

## Practical Management

# Practical Management of Patellofemoral Pain

Michael Fredericson, MD, and \*Christopher M. Powers, PhD, PT

Division of Physical Medicine & Rehabilitation, Department of Functional Restoration, Stanford University School of Medicine, Stanford; and \*Musculoskeletal Biomechanics Laboratory, Department of Biokinesiology and Physical Therapy, University of Southern California, Los Angeles, California, U.S.A.

### INTRODUCTION

Patellofemoral pain (PFP) is one of the most common disorders of the knee, accounting for 25% of all knees injuries seen in a sports medicine clinic.<sup>1</sup> The cause of PFP, however, is not clearly understood and may consist of multiple origins. The most commonly accepted hypothesis is related to increased patellofemoral joint stress (force per unit area) and subsequent articular cartilage wear.

Athletes typically note the insidious onset of an ill-defined ache localized to the anterior knee, behind the patella. Occasionally the pain may be centered along the medial or lateral patellofemoral joint and retinaculum. Typically, pain is aggravated with functions that increase patellofemoral compressive forces, such as ascending and descending hills or stairs, squatting, and prolonged sitting with the knee in a flexed position. While clinical studies have not been able to consistently demonstrate biomechanical or alignment differences between patients with patellofemoral pain and healthy individuals, a systematic exam may highlight predisposing factors.<sup>2,3</sup>

The location of symptoms may indicate the specific structures involved and may give direction with respect to making a differential diagnosis:<sup>3,4</sup> *lateral pain*—small nerve injury of the lateral retinaculum, or iliotibial band friction syndrome; *medial pain*—recurrent stretching of the medial retinaculum or symptomatic medial plica; *retropatellar pain*—articular cartilage damage or stress on the subchondral bone; *superior pain*—quadriceps tendinitis; *inferior pain*—patellar tendinitis or fat pad irritation. When making a diagnosis of PFP, it is important to rule out other disorders. For example, joint line tenderness may be indicative of meniscal injury or femorotibial arthritis, and more vague pain patterns may indicate referred pain from the hip or the L2–L4 nerve roots.

Magnetic resonance imaging (MRI) is particularly helpful at assessing degenerative joint changes such as cartilage fissuring or thinning, subchondral bone marrow

edema, subchondral cysts, synovial plica, and patellar tendinitis. If more definitive information is required regarding patellar tracking, kinematic studies can be obtained with MRI or computed tomography (CT).<sup>3,6</sup> To more accurately define patellar tracking abnormalities at our institution, we are now using an MR unit in which the patient can stand upright in a weight-bearing position while performing continuous flexion and extension movements (Figure 1).

### TREATMENT

Once the examination has been completed, patients should be classified by suspected contributing mechanisms: 1) abnormal patellofemoral joint mechanics, 2) altered lower extremity alignment and/or motion, or 3) overuse. Treatment decisions should then be focused appropriately (Table 1).

#### Abnormal Patellofemoral Tracking and Alignment

##### *Bony and Structural Abnormalities*

Significant deviations in patella alignment secondary to patella alta, trochlear dysplasia, femoral anteversion, knee valgus, and a laterally displaced tibial tuberosity will often require surgical intervention. Those with more minor alterations in patella alignment will usually obtain relief of symptoms by the treatment strategies noted below.

##### *Tightness of Soft Tissue Structures*

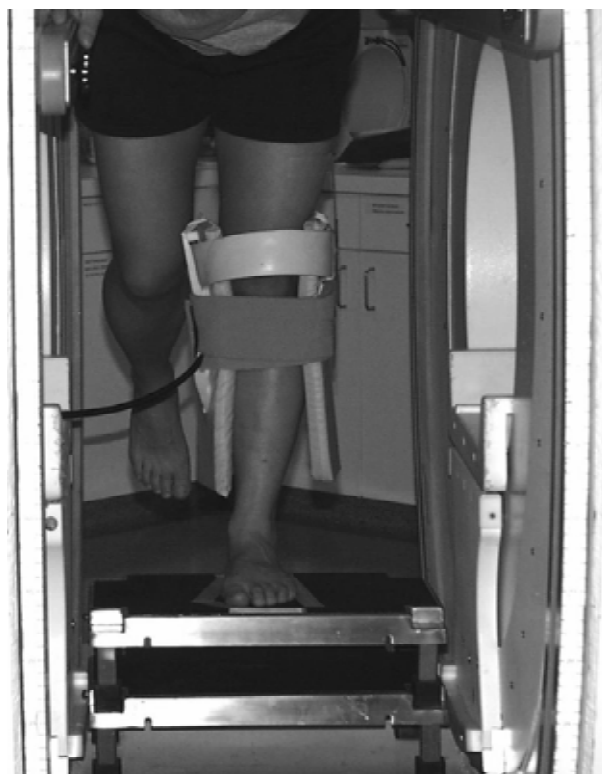
Tightness of the iliotibial band (ITB) can affect normal patella excursion. The distal ITB fibers blend with the superficial and deep fibers of the lateral retinaculum, and tightness in the ITB can contribute to lateral patellar tilt and excessive pressure on the lateral patella. Because the ITB is a very dense and fibrous tissue, the effectiveness of stretching is questionable. However, reducing adhesions between the ITB and the overlying fascia may be facilitated through deep longitudinal massage. Passive stretch may also be applied to the lateral structures through a sustained medial glide of the patella.

