Treatment of Patellofemoral Pain Syndrome (PFPS):

Quick Reference

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Overview:

Patellofemoral pain syndrome (PFPS) is the most prevalent disorder involving the knee (1, 2) and can have as many as 38 different subcategories of classification. (3) Unfortunately because of the broad spectrum of conditions classified under PFPS the symptoms are varied and quite often individuals will present with multiple symptoms in the involved extremity. (4, 5) In general, a positive patellar grind test (Clarke's Test) and discomfort with palpation of the medial and lateral borders of the patella are present. (5, 6)

Anatomy and Biomechanics:

Historically, conservative treatment of PFPS has focused on restoring normal patellar tracking by improving dynamic stability. (7, 8) The vastus medialis oblique muscle (VMO) has been often implicated as the primary medial stabilizer of the patella. Leib and Perry (9) identified the distal fibers of the VMO to be angled at approximately 55 degrees from the longitudinal axis of the femur, making this portion of the muscle best suited to prevent lateral subluxation of the patella, by counterbalancing the lateral pull of the larger vastus lateralis to ensure patellar stability within the trochlear groove. (10) Unfortunately the evidence available does not entirely support the notion of VMO strengthening to reduce PFPS. (11, 12, 13)

*To date there is no conclusive evidence that supports the notion of selective VMO inhibition with PFPS. (14) Typically what is seen is reduced recruitment of the entire quadriceps muscle (15) and even more interesting is that to date radiological examination has shown isolated lateral subluxation of the patella in less than 50% of patients with PFPS symptoms. (16, 17) This supports the notion that lateral tracking of the patella is not a universal finding with PFPS.

Neuromuscular timing of VMO versus vastus lateralis:

Even though there is much clinical focus on altering the timing of the VMO relative to the vastus lateralis through the use of muscle reeducation techniques, to date only a few studies (18, 19) with limited clinical significance (only a few milliseconds difference being reported so far) have been performed, and therefore further research is warranted to validate any of these treatment approaches. (14)

VMO selective recruitment and strengthening:

The premise for this treatment approach falls back to the belief that the VMO can be selectively recruited independently of the vastus lateralis through various exercises. The most common prescribed exercises, because of the origin and attachment of the VMO with the adductor longus and magnus tendons and the insertion and attachment in the tibia to the medial extensor aponeurosis (20), often include quadriceps strengthening exercises (ie, straight leg raises, isometric quadriceps sets, terminal knee extension, short arc quads), hip adduction, and internal tibial rotation. (14)

While one particular study found that medial tibial rotation and knee extension combined and knee extension alone were significantly greater than hip adduction and hip adduction and knee extension at producing higher proportion of VMO usage when compared to vastus lateralis, they found no differences in isometric forces between individuals with patellofemoral pain and control subjects.(21) Another study that reviewed 22 different variations of quadriceps exercises found that none resulted in greater VMO activity relative to the vastus lateralis. (11)

In summary in regards to recruitment, although there is significant controversy in the literature as to whether the VMO can be isolated and strengthened one fact remains consistent, that none of the studies have shown that the VMO functions independently of the vastus lateralis. (14) And even if an exercise were able to elicit greater VMO EMG activity relative to vastus lateralis, the contraction would need to be at least 60% of

maximum to stimulate hypertrophy (19) and given such it appears that any strengthening through selected exercises only serves to increase strength in the entire quadriceps muscle. (14)

With all that in mind, despite any limited ability to selectively recruit the VMO, it is apparent that strengthening of the quadriceps muscle can produce successful clinical results. (22, 23, 24) One suggested reason for this is that locomotor function in persons with patellofemoral pain is associated with increased quadriceps femoris muscle torque and thus would lend itself to the notion that strengthening of the quadriceps would be a useful treatment option. (25) Unfortunately the exact mechanism is still not known.

Studies suggest that quadriceps strengthening can be safely performed throughout the 0-90 degrees knee flexion range by varying the modes of exercise from open and closed chain and both can and should be used to promote hypertrophy. Also eccentric exercise has been shown to often times be more effective than concentric in this population. (26, 27)

Use of Bracing and/or Taping:

External patellar supports are commonly employed in the management of patellofemoral pain and are typically used as an adjunct to other treatment methods (ie, strengthening). (23, 28, 29, 30)

The primary goal of bracing or taping is to centralize the patella within the trochlear groove, thus improving tracking. (14) McConnell (23) reported that 92% of patients were pain free after 8 sessions with the use of taping which is in agreement with other studies that have shown 96% overall improvement. (14, 31)

