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Current concepts of lateral patella dislocation

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The term *patellar instability* is defined in different ways. For example, it is used to signify a clinical entity or diagnosis, (eg, a traumatic dislocation of the kneecap) [1]. It is used as a sign on physical examination, signifying the ability to translate the patella out of the groove in a passive fashion [2]. It can be a symptom, typically a giving way of the knee as a result of the patella slipping out of the trochlear groove or quadriceps inhibition the result of pain [3]. The semantics of the patellofemoral joint, its symptoms, injuries, and diseases, are particularly confusing. The need for standardized nomenclature to improve communication between clinicians and improve the usefulness of scientific patellofemoral studies is discussed [4,5].

For the purposes of this article, the term *patellar dislocation* is used to describe a clinical entity wherein a traumatic injury disrupts normal or previously uninjured confinement of the patella within the femoral groove. When reviewing historical discussions of patellar instability, however, the reader must bear in mind the confusion of terminology to date. Terms such as dislocation, instability, malalignment, and abnormal tracking are used frequently in the literature without precise definitions and without clear parameters to define severity. Often such terms describe indications for surgery. To the extent that language use reflects understanding of knee extensor function and its injury, it is apparent that there is only a limited understanding of the processes at work in patellofemoral disease and injury.

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Natural history of patellar dislocation

A definitive study of the epidemiology and natural history of patellar dislocation would require prospective patient entry with defined and reproducible history and physical examination data and appropriate longitudinal follow-up. Such a study is not yet available in our literature. Literature suggests, however, that an acute traumatic patellar dislocation can render significant disability for patients secondary to recurrent anterior knee pain and symptomatic giving way. McNab, in a study from 1952, noted a 15% redislocation rate and a 33% overall frequency of symptoms after initial patellar dislocation [6]. Hawkins et al [8] and Cofield and Bryan [7] reported that the sequelae of patellar dislocation affects up to one half of patients after injury At least two investigators suggested that young, active individuals were particularly prone to developing sequelae that impair function [7,9].

Despite troubling evidence that some patients with acute patellar dislocation are prone to reinjury and subsequent disability, it is not apparent that surgical procedures to improve alignment or restore stability can improve patients' outcomes reliably. Crosby and Insall noted that nonsurgically-treated patellar dislocations followed over time became less frequent with advancing age, and there was little evidence of osteoarthritis, even after multiple recurrences and many years of follow-up [10]. In their study, the results of operative repair were variable; many operated knees had unsatisfactory results. Arnbjornsson et al followed up their operative experience with unilateral repair for bilateral patellar instability (operated knees and contralateral controls). They reported less satisfactory results among patients whose knees were treated surgically [11]. Hawkins et al found that previous symptoms or anatomic abnormalities of the injured knee predispose patients to a poor result with nonoperative treatment. These investigators recommended that patients with anatomic abnormalities undergo immediate repair [8]. Cash and Hughston [12] reported that evidence of dysplasia in the opposite knee increased the likelihood of recurrent problems after an initial patellar dislocation.

Much of this literature is dated. Design flaws are present in many of the studies; therefore, reconciling the different findings is difficult. Most literature on patellar instability is retrospective. There is no consistent definition of terminology, and the patient samples often represent mixed symptomatology presenting with pain, instability, or both.

Several recent studies add significantly to our knowledge base by prospective study design, clearly defined patient populations, clear hypotheses, and other hallmarks of good scientific methodology. A recent report prospectively studied the characteristics and early recovery (six months) of patients with acute first-time lateral patellar dislocation [13]. The program used standardized criteria to enroll patients and standardized postinjury rehabilitation. Physical examination included clinical measurement of limb alignment (varus or valgus), quadriceps angle at 30° of flexion, hip rotation measurements, foot-thigh progression angle, and a measure of generalized ligamentous laxity. A variety of standardized radiographic measurements were performed. The population included 74 patients, equally divided between males and females. The average age at the time of injury was 19.9 years. The results showed that physical measurements of hyperlaxity, limb alignment, and hip rotation revealed no significant differences when compared with the contralateral limb or normal published values. Patella alta, as measured by the method of Blackburne and Peel [14], was present in 50% of the patients. Most injuries occured during sports. In looking at recovery of function, their findings showed sports participation remains significantly reduced throughout the first six months after injury. The greatest limitations were in kneeling and squatting activities. At six months postinjury, 58% of the patients noted limitations in strenuous activities. The investigators also compared patients' preinjury sports activity levels to other groups of patients presenting with knee injuries and found that their activity level prior to injury was comparable to patients with primary anterior cruciate ligament (ACL) injuries [15].

This study characterized the patellar dislocator as an active, young individual with no abnormal physical examination features among the parameters evaluated. Radiographic findings of patella alta were noted in 50% of the population. These observations contradicted the stereotype of an unfit adolescent female whose patella dislocates with little or no trauma. Patients were able to go back to sports by six months, although more than half noted some limitations. At six months there were no recurrences of patellar dislocation.

