Patellofemoral Instability

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INTRODUCTION

Disorders of the patellofemoral joint are common problems encountered by orthopaedic sports medicine specialists. The spectrum of involvement is broad and may present a diagnostic and therapeutic challenge. Among the disorders that must be considered are articular cartilage lesions, osteochondritis dissecans, plicae, patellar tendonitis, quadriceps tendonitis, osteoarthritis, malalignment, and patellar subluxation and dislocation. This review focuses on acute and recurrent patellofemoral instability in the athlete.

Patellofemoral instability is most commonly reported in young, active individuals involved in sports activities. In a prospective study of 74 patients with a first-time acute patellar dislocation, Atkin et al noted that 53 (72%) were injured during sports activity. In a similar study, Fithian et al found that 61% of the study cohort sustained their primary acute dislocation while participating in sports. Traditionally, females were noted to have a greater predisposition for patellofemoral instability than males, with the typical patient being a young, deconditioned female who was not involved in any type of sports activity at the time of the dislocation. Recent literature, however, favors an even distribution between the sexes.1–3 The study by Atkin et al showed a slightly increased risk in females during the second decade but a higher risk in males during the third decade.

Treatment of patellofemoral instability is influenced by several factors. A key consideration is whether the problem is acute or recurrent. Although many of the surgical and nonoperative treatments are the same, the approach to nonoperative treatment is different in acute versus recurrent instability. In the acute setting, the patient needs a brief period of immobilization and then a gradual initiation of range of motion and strengthening exercises. In the recurrent situation, physical therapy and quadriceps strengthening are begun immediately. Other factors influencing treatment include timing of the injury (eg, if during the playing season, a physician may wait until the end of the season to consider surgery) and the patient’s activity level and goals following treatment. Many questions remain unanswered as to the optimal treatment of these injuries and are the focus of ongoing research.

This manual reviews the clinical evaluation of patients who present with acute or recurrent patellofemoral instability as well as the nonoperative and surgical options for treatment of these patients. Knowledge of the normal anatomy and biomechanics of the patellofemoral joint is critical for understanding how to evaluate and treat patellofemoral instability. The review begins with a brief overview of the pertinent structures involved in normal patellofemoral function.

PATELLOFEMORAL ANATOMY AND BIOMECHANICS

The largest sesamoid bone in the body, the patella acts to increase the lever arm of the knee extensor mechanism, reducing the work required to extend the knee and centralizing the converging forces of the quadriceps muscles. The medial and lateral facets of the patella articulate with the medial and lateral facets of the femoral trochlea. The patella has the thickest articular cartilage found in the body, allowing it to tolerate the large joint-reactive forces generated during sports activities.

STABILIZING FORCES

Normal patellofemoral function during strenuous physical activity requires a combination of stabilizing forces afforded by bony, dynamic, and static soft tissue restraints. The bony elements of the generally congruent patellofemoral joint contribute significantly to its stability. The patella is proximal to the femoral trochlea when the knee is in extension and does not enter the sulcus until about 20 to 30 degrees of knee flexion. The lateral trochlear ridge acts as a buttress to help resist lateral translation of the patella. If the lateral ridge is hypoplastic, the restraint to lateral subluxation is decreased.4

The quadriceps muscles are the principal dynamic restraint. Of the 4 heads of the quadriceps, the vastus medialis obliquus (VMO) is best positioned to resist lateral subluxation, due to its approximately 60-degree...
angle of insertion on the patella.\textsuperscript{5} The function of the VMO as a restraint to subluxation is greatest in extension and early flexion because bony restraint at these positions is minimal. An underdeveloped VMO is a predisposing factor for recurrent instability and is a major focus of rehabilitative efforts during conservative management.