The exact mechanism by which taping or bracing affects the patellofemoral joint is not entirely clear, however some speculate that the compression allows for increased surface area between the patella and the trochlear even if no changes in the patella in a medial or lateral direction are produced. (14)

Of note is that recently Lesher et al. (32) developed a clinical prediction rule (CPR) for determining which individuals with PFPS would benefit from patellofemoral taping with a medial glide technique. They found that if the following four subject characteristics were present: 1) tibial angulation >5 degrees varus, 2) ankle dorsiflexion with knee flexed $\leq$ 15 degrees, 3) patellar tilt above the horizontal plane, and 4) relaxed Calcaneal stance >4 degrees varus, then the individual stood a much greater chance of having a successful outcome with use of the patellar taping. (32)

Footwear and Foot Orthoses as Treatment:

Attempts have been made to associate footwear selection with the reduction of PFPS. (33) Based on the premise that movements in the foot and lower leg are linked by tibial rotation, the thought is that an abnormal foot alignment may alter the mechanics of the patellofemoral joint and result in pain. (33) The term "motion control" is often used by shoe companies to describe a shoe which, in theory, aims to control the rear foot movement during locomotion in running and sports, in order to reduce excessive forefoot pronation. (33)

Unfortunately, to date there has been no conclusive evidence to point to a uniform relationship between tibial and foot movements in all individuals. This may be due to inter-subject variability including such factors as the articular surfaces, forces of the muscles, and strength of the ligaments. (34) In general however, in assessing a relationship between lower extremity rotation and patellofemoral joint kinematics, femoral rotation in excess of 20 degrees may be considered as a potential predisposing factor of PFPS. (33)

Another area studied in great depth, although complicated by confounding factors, has been that of foot orthosis prescription and its role as an intervention for PFPS. (35, 36, 37 38, 39) To date the literature suggests that individuals that have patellofemoral pain may benefit from foot orthoses if they also demonstrate signs of excessive foot pronation and/or a lower-extremity alignment profile that includes excessive lower extremity internal rotation during weight bearing and increased Q-angle. (35)

Although not known for sure, the suspected mechanisms by which foot orthoses may have a positive effect for individuals with PFPS would include, 1) a reduction in internal rotation of the lower extremity, 2) a reduction in Q-angle, 3) reduced laterally-directed soft tissue forces from the patellar tendon, quadriceps tendon and the iliotibial band, and 4) reduced patellofemoral contact pressures and altered patellofemoral contact pressure mapping. (35)

Ultrasound:

A Cochrane Collaboration Review looked at the benefits of using therapeutic ultrasound in the treatment of PFPS. (40) After reviewing 85 articles the authors were able to find only one randomized controlled trial. Unfortunately, out of all of the studies available the authors were unable to find any "significant, statistical differences" between the use of ultrasound and the concurrent use of ice and/or exercise for the treatment of PFPS, even though subjects in the one study did report a higher percentage of relief with the use of the Ultrasound. (40) Therefore further research is warranted prior to making any conclusive decision as to the effectiveness of ultrasound with PFPS.

Manual Therapy:

There are only a few randomized controlled trials that have looked at the effect of manual therapy (mobilization and/or manipulation) on PFPS. The rationale to perform manual therapy is based on the belief that tightness of the lateral retinacular structures, perhaps as increased tension from the ITB, may adversely alter tracking of the patella in the trochlear groove. (41)

Rowlands et al. (42) reported significantly lower levels of pain in subjects that received patellar mobilization consisting of manual sustained glide followed by high velocity, low amplitude manipulation when compared to a control group that just received detuned ultrasound. Unfortunately, the limitations in the study were plentiful including small sample size and therefore the results should be used cautiously.

Suter et al. (43) also looked at the use of manipulation and its effect on PFPS. They performed sacroiliac (SI) joint manipulation based on the idea that SI joint dysfunction may adversely alter patellofemoral biomechanics. When compared to a control group which did not receive manipulation of the SI joint, those that had received treatment reported decreased quadriceps activation failure and less pain. (43)

Summary:

In summary the treatment of PFPS, because of the multifactoral causes of PFPS can sometimes be very difficult. Further research is warranted in all areas at this time, however there is some good, strong evidence in support of patellar taping and bracing with a Clinical Prediction Rule available to assist the clinician in determining when patellar taping with a medial pull, will have the most success. The performance of strengthening exercises with PFPS also has some strong evidence to support positive clinical outcomes, however further research is required to determine the exact mechanism of the relief in symptoms. Ultrasound, manual therapy, footwear selection and the prescription of foot orthoses have at this time only anecdotal evidence, and therefore their use in the treatment of PFPS should guided by professional judgment with the risk/benefits being taken into account.

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