A critical review of studies published to date suggests that despite evidence that at least some patients with patellar dislocation are prone to reinjury or late disability, the population at risk for recurrent patellar dislocation or disability is not clearly defined. Can those at risk for first-time patellar dislocation be better defined?

Etiology and risk factors

Historically, patellar dislocations and subluxations have been considered primarily a disorder of females [12,16]. Although few studies are population-based (most studies are gleaned from surgical logs), and few are current, some studies in the literature on acute patellar dislocations clearly show a male preponderance [8,17–20]. One population-based study showed equal occurrence [13]. A few studies suggested that recurrent patellar dislocations occur more frequently in women [9]. With the exception of one population-based study [13], these results likely represent a sampling bias. Based on these studies, it cannot be said what the relative risk of patellar dislocation is among males and females.

The most consistent physical examination feature associated with patellar instability is patella alta (Fig. 1) [13,14,21–25]. At least one school of thought recognizes patella alta as a form of quadriceps dysplasia evidenced by shortening of the quadriceps muscle tendon complex [22]. Whatever the etiology of patella alta, its association suggests it plays a role in the risk of primary patellar dislocation, subsequent redislocation, or both. To the extent that a high-riding patella engages the trochlea later in flexion than one that is normally positioned, it

Fig. 1. This lateral knee radiograph reveals patella alta. The ratio of patella length to patella tendon length (P:PT) should equal 1 ± 0.2.

is easy to see how patella alta might increase the limits of passive patellar motion (laxity) by reducing the articular constraint provided by the trochlea for a given knee flexion angle and sulcus angle.

Torsional deformities are noted in relationship to patellofemoral instability, including increased external tibial torsion [26–28] and femoral torsional deformities [29–31]. Others believe that external tibial torsion has too much variation between individuals to have much clinical usefulness and find no difference in measurements of tibial torsion between patellar dislocators and control [22].

The physical examination measurement of a quadriceps angle, or Q angle, is found higher in patients with a history of patellar subluxation [12,32,33]. This is true in the injured knee and the contralateral knee. Other studies do not find Q angles greater in a group of patients with patellar subluxation compared with controls [34]. When tibial tubercle position is measured more objectively by axial computed tomography (CT) views, lateral displacement of the tubercle is found greater in patients with patellar instability [22].

Trochlear dysplasia, broadly defined as a flattening of the femoral sulcus angle, has been recognized as a factor of patellar instability since 1915, in a surgical report by Albee that discussed correcting trochlear dysplasia by a superolateral trochleoplasty [35]. Maldague and Malghem [36] first outlined the usefulness of the true lateral radiograph of the knee for study of the trochlea and its dysplasias. Dejour et al [22] more recently reviewed factors of patellar instability by radiographic study and found trochlear dysplasia the most consistent radiographic sign present in patients with objective patellar instability compared with controls [22] (Fig. 2).

Soft tissue dysplasias commonly are reported among patellar dislocators. Muscular weakness or imbalance is associated with patellar instability. It is not known whether this is developmental [37] or the result of recurrent dislocations

Fig. 2. This lateral knee radiograph exemplifies type I dysplasia; the crossing of the two condylar outlines with the outline of the trochlear floor is symmetric and proximal. Note that a maquet procedure and a patellectomy were performed in this patient with patella instability.

[38,39]. Ligamentous hyperlaxity also is described in patents with patellar instability [40,41] as the mechanism believed to be increasing the passive motion of ligamentous constraints of the patella. A more recent population-based study showed no relation between generalized hyperlaxity and primary patellar dislocation [13].

Despite much speculation and assorted papers in the literature, therefore, no definitive risk factor for lateral patellar dislocation is described. Only recently has the role of passive medial patellar stabilizers been described. In the opinion of the authors, there is strong evidence that excessive passive lateral patellar mobility should be considered an essential feature of lateral patellar instability.

Contributions to patellar stability

Two components of knee extensor mechanism primarily affect the limits of medial and lateral patellar displacement: bony constraints and ligamentous

