Addressing Patellar Height and Tibial Tubercle-Trochlear Groove Distance in Recurrent Patellar Instability
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In recent years there has been a changing paradigm in the surgical management of patellofemoral instability, such that medial patellofemoral ligament (MPFL) reconstruction has for many surgeons become the mainstay of surgical intervention, with tibial tubercle osteotomy (TTO) taking on an adjuvant role. When performed, TTO is increasingly used to address patella alta rather than to medialise the tibial tubercle.

Patella alta has long been recognized as a risk factor for recurrent patellar instability. It is important to understand that patella alta is the result of a long patellar tendon rather than a more proximal insertion of the tendon on the tibia. Patella alta means that the patella will engage in the trochlea later in flexion, making the patella more susceptible to lateral dislocation in early flexion. This can be exacerbated by a short and/or dysplastic trochlea.

Patellar height is typically measured on lateral X-rays with the knee in 20 to 30 degrees flexion. Various indices have been described. The Caton-Deschamps (C-D) and Blackburne-Peel (B-P) indices use the length of the patellar articular surface relative to the distance from the distal end of the patellar articular surface to either the plane of the tibial plateau, or to the anterosuperior corner of the tibia, respectively. The Insall-Salvati (I-S) index and the modified Insall-Salvati (mI-S) index use the length of the patellar tendon relative to the length of the patella or the articular surface of the patella, respectively. The I-S and mI-S indices cannot be used to measure the effect of tibial tubercle distalisation because the length of the patellar tendon is not changed.

A: Insall-Salvati, B: Caton-Deschamps, C: Blackburne-Peel, D: modified Insall-Salvati

Although satisfactory inter-observer reliability has been reported for individual indices, there is considerable variation between indices in terms of the number
patellae classified as normal, low or high. (2, 3) The indices (C-D and B-P) that use the length of the articular surface as a reference appear to be reasonably similar in terms of classification of patellae as normal, alta and baja. Whichever index is used, it is however important that the knee is in enough flexion, typically 20 to 30 degrees, to have tension in the patellar tendon. If the patellar tendon is lax, the patella may sit more distally, leading to an underestimation of patellar height.

With the increasing availability of MRI it has also been used to assess patellar height. Satisfactory correlation between plain radiographic and MRI measurements of the C-D index has been reported. (1) However, when using MRI to assess patellar height, consideration needs to be given to which sagittal slice to use. A slice that is too lateral may give the appearance of a shorter patella and therefore of patella alta. Thus, the slice that gives the longest length of the patellar articular surface is preferable. As with plain radiographs, the knee needs to be enough knee flexion to ensure that there is adequate tension in the patellar tendon.

More recently, MRI has been used to evaluate of the engagement of the patella in the trochlea in the sagittal plane. (4) There appears to be a group of patients with patellar instability in whom there is reduced engagement of the patella in the trochlea in early knee flexion but without obvious patella alta. However, patellar-trochlear indices are not yet in in widespread clinical use.

The TT-TG distance is commonly used to measure lateralisation of the tibial tubercle. This was originally described using two superimposed slices of a CT scan, with the patient supine, a support under the feet to ensure the knee is in extension, and the feet held in 15 degrees external rotation. (5) The first slice is where the intercondylar notch has the shape of a Roman arch and this is used is to identify the centre of the trochlear groove. The second slice is through the proximal tibial tubercle, and the distance between the centre of the trochlear groove and the centre of the tibial tubercle is measured and corrected for magnification. It is important that the knee is extended. In full extension, the tibia is externally rotated, which effectively shifts the tibial tubercle laterally. If the knee is flexed, the tibia rotates internally with an associated reduction in the TT-TG distance. (6) Despite being widely used for preoperative planning, the TT-TG distance is not a reliable measurement, with measurement errors as high as 6mm having been reported. (7)

As with patellar height, MRI has also been used to measure the TT-TG distance. Although good correlation between CT and MRI measurements of the TT-TG distance has been reported, (8) the two may not be interchangeable with MRI measurements be systematically smaller. (9) This may in some instances be partly due to the use of a knee coil in MRI, which can flex the knee. As already noted, knee flexion
will tend to reduce the TT-TG distance. Using the tibial tubercle itself or the patellar tendon insertion may also affect measurements. (10)

Since the rise in popularity of MPFL reconstruction and the reporting of its effectiveness, (11, 12) algorithms for surgical management of patellar instability have changed. The previously popular a la carte approach may no longer be applicable, particularly if MPFL reconstruction is regarded as the basis of surgery. The principal issue becomes when to add an additional procedure, typically a tibial tubercle osteotomy (TTO). In describing the a la carte approach, H. Dejour et al suggested threshold values of greater than 20mm for the TT-TG distance (as measured by CT scanning with the knee extended), and 1.2 or greater for the C-D index as indications for medialisation and distalisation of the tibial tubercle respectively. (5) However, these thresholds were used in an algorithm that did not include MPFL reconstruction. Including MPFL reconstruction means that potentially higher thresholds can be used. In one study, raising the threshold for TT-TG distance to greater than 21mm and the threshold for the Insall-Salvati index to greater than 1.4 was not associated with higher recurrence rates of patellar instability. (13)

My Approach

Where possible, I use an isolated MPFL reconstruction to treat recurrent patellar instability. In determining whether an additional procedure may be required, recurrent dislocation rather than subluxation, the presence of J-tracking and significant patella alta are relative indications for an additional TTO, usually distalising. As a general principle, I regard J-tracking as an indication that a bony procedure is likely to be required to achieve patellar stability.

The ideal patient for an isolated MPFL reconstruction has unilateral recurrent patellar dislocation or subluxation, no J-tracking, normal patellar height, normal trochlear morphology, and a normal TT-TG distance. The “less than ideal” patient importantly does not have J-tracking, but can have an I-S or C-D index up to 1.4 or 1.3 respectively, a TT-TG distance <24mm (measured with the knee in extension) and almost any degree of trochlear dysplasia with the possible exception of Dejour type D. It should be noted that patients with marked trochlear dysplasia are likely to demonstrate J-tracking and therefore, at least in my view, are not candidates for an isolated MPFL reconstruction.

Trochleoplasty as a primary procedure is reserved for marked trochlear dysplasia in more complex settings such as chronic dislocation or habitual dislocation

References