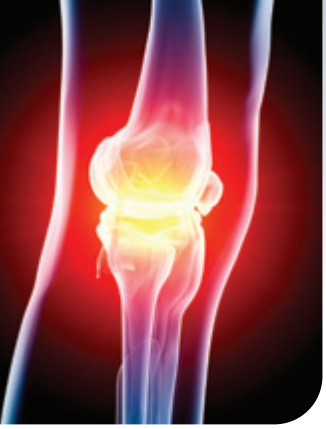


Patellofemoral Pain

Patellofemoral pain syndrome (PFPS) is one of the most prevalent musculoskeletal conditions of the lower limb and is a common problem among many exercisers. The issues are often associated with musculoskeletal deficiencies and repeated use injury response. One of the side effects of PFPS is quadriceps inhibition as a result of swelling in the knee joint. Since knee swelling can directly weaken the quadriceps, it can spawn a vicious cycle – if someone has a muscle imbalance that causes faulty knee function/stabilization he or she will develop a knee injury that is accompanied by swelling, which will inhibit the quadriceps and further exacerbate the muscle imbalances, which then worsens patellar tracking and joint function. Swelling becomes greater, and the cycle continues. In many cases the issues are related to imbalances in the hip and knee musculature. While the vastus medialis (VMO) and vastus lateralis (VL) are often cited as the culprits, inhibitory effects of tight hip flexors on hip extensors and disparities between medial lateral hip muscle range and recruitment can also exacerbate problems at the knee. The proper function of the VMO is extremely important as it is a primary contributor to appropriate patella tracking.

Many fail to realize that repeated action and overuse of a joint can lead to inhibitory signaling and promote greater imbalances when exercise is performed on swollen joints. The quadriceps muscle group is responsible for knee extension and these muscles are activated by alpha motor neurons (within the femoral nerve) coming from the spinal cord. The alpha motor neurons are tightly regulated by inhibitory interneurons in the spinal cord, which govern the motor neuron outflow to the quadriceps. Activation of these governing cells will inhibit the femoral motor units and weaken knee extension during movement. When continuing to perform exercises involving the knee joint with weakened quads, synergists will be forced to accommodate inhibition, resulting in faulty movement patterns and the issues worsen.

Similar to muscle and tendon proprioceptors (spindles, GTOs) used during muscle stretch and tension reflexes, joint receptors located within the fibrous joint capsule play a role in limb position and in the regulation of reflexive muscle tone through neuronal communication with the inhibitory interneurons. Capsular strain in the knee joint produced by swelling will activate neural impulses to these interneurons and lead to the withdrawal of signals being transmitted to the quadriceps muscles. Again, the body will attempt to replicate the desired movement through joint angle adjustments which affect alignment. Weakened quadriceps (especially in the VMO) can cause misalignment of the patella, tibial translation, or lead to overall artherokinetic knee dysfunction. Common signs of this phenomenon include failure of the quads to properly decelerate upon landing from a jump or during the downward phase of a squat or deadlift; or when the knee is being flexed rapidly by the hamstrings.

Researchers have directly infused fluid into the knee joint to measure the inhibitory effects on knee extension and found that approximately 25mL of fluid led to a 35% reduction in isokinetic quadricep force production. However, it is generally accepted that fluid volumes as low as 20mL elicit quadricep inhibition. The level of inhibition may be altered during varying angles of knee flexion due to increases in the capsular pressure throughout the range of motion. Nonetheless, swelling associated with patellofemoral pain syndrome will trigger a negative response.

Interestingly, in the 90's this evidence was equivocal, since not all studies were able to replicate the results. Some studies on arthritic patients, and studies using the infusion of fluid in healthy subjects, failed to find changes in quadriceps peak torque or work. It seems that the differences among studies helped reveal a critical component of training someone with knee swelling; the amount of non-weight bearing knee flexion and extension that occurred during the research protocol. Specifically, the studies that involved prolonged warm-up periods and greater volumes of submaximal knee extension and flexion were unable to show inhibition, while those studies involving less warm-up activity did show significant dampening of quadriceps force production. This evidence demonstrates the relevance of knee specific warm-ups prior to exercise participation.

