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DIAGNOSIS AND ORTHOSIS TREATMENT OF PATELLOFEMORAL PAIN SYNDROME

Pain within the anterior aspect of the knee is commonly known as patellofemoral pain syndrome (PFPS), but may also be known as "patellofemoral syndrome", "runner's knee", or "chondromalacia patella". Research published 22 years ago by Taunton and Ryan from British Columbia on 2,002 injured runners, PFPS was the single most common diagnosis among these runners with female athletes representing 62% and male athletes representing 38% of the PFPS cases (Taunton JE, Ryan MB et al.: A retrospective case-control analysis of 2002 running injuries. Br J Sports Med, 36:95-101, 2002).

On clinical examination, patients with PFPS will complain of pain either directly under or around the patella which is made worse by sitting in a knee flexed position for prolonged periods, known as the "theater sign". In addition, any knee-flexion activity under load such as squatting, running, jumping and/or climbing stairs will tend to increase the anterior knee pain due to the increased compression forces between the patella and the femur during these knee-flexion activities (Dixit S, Difiori JP et al.: Management of patellofemoral pain syndrome. Am Fam Physician, 75:194-202, 2007).

From a biomechanical standpoint, the patella functions to increase the knee extension moment arm for the quadriceps muscles. In other words, the patella helps the ability of the quadriceps to accelerate knee extension (e.g., rising up to an upright position from a squatting position), to decelerate knee flexion (e.g., going into a squatting position from an upright position), and/or to stabilize the knee (e.g., holding a half-squat position while gravity is causing a knee flexion moment). Since the patella transfers quadriceps muscle power to the tibia to increase knee extension moment, the posterior articular surface of the patella will also be forcefully pushed against the trochlear groove of the distal femur, especially when the knee is in a flexed position. In fact, the contact forces between the posterior patellar surface and the trochlear groove of the femur have been measured to be about 6.5 times body weight at just one-third of maximum quadriceps contractile activity (Huberti HH, Hayes WC: Patellofemoral contact pressures. The influence of q-angle and tendofemoral contact. JBJS, 66 (5):715-724, 1984).

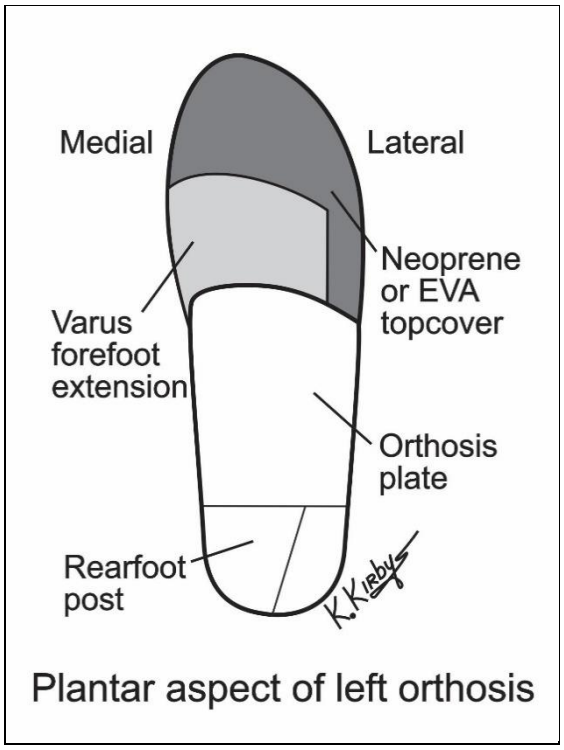

Figure 1. Custom foot orthoses made for patients with patella-femoral pain syndrome should include a varus forefoot extension, a medial heel skive and a relatively stiff and well-fitting medial longitudinal arch.

PFPS is thought to be due not only to this large magnitude of contact forces between the patella and femur but also to be due to abnormal lateral tracking of the patella with the trochlear groove of the femur. During running and jumping activities, when the patella-femoral contact forces are the greatest, any tendency toward lateral tracking of the patella within the trochlear groove of the femur will tend to increase the risk of PFPS developing. Factors that have been suggested to cause lateral tracking of the patella on the femur and PFPS are increased subtalar joint (STJ) pronation, pes planus deformity, forefoot varus, and an increased Q-angle (i.e., angle formed by line from anterior superior iliac spine to patellar bisection and line from patellar bisection to tibial tubercle). In addition, overuse and trauma have also been suggested as possible causes of PFPS, even though the research evidence is limited that supports the idea that these factors are responsible for the pain and disability caused by the common running injury of PFPS (Dixit S, Difiori JP et al., 2007).

