0008-3194/2004/259–265/$2.00/©JCCA 2004

Low-tech rehabilitation of bilateral patellofemoral knee pain in a runner: a case study

Gary F Stefanick, DC*

Patellofemoral pain is a common ailment within both the running and general populations. Many of the structures of the anterior knee that comprise the patellofemoral joint can be the source of chronic pain and inflammation that is associated with this condition. Much of the evidence in the literature points to a delay in activation of the vastus medialis oblique muscle as compared to the vastus lateralis, vastus medialis weakness, and ultimately faulty patellar tracking as the chief causative factors in the development of patellofemoral pain.

This is a single case study of a 51-year-old recreational runner with an 18-month history of bilateral patellofemoral knee pain. Treatment included the use of low-tech in office rehabilitation strategies known to affect those causative factors responsible for patellofemoral pain. Evidence based treatment modalities were utilized in combination, which included patellar mobilization, spinal manipulation, proprioceptive and strength training, and semi-rigid orthotic use, to effect vastus medialis oblique vs. vastus lateralis activation, vastus medialis strength, and patellar movement. The patient responded very well to a 12 week course of treatment and resumed recreational running with minimal to no pain at the six month, one and two year follow-ups.
(JCCA 2004; 48(4):259–265)

KEY WORDS: patellofemoral, knee, runner.

Le syndrome fémoro-rotulien est un malaise fréquent autant chez les coureurs que chez la population en général. Les douleurs chroniques et l'inflammation associées à cette condition peuvent être causées par un grand nombre de structures antérieures du genou, notamment l'articulation fémoro-rotulienne. La documentation prouve que les facteurs déterminants du développement du syndrome fémoro-rotulien comprennent le délai d'activation, comparativement à celui du muscle vaste externe, du muscle vaste oblique interne du membre inférieur, sa faiblesse et son mauvais repérage.

Cette étude de cas a été effectuée avec un seul coureur récréatif de 51 ans qui présentait des antécédents du syndrome fémoro-rotulien bilatéral pendant 18 mois. Le traitement, connu pour son effet sur les facteurs déterminants du syndrome, incluait une stratégie de réadaptation de faible technicité en cabinet. Différentes techniques de traitement fondées sur des preuves ont été utilisées en association, notamment une mobilisation de l'articulation fémoro-rotulienne, une manipulation de la colonne, un entraînement proprioceptif et musculaire et l'utilisation d'une orthèse semi-rigide. Ces techniques visaient à favoriser le mouvement rotulien ainsi que l'activation du muscle vaste interne oblique du membre inférieur par rapport à celle du muscle vaste externe, et à renforcer le muscle vaste médial. Le patient a bien répondu au traitement de douze semaines et a pu recommencer à courir de façon récréative. Il a ressenti peu ou pas de douleur lors des suivis du sixième, douzième et 24e mois.
(JACC 2004; 48(4):259–265)

MOTS CLÉS : fémoro-rotulien, genou, coureur.

* Private practice: New York City, 49 W. 12 Street, Suite 1E, New York, New York 10011.
Phone: 212-243-3080. E-mail GStefanick@aol.com

Introduction

The number of recreational runners in the United States is estimated to be 30 million, and of this population approximately 60 percent will eventually experience an injury to the lower extremity limiting their activities.[1] One of the most common injuries amongst runners is anterior knee pain. The anterior part of the knee consists mainly of structures belonging to the patellofemoral joint, which includes a variety of tissues, such as cartilage, subchondral bone, synovial plicae, bursae infrapatellar fat pad, retinaculae, capsule, and tendons. Each of these structures, alone or in combination, can be a source of anterior, or patellofemoral knee pain.[2]

