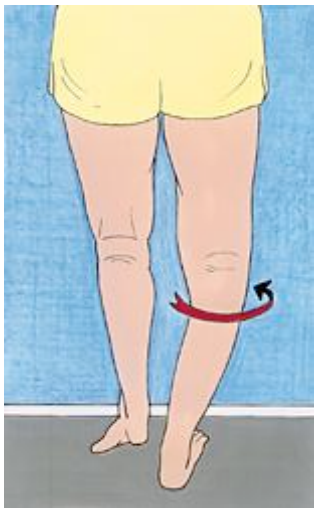

Figure 11 – Valgus deformity

(b) With lateral compartment wear, on the other hand, the tilt will be into valgus and flexion; it is best appreciated from in front.

(c)A tilt into recurvatum is rare; it is not well tolerated by the patient.

3 - EXAMINATION OF THE SUPINE PATIENT

3.1 General appearance

There are two cardinal features with which the examiner has to be familiar, since they are as important in the examination of the knee joint as the temperature and pulse rate are in the general examination of a patient. They make it possible for a "spot diagnosis" of a genuine, organic knee lesion to be made by the examiner.

(a) Looking for an effusion: *it is important to differentiate an effusion from soft tissue swelling.

Milking - Effusion is assessed by "milking" fluid distally from the suprapatellar pouch and palpating the area adjacent to the patellar tendon for fluid accumulation. (PREFERRED METHOD)

Patellar tap - The examiner's hands are placed on either side of the patella, with the thumb and middle to little fingers stroking the synovial fluid towards the patella, while the index finger is used to elicit the patellar tap: The patella is at first pressed down and submerged under the synovial fluid, and will strike the trochlea, producing a tap. As the pressure is relieved, the patella will bob up like an ice cube in a drink **(Fig. 12)**. (MORE USEFUL IN OBESE PATIENTS)

Baker’s cyst – can be palpated in the popliteal fossa.

(b) Looking for a fixed flexion deformity: The patient is positioned supine and made to relax. The examiner grasps both the patient's heels and supports them at a height of 10 cm above the examination couch. This is the best position for screening for a flexion deformity, which is a major feature of knee pathology. This sensitive and straightforward method is ideal for screening purposes. It does not, however, lend itself to a quantification (in degrees) of the deformity. Also, since the patient's feet are braced against the examiner's abdomen, the examiner may seek to reduce the flexion deformity by pressing down on the patient's knees.

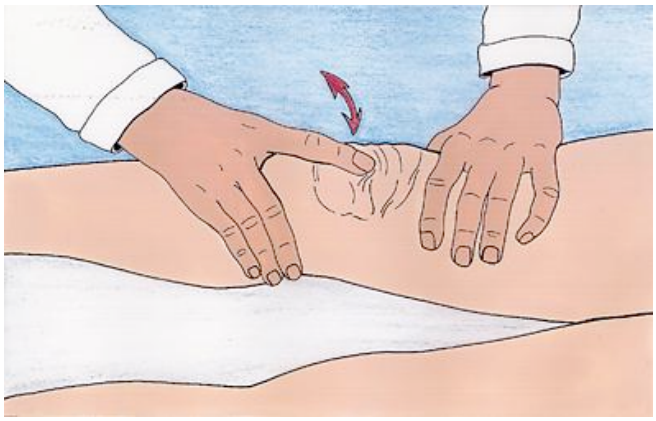

Figure 12 – Patellar Tap

- Knee pattern in the supine patient: As the patient goes from two-legged stance into the supine position, the deformity may or may not correct itself. If a lower limb malalignment was found with the patient standing on both feet, the examiner should check whether the deformity can be reduced in the supine patient, which would suggest that the deformity is articular (rather than extra-articular and bony) in origin.

In order to be able to tell whether a finding is abnormal, the affected side will have to be compared with the presumably healthy limb (the reference knee).

The range of movement (ROM) is tested at this stage of the examination (which also involves screening for quadriceps wasting). Three figures are used to denote the ROM. The first indicates flexion; the second, full extension; and the third, recurvatum.

Thus, 140, 0, 5 means that flexion is 140°; the knee can be extended fully; and there is 5° of recurvatum (hyperextension). 120, 5, 0 would mean that flexion is 120°, there is a flexion deformity of 5°; and no recurvatum.