Soft tissue static restraints include the quadriceps and patellar tendons, the lateral retinaculum, the medial retinaculum, and the medial patellofemoral ligament (MPFL). Warren and Marshall\textsuperscript{6} divided the medial soft tissue restraints into 3 layers; the superficial layer consists of the fasciae of the vastus medialis and sartorius, the second layer includes the MPFL and superficial medial collateral ligament (MCL), and the deepest layer consists of the joint capsule. Recent studies have documented the anatomy and function of the MPFL and identified it as the primary soft tissue restraint to lateral instability. The MPFL originates on the anterior aspect of the medial epicondyle and inserts on the proximal two thirds of the medial patella (Figure 1). The average width of the MPFL at the femoral origin is 15 mm, and the average width at the patellar insertion is 17 mm.\textsuperscript{7} The length of the MPFL is approximately 55 mm.\textsuperscript{8} In a cadaveric study with selective sectioning of soft tissue restraints around the knee, Desio et al\textsuperscript{9} found that the MPFL provided 60\% of restraint to lateral subluxation in extension and early flexion and the lateral retinaculum and medial patellomeniscal ligament contributed 10\% and 13\%, respectively. Similarly, Hautamaa et al\textsuperscript{10} reported a 50\% increase in lateral translation after sectioning of the MPFL followed by restoration of near-normal restraint to lateral subluxation with isolated repair of the MPFL. These authors reported a 25\% contribution to lateral restraint from the medial patellomeniscal ligament. Injury to the medial retinaculum and MPFL has been reported to be as high as 94\% to 98\% after acute dislocation of the patella.\textsuperscript{11,12}

**BIOMECHANICS**

The patellofemoral joint withstands the highest joint-reactive forces in the body. These forces are least when the knee is in extension and increase with flexion to approximately 7 to 8 times a person’s body weight at 130 degrees. As the knee flexes, the contact area on the patella moves from distal to proximal. The reverse is true of the femoral trochlea.

Given the role of the MPFL as primary soft tissue restraint to lateral instability, the biomechanical properties of the MPFL are of significant clinical interest. Steensen et al\textsuperscript{7} examined 12 cadaveric knees during flexion and determined that, from 0 to 90 degrees, the most isometric point of the MPFL coursed from the inferior portion of the patellar attachment to the superior portion of the femoral attachment. The authors suggest that this finding may help the surgeon in placing reconstructive grafts in a position that would reestablish normal biomechanics. Amis et al\textsuperscript{8} reported a mean tensile strength of the native MPFL of 208 N, and Conlan et al\textsuperscript{13} noted a mean stiffness of the native MPFL of 12.5 N/mm.

Another important biomechanical concept is that of the quadriceps (Q) angle, which is a measurement used to determine patellofemoral alignment. The Q angle is the angle formed by the intersection of a line drawn from the anterior superior iliac spine to the center of the patella and a line drawn from the center of the patella to the tibial tuberosity. The larger the Q angle, the greater the resultant lateral force tending to displace the patella laterally. Mizuno et al\textsuperscript{14} demonstrated that an increase in the Q angle may lead to increased lateral contact pressures or lateral patellar dislocation.

**CAUSES AND CLINICAL COURSE OF PATELLOFEMORAL INSTABILITY**

**ETIOLOGY AND RISK FACTORS**

Trauma can play an important role in acute instability. Patients may have sustained a direct blow to the knee.
from the medial side, forcing the patella out laterally. The most common mechanism is indirect, where a dislocation results from a twisting mechanism.

Several underlying anatomic factors can predispose to recurrent patellofemoral instability (Table). Excessive femoral anteversion increases lateral force on the patella. External tibial rotation has the same effect on the Q angle as does pes planus (associated with external tibial torsion). In a prospective cohort study, Fithian et al. found a slightly higher incidence of femoral torsion in females as compared with males; the difference was even greater in females with a history of prior subluxation. It should be noted that not all patients with anatomic variations demonstrate instability, and some patients with patellofemoral instability can have normal anatomy.

**NATURAL HISTORY**

Most natural history studies are retrospective and include patients with different types of patellofemoral instability, making it difficult to draw firm conclusions regarding outcomes with conservative treatment. Hawkins et al. noted a 30% rate of recurrent dislocation or subjective instability in patients treated without surgical stabilization. In their study of patients with a first-time acute patellar dislocation treated with a standard rehabilitation program, Atkin et al. found that 58% of patients reported difficulty with strenuous activities at 6 months. Garth et al. reviewed results of nonoperative treatment of 69 knees with a minimum 2-year follow-up and found that good or excellent results were obtained in only 66% of patients in the acute group and 50% of patients in the recurrent group. Because of these results, several authors recommend immediate operative intervention for select patients.

