

# Examination of the adult knee

This article outlines the examination of the adult knee in the elective orthopaedic clinic. The content of the article is targeted to MRCS level candidates and registrars of musculoskeletal specialties including orthopaedics, rheumatology and sports medicine.

## Anatomy

In its simplest form the knee joint is a hinged synovial joint (Ellis, 2002). The biomechanics of the knee joint are beyond the scope of this article; however, it is important to recognize that the tibiofemoral joint allows flexion and extension but there are also additional rotational and translation movements.

The knee joint comprises three articulating compartments (Ellis, 2002). The patellofemoral compartment describes the articulation between the patellar and the trochlear groove of the anterior femur and the tibiofemoral articulations comprise of two compartments, medial and lateral.

The articular boundaries of the knee are encased by a joint capsule which surrounds the joint and communicates with the large suprapatellar pouch ending 3–4 cm proximal to the patella in the midline (Ellis, 2002).

The anterior cruciate ligament origin is the posteromedial aspect of the lateral femoral condyle and it inserts into the intercondylar eminence of the proximal tibia while the posterior cruciate ligament origin is the medial femoral condyle and it inserts onto the posterior tibial sulcus. The medial and lateral collateral ligaments originate from their respective femoral condyles and insert onto the medial proximal tibia and proximal fibula respectively (Figure 1).

The medial and lateral menisci provide force distribution and act as secondary stabilizers of the knee joint. The medial meniscus is large and 'C'-shaped whereas the lateral meniscus is almost disc shaped. They are attached anteriorly via the transverse intermeniscal ligament and each has peripheral attachments via the coronary ligaments.

The posterolateral corner refers to the lateral collateral ligament, popliteus, popliteo-fibula ligament and the capsule which provide resistance to external rotation.

## Stepwise approach to the examination

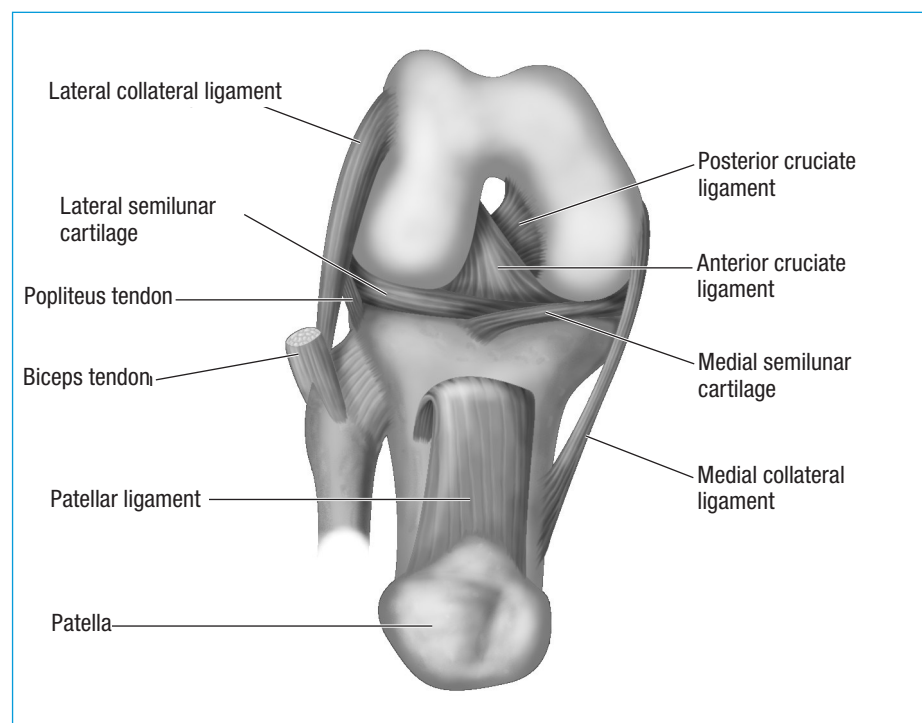
Whenever a patient is examined the clinician should introduce him-/herself, explain to the patient the purpose of the assessment and what will be involved. The patient should be asked for verbal consent and offered a chaperone. It is a good practice to perform hand washing before examining the patient.

## Observe the setting and the patient

The presence of any walking aids, stick or mobility frame should be noted in order to gauge the patient's current mobility, which may or may not be an indicator of pathology of the knee.

For examination of the knee ideally the patient should be exposed below the waist but for the purposes of professional examinations it is acceptable to expose from the mid thigh down. The clinician should aim to observe the patient from the front, side and from behind. This can be done

Figure 1. The knee, anterior view. The knee is flexed and the patella has been turned downwards. From Ellis (2010).