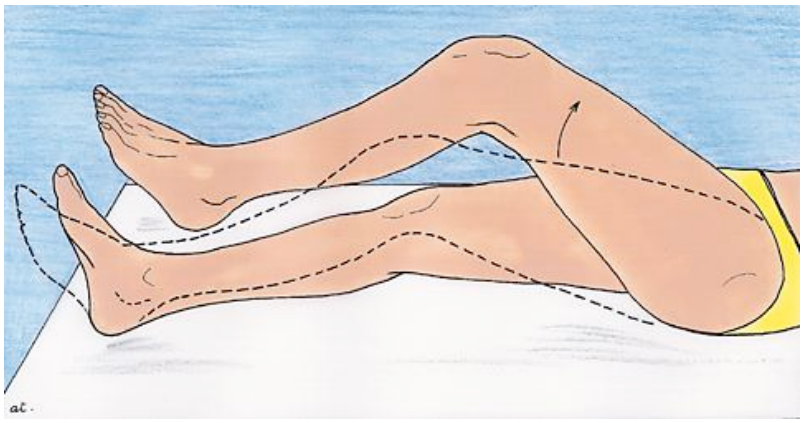

Figure 15

3.2 Extensor apparatus

Confirm the extensor apparatus is intact – ask the patient to fully extend the knee from a bent position and lift it off the table. If they cannot do this and keep the leg straight an “extensor lag” is present and a quadriceps or patellar tendon rupture must be fuled out.

° Palpation
- Looking for tender points is particularly useful if the patient has also reported symptoms of pain **(Fig. 16)**.

*** Tibial tubercle**: In adolescents, the tibial tubercle may be affected by apophysitis, with fragmentation of the apophysis (the accessory ossification centre). The patient will complain of pain in the tibial tubercle, and the examiner will be able to elicit tenderness over that structure (Osgood-Schlatter disease).

*** Patellar tendon**: This structure may be the site of repetitive strain injuries (jumper's knee); the patient will complain of pain in the patellar tendon, and extension against resistance will be painful.

*** Apex of the patella**: In adolescents, inflammation of the distal pole of the patella may occur as a very rare condition (Sinding-Larsen-Johansson syndrome).

*** Medial facet of the patella (Fig. 17a)**: The medial facet of the patella may be tender to palpation, and the patient may report pain at that site. The feature is usually part of an anterior knee pain syndrome.

*** Lateral facet of the patella (Fig. 17b)**: The examiner pushes the patella in a lateral direction, and palpates the lateral facet. Patellofemoral dysplasia will produce lateral impingement and pain and tenderness along the lateral border.

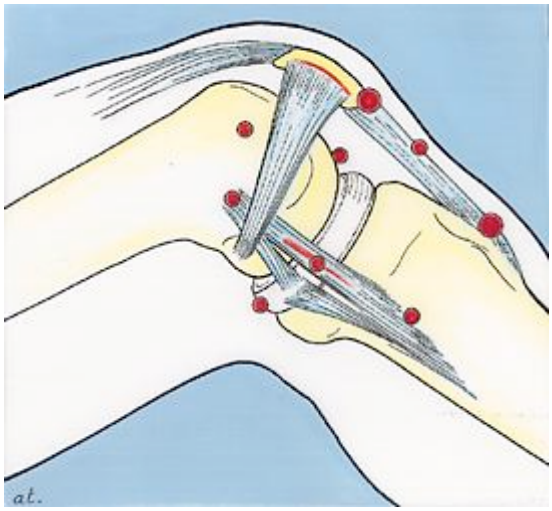

Figure 16

Figure 17

° Patellar tests

- Apprehension sign
The patient is positioned supine, with the knee flexed between 0° and 30°. The examiner firmly pushes the patella in a lateral direction. The patient, who knows and apprehends the dislocation that will be produced by this manoeuvre, will stop the examiner. Results are recorded as + or 0.

Pathophysiology: Between 0° and 30° of flexion, the patella is at its highest point in the trochlea. Pressure from the medial side will push the patella in a lateral direction, causing it to dislocate from the trochlear groove. This will cause not only pain, but apprehension on the part of the patient **(Fig. 19)**.

This sign may be elicited in recurrent dislocation; it is highly suggestive, and particularly useful in patella alta.