In general patellofemoral pain can affect about 25% of the population. In some cases, the etiology is unknown.[3] Many feel there to be a combination of factors such as the timing of the contraction of the vastus medialis obliquus (VMO) and vastus lateralis (VL) musculatures, as well as, VMO weakness that adversely affect muscular control and ultimately tracking of the patella. These factors lead to stress on the anterior knee structures, resulting in inflammation and pain. There is evidence to suggest that inappropriate control of the VMO and VL muscles by the central nervous system can contribute to maltracking of the patella. Apparently, the activation of the VMO and VL muscles of subjects with patellofemoral pain is consistent with a laterally tracking patella during eccentric contraction.[4] Research indicates that in asymptomatic subjects, contraction of the VMO and VL occurs simultaneously, however in subjects with patellofemoral pain the electromyographic onset of the VL occurs before that of the VMO.[5] Other studies agree. In the patellofemoral pain population, the EMG onset of the VL occurred before that of the VMO, while in the control group no such differences occurred.[6] There is additional evidence indicating that patients, who underwent physical therapy for patellofemoral pain and experienced a reduction in their anterior knee pain, saw a change in their VMO EMG compared with that of the VL. Before treatment, the EMG onset of the VL occurred before that of the VMO, while after physical therapy treatment, the onset of the VMO preceded the VL in eccentric phase and occurred at the same time in the concentric phase of the task under study.[7] In addition, weakness of the VMO is thought to be an important factor resulting in patellar subluxation and dislocation. Understanding the relationship between VMO weakness and patellar tracking will be useful in diagnosis, treatment and prevention of patellar subluxation.[8]

These findings indicate that reduction in patellofemoral pain may be achieved through techniques that selectively increase the VMO strength. Additionally addressing the functional significance of timing differences between the VMO and VL is an important consideration in patellofemoral pain treatment.

Case study

History

A 51-year-old male business executive, who describes himself as a recreational runner, complained of bilateral anterior knee pain, for 1.5 years duration. He stated that his anterior knee pain began approximately 2 years previously and affected his left knee. He continued to "run through the pain." He was running approximately 20 to 25 miles per week, and frequently entered short distance races. Approximately 1.5 years ago while running a 5-kilometer race he felt a sudden onset of right anterior knee pain. He has not been able to run since that race due to bilateral knee pain. He also complained of anterior knee pain with walking, climbing up the stairs, and prolonged sitting. These types of symptoms are commonly described in the clinical history of the patellofemoral pain syndrome patient.[9] He rated his knee pain a 5 over 10 on an analogue pain scale, with 10 being the worst possible pain. He stated that his goal of treatment was to resume recreational pain-free running once again. The patient indicated a life history of frequent inversion sprains of the ankle joints.

Findings

The patient presented with slight swelling on the inferior and medial aspects of both patellae. Palpation revealed significant global tenderness, with occasional zones of exquisite tenderness, especially on the inferior pole of the patella. Other than these findings the orthopaedic knee exam was normal. Radiographic examination of both knees from a prior orthopaedic consultation was normal. Muscle length assessment in the lower extremities revealed tightness of the hamstrings, with flexion at the hip restricted to 50 degrees bilaterally. Thomas test was positive, bilaterally, suggesting tightness of the iliopsoas muscle complex. Dorsiflexion of the foot was restricted, bilaterally, with the leg both fully extended and the knee flexed to 90 degrees indicating gastrocnemieus and soleus tightness. Ober's test was positive, bilaterally, indicative of tightness of the iliotibial band and abductor muscle groups. Range of motion testing in the subtalar joints revealed extreme hypermobility in both subtalar joints. Evaluation of the patient standing revealed marked subtalar joint pronation, bilaterally, with a slight valgus deformity present at both knees.

Treatment

The initial goal of treatment was to reduce inflammation in the soft tissues around the patellofemoral joint. Manual friction massage was utilized to break up scar tissue and disrupt the inflammatory process. For each knee, five minutes of cross friction massage was performed around the inferior and medial margins of the patella, medial patellar retinaculum, and the tendons of the quadriceps and sartorius muscles (Figure 1). In this initial phase of care, interferential therapy, ultrasound, and ice massage were also used to reduce inflammation, relieve pain, increase circulation, and facilitate the healing process. Chiropractic management included bilateral side posture manipulation of the sacroiliac joints and lumbar spine to correct biomechanical imbalances. Diversified manipulation of the thoracic and cervical spine was also performed to manage upper back and neck pain complaints of the patient. Mobilization of the patella was performed to correct malalignment and abnormal tracking of the patella.