Several studies have linked underlying anatomic abnormalities and prior history of instability with outcomes. In a retrospective review of 100 patients with a first episode of acute patellar dislocation, Cash and Hughston noted 52% of patients with a contralateral congenital abnormality of the extensor mechanism obtained good to excellent results with conservative treatment versus 75% of patients with no contralateral abnormality. Fithian et al. followed 189 patients for 2 to 5 years to assess potential risk factors for recurrent instability or poor outcomes. The authors found that risk for recurrence and poor outcome correlated with prior history of instability, being older, and being female.

**CLINICAL EVALUATION**

**HISTORY**

Patients with acute patellar dislocation usually report some form of direct trauma to the knee or a twisting-type injury with a planted foot. An example of the latter is a batter who twists on the back leg during the follow through of a swing and sustains a lateral dislocation. During this type of activity, the foot stays planted as the femur internally rotates and the patella stays with the foot. An audible pop is often heard at the time of injury. Occasionally, patients state that they thought the patella dislocated medially because they “saw” a large medial prominence, when in fact what they observed was a more prominent femoral condyle due to the patella being dislocated laterally.

Patients with recurrent instability will complain of repeated episodes of the knee “giving out” or “slipping” (eg, when planting one foot and twisting the body to get into a car). During such activities, the patella will track laterally and cause symptoms of instability. Trauma may have caused the first injury but is not necessary for subsequent episodes. It is important to distinguish instability symptoms from symptoms of patellofemoral pain syndrome (PFPS). Patients with PFPS may complain of pain after prolonged sitting or going up and down stairs.

**PHYSICAL EXAMINATION**

Patients with an acute dislocation should first be observed for swelling, bruising, or abrasions. These patients usually present to the emergency department (ED) with their knee in a flexed position if the patella has not spontaneously reduced. In this case, the patient may state that he or she saw a prominence medially, which actually was the medial femoral condyle (Figure 2). Often the patella will have self-reduced by the time radiographs are obtained, in which case the main finding would be a large hemarthrosis.

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**Table. Anatomic Abnormalities Predisposing to Patellofemoral Instability**

<table>
<thead>
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<th>Anatomic Abnormality</th>
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<tr>
<td>Excessive femoral anteversion</td>
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<td>Genu valgum</td>
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<tr>
<td>External tibial torsion</td>
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<tr>
<td>Pes planus</td>
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<tr>
<td>Hypoplastic lateral trochlear ridge</td>
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<tr>
<td>Patella alta</td>
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<tr>
<td>Hypoplastic vastus medialis obliquus</td>
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A medial bruise or abrasion could suggest direct trauma. Careful palpation of all surrounding structures of the patellofemoral joint, including the tibial tuberosity and patellar tendon, is important. Palpation should begin at the patellar insertion of the MPFL and proceed to the mid-substance and then to the femoral origin. Palpation of the medial peripatellar structures will often reveal tenderness of the MPFL. The area of maximal tenderness, which is likely the site of MPFL failure, should be noted.

A thorough ligamentous examination should also be performed to rule out concomitant injuries when a patellar dislocation is suspected, particularly a tear of the anterior cruciate ligament or MCL. MCL integrity is assessed by applying a valgus force at 30 degrees of knee flexion and measuring the amount of medial joint laxity. Examination of the extensor mechanism is also prudent. Asking the patient to extend the knee from a flexed position will verify the integrity of the quadriceps tendon, patella, and patellar tendon.

The apprehension test should also be performed. A laterally directed force is applied to the patella first with the knee in extension and then with the knee at 20 to 30 degrees of flexion, while noting the patient’s response. A clear distinction should be made between pain with this maneuver and a feeling of apprehension, which suggests previous instability episodes.

Assessment for Alignment Abnormalities

It is important to measure the Q angle with the patella captured in the femoral trochlear groove. This can be done by measuring the angle at 20 to 30 degrees of flexion when the bony constraints capture the patella or by placing the knee in full extension while manually reducing the patella into the groove. Excessive femoral anteversion is usually assessed by measuring hip internal rotation with the patient prone. Tibial torsion is typically measured with the patient prone and looking at the thigh-foot axis. Pes planus is assessed with the patient standing and observing the medial foot arch.

The presence of general ligamentous hyperlaxity should also be assessed using joint range of motion measurements. Significant hyperextension (> 10 degrees) in multiple joints suggests hypermobility syndrome.