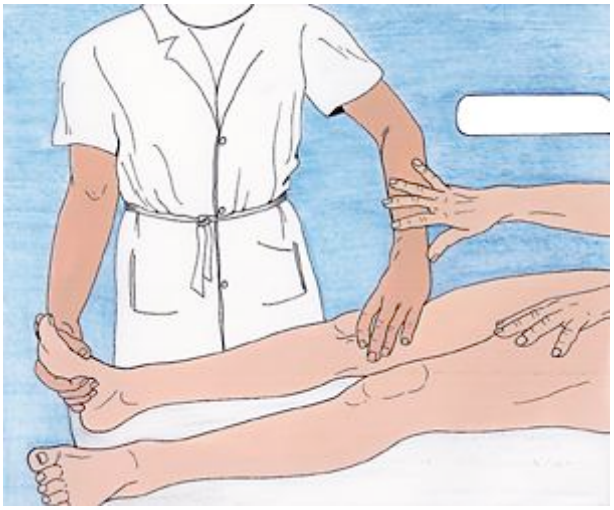

Figure 19

Patellar grind test
The examiner's hand is placed on the front of the knee. The patient performs flexion-extension. The examiner will feel a crepitus, and may even notice the patella catching. The crepitus is difficult to interpret. If there is nothing more than a positive grind test, a diagnosis of OA or of cartilage damage cannot be made.

Patellofemoral joint crepitus should be sought over the entire ROM from flexion to extension, against slight resistance. Crepitus in the tibiofemoral compartments is sought from flexion to extension, against resistance, as well as in valgus-flexion-external rotation (to test the lateral compartment) and in varus-flexion-internal rotation (to elicit medial compartment crepitus). Gradation depends on the loudness of the crepitus and on the pain produced by the manoeuvre.

3.3 The menisci

Broadly speaking, the menisci should be examined with the knee in flexion. There must be tenderness (i.e. the patient must respond to palpation with pain). There are various ways in which the sensitivity of the tests can be enhanced. However, all the tests for meniscal lesions rely on the same principle: Stressing an injured medial or lateral meniscus will cause pain.

° **Tenderness to palpation** is elicited with the knee flexed 90° and the patient's foot resting on the table. The examiner's index finger probes the meniscus along the joint line. The most frequently encountered sites of tenderness are over or behind the medial collateral ligament, at the medial meniscal tender point **(Fig. 21)**. Less often the tender point will be anterior, in which case the phenomenon may be part of a patellar disorder, a bucket-handle tear of the medial meniscus, or a lesion of the anterior horn of the lateral meniscus. The lateral meniscal tender point may be anywhere along the joint line.

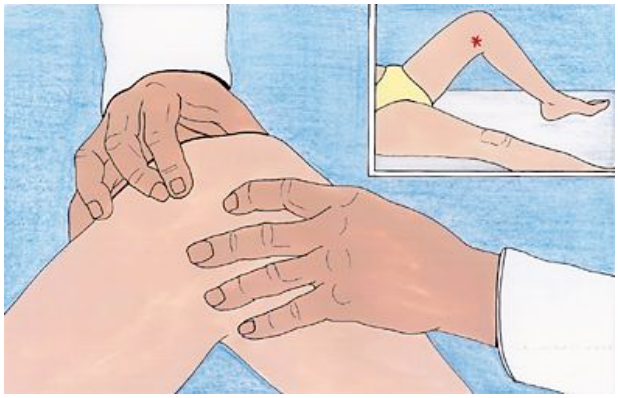

Figure 21

° **Meniscal tenderness on mobilization**: Compression of the different parts of the meniscus by the femoral condyle occurs as the meniscus glides backwards on the condyle during flexion, and forwards during extension.

This means that the posterior horn will be compressed when the knee is in hyperflexion **(Fig. 23)**; while the anterior horn will be compressed in hyperextension.

The diagnostic accuracy of the tests is improved by adding a component of tibial rotation to the simple flexion-extension manoeuvres. This rotation tends to bring the posterior horns forward. Medial pain will be elicited in external rotation, and lateral pain in internal rotation.

- McMurray's test: Forced flexion and external rotation with compression of the medial joint line will elicit pain in the medial meniscus. The hand pressed over the joint line will feel a click. The test may be reversed, to examine the lateral meniscus.

- Apley's grinding test: For this test, the patient is positioned prone, with his or her knee flexed. Compression and external or internal rotation may be painful, showing that the medial or the lateral meniscus are torn. This test is always checked, by performing rotation without compression. This manoeuvre should not cause discomfort, unless the collateral ligaments are affected **(Fig. 24)**.

