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### Runner's Knee

As the name infers, patellofemoral dysfunction is an injury that occurs at the articulation between the patella (kneecap) and the underlying femur. Anatomically, the patella is a diamond-shaped bone which lies in a correspondingly shaped groove in the front of the femur. It is designed to function as a pulley, assisting the quadriceps by providing a mechanical advantage for added strength. Generally speaking, patellofemoral dysfunction occurs under one of two broad circumstances -- either when the patella is forced with excessive pressure against the underlying femur or when it tracks excessively on one side or other of the groove. In either case, this would cause irritation and abrasion of the cartilage of the patella, resulting in inflammation and pain.

The management and prevention of PFD begin with an understanding of the risk factors that predispose to this injury. Excessive pressure of the patella against the underlying femur generally results from excessively tight quadricep muscles which is best addressed through appropriate stretching exercises. There are several risk factors that can cause the patella to ride excessively on the side of the groove, invariably along the lateral (outside) side of the groove. There are three primary causes of improper patellar tracking: 1) weakness of the vastus medialis obliquus (VMO) -- the large quadricep muscle in the inside/front of the thigh, 2) tightness of the iliotibial band, and 3) improper lower extremity biomechanics. When this is caused by weakness of the VMO, the medial pull of the VMO is overwhelmed by the lateral pull of the vastus lateralis (the quadricep muscle on the outside front of the thigh) and the iliotibial band, resulting in lateral tracking of the patella. Tightness of the iliotibial band will also cause an excessive lateral pulling of the patella, again by overwhelming the medial pull of the VMO.

Of all of the conditions that predispose to lateral tracking of the patella, faulty biomechanics may be the most consistent as well as the most significant. There are numerous studies in the medical literature that confirm the fact that biomechanical abnormalities are potentially the most common and, indeed, the most significant of all the potential causes of patellofemoral dysfunction. It is common to relate biomechanical problems, most commonly excessive subtalar pronation, with flattening of the arch or rolling in of the heel. However, when the foot (actually the subtalar joint of the foot) pronates, this results in internal rotation of the leg. When excessive pronation occurs, excessive internal rotation of the leg occurs as well which then causes the quadriceps to pull somewhat obliquely rather than in a more proper and functional straight position. This is an easy thing to observe in your runners, particularly when they run toward you, as you will frequently observe the foot and the knee tracking in different directions. When the foot is turned out in relation to the knee, or the knee turned in in relation to the foot, this is a

sign that is referred to as miserable malalignment and is a very significant risk factor for patellofemoral dysfunction.

Management of this problem falls into three broad categories: 1) acute management, 2) rehabilitation, and 3) prevention. As with most overuse injuries, the acute phase is managed with significant activity modification -- that is, discontinuance of all activity that induces symptoms. For conditioning during this phase, we frequently have our athletes training in the pool, since even partial weightbearing activities such as stairmaster and exercycle work can be irritating to the acutely inflamed patellofemoral joint. During this phase, ice, non-steroidal anti-inflammatory medications, and one of several modes of bracing can be useful. There are a number of patellofemoral sleeves available on the market that provide warmth and compression while helping the patella track properly in its groove. There are also methods of taping the patella (the one most commonly used is referred to as McConnell taping) which can be of help during this phase. When biomechanic faults are identified as possible causes for this problem, this should immediately be addressed through analysis of the shoes that the athlete is wearing with subsequent shoe recommendations and, if appropriate, temporary orthotics. The AAPSM makes available a current and frequently updated shoe recommendation list, and I would refer you to this list for the latest in anti-pronation shoes which would be useful for this condition.

