CHRONIC PATELLOFEMORAL INSTABILITY

DAVID J. DANDY

From Addenbrooke’s Hospital, Cambridge, England

This article aims to discuss the many causes of patellofemoral instability so that an appropriate stabilisation procedure may be selected. The emphasis is on a selective approach, rather than the use of one operation for all unstable patellae regardless of cause.

DYNAMICS OF THE PATELLOFEMORAL JOINT

The patellofemoral joint is intrinsically unstable because the tibial tubercle lies lateral to the long axis of the femur and the quadriceps muscle, and the patella is therefore subject to a laterally directed force. This apparent ‘design fault’ is minimised by the resistance of the lateral lip of the trochlea to lateral movement of the patella during flexion (Brattström 1964).

In full extension the patella lies at the upper end of the trochlea and enters its groove as flexion begins. It is important for stability that it should engage the trochlea correctly. Once engaged, the patella is held in place by two mechanisms. The first is its contact with the lateral edge of the trochlea, which acts as a lateral buffer, and the second is the soft-tissue tension which prevents it slipping laterally.

In the normal knee, from 0° to 30° of flexion, the median ridge of the patella lies lateral to the centre of the trochlea; it moves medially to become centred in the trochlear groove at between 30° and 60° of flexion. As flexion proceeds the patella is more deeply engaged in the trochlea and is held firmly by soft-tissue tension. When the knee is flexed beyond 90°, it tilts so that its medial facet articulates with the medial femoral condyle.

FACTORS LEADING TO PATELLAR INSTABILITY

Poor engagement. If the patella fails to engage securely in the trochlea at the start of flexion it will slip laterally and as flexion continues will either dislocate completely or slip back medially to its correct position. Failure to engage may be due to an abnormally high patella, patellar dysplasia (Fig. 1) or a poorly developed trochlea. The consequences of a high patella and a proximally deficient trochlea are the same; the patella is not securely engaged at the start of flexion.

Failure to stay in the trochlea. Sometimes the patella engages correctly at the start of the flexion but subluxes or dislocates as flexion proceeds. This may be due to a defective lateral trochlear margin or an unusually shallow trochlear groove.

The laterally directed force applied to the patella is greater if the knee is in excessive valgus.

Soft-tissue imbalance from excessively tight lateral structures or deficient medial structures can also increase the laterally directed force. The lateral structures may be tight from fibrosis of the vastus lateralis (Lloyd-Roberts and Thomas 1964) or for no obvious reason. The medial structures may be loose after injury to the medial retinaculum, from stretching after repeated dislocations or from severe wasting of the vastus medialis.

ASSESSMENT

The purpose of assessment is to identify the factors causing instability so that appropriate treatment may be selected.

---

Fig. 1

A dysplastic patella.
Assessment follows the usual procedure of a clinical history, clinical examination and investigation.

**History.** The history will reveal whether the symptoms began with a sudden traumatic event. The circumstances of the dislocation are also important. Does it occur with every flexion of the knee or only with twisting movements? Is there a particular movement which causes dislocation?

It is also important to know the effect of the symptoms on the patient’s way of life. There is little point in advising a major operation, with a prolonged period of rehabilitation, if the dislocations cause only minor inconvenience.

**Clinical examination.** The patella is observed while the patient flexes the knee to see if it engages smoothly at the proximal end of the trochlea or more distally than normal. Does the knee flex fully or is flexion restricted by tight structures? Tests are required for generalised ligament laxity and for abnormally loose patellar retinacula.

Patellar stability is assessed by gently pushing the patella laterally while flexing the knee. If the patient is apprehensive when this is done, the problem is poor patellar engagement. Sideways movement of the patella also allows the lateral and medial structures to be assessed.

The Q-angle between the long axes of the quadriceps and the patellar tendon (Fig. 2) is a poor indication of the lateral forces on the patella. It is better to measure the position of the tibial tubercle with respect to the mid-line of the trochlea. With the knee flexed to 90° the tibial tubercle should lie less than 20 mm lateral to the mid-line of the femur at the upper edge of the femoral condyles; more than 20 mm indicates an abnormally lateral tubercle.

Patellar height can be measured most accurately on radiographs. The patella is usually a little shorter than the patellar tendon and a rough estimate can be made clinically.

**Radiological measurements of patellar height.** There are many methods of measuring the height of the patella on radiographs. The Insall-Salvati index (1971) (Fig. 3a), which compares the length of the patella with the length of the patellar tendon (men 0.9 to 1.1, women 0.94 to 1.18), is popular but it has a number of practical disadvantages. The point of attachment of the tendon to the tibia is indistinct, and measurements are difficult to make after transposition of the tibial tubercle. Furthermore, the length of the patella is not always an indication of the length of its articular surface.

