Traumatic problems of the patella

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Abstract

This article will outline the clinical presentation and management of patellar instability and fracture. Patellar instability is a generic term that describes anything from symptomatic apprehension to patellar subluxation and through to patellar dislocation. It can result from osseous abnormalities such as patella alta or patellofemoral dysplasia or it can arise secondary to soft tissue abnormalities such as a torn medial patellofemoral ligament. Failing conservative management, surgical treatment is directed to the underlying cause(s) of the instability, and can include medial patellofemoral ligament reconstruction or a bony realignment procedure.

Patellar fracture is a common injury caused by excessive tension through the extensor mechanism or a direct blow. Such injury can lead to stiffness, extension weakness and patellofemoral arthritis. Non-surgical management is indicated for non-displaced fractures with an intact extensor mechanism. Surgical fixation is recommended for fractures that either disrupt the extensor mechanism or that demonstrate over 2–3 mm of step-off and/or over 1–4 mm of displacement. Anatomic reduction and fixation with a tension-band technique is associated with the best outcomes; however, symptomatic hardware is a frequent complication.

Keywords patella alta; patellar dislocation; patellar fracture; patellar instability; patellofemoral dysplasia; trochlear dysplasia

Patellar instability

The incidence of primary patellar dislocation is 6 per 100,000, and increases to 29 per 100,000 in the 10–17-year-old age group.[1] The recurrence rate ranges from 15% to 44% after non-operative treatment of an acute injury. If a patient experiences a subsequent patellar dislocation, there is then a 50% chance of recurrent episodes.[1] After the primary dislocation, many patients continue to have pain and mechanical symptoms suggesting patellar instability.

The aetiology of patellar instability is multifactorial and is outlined in Table 1. Structural and functional imbalance of the patellofemoral joint (PFJ) can lead to chronic instability and secondary flattening, or, dysplasia, of the lateral part of the trochlea. This ultimately reduces containment of the patella within the trochlear groove. If the patella is not securely engaged at the start of flexion then it may sublux laterally. As flexion continues, the patella may either dislocate completely or slip back medially to its correct position. Stability of the patella is dependent on limb alignment, the osseous anatomy of the patella and the trochlea, the integrity of the soft-tissue constraints and the state of the surrounding musculature. Treatment of patellar instability requires an understanding of these relationships and how to evaluate them.

Aetiology of patellar instability

Patella alta
Trochlear dysplasia
Lateral femoral condyle dysplasia
Defective lateral trochlear margin
Shallow trochlear groove
Vastus medialis obliquus insufficiency
Generalized joint laxity
Tight lateral structures (e.g. lateral retinaculum and iliotibial band)
Trauma

Table 1

Anatomy

The patella: the patella is the largest sesamoid bone in the body, lying between the fibres of the quadriceps tendon and the patellar ligament (tendon). The superior three fourths of the posterior surface of the patella is covered with articular cartilage, dividing into the medial and lateral facets. The median ridge separates the two facets, with a second vertical ridge near the medial border defining a small strip known as the 'odd facet'. Less defined are two transverse ridges across the lateral and medial facets that produce the superior, intermediate and inferior facets. Patellar medio-lateral width appears to be consistently twice its maximum thickness.[2]

The patella typically forms from a single ossific nucleus. However, in 2–3% of the population a secondary ossific nucleus fails to unite with the primary nucleus, resulting in a bipartite patella. These are bilateral in 50% of patients and occur most frequently at the superolateral edge. Bipartite patella should not be confused with fracture.

The trochlear groove: patellofemoral joint stability is in part a function of the geometry of the trochlear groove, including its depth and steepness. The trochlear groove has a sophisticated geometry, with a complex shape that does not have a constant cross-section along its length. The lateral facet of the trochlear groove is highest on the anterior aspect of the femur and decreases in height more distally and posteriorly, giving more osseous constraint to the patella in extension and early flexion.

Path of the patella in the trochlear groove: the quadriceps and patellar tendons provide a strong posterior force vector during knee flexion, contributing to increased patellar stability. As the knee flexes and extends, the contact area moves across the

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patella. In full extension, the patella is typically not engaged in the trochlear groove. The distal and lateral edge of the patella initially makes contact with the femoral sulcus at 30° of flexion; this contact shifts more proximally as the knee flexes further. Beyond 90°, the patella rotates such that only the medial facet articulates, until extreme flexion when the entire patella lies within the trochlear groove. The odd facet engages the lateral aspect of the medial femoral condyle past 90° of flexion.