A useful tip when attempting to assess the severity of the injury and the progress and success of treatment is to monitor two particular symptoms. The first is frequently referred to as "theater symptom". Theater symptom is that complaint of pain after sitting for varying periods of time -- the period of time required to produce this symptom directly relating to the degree of injury. This occurs because the patellofemoral joint is under the highest degree of compression when the knee is bent 90 degrees and the inflamed patellofemoral joint will indeed become symptomatic when the knee is bent for excessive periods of time. The other symptom frequently reported by patients is pain going up and down stairs and hills. This occurs because, again, the patellofemoral joint is under higher levels of compression due to increased quadricep activity and degree of knee flexion when going up and down stairs and hills. Both of these symptoms can be very useful indicators as to the success of treatment and helpful determinants as to the athlete's ability to return to activity.

As symptoms improve, rehabilitation of those structures predisposing to this injury can be initiated. Strengthening of the VMO is a key factor in the rehabilitation of this injury, and numerous studies have been performed to determine which of the many exercises available for this purpose are indeed most effective and least irritating. The medical literature indicates that the three most beneficial exercises are: 1) an exercise most frequently referred to as "quad sets", simply tightening the VMO when seated or supine with the knee extended for a period of 7-10 seconds and repeated several times per session and repeated several times per day; 2) an exercise called "wall sits", where the injured athlete actually stands with their back to a wall with 20-30 degrees of knee flexion while squeezing an object such as a volleyball between the knees. The squeezing of the object between the knees is important since this recruits the groin muscles (adductors) which are an attachment point of the VMO. As a result, by recruiting the adductors, the patient is indeed selectively strengthening the VMO relative to the other quadriceps -- the key objective of this exercise; and 3) side-step-ups (when symptoms improve

sufficiently to allow this exercise) with varying height of step to be determined by the status of the patient and the patient's injury. This is an excellent exercise to selectively recruit the VMO.

In addition to VMO rehabilitation, iliotibial band stretching is most important. This is effectively done with the patient lying on their side on a firm surface such as a bench, and allowing the upper leg to hang over the side and using the lower leg for counter-pressure. This, as with all stretches, should be maintained for a minimum of 30 seconds and should be performed only when the muscle is warmed up in some fashion. There are other methods of stretching the iliotibial band which, along with specific techniques for quadriceps stretching, can be described by a well-trained and experienced athletic trainer or physical therapist. Hamstring tightness and gluteus medius weakness have also been implicated in this problem, and specific stretching and strengthening for these structures should be implemented as well.

As symptoms subside and normal function through appropriate stretching and strengthening exercises is joined with appropriate biomechanic intervention, conditioning exercise can be advanced. At some point during the rehabilitation phase, exercycle, cross-aerobics and/or stairmaster work-outs can be introduced, with intensity, frequency and duration of work-outs to be determined by the patient's symptomatic status. During this phase, if temporary orthotics have proven to be beneficial for the patient and it is determined that the patient's biomechanical make-up has indeed been significant in its contribution to this injury, functional foot orthoses should be made. A gradual return to running is considered safe and appropriate when the patient is fully rehabilitated with regard to the specific stretching and strengthening exercises mentioned above, when biomechanical stability has been achieved, and inflammatory signs resolved. A gradual return to running should be introduced through a walk-run program which should involve initially running on flat surfaces only and beginning with a fairly modest pace. As the athlete progresses in their work-outs, hill training should be the last aspect of training to be introduced, since this is the area of greatest stress to the patellofemoral joint.

Prevention centers around maintenance of optimal biomechanic function through appropriate shoe gear and foot orthoses as needed. Maintenance of VMO tone and strength as well as quadricep and iliotibial band flexibility are also important. Finally, activities that involve repetitive and excessive patellofemoral joint compressive forces should be avoided. Squats, lunges, leg extensions and leg presses are all activities that apply considerable stress to the patellofemoral articulation, since they couple quadricep-intense resistance work with high degrees of knee flexion. When the athlete's specific sport or event requires that these types of exercises be performed (i.e. football lineman), they should be done carefully, and the athlete should be closely monitored to ensure optimal technique with regard to alignment and selection of specific strengthening parameters (repetitions, frequency and intensity).