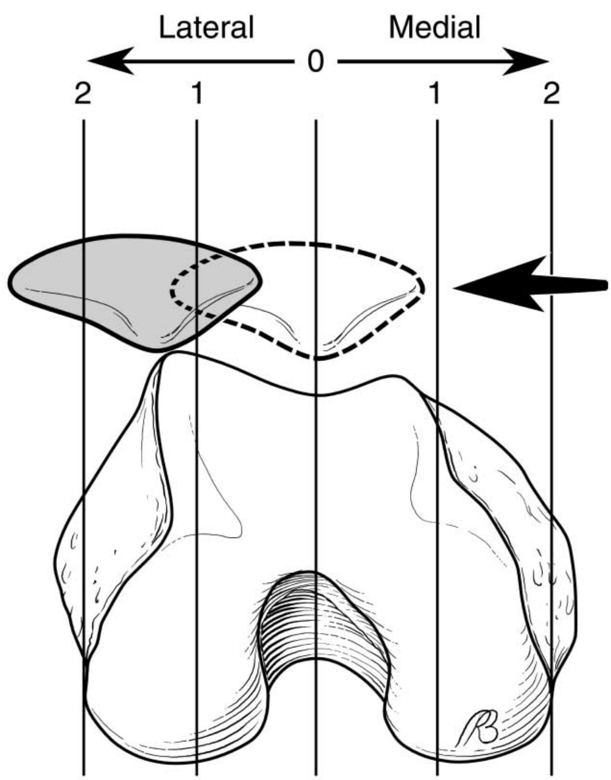

Fig. 3. The resting position of the kneecap, with the knee in full extension, is considered the "zero" position. With manual force, medial or lateral patella translation is measured by "quadrants" (one-quarter the width of the patella). This picture depicts two quadrants lateral translation of the patella.

tethers. Together, these elements combine to determine the limits of passive patellar displacement.

To understand the contribution of any one anatomic factor to patellar instability after patellar dislocations, the difference between normal and pathologic joint motion limits must be established. For patellar instability, this implies some measurement of the limits of displacement of the patella from its location in the trochlear groove. Kolowich et al [42] divided the patella into four quadrants, patella and passive patella, medial or lateral displacement on used physical examination as a qualitative indicator of laxity or tightness of patellar restraints. The authors stated that greater than two quadrants medial or lateral motion from baseline represented excessive motion (laxity) (Fig. 3).

Others measure patellofemoral joint compliance or patellar mobility using an applied force. Teige et al [43] used stress radiography to compare patellar mobility. The investigators used an applied force of 16 lb with the knee flexed at 30°, comparing patellar mobility in 20 normal volunteers with 27 patients with a diagnosis of unilateral lateral patellar dislocation. Fithian et al [44] also tested the knee in 30° of flexion, using an instrumented arthrometer with a smaller applied force (5 lb). They compared 94 normal subjects to 22 unilateral patellar dislocators. Skalley et al [45] evaluated the restraints to medial and lateral patellar motion in 57 normal volunteers. They used an instrumented arthrometer testing device with a known force of 10 lb (45 N), with the knee at 0° and 35° of flexion. The results of these studies are summarized in Table 1.

The collective results of these studies demonstrate considerable variation in patellar mobility among normal individuals and even greater variability among patients with a history of patellar dislocation. In an effort to try to control for this variability, the concept of measuring medial-lateral "balance" of the patellar restraints, as measured by lateral minus medial displacement, was used by the Kaiser study [44]. The concept of balance of patellar restraints was introduced as a way to control for individual variations without relying on the opposite knee as a control. The mean lateral minus medial difference is slightly negative among normal knees, meaning that medial displacement is slightly greater that lateral displacement with two and five pounds of applied force. In the injured and contralateral knees of unilateral patellar dislocators, lateral mobility exceeds medial patellar mobility, and this difference is greatest in previously dislocated

Table 1
Patellar displacement: normal knees

	N	Total	L − R	Lat − Med
Reider et al [48]	50	22		
Kujala [24]	34	31 ± 4		
Teige [78]	25		M 1 ± 1	
			L 1.5 ± 2	
Fithian et al [44]	94	17 ± 4	M 0 ± 2	R −2 ± 3
			L 0 ± 1	L −2 ± 3

L = left; R = right; Lat = lateral; Med = medial.

knees. These studies demonstrate that a quantifiable increase in lateral patellar displacement is associated with a previous history of lateral patellar dislocation. Patellar displacement can be elicited either through instrumented testing, stress radiographs, or physical examination measurements.

These studies also suggest an increase in passive lateral patellar displacement in the contralateral (uninjured) limb of acute patellar dislocators, lending support for the idea that increased laxity of passive patellar restraints is a potential risk factor for acute patellar dislocation, the so-called "patella at risk" [44]. In other words, patients with a history of acute unilateral patellar dislocation demonstrate greater lateral displacement of the patella in their uninjured knees than is seen among normal control subjects. The injured knee of unilateral dislocators, however, has additional lateral patellar displacement over and above that which is observed in the contralateral uninjured knee. Medial displacement is similar in the injured and contralateral knee.

It is important to note that patellar motion measurements cannot distinguish between the contributions of soft tissue versus bony restraints as limiting motion. Passive lateral patellar motion can be attributed to a variety of factors, including patella alta, trochlear dysplasia, or hyperlax ligaments. Because of limb symmetry in most individuals, however, many of these other contributing factors would be similar between limbs. The observed side-to-side differences in lateral patellar displacement in unilateral dislocators, therefore, are believed to represent greater laxity in medial retinacular structures of the injured knee, presumably because of injury. This lends strong support to the argument that the medial retinaculum, in particular the medial patellofemoral ligament (MPFL), represents the "essential lesion" that permits unilateral recurrent patellar instability after the initial dislocation event.