Figure 23

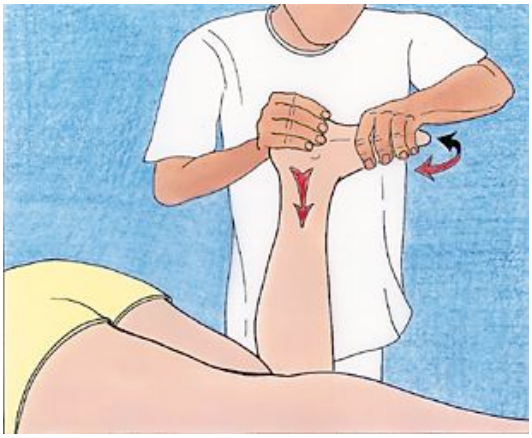

Figure 24

° Cysts of the lateral meniscus will be seen in extension, and disappear in flexion. They are on or near the lateral joint line. They are best seen in semiflexion. The cysts will disappear in hyperflexion, and reappear as the knee is gradually extended; in full extension, they will once again be out of sight.

(In children, a malformation of the lateral meniscus may give rise to snapping when the knee is taken through flexion and extension. This abnormal movement is associated with a clicking noise, which may be very pronounced.)

3.4 Stability testing

3.4.1. Medial/lateral instability in extension

(a) Medial instability in extension

The examiner grasps the patient's leg between their arm and torso with hands placed along the medial and lateral joint lines. A valgus stress is imparted and released. Medial instability is demonstrated if the medial joint line opens up **(Fig. 25)**.

Figure 25

Several points need to be borne in mind:
° The abnormal feature is the asymmetrical pattern of the instability (examine both knes) The examiner may also ask the patient, "Do you think your right knee is different from your left knee?"

° The instability will be due to a lesion of the ligaments on the medial side and/or to medial tibiofemoral compartment wear.

(b) Lateral instability in extension

Same approach but apply a varus stress. Lateral joint gaping is physiological. It is the asymmetry of the gaping that constitutes the abnormal finding.

3.4.2. Medial/lateral instability in 30° flexion

Description: The leg is held as described above, but the knee is unlocked by putting it in 20°-30° flexion.

(a) Medial instability
The movement imparted is one of valgus-flexion rather than valgus-flexion-external rotation. Instability in valgus-flexion-external rotation would be a sign of an injured medial collateral ligament.

(b) Lateral instability
Varus-flexion-internal rotation is used to investigate the lateral collateral ligaments. Once again, asymmetry would have to be demonstrated to qualify the result as abnormal.

3.4.3. Anterior instability

(a) Lachman-Trillat test
It is important to ensure that the patient is relaxed. This is all the more vital in recent trauma cases. In order to obtain relaxation, the patient is made to rest his or her head on the couch. It may be useful to roll the thigh in and out, to get the muscles to relax.

For the test, the knee is unlocked in 20° flexion. The patient's heel rests on the couch or just off the table and supported by the examiner. The examiner holds the patient's tibia, with the thumb on the tibial tubercle. The examiner's other hand is placed on the patient's thigh, a few centimetres above the patella. The hand on the tibia applies a brisk anteriorly directed force to the tibia **(Fig. 30)**.

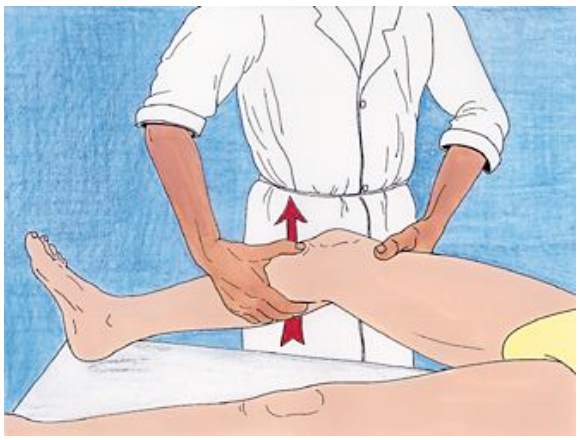

Figure 30

The quality of the endpoint at the end of the movement is described as either "firm" or "soft." Grading depends on the quality of the endpoint observed, and on whether there is a difference of 3-5 mm between the affected and the unaffected knee. A soft endpoint will make the grading "abnormal" rather than "nearly normal."