What has been known for nearly a half-century by sports podiatrists is that the symptoms of PFPS can be successfully treated with custom foot orthoses. Forty-nine years ago, Steve Subotnick, DPM, first suggested that PFPS can be caused by excessive STJ pronation which leads to increased femoral and

tibial internal rotation during running and, in turn, leads to lateral mistracking of the patella on the trochlear groove of the femur. Subotnick suggested that one of the primary treatments for PFPS should be providing the runner with a full-length anti-pronation custom foot orthosis to limit STJ pronation during running (Subotnick SI: *Podiatric Sports Medicine*, Futura Publishing Co., Mt. Kisco, NY, 1975, pp. 115-123).

Later research evidence has supported the use of custom foot orthoses for the treatment of PFPS. In 1993, Eng and Pierrynowski studied 20 adolescent female subjects with PFPS and found that custom foot orthoses were significantly better at reducing the pain of PFPS than no orthoses (Eng JJ, Pierrynowski MR: Evaluation of soft foot orthotics in the treatment of patellofemoral pain syndrome. Phys Therapy, 73:62-70, 1993). In addition, in 2008, Collins and Crossley studied 179 subjects with PFPS and found that foot orthoses produced improvement beyond that of flat inserts (Collins N, Crossley K et al.: Foot orthoses and physiotherapy in the treatment of patellofemoral pain syndrome: randomised clinical trial. BMJ, 337:a1735, 2008.) In 2009, Nejati et al. studied 25 female athletes with PFPS who were provided full-length foot orthoses and found not only a reduction of pain, but also an improvement in sports activities at 2-weeks and 6-weeks after dispensing orthoses to the subjects (Nejati P et al.: Effects of foot orthoses on knee pain and function of female athletes with patellofemoral pain syndrome. J Adv Med Biomed Res, 17(66):49-60, 2009). More recently, in 2011, Mills et al. studied 40 individuals with PFPS and found that foot orthoses produced a significant global improvement in PFPS symptoms compared with the control group and concluded that foot orthoses provide greater improvements in PFPS than a wait-and-see clinical approach (Mills K et al.: A randomized control trial of short term efficacy of in-shoe foot orthoses compared with a wait and see policy for anterior knee pain and the role of foot mobility. Br J Sports Med, 46:247-252, 2011).

In my own podiatric practice of 39 years, I have likewise found that custom foot orthoses can be very helpful at treating the pain and disability of PFPS in both recreational and competitive athletes. In nearly all cases of PFPS, clinical examination shows increased STJ pronation and decreased medial longitudinal arch height noted during walking and running. Also, if the PFPS is unilateral, the lower extremity with PFPS is nearly always the same extremity with increased STJ pronation and a lower medial longitudinal arch height.

On their initial office visit, the patient with PFPS will be given an insole modification to decrease STJ pronation during running along with instructions on strengthening exercises for the medial quadriceps, hip abductors/external rotators and stretching exercises for the hamstrings. Assuming the patient has already purchased pre-made foot orthoses to treat their PFPS, a 3-6 mm adhesive felt medial arch addition and 3 mm adhesive felt varus forefoot extension is added to the plantar aspect of their orthosis on the initial office visit to simulate the biomechanical correction of a properly-made anti-pronation custom foot orthosis. Their running shoes are also checked for excessive wear and possible training errors are discussed with the patient, including suddenly increasing training mileage and intensity, changing shoes or changing running surfaces (Kirby KA, Valmassy RL: The runner-patient history: What to ask and why. JAPA, 73: 39-43, 1983).

If the PFPS symptoms do not significantly improve after their pre-made orthoses have been modified and their exercises have been started, full-length anti-pronation foot orthoses are then made for the patient. I will use either firm Plastazote or 3-4 mm polypropylene in the orthosis shell for the runner, with the Plastazote orthosis material reserved for runners under 180 pounds in weight. The orthoses are also balanced $3\text{-}5^0$ inverted, with a 2-4 mm medial heel skive, 16-18 mm heel cups, full length neoprene or EVA topcover and a $3\text{-}5^0$ Korex or EVA forefoot varus extension distal to the orthosis plate (Fig. 1). In runners over 180 lbs in weight, a 4 mm polypropylene shell is used due to its increased durability in heavier patients. In my clinical experience, the combination of properly-made anti-pronation full-length custom foot orthoses, knee and hip exercises, and proper running shoes will reduce or eliminate the pain from PFPS in over 90% of patients.

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