Anatomy of the medial soft tissue stabilizers of the patella

Passive stabilizers are present as uniform restrainers of joint motion. In the patellofemoral joint, these structures are labeled the patellar ligament or patellar retinacular complexes and include patellofemoral and patellotibial ligaments. More recently in the literature, patellomeniscal ligaments are identified. There is inconsistent description and nomination of the passive stabilizers throughout the English-language literature [46]. These are reviewed briefly.

In 1979, Warren and Marshall published an article with a thorough description of the medial side of the knee, basing their description on the dissection of 154 fresh-frozen cadavers [47]. They considered the MPFL, along with the superficial medial collateral ligament (MCL), to be part of layer 2, which is an extracapsular structure.

The MPFL is a continuation of the deep retinacular surface of the vastus medialis obliques (VMO) muscle fibers (see Fig. 1). The patellofemoral ligament extends from the superior medial border of the patella (approximately at the two o'clock position on a right knee), and it attaches firmly to bone just anterior to the

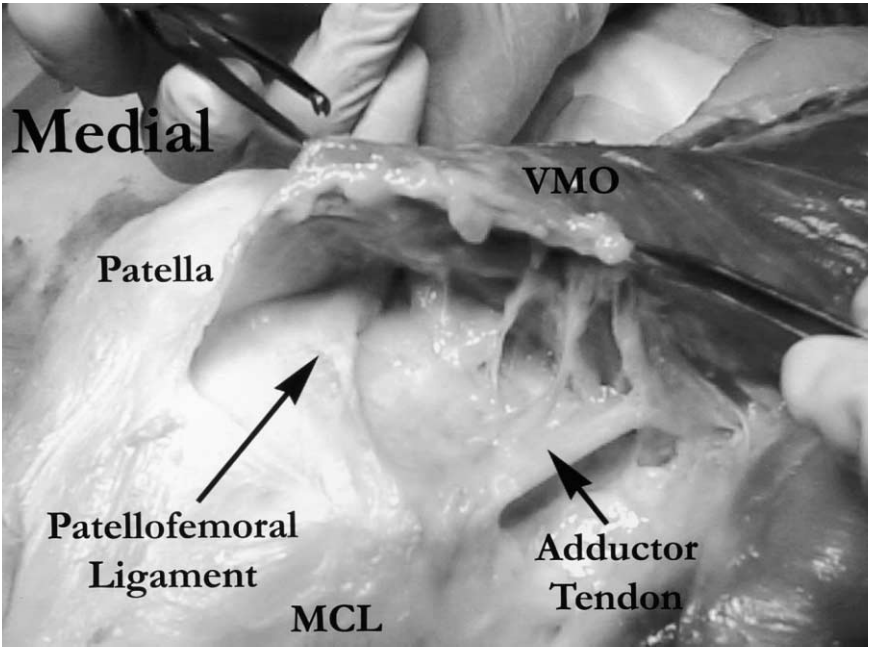

Fig. 4. The medial patellofemoral ligament is distal to the vastas medialis obliques (VMO) muscle and courses from the medial patella border to insert on the medial epicondyle.

MCL on the medial epicondyle (Fig. 4). This is where it has a firm bony attachment. Some superficial fibers of the MPFL can be seen to cross over the

Fig. 5. Axial gradient-echo image (TR/TE, 450/10, flip angle 30°), demonstrating two separate injuries to the retinaculum (*large white and black arrows*) and contusion to the lateral femoral condyle (*small white arrows*).

epicondyle and blend into the soft tissue posterior to the medial epicondyle. The medial epicondyle is the attachment site for the adductor tendon, the MCL, and the MPFL (Fig. 4).

The size and thickness of the MPFL vary considerably. Reider et al could not identify the MPFL in some specimens [48]. Conlan et al found the MPFL to be variable, representing a distinct structure in 29 of 33 fresh-frozen cadavers [49]. In a study dissecting nine fresh-frozen cadavers, Desio et al reported that the MPFL was identified in all specimens, although its size was variable [50]. Hautamaa and coauthors identified a band running between the medial femoral epicondyle and the upper medial border of the patella in all specimens [51]. Arendt et al [46] believed that they could not always identify a separate tissue thickening that could be defined as a ligament, but that there was always a layer that originated from the medial femoral epicondyle and inserted onto the medial border of the patella that was distinct from the capsular layer. There is agreement, therefore, that this layer is always present and is extracapsular, although variable, in its size and thickness.