**Mr Dominic Davenport** is ST3 Registrar in Trauma and Orthopaedic Surgery in the Department of Trauma and Orthopaedics, Princess Royal University Hospital, Farnborough Common, Orpington, Kent BR6 8ND

**Mr Henry B Colaco** is Senior Clinical Fellow in Upper Limb Trauma and Orthopaedics in the Department of Trauma and Orthopaedics, Princess Royal University Hospital, Farnborough Common, Orpington, Kent

**Mr Max R Edwards** is Consultant Trauma and Orthopaedic Surgeon in the Department of Trauma and Orthopaedics, Princess Royal University Hospital, Farnborough Common, Orpington, Kent

Correspondence to: Mr D Davenport (dominic.davenport@nhs.net)

### 66 Patellar instability problems can relate to a single acute episode following a traumatic injury or a chronic condition.99

either by moving systematically around the patient or remaining still and asking the patient to turn at 90° and 180° respectively. While examining the patient, the clinician should keep describing to the examiner the presence of positive findings as well as the absence of important and relevant negative findings.

The clinician should begin by observing the general skeletal alignment, noting asymmetry, scoliosis, lumbar lordosis and look for clues that may tell him/her whether there is a leg length discrepancy such as deformity of the spine, pelvic tilt or orthotic shoe raisers which should be examined inside and out. Examples of local deformity which may be noted on observation include coronal plane deformity such as genu varus or valgus and sagittal plane deformity such as flexion at the knee.

Further observations of the limb may reveal muscle wasting, scars, hair loss, skin changes such as psoriatic plaques, pallor or ulceration as a result of vascular disease. Specific wasting of the quadriceps muscles is common in knee conditions and a formal assessment of quadriceps bulk can be performed by measuring the circumference 10 cm above the patella and comparing sides. A common finding is abnormal lumps around the front of the knee or in the popliteal fossa. The nature of such lumps is better determined by palpation later in the examination.

#### Examine the patient while standing

##### Gait

The clinician should ask the patient to walk to the end of the room, turn and return. During this observation note abnormalities of gait which may include antalgic gait, high stepping gait, and asymmetry secondary to limb length discrepancy or fixed flexion deformities. In addition one might observe a varus or valgus thrust gait which occur as a result of lateral or medial knee instability respectively and have a strong association with progression to arthritic change. A varus thrust is described as a dynamic worsening of the genu varus limb deformity seen during the heel strike and (weight bearing) mid stance phase of

gait. There is a marked widening of the joint space on the lateral side of the knee which spontaneously returns to normal alignment during the (non-weight bearing) swing phase of gait.

#### Examination of the patient lying on the couch

##### Palpation

The clinician should ask the patient to lie flat on his/her back on the examination couch with his/her legs out straight. Observations such as fixed flexion deformity may be more obvious at this point. The order of palpation can be developed by the clinician with practise but the authors recommend starting with palpation of the joint margins working anteriorly and progressing around the popliteal fossa. Following this palpation of the extensor mechanism should start anteriorly at the level of the distal quadriceps and follow distally to its tendinous insertion on the patella. The patella should be palpated and if 'ballotable' this is strongly suggestive of an effusion (which could be inflammatory or blood or infection). To accentuate any minor effusion the clinician may attempt to 'milk' the effusion with direct pressure over the supra-patellar pouch.

#### Active and passive movements

The vast majority of movement at the knee joint is isolated to flexion and extension in the sagittal plane. By asking the patient to relax his/her legs in a straight position the clinician can then lift the ankles and observe any hyperextension of the knee. It is within the normal range to see up to 10° of hyperextension. The clinician should then ask the patient to bend his/her knee up to his/her chest or alternatively his/her heel to his/her bottom. This allows the clinician to observe the active range of motion and also gives a clue as to the limits tolerated by the patient when the clinician attempt to passively flex the knee. The authors would encourage passive movements to also be performed by the examiner as this allows simultaneous assessment of joint crepitus. Typical range of movement for the knee joint is -10° to 130° but because of the variation in normal flexion between

patients comparison with the patient's contralateral knee is recommended.

In full extension there is very little additional varus or valgus movement in the normal knee nor is there much rotation. Once the knee is passively flexed up to 90° the clinician may elicit around 30° of internal and external rotation and 5° of varus and valgus tilt even in the normal knee.

#### Tests for patellar instability

Patellar instability problems can relate to a single acute episode following a traumatic injury or a chronic condition. The authors believe that the routine knee examination should include a basic test of patellar instability.