IMAGING STUDIES

Radiography

Radiographic evaluation is indicated for most acute knee injuries and should initially consist of weight-bearing anteroposterior, lateral, and axial views. Tunnel views may be obtained to evaluate for osteochondritis dissecans or loose bodies.

The axial view should be obtained with the knee in 30 to 45 degrees of flexion; excessive flexion may mask subtle signs of instability. The Merchant view is most useful for measuring sulcus and congruence angles and patellar tilt. The congruence angle measures the relationship of the patella to the intercondylar sulcus and provides a gross estimate of the tendency of the patella to subluxate. Congruence angles greater than 16 degrees are considered abnormal. The patellar tilt angle is formed by the intersection of a line connecting the highest points of the trochlear ridges and a line between the lateral patellar facet and the median ridge of the patella. Laurin et al. noted that in normal controls, 97% of these angles opened laterally and 3% were parallel, whereas in patients with subluxation, 0% opened laterally, 60% were parallel, and 40% opened medially. An excessively high patellar tilt suggests the presence of a tight lateral retinaculum, which may need to be released if surgery is performed.

The lateral view should be taken with the knee in 30 degrees of flexion and is most useful to assess for patella alta. The Insall-Salvati ratio is calculated by dividing the length of the patellar tendon (tibial tuberosity to inferior pole of the patella) by the length of the patella. A ratio greater than 1.2 (normal is 0.8–1.2) is diagnostic of patella alta.

Computed Tomography

Computed tomography (CT) allows a more detailed and accurate evaluation of the same parameters measured by plain radiographs and can be useful for...
identifying more subtle abnormalities. Axial CT scans at different flexion angles are also able to evaluate patellar tracking. Schutzer et al.22 found that 15 of 40 knees that demonstrated malalignment on CT in very early flexion showed no malalignment at 30 degrees of flexion; this malalignment would be missed on axial view plain radiography. CT is also more reliable for measuring patellar tilt angle. The anatomy of the femoral trochlea changes as the knee is flexed, which can alter measurements made by plain radiography. On CT, measurements of the tilt can be referenced to the posterior femoral condyles, which are a more constant reference point. It also eliminates error that could be introduced by abnormal hip rotation.

**Magnetic Resonance Imaging**

The use of magnetic resonance imaging (MRI) has become more widespread in evaluation of knee injury and offers the greatest benefit for identifying concomitant soft tissue injuries. Injury to the MPFL, such as rupture (Figure 3), can occur at the patellar insertion, the femoral origin, or the mid-substance of the ligament. Elias et al.23 used MRI to evaluate 82 knees after a lateral patellar dislocation and found injury to the medial retinacular structures including the MPFL in 87% of cases. The authors noted that injury to the MPFL most commonly occurred at or near its femoral origin.

MRI can often help confirm the diagnosis in cases of a dislocation that has spontaneously reduced. After a dislocation, bone marrow edema of the anterolateral femoral condyle has been seen in up to 80% of cases.23 Edema of the medial patella has been noted in 61% of patients after lateral patellar dislocation.23

**TREATMENT OF ACUTE DISLOCATION**

**NONOPERATIVE TREATMENT**

Patients with acute patellar dislocation may present after spontaneous reduction of the injury. However, in the on-field situation or ED, a closed reduction may need to be performed. With the knee in extension, gentle lateral-to-medial pressure is applied to reduce the patella. Occasionally, intravenous sedation is required to help the patient relax enough for the reduction maneuver to work.

Acute swelling and pain are typically managed with cryotherapy, gentle compression, and nonsteroidal anti-inflammatory drugs (NSAIDs). Many patients will require a knee immobilizer or hinged knee brace for comfort and protected weight-bearing.24 Most patients will also require crutches initially until they are able to walk safely. Standard conservative management usually involves physical therapy focusing on VMO strengthening, orthotics, quadriceps stretching, aerobic conditioning, and taping.24 Conservative management remains the gold standard for initial treatment of acute primary patellar dislocation.

**SURGICAL TREATMENT**

Surgery is reserved for symptomatic patients who have failed conservative management or for initial treatment of patients with an acute dislocation with a concomitant injury, such as osteochondral fracture, meniscal tear, or a loose body (Figure 4). Current emphasis is on anatomic reconstruction of the MPFL although, in the presence of malalignment or articular pathology of the patella, a distal bony realignment may be added.