##### *Decreased Patellar Mobility*

Patellar mobilization techniques should be performed if evidence of decreased patellar mobility is noted. These

Received November 2001; accepted December 4, 2001.

Address correspondence to Dr. Michael Fredericson, PM & R Sports Medicine Clinics, Stanford University, 300 Pasteur Drive, Room R107B, Stanford, CA 94305, U.S.A. E-mail: Michael.Fredericson@stanford.edu



**FIG. 1.** Patient standing in an open magnetic resonance imaging unit while performing continuous flexion-extension movements to more accurately define patellar tracking.

techniques should be performed with care to prevent excessive patellofemoral joint compression. To facilitate mobilization of the patella, the knee should be in extension or slightly flexed (no more than 20°). If the knee is flexed beyond 20°, the patella becomes seated within the trochlear groove, and passive tension of the quadriceps will restrict patellar mobility.

#### *Quadriceps Muscle Strengthening*

Restoration of quadriceps strength and function has been demonstrated to be a significant factor contributing to recovery from patellofemoral symptoms.<sup>7</sup> In addition, enhanced locomotor function in persons with PFP has been shown to be associated with increased quadriceps femoris muscle torque, supporting the role of strengthening.<sup>6</sup> However, the mechanism by which strengthening improves PFP symptoms and functional ability is not entirely clear. While it is possible that improved quadriceps strength alters patellar tracking, subtle changes in contact location and pressure distribution may additionally explain this phenomena.

Choosing the correct exercises to prescribe for an individual with PFP requires an understanding of patellofemoral joint biomechanics. During open chain exercises (nonweight-bearing knee extension with weight applied at the ankle), the amount of quadriceps muscle force required to extend the knee steadily increases as the knee moves from 90° to full knee extension.<sup>6</sup> In addition, the patellofemoral joint contact area decreases as the knee

extends, thereby increasing patellofemoral joint stress. Conversely, during closed chain exercises, the quadriceps muscle force is minimal at full knee extension, and therefore patellofemoral joint stresses is reduced.<sup>6</sup> Examples of closed chain exercises include lunges, wall slides, and leg press machines. Apart from increasing quadriceps strength, all of these exercises can improve quadriceps endurance when performed with higher repetitions at lower loads. Both open and closed chain strengthening exercises should be performed so that strengthening can be performed throughout a large arc of motion.<sup>6</sup>

To improve eccentric control of the quadriceps, the rehabilitation program also should include exercises performed while standing on one leg. In this position, the lower abdominals and the gluteals work together to maintain a level pelvis, simulating the activity of the stance phase of gait.<sup>4</sup> Activation of the lower abdominal and oblique muscles helps to decrease the anterior rotation of the pelvis and resultant internal rotation of the femur.

#### *Role of the Vastus Medialis Obliquus*

Isolated recruitment of the vastus medialis obliquus (VMO), has not been proven to occur with exercises commonly prescribed for patellofemoral pain. The concept of VMO strengthening is prefaced on the belief that the VMO can be selectively recruited, independent of the vastus lateralis (VL), through various exercises. A thorough review of the existing literature has revealed that isolated contraction of the VMO independent of the VL has never been documented.<sup>6</sup> Thus, isolated recruitment of the VMO does not occur with commonly prescribed exercises, and that selective strengthening is unlikely. Even if greater VMO electromyograph (EMG) activity could be elicited relative to the VL, the magnitude of VMO contraction would have to be at least 60% of maximum to stimulate hypertrophy. As such, isolated recruitment or strengthening of the VMO through selected exercises is unrealistic, and most likely translates into a general quadriceps muscle strengthening effect.

**TABLE 1.** Patellofemoral pain treatment algorithm

<i>Initial phase (pain control)</i>
Activity modification
Antiinflammatory medication and modalities
Patellar taping and bracing
<i>Reactivation phase (correcting malalignment and strength deficits)</i>
Patellar taping
Patellar mobilization (medial > lateral)
Soft tissue mobilization—iliotibial band and lateral retinaculum
Quadriceps strengthening
Open kinetic chain—avoid terminal extension
Closed kinetic chain—avoid excessive flexion
Hip girdle (core) strengthening—hip flexors and external rotators
<i>Maintenance phase (functional adaptations)</i>
Normalization of gait mechanics
Orthotic management for subtalar joint pronation
Comprehensive independent exercise program

### Patellar Taping

Correcting abnormal patella posture using the McConnell taping technique<sup>4</sup> may help to align the patella within the trochlea for those patients unable to perform strengthening exercises due to pain. Although the mechanism is unclear, taping the patella has been shown to reduce symptoms by at least 50%. In addition, it has been shown to increase quadriceps activity and permit increased loading of the knee joint.<sup>6</sup>

### Patellar Braces

Patients with patellar pain may report decreased pain from wearing a properly fitted dynamic patellar stabilization brace. Powers and colleagues<sup>8</sup> found that 50% of subjects experienced an improvement in symptoms with use of the Bauerfeind Genutrain P3 Brace (Bauerfeind USA, Inc., Kennesaw, GA, U.S.A.). Further study evaluating the same brace, however, did not find that it was able to correct patellar tracking patterns as measured quantitatively by kinematic MRI.<sup>7</sup> The improvement with bracing may be related to increasing contact area (through compression), dispersing joint reaction forces over a greater surface and thus decreasing joint stress.