Clinical significance of medial patellofemoral ligament

There are many studies in the literature showing the clinical significance of the MPFL in patellofemoral stability. The cadaveric cutting studies of Conlan et al [49] reported that the MPFL contributes an average of 53% of the restraining force against lateral patellar displacement. Desio et al [50] reported that the MPFL contributes 60% (range, 41–80%) of the total restraining force against lateral patellar displacement. In a different type of cutting study, Hautamaa et al [51] observed that when the MPFL was cut, lateral patellar displacement increased by 50%. Hautamaa et al further showed that repairing the MPFL restored lateral displacement to within normal values. Additional repair of other retinacular structures provides no additional stability [51]. These biomechanical studies suggest that the procedures intended to restore normal passive limits against lateral patellar motion should repair or re-establish the integrity of the MPFL.

Historically, acute lateral patellar dislocation has been associated with medial retinacular injury [38,50,52]. In a retrospective series of 55 patients who underwent surgery for acute primary patellar dislocation, Vainionpaa et al reported that the medial retinaculum ruptured in 54 and stretched in one [20]. The exact location of the rupture and the condition and nomination of individual medial structures were not specified. Avikianen et al [53] reported that all of 14 patients who underwent surgical exploration for acute patellar dislocation had avulsed the MPFL from its femoral attachment. Sallay reported a retrospective study of magnetic resonance imaging (MRI) associated with early surgical exploration and repair in 23 patients who presented with acute primary patellar dislocation [39]. Preoperatively, the MRI revealed a tear of the MPFL at the adductor tubercle in 87% of the cases. Arthroscopic evaluation was unrevealing

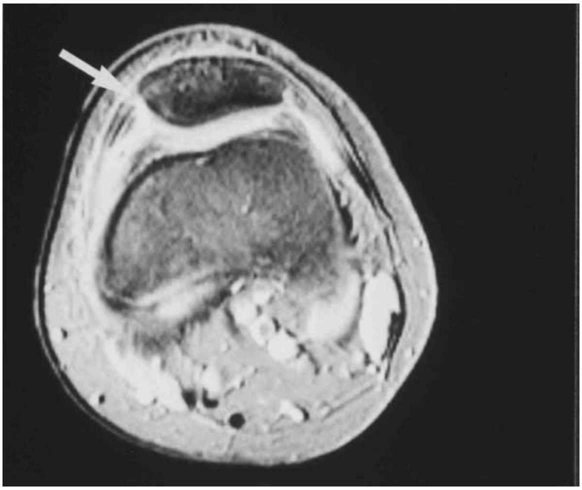

Fig. 6. Axial gradient-echo image (TR/TE, 450/10, Flip angle 30°) of complete retinacular disruption near the patellar insertion (*white arrow*).

in the majority of cases, with only three knees showing subsynovial hemorrhage in the medial gutter near the adductor tubercle. Open surgical dissection revealed avulsion of the MPFL from the adductor tubercle in 94% of the knees. The preoperative MRI also showed increased magnetic resonance (MR) signal along the course of the MPFL in 43% of the knees, with only one patient appearing to have a complete rupture at the patellar insertion. In a consecutive series of 74 cases of acute lateral patellar dislocation, Marangi et al [54] reported on the MRI of the injured knee in 56 patients. Evidence of medial retinacular injury was seen in 75% of patients. In 44% of knees, complete retinacular disruption was noted near the patellar attachment (Fig. 6); in 16%, the disruption was in the midsubstance; 25% had a complete disruption of the retinacular signal near the medial epicondyle; and 26% had a complete disruption of the retinacular signal in more than one location (Fig. 5). This study looked only at the MRI evaluation of injury; no surgical exploration was performed.

Burks et al [55] reported a simulation of patellar dislocation using a cadaveric model. They compared MRI and gross anatomic findings in 10 fresh-frozen cadaveric knees. After MRI imaging, they dissected the medial structures to determine where the ligamentous injury occured. The MPFL was injured in eight out of the 10 knees. Although the location varied, the most frequent site was the femoral attachment of the MPFL. Nomura [56] reported on the surgical findings of 67 knees, 18 with acute patellar dislocations and 49 with chronic patellar dislocations. Of the 18 acute dislocations, an avulsion or detachment of the ligament from the epicondyle was evident in seven knees, and an intrasubstance-type tear was present in 10. Of these 10 knees, a tear of the MPFL was found typically during the immediate vicinity of its femoral attachment. One patient had no discrete injury to the ligament, but it was quite loose.

These studies included biomechanical cutting studies, imaging studies, and surgical exploration data. Taken collectively, they provide strong evidence that the MPFL provides the critical soft tissue restraint against lateral patellar translation. It is reasonable to hypothesize further that residual laxity in the MPFL is responsible for the increased patellar mobility that is reported after "healing" of the initial injury. One may conclude, therefore, that surgical procedures intended to restore normal passive limits of the patella against lateral translation should involve, at a minimum, re-establishing the restraint provided by the uninjured MPFL.