If the movement of the tibia on the femur comes to a sudden stop, this is described as a firm endpoint. If it does not, the endpoint is described as soft. A soft endpoint is pathognomonic of a torn ACL. It is easier to demonstrate a firm endpoint, which is also recognized by the patient. If the ACL is torn in one knee, the patient will be perfectly aware of the difference between the firm endpoint in the healthy, and the soft endpoint in the cruciate-deficient knee. Sometimes, the endpoint will be firm, but translation will be seen to be asymmetrical. This is known as a "delayed firm endpoint" (increased excursion and a good endpoint). It is indicative of a torn and partially healed ACL (ACL adherent to PCL), of a stretched ACL graft, or a torn PCL (changing the "starting point" of the test). A firm endpoint results from the sudden tensioning of the ACL. The test is of lesser value in knees affected by OA, with a large number of osteophytes.

Lachman used to perform the test with the thumb of the distal hand on the medial joint line, so as to feel the displacement of the tibia on the femur.

(c) Pivot shifts. At present, attempts are being made to substantiate the diagnostic value of these tests. However, they should not be expected to provide more than they can: A shift means that the ACL has gone. Sometimes, though, the ACL may be deficient without a pivot shift occurring during the relevant tests.

(c) Anterior drawer in 90° flexion, or direct anterior drawer
The examiner sits on the patient's foot, which has been placed in neutral position. The knee is in 90° flexion. The index fingers are used to check that the hamstrings are relaxed, while the other fingers encircle the upper end of the tibia and push the tibia forwards **(Fig. 37)**.

Figure 37

If a direct anterior drawer is obtained, the ACL will be torn. However, for this sign to be elicited, peripheral structures such as the medial meniscus or the meniscotibial ligament must also be damaged. This ligament forms a wedge, in 90° flexion, preventing anterior tibial translation. The finding of an anterior drawer is conclusive evidence of an ACL tear. However, not every ACL tear will be associated with a positive anterior drawer test.

° Drawer in external rotation (foot in external rotation). This test examines the posteromedial structures (posteromedial corner, posterior horn of medial meniscus). The results are recorded as +++/0.

° Drawer in internal rotation (foot in internal rotation). The diagnostic value of this test is less well established.

3.4.4. Posterior instability

- Godfrey's drop back test (Sag sign): The patient is supine, with the thighs and knees flexed 90°, legs horizontal, and heels held by the examiner in such a way as to have the legs parallel to the table. The test is positive if the upper end of the tibia on the affected side is seen to drop backwards and it indicates that the PCL is torn **(Fig. 38)**.

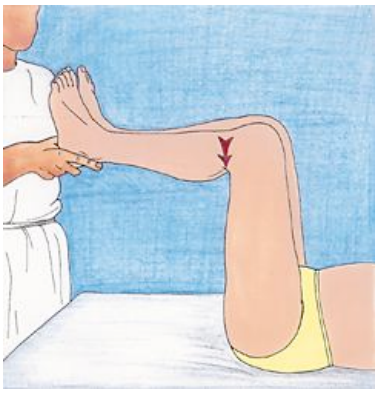

Figure 38

3 - FURTHER INVESTIGATIONS

The following techniques are available for the further workup of knee patients:

1 - RADIOGRAPHS

A.p. single-leg stance; lateral in 30° of flexion; axial views in 30° of flexion.

Long films may be used to measure limb length and study the axes of the lower limb.

Rosenberg views (p.a. weight-bearing views in flexion) may be used to detect incipient OA or to screen for osteochondritis dissecans of the medial femoral condyle.

2 - Other imaging techniques

° **Arthrography**: This is a useful technique in peripheral meniscal detachment, or when there is a suspicion of recurrent meniscal lesions.

° CT is may be useful in cases of patellar instability, bony trauma and of bone disease (e.g. tumour).

° MRI shows meniscal lesions, injuries of the cruciates, villonodular synovitis, and necrosis of the femoral condyles.

° Radionuclide bone scans should be requested if it is thought that the patient may be suffering from a tumour, from incipient avascular necrosis of a femoral condyle, or from reflex sympathetic dystrophy; or if an infection is suspected.

3 - Blood tests

Sed rate, blood count, CRP, and rheumatological tests (latex fixation, RF, complement, ANA, antimitochondrial antibodies, Lyme serology, uric acid etc.) should be ordered in inflammatory knee conditions.