After 2 weeks of treatment, PNF stretching of the involved musculature was initiated, as well as a home stretching program. Emphasis was placed on stretching the hamstrings, iliotibial band, iliopsoas, gastrocnemius and soleus. Proprioceptive training was initiated to effect CNS activation in the lower extremities, especially in the quadriceps. Proprioceptive exercises included the use of

Figure 1 Transverse friction massage across the inferior medial border of the patellar tendon. Upper hand stabilizes the patella and the index finger of the lower hand is use to apply friction massage.

Figure 2 Single leg stance on a wobble board. Patient is progressed from a two leg stance to a singe leg stance which provides more proprioceptive activation in the lower extremity.

rocker boards, wobble boards, and balance sandals (Figure 2). This phase of care lasted 4 weeks.

Halfway through the proprioceptive training phase, strength training was initiated. Strength training consisted of closed kinetic chain floor and Swiss gym ball exercises designed to strengthen the thigh, buttock, and trunk muscles. The patient was started with bridging type exercises on the floor, and instructed to work up to 15 repetitions per exercise and perform 2 sets of each exercise. The patient was taught these exercises in office and instructed to perform them daily at home (Figure 3). He then progressed to exercising on an unstable surface, the Swiss gym ball, which provided additional challenge to the patient and greater activation of the muscles trained (Figure 4). Squatting exercises were introduced, and the patient was trained within a functional range of 0 to 50 degrees knee flexion (Figure 5).

Early in the treatment program custom-made foot orthotics were prescribed to control the excessive subtalar joint pronation present in the lower extremities. For this patient, plaster molds of the feet were obtained in office in a non-weight bearing, subtalar neutral position. The orthotics were constructed with a 4-degree rear foot post, bilaterally, as determined by the lab. Two pair of orthotics were constructed, a slimmer pair for his dress shoes, and a more substantial pair to be worn in his athletic shoes when he was to return to running.

Figure 3 Single leg bridge exercise. Patient will lower the hips and pelvis toward the floor, and raise them back up again for one repetition. This exercise is also performed with both feet on the floor.

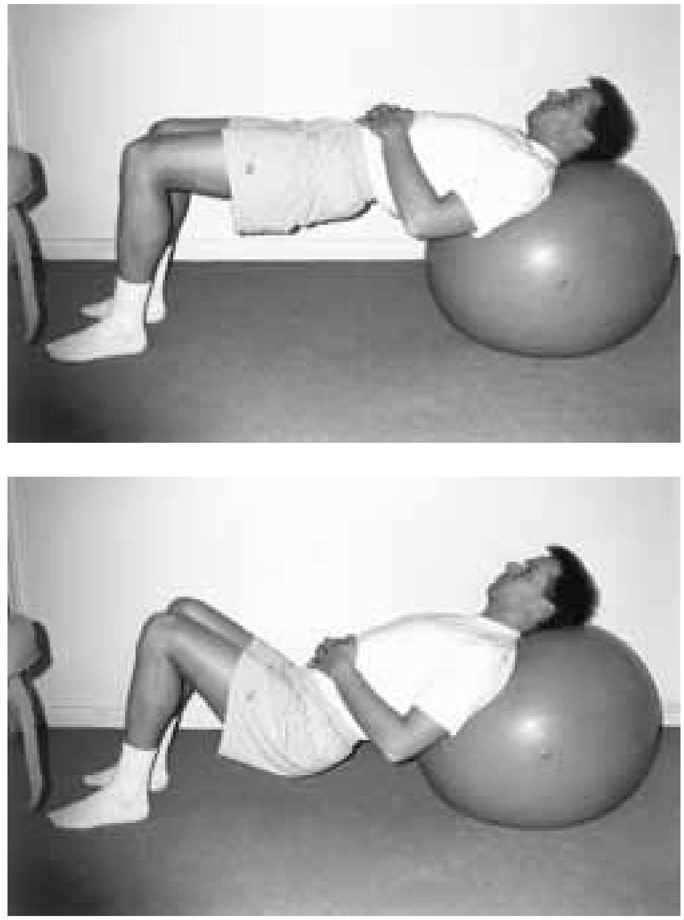

Figure 4 Bridge exercise on Swiss gym ball. Patient will lower and raise the hips and pelvis for 12 to 15 repetitions.

Overall the patient was treated in office, with low-tech rehabilitation methods for 12 weeks at 2 visits per week.