With the patient lying on the examination couch the clinician should observe for signs of effusion in the knee and further confirm this by attempting to ballot the patella which may be consistent with recent acute injury. Palpation over the antero-medial aspect of the knee adjacent to the patella should elicit tenderness if there is injury to the medial patellofemoral ligament following a dislocation episode.

The clinician should then assess medial to lateral translation of the patella by manual displacement in the trochlear groove and compare both knees for any difference. The apprehension test involves the clinician applying pressure over the medial aspect of the patella directed laterally. If the patient has true instability he/she will resist this pressure and complain of a feeling of apprehension or feeling unstable. Finally, ask the patient to slowly move the knee from extension to flexion and observe movement of the patella. In the normal knee the patella tracks in a linear fashion. A positive 'J' sign occurs when a laterally subluxed patella is seen to move in a curved path or in some cases 'jump' back into the trochlear groove in early flexion.

#### Tests for ligamentous instability

##### The posterior sag test

The clinician should perform the posterior sag test before proceeding with examination for anterior cruciate ligament stability because an unstable posterior cruciate ligament can produce positive examination findings when examining for anterior cruciate ligament tears. The patient should be asked to flex both knees to around 90° and have his/her feet planted on the couch. It is then the clinician's responsibility to check the knees are flexed to the same level. At this point, on observation

from the side, with the clinician's eyes level with the knee, one might see a depression of the proximal tibia consistent with posterior cruciate ligament injury.

### The step off test

With the leg rested on the couch and the knee flexed to 90° the clinician runs both thumbs over the anterior aspect of the knee from the distal femoral condyles down to the tibial plateau. It is normal to palpate the medial tibial plateau as an anterior structure to the medial femoral condyle, but in a patient with a posterior cruciate ligament injury the tibial plateau may be level with or posterior to the medial femoral condyle.

### The posterior drawer test

With the knee relaxed at 90° and the foot secured on the couch, the clinician may attempt to manually depress the tibia from anterior to posterior with reference to the femoral condyles.

### The quadriceps active test

Following the posterior drawer test and maintaining the same position of the knee the patient is asked to contract his/her quads in an attempt to straighten the leg while the examiner applies resistance to the ankle. A positive test occurs when the posteriorly subluxed tibial plateau appears to reduce anteriorly during quads contraction.

### The anterior drawer test

The leg under examination should be flexed between 60° and 90° and the other side extended comfortably. The clinician should sit on the couch to prevent the patient's foot from moving without sitting directly on the toes. The clinician places both hands with digits interlaced behind the proximal tibia and thumbs anteriorly then attempts to draw the tibia forward on the femoral condyles. Anterior cruciate ligament instability should result in the apparent anterior translation of the tibia on the femur when under examination (*Figure 2*). This test may be positive in patients with posterior cruciate ligament pathology and further tests can be used to evaluate the anterior cruciate ligament.

### Lachman's test

The patient's leg is this time held off the bed by the clinician who places a hand under the upper calf and stabilizes the distal thigh in the other hand (*Figure 3*). Anterior-posterior

Figure 2. Anterior drawer test.



Figure 3. Lachman's test.



Figure 4. The pivot shift test.



Figure 5. The dial test.



Table 1. Grades of anterior cruciate ligament laxity

Grade of laxity	Observed translation
I	<5 mm
IIA	5–10 mm with a firm end point
IIB	5–10 mm without a firm end point
IIIA	>10 mm with a firm end point
IIIB	>10 mm without a firm end point

translation of the tibia on the femur is assessed by direct pressure by the examiner. This test may be graded I–III depending upon the severity of laxity observed and the presence or absence of an end point to translation. *Table 1* outlines the grading system (Gurtler et al, 1987).

### The pivot shift test

The pivot shift test also tests for anterior cruciate ligament rupture and associated instability. Typically this test is too uncomfortable to perform on a patient in clinic and may be more easily performed under general anaesthetic in theatre. The tibia is passively internally rotated and the leg is pushed into a valgus position relative to the femur. The clinician should then gently flex the knee while using his/her free hand to apply direct pressure over the lateral joint

line (Galway and MacIntosh, 1980). In the context of an anterior cruciate ligament-deficient knee joint a mechanical clunk will be heard or felt by the clinician as the subluxed joint relocates, typically between 20° and 40°. This test only works if the medial collateral ligament and the iliotibial band are intact (Matsumoto, 1990) (*Figure 4*).

