■ EDITORIAL

Towards a better understanding of patellofemoral instability

A TOWER OF BABEL CHALLENGE

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A great deal of recent research and debate has advanced our understanding of instability of the patellofemoral joint (PFJ),[1-3] but a definitive language, understanding, and approach to management remains elusive. Attempts at a consensus and at flushing out the unknowns and key research questions are therefore timely. In this issue of *The Bone & Joint Journal*, the authors of a modified Delphi study have integrated the opinions of 60 surgeons from 11 countries.[4,5] While emphasizing areas of agreement, this research highlights persistent areas of debate.

The stability of the PFJ depends on an intricate balance between local and distant factors, with both static and dynamic stabilizers.[6] Locally, the stability is derived from the bony and cartilaginous morphology, and the ligaments which offer static support.[7] Distant static factors, of secondary significance, include femoral anteversion, the rotation of the knee, and external tibial torsion.[8] Locally, dynamic balance is mainly provided by the extensor muscles including the vastus medialis obliquus. Distant dynamic influences include the iliotibial band complex, the abductors and external rotators of the hip, and pronation of the subtalar joint, which may generate a dynamic valgus force moving the patella laterally.

It is widely accepted that the medial patellofemoral ligament (MPFL) acts as the main passive check rein of the patella during the initial stages of knee flexion, from 20° to 30°.[9] The stability of the PFJ in deeper flexion relies on the bony geometry and cartilaginous cover of the patella and trochlea.

The diagnostic criteria for patellar instability are opaque. Efforts to quantify instability and adopt an à la carte approach have been riddled with difficulty and are prone to misinterpretation.[10] While MRI and CT can identify static abnormalities, they often fail to capture the complex dynamic interactions. Moreover, these anatomical variations might lead to PFJ instability in some patients and remain inconsequential in others. Anatomical variation does not, therefore, always result in dysfunction or discomfort. A persistent question that challenges many is: when does a simple anatomical deviation evolve from an innocuous finding into a medical concern?

It is broadly recognized that the key factors influencing PFJ stability are the tibial tubercle-trochlear groove distance (TT-TG), trochlear morphology, the MPFL, and the height of the patella. Consequently, most orthopaedic surgeons focus on evaluating these parameters before deciding on the appropriate operative treatment.[11]

Goutallier et al[12] initially referred to the TT-TG distance as the tibial tubercle-patella groove (TT-PG), in 1978. Evaluations of this were based on a cohort of 60 patients, mainly aged > 60 years and with osteoarthritis (OA). This demographic does not, however, represent the typical patients with PFJ instability and, on this basis alone, the TT-TG measurements must be approached with circumspection.

The TT-TG distance varies considerably, depending upon an individual's stature and body dimensions.[13] A 20 mm distance can exert a more pronounced effect on the kinematics of the PFJ in shorter individuals. This discrepancy arises because the TT-TG distance is gauged as an absolute metric, rather than as a proportion of the individual's height and the dimensions of the knee.[14] The reproducibility of this measurement among observers is poor, with discrepancies of between 3 and 5 mm having been documented.[13] The accuracy of the measurement is also significantly influenced by the degree of knee flexion and the patient's weightbearing status.[14–16] A high TT-TG value of > 20 mm may provoke PFJ instability in some individuals, but not in others.[13] Interestingly, this measurement may also have a different effect on PFJ stability between the two legs of the same individual.[8,17] Determining the diagnosis of instability on measurements made in millimetres, especially when using static imaging, is too rigid for such a nuanced issue.

Approximately 10% of the general population have high-grade trochlear dysplasia, defined by a sulcus angle of ≥ 154°.[18] The incidence of primary patellar dislocation is between 5.8 and 42 per 100,000 individuals annually depending on the

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age group.[17,19] This highlights the discrepancy between structural abnormalities and symptomatic presentations, and raises questions about the appropriateness of surgery in patients with low- to medium-grade dysplasia, particularly in view of the uncertainty surrounding its long-term impact on the development of OA.[20]

Dejour's categorization of trochlear dysplasia remains useful,[21] albeit with some adjustments. Traditionally, our primary research focus and algorithms for initial treatment have leaned heavily on bone morphology using radiological classifications. There is evidence that this emphasizes distinctions between bony and cartilage morphology, indicating that cartilage might have a different grade of dysplasia when compared with its bony counterpart.[22] The patella also tends to mirror the morphology and topography of the trochlea. This adaptability and interplay implies that a flat trochlea may articulate with a flat patella, or a shallow trochlea might still align with a matching type of patella, as they typically develop together from childhood.[23] Based on this mutual adaptability, one might wonder: if the PFJ is congruently dysplastic, why would surgeons opt to deepen the trochlea?[24,25]

Radiological methods for determining the patellar height remain controversial due to the lack of a universally endorsed approach. Discrepancies may arise due to inconsistencies in the landmarks as well as intra- and interobserver disagreements.[26] Measurements of the indices of patellar height from radiographs can vary considerably from those derived from MRI scans.[27] The techniques used for measurement, which we often depend on, can also be influenced by variables such as the length of the patella and of the patellar tendon, the angle of flexion of the knee, and the tibial slope.