Arterial blood supply: the primary blood supply is from an extraosseous dorsal arterial ring derived from branches of the geniculate anastomotic system, found around the knee. The arterial ring is made up of a central superior geniculate vessel, medial, lateral, superior and lateral inferior geniculate vessels and an inferior recurrent tibial vessel. The superior portion of the vascular ring passes anterior to the quadriceps tendon whereas the inferior portion passes posterior to the patellar tendon, through the fat pad. The primary interosseous blood supply enters through the middle of the anterior portion of the body of the patella and through the distal pole vessels. Circumferential dissection or excessive stripping of the anterior surface should be avoided given the centripetal blood supply.

Soft tissue anatomy: the patella is firmly invested in a strong fascial structure formed by the coalition of the quadriceps tendon, fascia lata and iliotibial band. These structures join to form a strong expansion that cascades across the knee joint to form the lateral and medial retinacula. The retinacula derive from the deep investing fibres of the fascia lata in combination with the aponeurotic fibres from the vastus medialis and vastus lateralis. The retinacula insert directly into the proximal tibia, blending with the patellar tendon at its insertion. Contributions from the lateral aspect of the vastus lateralis, iliotibial tract and patellofemoral ligaments of the capsule complete the retinacula. The primary function of the medial and lateral retinacula is to serve as the auxiliary extensors of the knee.

The quadriceps tendon acts as a dynamic stabilizer of the patella, with the medial patellofemoral ligament (MPFL) being the primary soft tissue restraint to lateral translation. When engaged in the trochlear groove, the patella is held in place by both the tension of the medial soft tissue sleeve and the lateral aspect of the trochlear groove. The patella acts as a pulley, shifting the pull of the quadriceps anteriorly, thereby increasing the moment arm of the quadriceps by up to 30%.[3]

The lateral aspect of knee: the iliotibial band attaches to Gerdy's tubercle distally but also to the patellar and quadriceps tendon. Tension in the iliotibial band causes the patella to track in a more lateral position. There are three layers that make up the lateral side of the patellar attachments. The superficial layer is confluent with the iliotibial band. The intermediate layer is the lateral patellofemoral band, or the iliotibial patellar band; this band extends from the deep layer of the iliotibial band to the mid-lateral aspect of the patella. The deep layer is confluent with the knee capsule.

The medial aspect of knee: Warren and Marshall first described the medial anatomy of the knee as being a three-layered structure.[4] The superficial layer consists of the deep crural fascia and fascia over the vastus medialis. The second layer is composed of the superficial and posterior oblique fibres of the medial collateral ligament (MCL) and the medial patellofemoral ligament (MPFL). The deep layer is composed of the deep MCL and the meniscotibial and meniscofemoral ligaments.

The MPFL is an important structure for patellofemoral instability. Arising from the region of the medial femoral epicondyle, it inserts into the superomedial two thirds of the patella, fusing anteriorly with the inferior surface of the vastus medialis obliquus. It has been reported to provide over 50% of the medial restraint forces during cadaveric testing.[5,6]

Musculature around the knee: the vastus medialis obliquus and vastus lateralis obliquus originate from septa alongside the femur and approach the patella from directions that deviate from the anatomic axis of the femur.

These muscles can pull the patella medially or laterally. The vastus medialis obliquus has a mean orientation that deviates 47° ± 5° medially from the femoral axis, and the vastus lateralis obliquus has a mean orientation that deviates 35° ± 4° laterally from the axis.[7] An imbalance of strength may lead to instability. The vastus medialis obliquus is the first part of the quadriceps to weaken and the last to strengthen when function is inhibited.[8]

Presentation and history

Patients with patellar instability sometimes experience anterior knee pain, but episodes of collapsing or shifting in the knee are more prominent. A common clue is the feeling of the knee ''giving way'' or ''popping out''. It should be determined whether symptoms began with a sudden traumatic event. Previous treatment and the patient's response to that treatment should be noted. If treatment was unsuccessful, it is essential to determine whether the failure was due to an incorrect diagnosis, inappropriate treatment, poor patient compliance or instability that exceeded the effectiveness of non-operative treatment.

Physical examination of the patellofemoral joint

Dynamic tests:

Patella J sign – patellar tracking is observed: normally, the patella engages the trochlear groove at 30–40° flexion. At terminal extension, the patella may be observed to sublux laterally, and when in flexion it jumps back into place, indicating lateral tracking. Lateral deviation in terminal extension is characterized as the 'J sign'.

Active quadriceps pull test – with the knee extended, the patient is asked to contract the quadriceps and patella movement observed. Normally, the patella should be pulled superiorly in a straight line. When the pull is excessive in a lateral direction the test is considered abnormal, indicating an overpull of the vastus lateralis or failure of the medial retinacular structures. This test is useful to determine the integrity of the extensor retinaculum if considering conservative *versus* open reduction of the minimally displaced patellar fracture.

Static tests:

Patellar apprehension test of Fairbanks – patellar stability can be assessed by the examiner holding the relaxed knee in 20–30° of flexion while subluxating the patella laterally and then pushing the patella laterally while flexing the knee. The MPFL