**MPFL Repair**

The number of recent studies of surgical management for acute patellofemoral instability reflects a growing interest in the surgical treatment of young active patients who have a torn MPFL. Owens et al.25 described the results of immediate surgical intervention for acute primary dislocations with clinical and radiographic evidence of MPFL injury in active military recruits. The
authors performed diagnostic arthroscopy at the time of surgery and open repair of the MPFL on 5 patients. They noted that the injury site was most often off the femoral side, and they employed a suture anchor technique for repair. After appropriate tensioning of the repair, the arthroscope was reintroduced into the knee to assess patellar tracking. It was at this point that a lateral retinacular release was performed, if needed. No cases of recurrent instability were noted, and all patients were able to complete their military training.

Ahmad et al\textsuperscript{18} also reviewed results in 8 patients with acute primary dislocation who underwent an open technique to repair a torn MPFL and an injured VMO. The VMO was repaired back to the adductor magnus tendon. The average time to surgery was 7.6 days, and the average follow-up was 3 years (minimum, 1.5 years). The average postoperative Kujala score was 91.9 (out of a maximum of 100), and the overall patient satisfaction rate was 97%. No patient experienced recurrent dislocation, and 86% of patients returned to preinjury activity level. Similarly, Sallay et al\textsuperscript{11} reviewed their experience with 12 patients who were followed for an average of 34 months after a primary repair of an acute MPFL rupture. No patient experienced recurrent instability, and 58% returned to sport.

Fukushima et al\textsuperscript{25} described an arthroscopic technique for treatment of acute patellar instability, which involves a lateral release first (if necessary) followed by a suture anchor repair of the torn medial restraint with an imbricating suture and arthroscopic knot tying. While this repair technique offers the advantage of being minimally invasive, the disadvantage is that the MPFL most often is torn at the femoral attachment, a location that cannot be evaluated arthroscopically. As no results were reported in this study,\textsuperscript{25} critical evaluation and appropriate follow-up will be necessary in order to compare it with open procedures.

Not all authors have reported such encouraging results, however. In a retrospective study, Buchner et al\textsuperscript{26} examined 126 patients at a mean of 8.1 years after initial treatment for primary traumatic patellar dislocation; 63 patients were treated conservatively and 63 had some form of surgery (ie, arthroscopy only, fixation of concomitant osteochondral fractures, or repair of the MPFL). The authors reported no significant difference between the 2 groups with respect to recurrent instability, activity level, and functional outcomes as expressed by Lysholm scores. It should be noted that patients with predisposing factors to recurrent instability were not included in the study.

These studies are retrospective, and additional long-term prospective studies are needed to determine whether early surgical intervention results in better outcomes.

**TREATMENT OF RECURRENT INSTABILITY**

**NONOPERATIVE TREATMENT**

Patients with recurrent instability will benefit from an initial course of physical therapy. Physical therapy should focus on quadriceps strengthening (especially of the VMO) and stretching. Occasionally, bracing during sports activity will help reduce the instability episodes.

Maenpaa and Lehto\textsuperscript{3} reported on 44 patients who failed initial conservative treatment for a primary acute patellar dislocation, 14 of whom underwent surgical management and the remainder of whom were treated conservatively. Both groups had satisfactory results with respect to anterior knee pain. However, a higher incidence of apprehension was noted on physical examination in the conservatively managed group. The authors concluded that patients with recurrent instability benefit from surgery.

**SURGICAL TREATMENT**

More than 100 different surgical procedures have been described to treat patellofemoral instability. In the case of recurrent instability, careful identification of the underlying pathology is critical. Once the site of pathology is identified, surgical treatment is considered.
Treatments can be divided into proximal soft tissue procedures, distal osteotomy or soft tissue realignment, and combined procedures (Figure 5).

**Proximal Procedures**

**MPFL repair/reconstruction.** Drez et al\(^\text{19}\) reported results of MPFL reconstruction using autogenous hamstring graft or autogenous fascia lata in 19 patients. Patients with recurrent instability who had failed nonoperative management and patients with acute primary dislocations with an osteochondral injury were included; minimum follow-up was 2 years. The authors reported good or excellent results on the Fulkerson functional knee score in 93% of patients and an average postoperative Kujala score of 88; 11 patients returned to preinjury level, and only 1 had an episode of recurrent instability. Radiographic evaluation of study patients also demonstrated an average decrease in congruence angle of 20 degrees and an average decrease in lateral patellofemoral angle of 10 degrees.