The Blackburne and Peel index (1977) (Fig. 3b) relates the length of the articular surface of the patella to the distance of its inferior margin from the tibial plateau (men 0.85 to 1.09, women 0.79 to 1.09). It provides a more useful measure of the relationship of the patella to the trochlea than the Insall-Salvati index.

**Observations on a true lateral radiograph.** Déjour et al (1994) have shown that a true lateral radiograph can provide much information about the anatomy of the femoral trochlea. The base of the trochlea can be seen as a radio-dense line which is in direct continuity with the anterior cortex of the femur (Fig. 4). Several abnormal variants are seen.

The **crossing sign.** If the line indicating the floor of the trochlea crosses the lateral lip of the trochlea (Figs 5b and 6), the trochlea is deficient proximally and the patella may not engage correctly.

The **‘bump’ sign.** If the radiological line linking the anterior cortex of the femur and the floor of the trochlea is convex and has a ‘bump’, engagement of the patella will also be incorrect. A bump of more than 3 mm is abnormal (Déjour et al 1994).

**Dysplastic condyles.** These may be indicated by an abnor-
mal appearance of the lateral lip of the trochlea; there is often a small beak or spike at its upper end (see Fig. 7).

**Trochlear depth.** The depth of the trochlea can be measured; the normal mean depth is 7.8 mm (Déjour et al 1994). A shallow trochlea (Fig. 5c) may be insufficient to prevent the patella dislocating laterally even if it engages correctly at the start of flexion.

**Relationship of the tibial tubercle to the trochlea.** Goutallier, Bernageau and Lecudonnec (1978) described the relationship between the centre of the trochlea and the tibial tubercle on axial radiographs. These measurements can be made more accurately by CT. In normal subjects, the distance between the centre of the trochlea and the tibial tubercle is 10 to 15 mm (Fig. 8).

**Patellar angle.** MRI or CT gives more reliable information about the condition of the trochlea and the angle of the patella than tangential radiographs (Merchant et al 1974). Lateral tilting of the patella indicates tight lateral structures.

**Q-angle.** The Q-angle is a useful dynamic concept but an unreliable measurement, because an unstable patella lies more laterally than normal in full extension thereby decreasing the angle. CT has shown that the Q-angle measured from the centre of the patella is actually less in patients with unstable patellae than in normal subjects; if it is measured from the centre of the trochlea, it is greater in patients with unstable patellae, as would be expected.

**Arthroscopy.** This is not needed to diagnose patellar
instability but it is a valuable preliminary to surgical stabilisation.

From the medial or suprapatellar approach the patella can be seen engaging in the trochlea. A normal patella centres at between 30° and 60° of flexion. Failure to centre in a normal trochlea suggests tight lateral structures. The contours of the trochlea and of the patella can be seen directly. A dysplastic or flattened trochlea can be seen clearly and the problems of achieving stability assessed.

Lastly, the joint surfaces can be examined. Vertical fissures resembling the side of a clinker-built boat (Dandy 1984; Dandy and Griffiths 1989) are almost diagnostic of patellar instability and may be the first signs of progressive osteoarthritis. The presence of the latter indicates a poor prognosis.

SELECTING THE OPERATION

Many procedures have been described for stabilising the patella. Broadly speaking, they can be classed as distal realignments to transpose the tibial tubercle, or proximal realignments to alter the tension of the tissues attached to the patella.

When selecting an operation it is important to choose the procedure which will correct the underlying problem in the individual patient; the precise technique is less important. It is wrong to use one procedure on all patients regardless of the underlying cause of dislocation.

Distal realignment. This is required if the patella is abnormally high and the trochlea normal. It is achieved by transferring the tibial tubercle far enough distally to allow the patella to engage correctly in the trochlea and to bring the Blackburne-Peel index to the lower end of its normal range (Fig. 9). The amount of transposition required is variable but is usually between 10 and 20 mm.

Distal transposition may also be needed if the trochlea is deficient at its upper end even although this may bring the index of patellar height below the lower limit of its normal range.

Techniques for lifting the tibial tubercle anteriorly at the time of transposition, based on the work of Maquet (1976) in patients with patellofemoral osteoarthritis, are not applicable to patellofemoral instability. Moving the tibial tubercle anteriorly must reduce patellar stability (Fig. 10).

Medial transposition. This is indicated if the tubercle lies too far laterally and is usually done as part of a distal
transposition (Fig. 11). Care should be taken not to move the tubercle medial to the mid-line of the trochlea; this may lead to recurrent medial dislocation.