Biologic considerations

The MPFL is an extra-articular structure that shares anatomic similarities to the medial collateral ligament. Its biology in recurrent patellar instability has not been studied. One could hypothesize, however, that a rupture of the MPFL can result in some healing and potential lengthening of the ligament as in MCL injuries [57,58]. The MPFL may heal at increased length and, if the resultant length is not too great, may be satisfactory to prevent recurrent instability after acute patellar dislocations. On the other hand, if the ligament lengthens excessively or fails to heal, the loss of medial restraint may result in recurrent patellar dislocations. This is not dissimilar to the MRI findings of MCL disruptions, with frequent signal abnormalities along the entire ligament length. Conservative treatment of MCLs is associated with satisfactory stability [59,60]. This suggests that the outcomes of ruptures of the MPFL ruptures may vary, depending on whether they are ruptured at the medial epicondyle, in midsubstance, or at the patella. This has not been studied.

Surgical management—the spectrum

Over the past two decades, the desirability of restoring or replacing injured passive motion restraints to normal has become a fundamental surgical principle in the reconstruction of unstable joints. The current approach to stabilizing instability of the shoulder, the ankle, and the knee illustrates this point [61]. Surgical procedures that moved extra-articular structures to prevent motion in a certain plane (iliotibial band tendosis for anterolateral knee instability, Bristow procedure for anterior shoulder instability) now are replaced with primary repair or reconstruction of the damaged ligament (anterior cruciate ligament reconstruction and glenoid labrum stabilization, respectively). Interest in identifying the essential lesion in the pathomechanics of the injury and subsequent instability, and repairing or reconstructing that essential lesion, has found favor over performing muscle or tendon transfers, arthrodesis, or excision for the treatment of joint instability. The authors advocate a similar approach for patellofemoral instability.

One could advocate that the MPFL is the essential lesion to restore to a suitable tension or length after an acute lateral patellar dislocation, but debate continues as to the exact method of treatment. Classically, the medial retinaculum is imbricated or reefed by advancing tissue at or near its attachment to the medial patellar border. Frequently, this is accompanied by advancement of the VMO muscle. More recently, identifying the primary site of injury as the medial epicondyle has led to interest in repairing or reattaching the ligament at this site. If the ligament heals with enough strength to generate tension when a displacing force is applied to the patella, then advancement of the healed ligament at either end or imbrication in its midsubstance may be expected to restore normal motion limits to the patella. This may be true in all cases except in those injuries that are multifocal, and one or more injury sites are missed. Biomechanical studies and surgical exploration studies to date suggest that the femoral epicondyle is the most frequent site of rupture to this ligament. It also seems logical that if this ligament heals without a firm attachment to the bone, it would be unable to be a restraining force to subsequent lateral patella displacement.

In identifying and treating medial retinacular injury and subsequent lengthening in the setting of patellar dislocations, there is uncertainty in the literature regarding the exact method of treatment. Sargent and Teipner [62] repaired the medial retinaculum back to the medial border of the patella using sutures through drill the holes. They reported a 10% recurrence of patellar instability. This procedure was combined with a lateral retinacular release (LRR). Avikainen et al [53] and Sallay et al [39] reported good results with isolated acute repair of MPFL when the injury occured at the adductor tubercle. Vainionpaa et al [20] also reported good results with acute medial retinacular repair at the site of injury. In the only randomized study of acute repair published in the English literature, however, Nikku et al [63] found no improvement in the risk of recurrent instability among patients who have surgery, compared with those who have conservative treatment after the initial event. Not all the procedures used in Nikku's study, however, followed a single technique.

The role of lateral retinacular release

In addition to some form of medial retinacular imbrication, the addition of a LRR historically has been added to the surgical stabilization against lateral patellar subluxation. Frequently, the need for LRR release is not based on any physical examination features of a tight retinaculum; it is done with the belief that a tight lateral retinaculum is a predisposing factor to the initial patellar dislocation. Treatment of choice for patellar tilt that fails unsuccessful trial of nonoperative therapy traditionally is an arthroscopic lateral release [64]; however, its role in surgical procedures to address patellar instability has met with less satisfactory results. Jensen and Roosen [65] reported no advantage when adding a LRR in a study of 23 patients who underwent medial capsulorrhaphy for acute traumatic dislocations of the patella. In an arthroscopic study, Dainer et al [66] reported worse results when the LRR was added to medial capsular repair, with a higher incidence of redislocation and fewer good or excellent results. In a study by Vainionpaa et al [20], four of five patients who redislocated had LRR in addition to medial capsular repair. Kolowich et al [42] found that the most predictable criteria for the success of a LRR was a physical examination measurement, the negative passive patellar tilt [2,64], defined as not being able to lift the lateral border of the patella to the level of the horizon. Indeed, in their Group II patients, those defined as failures, 28 patients received a LRR for patellar instability. All 28 continued to have episodes of dislocations.