Results

The patient, upon completion of the 12-week rehab program, did resume recreational running. He was asymptomatic with the activities of daily living that once caused him pain (i.e. stair climbing). With recreational running his symptoms as reported on the quadruple pain scale were as follows: Present pain 0, pain at it's worst 1, pain at its best 0, and average pain 0. This pain scale report remained consistent at the six-month, one year, and two year follow up. The patient also indicated that he continued to wear his orthotics, both for street and athletic use.

Figure 5 Wall squats using the Swiss gym ball. Patient will lower the buttock toward the floor and raise back up working in a functional range of zero to 50 degrees of knee flexion. The patient's back rolls the ball up and down the wall.

The patient responded very well to care, and was extremely pleased with the outcome. At the end of the program the patient indicated that he wanted to continue with a strength-training program, and was instructed to join a health club and utilize the services of an athletic trainer. At the two year follow up the patient indicated that he still continues to work on strength, stretching and proprioceptive training with an athletic trainer. More than likely this work has contributed to the long tem stability of his condition.

Discussion

The initiation of treatment with cross fiber friction massage was performed in order to address abnormal scar tissue build-up in the chronically inflamed tissues around the patella. If excessive soft tissue overuse or immobilization occurs increased fibrous scar tissue will result which may spread and become tethered to surrounding normal tissue. Transverse motion across the involved tissue and the resultant hyperemia are the chief healing factors of friction massage. Cyriax states that moving across the soft tissue fibers at right angles does not injure the normal healing tissue but prevents the formation of or a breakdown of abnormal scar tissue.[10]

Chiropractic manipulation can alter the mechanics of the hips, spine, and pelvis and there is also evidence to suggest that sacroiliac joint manipulation may reduce inhibition of the knee-extensors muscles. Knee joint pathologies, such as anterior knee pain, are associated with strength deficits and reduced activation to the knee extensors, which is referred to as muscle inhibition. It is suggested that sacroiliac joint manipulation reduces this knee extensor muscle inhibition and may possibly be an effective treatment of muscle inhibition in the lower limb.[11] Mobilization of the patella was also performed. In a single study it was concluded that patella mobilization was superior to placebo in the treatment of patellofemoral pain syndrome.[12]

Proprioceptive training was used to increase the speed of muscle activation and coordination in the trunk and lower extremities. It is possible to accelerate muscle contraction approximately twofold with increased proprioceptive flow through the use of balance exercises.[13] Challenging balance is achieved with the use of multi-planar devices including rocker and wobble boards and balance shoes. The use of multi-planar exercises is now a contemporary trend in exercise rehabilitation where proprioceptive deficits are known to occur.[14]

There is good evidence in the literature to suggest the use of closed kinetic chain strength training exercises in the rehabilitation of the patellofemoral pain patient.[15] In comparing closed kinetic chain and joint isolation exercise (open kinetic chain) it was concluded that closed kinetic chain training may be more effective that joint isolation exercise in restoring function in patients with patellofemoral dysfunction.[16] In another study comparing open and closed kinetic chain exercises, maximal VMO activation and greatest VMO muscle contraction intensity was found at 60 degrees knee flexion in the closed kinetic chain exercise group.[17] In addition, closed kinetic chain exercises simulate normal physiological and biomechanical functions, create little shear stress across injured or healing joints, and reproduce proprioceptive stimuli.[18] Strength training incorporated the use of floor and Swiss gym ball exercises that emphasized bridge and squatting type exercises. Of all exercises, the squat, by far has the greatest effect on strength development in the lower extremities. Evidence suggests that there is a greater muscle activity and knee force in the squat when compared with other similar exercises. This implies that the squat may be more effective in muscle development, but should be used cautiously with patellofemoral disorders, especially at greater knee flexion angles. Because all forces increased with knee flexion, training within the functional 0–50 degree range may be efficacious for those whose goal is to minimize knee forces.[19] Other studies agreed. The squat does not compromise knee stability, and can enhance stability if performed correctly. The squat can be effective in developing hip, knee and ankle musculature, because moderate to high quadriceps, hamstring, and gastrocnemius activity are produced during the squat. Patellofemoral compressive forces and shear forces progressively increase as the knees flex and decrease as the knees extend, reaching peak values near maximum knee flexion. Training with the squat in the functional range between 0 and 50 degrees knee flexion may be appropriate because knee forces are minimal in this functional range.[20] Still another study finds that there is more activation of the VMO than the VL at 40 degrees of semi squat with the hip medially rotated by 30 degrees, and this has great implications for training the VMO in patients with patellofemoral joint pain syndrome.[21]