Medial transposition alone is appropriate if the trochlea is dysplastic and the patella is of normal size and height, but engages poorly in the trochlea.

Adjustment of tissue tension. The tension of the soft tissues around the patella can be altered by releasing lateral structures or tightening medial structures.

Lateral release. This alone is a reliable procedure for recurrent dislocation if the patella is not abnormally high and if the ligaments are not loose (Dandy and Desai 1994). For patients with normal anatomy the results of this procedure are better than those of tibial tubercle transfer or medial plication.

Lateral release may be performed subcutaneously but must extend at least 4 cm above the upper pole of the patella (Dandy 1987). It is also used as an adjunct to medial plication and distal transposition; without a lateral release the patella cannot be moved to its new position.

Medial tightening. The medial structures may be plicated or tightened using fascia, tendon, imbrication or advancement of the vastus medialis (Fig. 12).

Medial tightening alone will correct the underlying problem only if the cause is abnormal laxity of the medial structures, which is rare. In other conditions it may be an adjunct to the main corrective procedure.

Reconstruction of the lateral condyle. Procedures have been described (Albee 1919) to increase the height of a dysplastic lateral trochlear margin (Fig. 13). They are difficult to perform and often result in damage to the trochlear articular surface.

The indications for increasing the height of the lateral margin of the trochlea are rare and few results have been
published. There is a suspicion that results are generally poor because of early degenerative changes on the femur. **Deepening the trochlea.** Procedures to deepen the trochlea by removing bone from beneath its articular surface and covering the excavated area with osteochondral flaps are an attractive intellectual solution to the problem of a defective femoral trochlea. Damage to the articular surface is, however, inevitable and there are few published results.

**PATTERNS OF DISLOCATION**

Some confusion exists over the terminology of patellofemoral instability. **Recurrent dislocation.** This is generally taken to mean repeated, occasional dislocation and it is the commonest form. The dislocations may occur at intervals of weeks or months.

**Recurrent subluxation.** This implies a less drastic event than a dislocation but the distinction between the two is often unclear, particularly in patients with lax joints. The terminology has been confused by authors who have described the lateral pressure syndrome of Ficat as lateral subluxation of the patella (Metcalf 1982).

**Habitual dislocation.** The term was probably first used to describe voluntary dislocation of the patella by children with lax ligaments. These patients may also dislocate their shoulders and temporomandibular and first carpometacarpal joints as party tricks. They should be encouraged not to do so but they may require tibial tubercle transposition and medial plication to achieve stability.

The term is also applied to a patella which dislocates every time the knee flexes; in these cases it cannot be held in the reduced position throughout the full range of flexion. Common causes are a deficient or shallow trochlea combined with tight lateral structures. This type of habitual dislocation requires an extensive soft-tissue release, often extending far up the thigh, combined with tibial tubercle transfer and medial plication. Flexion may be limited because of quadriceps contracture and release of the rectus femoris is sometimes needed. **Permanent dislocation.** The permanently dislocated patella lies on the lateral side of the femur and cannot be reduced. Active extension of the knee is very weak and there is often a valgus deformity because the quadriceps acts as an abductor instead of an extensor of the knee. **Congenital dislocation.** Sometimes the patella is permanently dislocated from birth from congenital deformities or contractures of the vastus lateralis (Conn 1925). Contractures of the quadriceps muscle may also occur after intramuscular injections in the neonatal period (Green and Waugh 1968).

The permanent or congenitally dislocated patella requires an extensive soft-tissue release, transfer of the tibial tubercle and medial plication. The patellofemoral joint is seldom congruent, the articular cartilage is usually deficient and the prognosis is poor. Relocation of the patella on the front of the femur may restore extension in these patients but flexion is usually severely restricted and release of the rectus femoris from its attachment to the pelvis may be required.

**SPECIAL SITUATIONS**

There are a few special disorders which require different methods from those outlined above. **Dislocation in the immature skeleton.** It is not safe to perform relocation of the tibial tubercle until growth is complete because of the risk of premature fusion at the front of the tibial physis and genu recurvatum deformity (Pappas, Anas and Toczylowski 1984). Stabilising procedures in children must use soft tissue only. Many of these fail and must be considered as the first steps in a two-stage procedure, the second being performed when growth is complete.

Stabilisation is important in children for two reasons. First, it is necessary to replace the patella in the trochlea to encourage normal development of the patellofemoral joint. Secondly, articular surface lesions from recurrent dislocation in childhood lead to early osteoarthritis.