Most investigators, therefore, would recommend that a lateral release be used only when there is residual patellar tilt (a physical examination sign) after restoration of the medial retinacular structures or limited medial passive patellar displacement. Lateral patellar tilt presenting on radiographic imaging without a history of patellar dislocation is better defined as malalignment, which is reviewed separately in this volume. A LRR is performed best if it facilitates other procedures to recenter the patella. This is most necessary when patellar instability is associated with anatomic dysplastic features.

The role of arthroscopy

The role of arthroscopy as a diagnostic tool is necessary less often with improved physical examination skills and MR imaging. The role of arthroscopy in diagnosing patellar dislocations becomes less clear, especially with the added knowledge that the MPFL clearly is an extrasynovial structure. Injury to the MPFL, however, can be visualized as hemorrhage discoloration through the synovial membrane. Also, arthroscopy remains a valuable tool for identifying and treating osteochondral fractures, frequently not seen on initial radiographs [66–68]. The treatment of osteochondral fractures remains controversial. Some investigators report excellent results with removal alone [69–72]. Others are more aggressive about fixing osteochondral fractures [7,20,73]. Currently, it is recommended to repair osteochondral fragments that are greater than 1.5 cm in size, have a sufficient osseous surface, and are part of the weight-bearing area of the patellofemoral articulation. Chondral fragmentation along the medial patellar border or along the lateral femoral condylar border frequently is excised, even when they are of large size. The arthroscopic evaluation of the knee after a patellar dislocation is most useful for inspection of the articular surfaces of the patella and femur for evaluating the extent and type of chondral lesions. The majority of traumatic chondral lesions come from the medial aspect of the medial patellar facet and the lateral aspect of the lateral femoral condyle and are believed to be induced by the patella relocating into the trochlear groove.

Newer techniques that arthroscopically repair the medial retinaculum are being explored [17,66,74].

The arthroscope may also be used to assess passive patellar tracking. Regarding evaluation of patellar tracking and patellar tilt, the superior medial portal is particularly useful [75]. Patellar tilt after primary or recurrent patellar dislocation needs to be viewed with some skepticism, however. If you have lax medial structures and the knee is distended with arthroscopic fluid, this can result in patellar tilt by arthroscopic evaluation. This patellar tilt does not correlate with radiographic interpretation of this same patellar or trochlear relationship [20]. Using a classification of patellar tilt as a criterion for LRR can be deceiving in patients with a history of patellar dislocations. Arendt et al [76] showed that lateral patellar tilt could be a function not only of lateral retinacular tension, but also isolated medial retinacular laxity. Based on the previous discussion, one would expect medial retinacular laxity to be present after a lateral patellar dislocation, as there is disruption of the MPFL and other medial retinacular structures.

The role of MPFL reconstruction

Several investigators advocate a reconstruction of the MPFL rather than repair, especially with recurrent dislocations. Reconstruction is advocated because of the belief that the medial retinacular tissue in most patients with deficient trochlea or patella alta is inadequate to establish a sufficient check-rein against lateral dislocation. Reconstructions reported in the literature use the semitendinous tendon [77], quadriceps tendon, [78] or adductor tendon [53,78]. The role of acute repair versus reconstruction of the MPFL has yet to be defined.

The role of tibial tubercle transfer

Brattstrom [79] defined the "Q angle" as the angle from the quadriceps vector to the center of the patella and from the center of the patella to the tibial tubercle. Reducing the Q angle by medializing the tibial tubercle insertion has long played a role in patellar realignment surgery. The most popular current operation is one that involves medial displacement of the anterior tibial tubercle. This operation was originated and performed by Roux [80] in 1887. Principles were modified by Elmslie and published by Trillat et al in 1964 [81]. A modification of this procedure has been popularized in the United States by Cox, and a critical review of its outcomes is published [82,83]. The intent of the operation was to diminish the Q angle and effectively medialize the extensor mechanism to correct lateral tracking of the patella.

Literature review, particularly of biomechanical studies, does not support the logic of decreasing the Q angle in patellar stabilization by medializing the tibial tubercle. Huberti and Hayes [32] showed that too much decrease in Q angle causes an increase in medial patellar facet loading or at a minimum an unusual loading pattern. Medial tibial tubercle transfer may lead to medial patellofemoral arthrosis [84]. Although difficult to define in a natural history study, it also is the opinion of some surgeons that there is an increase in medial compartment arthrosis compared with the opposite knee in patients who have medialization of the tibial tubercle [85,86]. In addition to loading the medial patellar facet, cadaveric biomechanical studies reveal that medial transfer of the tibial tubercle has little effect on stabilizing the patella; rather, its greatest effect is on externally rotating the tibia [76] and altering patellar rotation [76].