Abnormal foot position has been suggested as an important factor that may lead to patellofemoral malalignment. The use of a foot orthotic to correct a pronated or supinated foot might not result in a change in quadriceps muscle activation intensity but more than likely changes other mechanical factors related to the knee.[22] It is postulated that patellar position is influenced by subtalar joint mechanics. In one study a statistically significant change in patellar positioning was noted on radiograph after the placement of a semi rigid orthotic devices in the subject's shoes.[23] Foot orthotics are an extremely useful tool in the long-term management of the patellofemoral pain patient. In comparing treatment using an exercise program alone or treatment that included foot orthotics in addition to the exercise program, the improvement in the exercise plus orthotic group was significantly greater than that of the exercise only group.[24]

One treatment modality that was not utilized in this case was the inexpensive elastic patellofemoral sleeve brace. Evidence indicates that clinical improvements seen with bracing in subjects with patellofemoral pain does not come from a correction in patellar tracking patterns and alignment, but are the result of other subtle differences in joint mechanics. Most feel that braces are best used as an adjunct to other therapies.[25,26]

Conclusion

Evidenced by the rate of occurrence and chronicity of patellofemoral pain in the recreational running population, and the large number of patellofemoral elastic sleeve braces on the market today, there is still little known within this group and the population in general about treatment options for this condition. Presently, many runners will use an inexpensive over the counter elastic knee brace in an attempt to temporarily relieve their knee pain, and assume an "I will deal with it later" attitude until the pain forces them to either slow or stop their running program altogether and disrupts other activities of daily living.

In summary, this single case study, presents a number of low-tech treatment options available to both the patient and rehabilitation specialist, specifically addressing known causative factors that generate patellofemoral knee pain. These risk factors include VMO muscle response time, decreased VMO strength, and mobility problems of the patella. Management of this condition involves consideration of all factors when determining a specific course of treatment. Soft tissue mobilization, spinal manipulation, stretching, patellar mobilization, proprioceptive and strength training, and orthotic use can all be used selectively and in combination to effectively decrease stresses placed upon patellofemoral joint tissues.

For many recreational runners, the concept of strength training is a new one. Many feel they get all necessary conditioning through running only and exclude strength training as part of their exercise regimen. The prevailing attitude amongst runners, albeit slowly changing, has been that the running itself builds muscular strength. In reality, running being a mostly aerobic activity, effects the endurance components of muscle much more than it contributes to strength development. By combining proprioceptive and strength training in a running program, one may address issues of VMO timing and strength, and possibly prevent many patellofemoral knee problems from occurring.