### Lower Kinetic Chain Problems

#### Subtalar Joint Pronation

Orthotics can be used as a means to reduce the Q-angle (the angle formed by lines connecting the anterior superior iliac spine, the center of the patella, and the tibial tuberosity) by controlling lower extremity rotation. If the Q-angle does not change more than 5° between relaxed standing and placing the patient in subtalar joint neutral, then the use of an orthotic may not have a significant influence on lower extremity alignment. Over-the-counter arch supports may work for mild cases, but custom-molded orthotics are usually necessary in athletes for maximal biomechanical control. Traditionally, orthotic devices have been primarily designed to control rearfoot motion. Forefoot stability may additionally play an integral role in rearfoot stability, as instability in the forefoot at push-off may create rearfoot instability.<sup>9</sup> For this reason, orthotics need to extend to the sulcus or web space of the toes for control of forefoot instability in athletes.<sup>5</sup>

#### Hip Internal Rotation

The functional significance of an internally rotated femur is that the trochlear groove can rotate beneath the patella, placing the patella in a relatively lateral position. If it is observed that the femur "collapses" into internal rotation during gait, and this motion appears to originate from the pelvis (as opposed to being influenced by tibial rotation), then strengthening of the external rotators including gluteus maximus, gluteus medius, and the deep rotators may be indicated.

If the femur remains in a constant state of internal rotation during the entire gait cycle (as opposed to collapsing inward), then femoral anteversion should be suspected. As femoral anteversion is a fixed bony deformity, little can be done from a nonsurgical standpoint to correct this abnormality.

### Gait Deviations

The restoration of normal gait function is essential to the overall treatment plan, especially for the running athlete, where slight gait deviations can lead to injury at other joints. Of notable interest for the clinician should be the reversal of hyperextension or decreased knee flexion with weight acceptance, indicative of a quadriceps avoidance gait pattern. As knee flexion during weight acceptance is critical for shock absorption, restoration of this key function is necessary to prevent the deleterious effects of high impact loading. EMG biofeedback can be used as an effective tool to augment quadriceps activity, reversing the quadriceps avoidance pattern.

### Overuse

The lack of significant findings on physical examination (i.e., normal patellar mechanics, normal lower extremity function) suggests that the source of PFP symptoms may be related to overuse. This is often seen in an athletic population. The treatment program should focus on relative rest with activity modification. The training program also should be evaluated for obvious errors, including increasing exercise intensity too quickly, inadequate time for recovery, and excessive hill work.

### CONCLUSIONS

The vast majority of athletes with patellofemoral pain, including those with minor instability problems, will likely respond to nonoperative treatment. Rehabilitation should emphasize general quadriceps muscle strengthening, taking into consideration patellofemoral joint biomechanics and sensible exercise progression that minimize joint stress. Taping and bracing should be considered when an exercise program cannot be progressed because of pain. The clinician also should consider performing a thorough lower extremity biomechanical assessment to determine if abnormalities exist.

### REFERENCES

1. Devereaux M, Lachmann S. Patellofemoral arthralgia in athletes attending a sports injury clinic. *Br J Sports Med* 1984;18:18-21.
2. Messier SP, Davis SE, Curl WW, et al. Etiologic factors associated with patellofemoral pain in runners. *Med Sci Sports Exerc* 1991; 23:1008-1015.
3. Fredericson M. Patellofemoral problems. In: Wilder R, O'Connor F, eds. *The Complete Book of Running Medicine*. New York: McGraw-Hill Publishers, 2001:169-180.
4. Grelsamer RP, McConnell J. *The Patella: A Team Approach*. Gaithersburg, MD: Aspen Publishers, Inc., 1998.
5. Watson CJ, Propps M, Galt W, et al. Reliability of McConnell's classification of patellar orientation in symptomatic and asymptomatic subjects. *J Orthop Sports Phys Ther* 1999;29:378-385.
6. Powers CM. Rehabilitation of patellofemoral joint disorders: a critical review. *J Ortho Sports Phys Ther* 1998;28:3453-3454.
7. Natri A, Kannus P, Jarvinen M. Which factors predict the long-term outcome in chronic patellofemoral pain syndrome? A 7-yr prospective follow-up study. *Med Sci Sports Exerc* 1998;30:1572-1577.
8. Powers CM, Shellock FG, Beering TV. Effect of bracing on patellar kinematics in patients with patellofemoral joint pain. *Med Sci Sports Exerc* 1999;31:1714-1720.
9. Eng JJ, Pierrynowski MR. The effects of foot orthotic on three-dimensional lower-limb kinematics during walking and running. *Phys Ther* 1994;74:836-844.