Other concerns with using the Q angle as a correctable factor in patellar instability are the inaccuracy in its measurements and variable descriptions of normal Q angle from the literature [87]. Indeed, as one flexes the knee, the tibia internally rotates. This leads some to suggest further that a 90° Q angle or a tubercle sulcus angle is a more reliable measurement of the relationship between the patella and the patellar tendon insertion [42]. Often times, Q angles that are interpreted as excessively high in extension do have a tubercle sulcus angle of 0° at 90°. If one would medialize the tibial tubercle in such a patient, based on an excessively high Q angle in extension, that would correspond to the medialization of the tibial tubercle in flexion and may lead to excessive medial forces on the patellar vector and patellofemoral contact forces. This could lead to patellofemoral arthrosis or medial patellar instability.

To avoid potential loading of the medial patellar facet, or to unload potential damage to patellar articular cartilage in primary or recurrent patellar dislocations, some investigators advocate anteriorization of the tibial tubercle and medialization. Maquet [88] and Bandi [89] first introduced elongation of the extensor lever arm by anterior displacement of the tibial tuberosity. This operation has been modified further by Ferguson [90] and Fulkerson et al [91,92]. Although these procedures may have some applicability in malalignment procedures to treat patellofemoral arthrosis, their role in stabilizing the patella from instability episodes is not supported in the literature concerning outcomes studies or biomechanical studies to date.

The role of dysplastic factors

Morphologic factors associated with patellar instability based on a population norm continue to be debatable. Trochlear dysplasia is identified as a predominant factor in symptomatic patellar dislocation [22]. Trochlear dysplasia, however, is an anomaly that is difficult to correct. A trench-type trochleoplasty is technically difficult to perform, and there is concern that there is potential disruption of the cartilage surface or change in contact pressure that may lead to pain and arthrosis postoperatively. Its clinical outcome seemingly would depend also on the type and shape of the patella, which are factors particularly difficult to simulate and for which to predict an outcome. A superior lateral wedging trochleoplasty [35] may help stabilize the patella against current subluxation, but it can give rise to lateral patellofemoral impingement [22].

The presence of patella alta is another dysplastic feature that some surgeons believe needs to be corrected to stabilize patellas from further subluxation. The concern in distal displacement of the tibial tubercle, however, which is technically feasible, is increasing patellofemoral contact forces potentially leading to pain and arthrosis postoperatively

Summary

Surgical treatment of patellar dislocations, acute and chronic, has evolved significantly over the past decade with the advance of biomechanical knowledge of patellofemoral restraints and injury patterns identified by physical examination and improved imaging techniques. There continues to be no consensus on treatment parameters.

Despite the presence of predisposing factors, such as dysplasia or generalized hyperlaxity, medial retinacular injury associated with primary (first-time) patellar dislocations represents a ligament injury, which may result in residual laxity of the injured structure. This residual laxity is defined objectively by an increase in passive lateral excursion of the patella. Repair or reconstructive procedures to restore this medial constraint is considered paramount in any procedure to stabilize the patella against subsequent dislocations. How best to accomplish this continues to be a matter of debate. The establishment of a medial check-rein by either repairing or reconstructing the MPFL is the procedure of choice for stabilizing a kneecap after first-time dislocation, largely because the literature to date does not provide clear guidelines about when more extensive surgery is indicated. Whether or not all first-time dislocators have improved outcome after surgical repair remains speculative, however. Improved outcome would involve both the elimination of recurrent instability episodes and continued satisfactory function of this patella in activities-of-daily-living and sporting activities. These outcomes have not been studied critically in operative versus nonoperative treatment of first-time patellar dislocation.

For the first-time dislocator, most investigators would agree that an arthroscopy should be performed if intra-articular chondral damage is suspected. Nonoperative management of first-time patellar dislocations continues to be the preferred practice pattern in the United States. If surgical management is elected, because of individual characteristics of the injury pattern or the patient's lifestyle, it is important to inspect the MPFL along its length and repair any or all ligamentous disruptions. If the ligament is avulsed from the medial epicondyle, reattachment to bone is necessary to restore passive restraint to lateral patella motion. MRI may be useful in order to identify the location and degree of medial soft tissue injury preoperatively. The establishment of a medial check-rein by either repairing or reconstructing the MPFL is a necessary component of all surgical procedures performed to correct objective lateral instability of the patella. The addition of a LRR should be additive to this procedure only when it facilitates other procedures to recenter the patella or when objective lateral tilt by physical examination measurements is present.

A practical approach to surgery after patellar dislocation is the minimal amount of surgery necessary to re-establish objective constraints of the patella.

Correcting dysplastic factors, in particular tibial tubercle transfers and trochleoplasties, are best reserved if more minimal surgery has failed. This failure is defined as continued functional instability of the kneecap.

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