### Testing the collateral ligaments

The medial and lateral collateral ligaments may be tested by applying valgus and varus stress to the knee respectively. The authors recommend that this is done with the leg held by the examiner in both hands, one proximal and one distal to the joint. To fully assess the integrity of the collateral ligaments the knee should be flexed to around 30°. If the test is also positive in full extension then suspect a concomitant anterior cruciate ligament or

**Table 2. Grades of medial collateral ligament or lateral collateral ligament laxity**

Grade of laxity	Observed joint line opening	Pathology
I	<5 mm	Sprain
II	5–10 mm with a firm end point	Partial tear
III	>10 mm without a firm end point	Complete tear

**Table 3. Key differential diagnoses during knee examination**

Structure injured	History	Examination tests
Anterior cruciate ligament	Usually non-contact Felt a pop Instant pain and swelling	Anterior drawer Lachman's test Pivot shift test
Posterior cruciate ligament	Direct blow, e.g. dashboard Instant pain and swelling	Posterior sag Posterior drawer Quadriceps active test
Medial collateral ligament	Valgus stress injury	Point tenderness Unstable to valgus stress
Lateral collateral ligament	Varus stress injury	Point tenderness Unstable to varus stress
Medial meniscus	Medial joint line pain Delayed swelling Locking and giving way	Joint line tenderness McMurray's test
Lateral meniscus	Lateral joint line pain Delayed swelling Locking and giving way	Joint line tenderness McMurray's test
Posterolateral corner	(Associated with other ligament injuries)	Dial test
Patellar tendon or quadriceps tendon	Localized pain Unable to weight bear	Restricted or no active extension
Patellar subluxation	Feel, hear or see the kneecap shift laterally Usually spontaneously reduces Anterior knee pain and swelling	Tenderness over medial patella-femoral ligament Patellar apprehension test J-sign

From Allen (2016)

posterior cruciate ligament injury. *Table 2* describes the grading system applicable to both medial collateral ligament and lateral collateral ligament laxity.

### The dial test

The dial test is performed by the clinician asking the patient to lie supine on the couch and flex both knees to 30° (*Figure 5*). The aim is to assess for the presence of a posterolateral corner injury and furthermore assess whether the posterior cruciate ligament is also injured. The clinician passively externally rotates the patient's legs at 30° comparing the rotation of both sides. A positive test, indicating a

posterolateral corner injury, occurs when the external rotation of the affected leg is more than 10° when compared to the contralateral leg. The test is then repeated with the patient's knees in 90° flexion and if it remains positive then a posterior cruciate ligament injury is likely present too.

### Tests for meniscal pathology

The clinician should ask the patient to flex the knee being examined and allow the clinician to apply external rotation to the tibia by securing at the ankle while gently allowing the patient to extend the knee. A positive finding is pain over the medial side of the knee consistent

### KEY POINTS

- It is important to recognize the presence of walking aids or orthoses early.
- Observation, particularly during gait, often assists in identifying the underlying pathology.
- Special tests are important to isolate specific pathology.
- Concluding the examination of the knee should involve an assessment of the neurovascular system of the lower limb, a summary of findings and a differential diagnosis.

with impingement of the meniscal tear in the joint line as the knee moves from flexion to extension. The same test may be performed again with the tibia in internal rotation to assess the lateral meniscus.

### Completing the examination

Completion of the examination should involve examination of the hip and ankle joints and a neurovascular examination of the limb being examined. In an acute setting thorough examination may be restricted by pain and swelling in which case an examination at a later stage is appropriate. It is reasonable to offer differential diagnoses based of the history and examination findings followed by appropriate investigations which typically include routine blood tests and radiographs of the knee joint in two (orthogonal) views and a skyline view if patellofemoral joint pathology is expected. *Table 3* offers a summary of possible common diagnoses and their associated history and examination findings (Allen, 2016). **BJHM**

Figure 1 is reproduced from Ellis (2010).  
Conflict of interest: none.

- Allen D (2016) History and Physical Exam of the Knee. [www.orthobullets.com/sports/3003/history-and-physical-exam-of-the-knee](http://www.orthobullets.com/sports/3003/history-and-physical-exam-of-the-knee) (accessed 1 January 2016)
- Ellis H (2002) *Clinical Anatomy: a revision and applied anatomy for clinical students*. 10th edn. Blackwell Publishing, Oxford
- Ellis H (2010) Applied anatomy of examination of the knee. *Br J Hosp Med* **71**(5): M60–M61 (doi: 10.12968/hmed.2010.71.Sup5.47928)
- Galway HR, MacIntosh DL (1980) The lateral pivot shift: a symptom and sign of anterior cruciate ligament insufficiency. *Clin Orthop Relat Res* **147**: 45–50
- Gurtler RA, Steine R, Torg JS (1987) Lachman test evaluated. Quantification of a clinical observation. *Clin Orthop Relat Res* **216**: 141–50
- Matsumoto H (1990) Mechanism of the pivot shift. *J Bone Joint Surg Br* **72**: 816–21