Ellera Gomes et al\(^\text{22}\) reported results of MPFL reconstruction with a semitendinosus graft in 16 knees (15 patients) followed for a minimum of 5 years. In all patients, a tunnel was made through the mid-patella, through which the graft was fixed distally. The proximal portion of the graft was secured around the adductor magnus and folded upon itself. The authors reported 15 knees with good or excellent results and 1 poor result. Patellar tracking was considered normal in 88% of knees. Patellofemoral pain and apprehension were not present in 94% of knees. The authors found that isolated MPFL reconstruction was best performed in patients without an underlying rotational abnormality.

Some authors have expressed concern that reconstructing the native fan-shaped MPFL with the cord-like hamstring autograft may not reproduce the normal biomechanics of lateral restraint. The strength of the semitendinosus has been reported to be 1216 ± 50 N and the stiffness to be 186 ± 9 N/mm.\(^\text{28}\) These values are dramatically different than those reported for the native MPFL. In light of these differences, reconstruction of the native ligament with a hamstring autograft makes precise surgical placement of the graft critical. Elias and Cosgrove\(^\text{29}\) in a computational knee model, simulated MPFL reconstructions incorporating a malpositioned and anatomically shortened graft. They concluded that even a small error in graft placement or length caused significant increases in the contact pressures on the medial patellofemoral joint, which could lead to arthrosis or early degenerative changes.

**Medial reefing procedures.** Reefing of the medial soft tissue stabilizers involves repairing damage to the medial retinaculum and advancing the attachment of the VMO to the patella distally and laterally. Indications for reefing procedures include the presence of a deficient medial patellar retinaculum and/or MPFL and the ability to perform these repairs without increasing joint-reactive force to an underlying articular lesion.\(^\text{24}\) Because medial articular injuries to the patella commonly occur after dislocation, care must be taken when considering medial soft tissue procedures so as not to overload the medial patellar facet. Nam and Karzel\(^\text{20}\) reported 95% good or excellent results with a mini-open medial reefing procedure and arthroscopic lateral retinacular release in 22 patients (23 knees) with recurrent patellar dislocations (average follow-up, 4.4 years). Lateral retinacular release was included in the surgical approach because of the presence of negative passive patellar tilt on physical examination.

**Lateral retinacular release.** In a survey of an international group of physicians interested in extensor mechanism disorders, fewer than 20% of respondents said they considered a diagnosis of patellar dislocation or subluxation an appropriate reason to perform a lateral retinacular release.\(^\text{31}\) Historically, this procedure was performed because it was thought that a tight lateral retinaculum may predispose patients to dislocation. Currently, isolated lateral retinacular release is considered to have little role in the management of lateral patellar instability. Panni et al\(^\text{32}\) reported long-term (5- to 12-year) results of lateral retinacular release in 100 patients evaluated for a variety of anterior knee pain problems; half of the patients had clear signs of patellar instability. Among patients with a tight retinaculum and no signs of patellofemoral instability at initial evaluation, 70% reported satisfactory results at follow-up. In comparison, only 50% of patients with patellofemoral instability at initial evaluation reported a satisfactory outcome at follow-up.
Distal Procedures

Distal realignment procedures address underlying bony angular or rotational abnormalities. There are 2 main types of distal bony osteotomies: the straight medialization osteotomy popularized by Elmslie and Trillat to reduce the Q angle, and the oblique osteotomy popularized by Fulkerson. The Fulkerson procedure also involves moving the tibial tuberosity anteriorly in addition to medially, which serves to unload the patellofemoral joint distally in the event of joint disease (Maquet effect). Maquet described a technique for anteriorization of the tibial tubercle to decrease the joint-reactive force. Surgically elevating the tibial tubercle increases the lever arm of the patella. The cumulative resultant force vector of the patellar tendon and the quadriceps is decreased in relation to the amount of anterior displacement. Additionally, anteriorization decreases distal joint-reactive forces and increases proximal joint-reactive forces. Occasionally, in the presence of patella alta it is necessary to move the patella distally as well.