Generalized warm-ups and specific movements act to

reduce the level of quadriceps inhibition by reducing the intracapsular pressure (by up to 50%). The reduction in knee pressure during continuous and intermittent submaximal exercise is presumed to occur due to an increase in the compliance of the joint capsule or due to the distribution of fluid within the knee to alternative compartments. Therefore, a proper warm-up before exercise is essential for clients with knee pain, particularly with swelling. Specific warm-up activities should include a series of open chain extension and flexion movements as well as weight bearing actions (assisted/unassisted closed chain) to reduce inhibitory effects of knee swelling and prevent tibial translation and other mechanical problems that can aggravate an existing knee problem or arthritis.

Research published in *Physical Therapy and Sport* (2010) suggests that the effects of a warm-up on knee joint position using merely an open kinetic chain technique, would underestimate the valuable role of the warm-up. It was found that warm-up programs enhance knee joint position most effectively when closed kinetic chain exercises are employed. Squats with isometric hip adduction and lunges were also cited as relevant inclusions to preparation programs. Specifically, in closed kinetic chain exercises, more selective VMO activation can be obtained at 60 degrees knee flexion. Maximal VMO/VL ratio was observed at this knee flexion angle, and muscle contraction intensity was also found to be greatest. A common error in closed kinetic chain activities aimed at PFPS is use of excessive ROM, particularly excessive levels of flexion.

A review of 10 randomized trials that included 14 different interventions was performed by the International Centre for Allied Health Evidence (2011). According to the review, the current body of evidence demonstrates positive results with exercise interventions for individuals with patellofemoral pain syndrome. The literature suggests that a progressive regime of daily exercises of two to four sets of ten or more repetitions, over an intervention period of 6 weeks or more, combined with exercises to address flexibility of the

Assisted Reverse Lunge Start

Assisted Reverse Lunge End

Decelerated Step Down Start

Decelerated Step Down End

PB Leg Curl Start

PB Leg Curl End

lower limb musculature was common and successfully employed. In addition, longer warm-ups and post-exercise icing will help manage the swelling and consequent inhibition.

Athletes and fitness enthusiasts will encounter problems with their knees; it's virtually inevitable. A critical aspect of being a successful coach or personal trainer is to guide athletes toward optimum injury prevention strategies and to aid the injury recovery process. Muscle strength and flexibility imbalances at the ankle, knee, or hip can increase the risk of knee problems due to improper patella alignment and tracking. A common example is seen when gluteus maximus weakness leads to greater reliance on the medial hamstrings during hip extension (synergist dominance), which will rotate the hip internally and alter the tracking of the patella causing irritation or injury to the cartilage, tendons, ligaments, and bursa. Several other, even more common conditions can lead to knee joint dysfunction, such as weak inner quadriceps, tight hamstrings, a tight IT band, overzealous training volume, and improper or worn out footwear. Overuse of the knee joint, especially with flawed mechanics, will most often lead to knee problems accompanied by knee swelling.

NCSF certified trainers should constantly evaluate client biomechanics, such as during the performance of a lunge or squat, and look for signs of musculoskeletal impairments that can lead to knee pain or injury. Moreover, trainers should implement a training program with an appropriate progression and recovery to minimize overtraining ensuring an effective warm-up plan is implemented. It is also important to recognize that a swollen knee will directly weaken the quadriceps and trainers must emphasize a thorough warm-up to remove the inhibitory effects and preserve functional knee extension strength during exercise to avert injury. The exercises displayed can be viable options for prevention and management of PFPS and can be easily implemented in a comprehensive program.

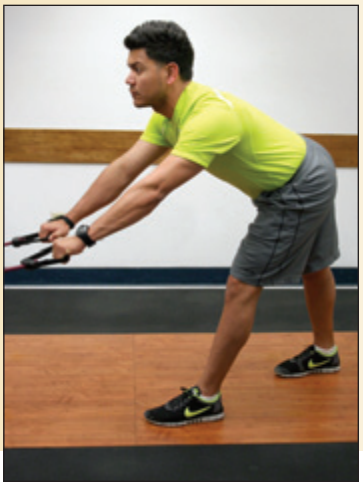
PB Supine Leg Marches Start

PB Supine Leg Marches End

PB Supine Leg Marches Alt. End

Split Stance Band Reaches Start

Split Stance Band Reaches End



Split Stance Band Reaches Alt. End