Of the many soft-tissue operations described, medial plication and lateral release are probably the procedures of choice. If they do not control the stability, a semitendinosus tenodesis (Baker et al 1972) (Fig. 14) is effective but it may need to be reversed later to avoid osteoarthritis of the medial facet. **Pathological ligament laxity.** Ligamentous laxity of the knee may be part of a generalised joint laxity or, less commonly, be confined to the knee (Carter and Sweetnam 1958). The patella can be very difficult to stabilise if there is abnormal laxity because the soft tissues neither guide it into the trochlea at the start of flexion nor hold it there once engaged. Lateral release alone is ineffective and must be combined with medial tightening and transfer of the tibial tubercle. Care must be taken not to produce medial dislocation of the patella in these cases.

![Fig. 14](image)
Subluxation on extension. In some knees the patella subluxes laterally on full extension and reduces on flexion as it engages in the trochlea (Dandy 1971). In these patients there is usually a high patella, ligament laxity and often a deficient lateral condyle. Many such patients have other congenital anomalies such as talipes or congenital dislocation of the hip in the same limb.

Lateral release alone is never sufficient and an extensive reconstructive procedure is required for stabilisation.

Dislocation after patellectomy. Patellectomy enjoyed a brief period of popularity for patellofemoral instability but it has proved ineffective. Dislocation of the patellar tendon ensues and this may be more difficult to stabilise than dislocation of the patella itself. It may also follow patellectomy for fractures of the patella.

The patellar tendon can be stabilised by a wide lateral release combined with transfer of the tibial tubercle. Medial transposition alone may be adequate but distal transposition is helpful if there is an extensor lag.

These procedures alone are insufficient because the undersurface of the tendon becomes concave to conform with the convexity of the lateral edge of the trochlea. This concavity must be reversed by a series of transverse cuts along its lateral edge so that the tendon lies comfortably in the trochlea. A convenient technique is to split the lateral half of the tendon in the coronal plane and make the transverse cuts in such a way that they coincide with an intact leaf of tendon above and below (Fig. 15). For additional security the flaps can be rolled anteriorly and stitched to the medial half of the tendon to form a tube.

Instability in the presence of patellofemoral osteoarthritis. Severe osteoarthritis combined with patellar instability presents a difficult problem. Stabilisation may aggravate the osteoarthritis but patellectomy will not stabilise the patella. Both patellectomy and stabilisation may be required, either combined or as staged procedures, and the complexity of the problem should be explained to the patient.

COMPLICATIONS

Patellofemoral osteoarthritis. This is common in the presence of patellar instability, whether treated or untreated. Inappropriate transfer of the tubercle is said to aggravate the condition by exposing the patellar articular surface to increased loads but there is no evidence that judicious transposition to correct a high patella carries the same risk. There is no evidence, either, that anterior advancement of the tibial tubercle at the time of transposition reduces the incidence of later osteoarthritis.

Medial dislocation of the patella. This may follow excessive medial transposition of the tubercle particularly if there is ligament laxity, a defective trochlea or excessive medial plication.

The tubercle should never be moved medial to the centre of the trochlea. The movement of the patella along the trochlea should be observed at the end of the operation to exclude medial subluxation.

Loss of flexion. Distal transposition or relocation of a permanently dislocated patella may be followed by loss of flexion. Persistent gentle physiotherapy will eventually restore flexion but this may take as long as a year. Release of the rectus femoris from the pelvis is said to relieve this problem but I have no personal experience of this technique.

Recurrence of dislocation after stabilisation. The management after a failed stabilisation operation is no different from that of a patella which has not undergone previous surgery. Thorough assessment to discover the cause of failure is essential. Corrective surgery is usually effective but some patellae continue to dislocate even when all underlying causes appear to have been removed.

ASSESSMENT OF RESULTS

There is no general agreement on the best way to assess the outcome of surgery for chronic patellar instability. The scoring system of Crosby and Insall (1976) is widely used but the good and excellent grades are generous and may include patients with a recurrence of dislocation.

The situation is complicated because some patients experience an occasional dislocation in the immediate postoperative period before the tissues have matured and the quadriceps has regained power. Such a patient may later achieve an excellent result. The symptoms of osteoarthritis may also interfere with the assessment of stability by the Crosby and Insall score.

Few scoring systems take account of the patients’ frequent complaint that although the patella has never dislocated, it feels as though it might. The subjective grading of ‘feels completely stable; feels occasionally unstable but
never dislocates; continues to dislocate’ is simple to apply and may yield more information than complicated knee scores.

REFERENCES


Dandy DJ, Desai SS. The results of arthroscopic lateral release of the extensor mechanism for recurrent dislocation of the patella after 8 years. Arthroscopy 1994;10:540-5.