Brown et al reported results of the Elmslie-Trillat procedure for correction of patellofemoral malalignment in 27 knees at an average follow-up of 42 months; good or excellent results were reported in 81%. The authors noted that postoperative Q angle correlated directly with good results; they therefore recommended intraoperative measurement of the Q angle to reduce the angle to less than 10 degrees. No complications related to the operative procedure were reported. Shelbourne et al also reported results of 45 Elmslie-Trillat osteotomies performed for recurrent instability or for PFPS with malalignment (mean follow-up, 2 years). The authors were able to reduce the congruence angles from a preoperative average of +21.5 to a postoperative average of +3.4. They reported that in patients with postoperative congruence angles less than +15 degrees, the incidence of recurrent instability was 6% compared with 46% in patients with angles greater than +15 degrees.

Bellemans et al reported on 29 patients who underwent Fulkerson-type distal osteotomies for chronic anterior knee pain and lateral subluxation (average follow-up, 32 months). Fourteen patients had subluxation-type malalignment and were treated with osteotomy only; 15 patients had excessive lateral tilt in addition to subluxation-type malalignment and were treated with osteotomy plus lateral retinacular release. The authors reported an average increase of 30 points in patients’ Lysholm scores and an average increase of 46 points in Kujala scores postoperatively. Radiographic evaluation of study patients also demonstrated improvements in congruence angles and patellar tilt. A tibial fracture complication was reported in 1 patient. The authors concluded that in the absence of excessive patellar tilt, an isolated Fulkerson-type distal osteotomy yielded good results. They recommended adding a lateral release when excessive tilt is noted.

Cosgarea et al reported on biomechanical evaluation of oblique versus flat tibial osteotomies and their risk for fracture. The authors noted that the force required to fracture the tibia following oblique osteotomy was significantly lower as compared with a flat osteotomy. They recommended that patients undergoing oblique procedures should be protected postoperatively with a brace and protected weight-bearing until the osteotomy heals.

Although good results with distal realignment procedures have been reported, the biomechanics of the osteotomy that reduce the Q angle do not consistently and uniformly reduce joint forces. In a computer simulation study examining the effects of medialization osteotomies on patellofemoral forces Elias et al reported that although the lateral subluxation force and mean pressure were reduced, the maximal joint pressure was not always reduced. The authors concluded that this may in part explain why procedures that stabilize the patella do not always provide pain relief.

Pidoriano et al retrospectively studied outcomes following anteromedialization of the tibial tubercle in 36 patients who had patellar articular cartilage lesions. The authors reported good to excellent results in 87% of patients with distal or lateral articular lesions. In contrast, only 55% of patients with medial lesions and 20% of patients with proximal lesions had good or excellent results. All patients with central trochlear lesions had poor results.

Combined Procedures

Results of combined proximal and distal procedures have also been reported. Garth et al reviewed 20 cases of acute traumatic patellar dislocations treated with MPFL repair when possible (10 knees), VMO/medial retinacular advancement, and distal tibial realignment. The authors reported good or excellent results in 90% of patients at a 2-year minimum follow-up.

CONCLUSION

Patellofemoral joint instability is a common but complex clinical problem that all sports medicine specialists will see in their practice. A wide variety of procedures have been described to treat this disorder, but research to date has been largely retrospective and
good long-term prospective studies are lacking. Despite this, definite strides have been made toward improving our understanding of the pertinent anatomy and biomechanics of normal patellofemoral function as well as common pathophysiologic factors. This knowledge has led to a new focus on MPFL-based procedures, which appear to be promising. It has also allowed us to better understand why many of our classic and historical procedures have not been completely successful. A systematic and careful history and physical examination will allow the physician to tailor the treatment appropriately. The gold standard for treatment of acute and recurrent dislocation and subluxation is initially conservative. However, this belief is currently being challenged, and in certain cases initial operative treatment is warranted.

For the patient with an acute primary dislocation and no concomitant injury, rehabilitation is generally the recommended treatment of choice. If concomitant intra-articular pathology is noted at initial presentation, immediate MPFL repair may be indicated along with fixation of an osteochondral fracture or meniscal tear. For the patient with recurrent instability, initial rehabilitation is also recommended, but surgical intervention is frequently necessary. Careful identification of the underlying pathology is critical if surgery is considered. Consideration of the limb alignment, condition of the patellar articular surface, and status of the medial retinacular structures is important. This will dictate whether a MPFL repair or reconstruction, distal bony medialization or anteromedialization, or combined procedure is required.

REFERENCES


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