References

1 Austin WM. Chiropractic Health for Recreational Runners. J Am Chiropr Assoc 2002; 39(5):32–37.
2 Biedert RM, Sanchis-Alfonso V. Sources of anterior knee pain. Clinical Sports Medicine 2002; 21(3):335–347, vii.
3 Heino Brechter J, Powers CM. Patellofemoral stress during walking in persons with and without patellofemoral pain. Medicine And Science In Sports And Exercise. 2002; 34(10):1582–1593.
4 Owings TM, Grabiner MD. Motor control of the vastus medialis oblique and vastus laterali muscles is disrupted during eccentric contractions in subjects with patellofemoral pain. Am J Sports Medicine 2002; 30(4):483–487.
5 Cowan SM, Hodges PW, Bennell KL, Crossley KM. Altered vasti recruitment when people with patellofemoral pain syndrome complete a postural task. Arch Phys Med Rehab 2002; 83(7):989–995.
6 Cowan SM, Bennell KL, Hodges PW, Crossly KM, McConnell J. Delayed onset of electromyographic activity of vastus medialis obliquus relative to vastus lateralis in subjects with patellofemoral pain syndrome. Arch Phys Med Rehab 2001; 82(2):183–189.
7 Cowan SM, Bennell KL, Crossley KM, Hodges PW, McConnell J. Physical therapy alters recruitment of the vasti in patellofemoral pain syndrome. Medicine And Science In Sports And Exercise. 2002; 34(12):1879– 1885.
8 Sakai N, Luo ZP, Rand JA, An KN. The influence of weakness in the vastus medialis oblique muscle on the patellofemoral joint: an in vitro biomechanical study. Clinical Biomechanics 2000; 15(5):335–339.
9 LaBore AJ, Weiss DJ. Vastus lateralis strain associated with patellofemoral pain syndrome: a report of 2 cases. Arch Phys Med Rehab 2003; 84(4):613–615.
10 Cyriax J. Textbook Of Orthopaedic Medicine. London: Bailliere-Tindall; 1984; 2.
11 Sutter E, McMorland G, Herzog W, Bray R. Conservative lower back treatment reduces inhibition in knee-extensor muscles: a randomized controlled trial. J Manip Physiol Ther 2000; 23(2):76–80.
12 Rowlands BW, Brantingham JW. The efficacy of patella mobilization in patients suffering from patellofemoral pain syndrome. J Neuromusculoskeletal System 1999; 7(4):142–149.
13 Liebenson C. Rehabilitation Of The Spine. Williams & Wilkins; 1996; 320–321.
14 Surburg PR, Schrader JW. Proprioceptive neuromuscular facilitation techniques in sports medicine: A reassessment. J Athletic Training 1997; 32:34–39.
15 Witvrouw E, Lysens R, Bellemans J, Peers K, Vanderstraeten G. Open versus closed kinetic chain exercises for patellofemoral pain. A prospective, randomized study. Am J Sports Medicine 2000; 28(5):687–694.
16 Stiene H, Brosky T, Reinking M, Nyland J, Mason M. A comparison of closed kinetic chain and isokinetic joint isolation exercise in patients patellofemoral joint dysfunction. J Ortho Sports Physl Ther 1996; 24(3):1356–1341.
17 Tang S, Chen C, Hsu,R, Chou S, Hong W, Lew H. Vastus medialis obliquus and vastus lateralis activity in open and closed kinetic chain exercises in patients with patellofemoral pain syndrome: an electromyographic study. Arch Phys Med Rehab 2001; 82(10):1441–1445.
18 Kibler WB, Livingston B. Closed-chain rehabilitation for upper and lower extremities. J Am Acad Ortho Surg 2001; 9(6):412–421.
19 Escamilla RF, Fleisig GS, Zheng N, Lander JE, Barrentine SW, Andrews JR, Bergemann BW, Moorman CT III. Effects of Technique Variation on Knee Biomechanics During the Squat and Leg Press. Medicine And Science In Sports And Exercise 2001; 33(9):1552–1566.
20 Escamilla RF. Knee Biomechanics of the Dymanic Squat Exercise. Medicine and Science In Sports And Exercise 2001; 33(1):127–141.
21 Lam PL, Ng GY. Activation of the quadriceps muscle during semisquatting with different hip and knee positions in patients with anterior knee pain. Am J Phys Med Rehab 2001; 80(11):804–808.
22 Hung YJ, Gross MT. Effect of foot position on electromyographic activity of the vastus medialis oblique and vastus lateralis during lower-extremity weight-bearing activities. J Ortho Sports Phys The 1999; 29(2):421.
23 Klingman RE, Liaos SM, Hardin KM. The effect of subtalar joint posting on patellar glide position in subjects with excessive rearfoot pronation. J Ortho Sports Phys Ther 1996; 25(3):185–191.
24 Pain, Orthotic Devices, Therapy, Pain-Th, Patella, Knee Injuries-Th, Human, Exercise. Evaluation of soft foot orthotics in the treatment of patellofemoral pain syndrome. Physical Therapy 1993; 73(2):62–68.
25 Paluska SA, Mckeag DB. Using patellofemoral braces for anterior knee pain. Phys Sportsmed 1999; 27(8):81–82.
26 Powers CM, Shellock FG, Beering TV, Garrido DE, Goldbach RM, Molnar T. Effect of bracing on patellar kinematics in patients with patellofemoral joint pain. Medicine And Science In Sports And Exercise 1999; 31(12):1714–1720.