Given the intricacies of quantifying patellar malalignment and malrotation, and the uncertainty about their correlation with dysfunction, it is essential to use a variety of clinical tests and radiological evaluations, and avoid over-reliance on specific numerical values and abstract algorithms.

The management of PFJ instability has evolved since the Lyonnaise school described its initial principles.[21] The primary forms of surgical treatment for instability include MPFL reconstruction, tibial tubercle osteotomy, and trochleoplasty. Patients may rarely require a derotation osteotomy. Most patients with instability without significant bony malalignment or severe (grade C and D) Dejour trochlear dysplasia can be treated with isolated MPFL reconstruction. The MPFL is injured in approximately 95% of patients who sustain a dislocation of the PFJ.[9] Yet, a torn MPFL on MRI should not automatically be an indication for MPFL reconstruction.[28] Many factors contribute to the decision about whether to operate and which operation to perform.

When an isolated MPFL reconstruction will reliably lead to a successful outcome remains difficult to determine. It is unclear whether the techniques of reconstruction which are described in the literature consistently adhere to similar standards in relation to the type of graft, its fixation and tensioning, and the position of the tunnel. In view of these potential variations, we might be comparing fundamentally different procedures under the label of MPFL reconstruction.[29–35]

The management of PFJ instability with MPFL reconstruction is fraught with inconsistencies. The debate around the femoral attachment of the MPFL exemplifies the possible discrepancies in the literature. Although all the following research workers have defined their reference points as "anatomical", their findings are significantly different. Amis et al[36] determined that the MPFL has its origins at the medial epicondyle of the femur. However, Desio et al[9] and Schöttle et al[37] identified its femoral origin to be 8.8 mm and 1 mm anterior to the posterior femoral cortical extension line, respectively.

Adding to the debate, it is suggested from cadaveric studies that the MPFL connects to an expansive area between the medial femoral epicondyle and the adductor tubercle.[38–41] When the midpoint of this attachment was identified radiologically, it corresponded to a point just posterior to the posterior femoral cortex and just anterior to the intersecting point of Blumensaat's line[42] and the curved line from the posterior cortex: hence the name "confluence point".[38,40] This point corresponds to the centre of rotation of the knee and is best identified radiologically intraoperatively.

Consequently, methods of reconstructing the MPFL vary. In some instances, the procedure deviates by between 5 mm and 10 mm from its anatomical attachment. Such variations can result in elevated medial facet contact pressures and medial translation of the patella.[43] The long-term complications, such as the possible development of OA, remain uncertain. It is also extremely difficult to accurately drill a 4 mm to 5 mm diagonal tunnel in the femur to a landmark that is determined in millimetres. The precision that this requires makes it difficult to replicate the recommended positions of the tunnel exactly, even if they were in the correct anatomical location.

These problems also beset tibial tubercle osteotomy and trochleoplasty. The decision to perform a trochleoplasty remains highly subjective, setting it apart as the only area yet to see substantial progress. It is clear that the indications for this procedure are determined more by individual preference than by established evidence, making it a weak contributor to the surgical treatment of PFJ instability.[44]

In conclusion, the management of PFJ instability is a delicate balance between art and science. It involves synthesizing information from a spectrum of clinical tests and radiological evaluations, combined with the expectations of the patient and surgical experience, while avoiding an over-reliance on strict numerical values determined in millimetres.

While nearly 60% of patients with PFJ instability have several anatomical abnormalities,[45] priority should be given to rectifying the main anatomical anomaly that would lead to redislocation without creating further local pathology. In essence, MPFL reconstruction may compensate for mild patella alta (Caton-Deschamps < 1.4, the normal being between 0.6 and 1.3)[46,47] and minor maltracking. Yet, in patients with severe patella alta, reconstruction might inadvertently introduce further local pathology. In such situations, distalization of the TT should also be considered.

In our practice, surgery – when indicated – involves addressing the soft-tissue disturbance caused by dislocation using MPFL reconstruction with additional distalization of the TT and medialization in selected cases. Trochleoplasty is reserved for severe cases of grade C and D Dejour dysplasia. There is a subset of patients with permanently dislocated patellae that track in the lateral gutter in flexion for whom several procedures may be required to ensure patellar stability.

In order to progress we must agree on the basic terminology, the stratification of risk factors, and our descriptions of anatomical landmarks to ensure consistent communication. Standardizing assessment protocols will minimize subjectivity. Advancing dynamic imaging techniques may also aid in detecting subtle forms of instability and offer a deeper insight into the complex interplay of risk factors leading to dislocation.[48]

In light of these considerations, we should also refine our approach to reconstruction. Clear indications for various surgical procedures, particularly the more invasive ones like trochleoplasty, become imperative. While the topic remains contentious, placing emphasis on blinded, independent clinical reviews marks a step forward in ensuring impartiality and the unbiased reporting of outcome

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