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Point/Counterpoint

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A Tale of Two Treatments for Patellofemoral Pain

CASE SCENARIO

A 23-year-old female competitive runner presents with bilateral retropatellar pain. She has been evaluated by a physician previously and diagnosed with patellofemoral pain (PFP). Treatment to date has included physical therapy, which has been focused on quadriceps strengthening and passive modalities. She reports the treatment to be of minimal benefit.

On examination, she has normal lower extremity alignment. Performing a single-leg squat reproduces her PFP. Her lumbar spine examination is unremarkable. Isolated hip abduction strength is 4/5 bilaterally, and the Ober test is negative.

When evaluated on a treadmill, she runs with a rearfoot strike (RFS) pattern. She has an upright running posture with no evidence of excessive hip adduction, hip internal rotation, or foot pronation. Her goal is to return to competitive running, including a marathon within the next year, and she currently runs in neutral shoes approximately 40 miles per week.

She has been reading of the benefits of minimalist footwear with transitioning to a forefoot strike (FFS) pattern and wants to know whether she should make this change. Dr Irene Davis will be arguing for modifying foot strike augmented by minimalist footwear. Dr Christopher Powers will be arguing for addressing hip mechanics using a trunk lean.

Irene Davis, PhD, PT, Responds

Running is an intrinsically repetitive activity, thus multiplying the risk for overuse injuries. Over the course of a running 1 mile, a runner strikes the ground approximately 1000 times per foot. At 20 miles per week, this accumulates to a million steps per year (or 2 million in this case, in which the patient was running 40 miles per week). Each single-leg landing averages 2-2.5 body weight of force, with loading rates typically in the 60-80 bodyweights per second range [1]. With the repetitive nature of running, even minor deviations in mechanics can result in overuse injuries over time.

Mechanics can be divided into faulty alignment (kinematics) and excessive forces (kinetics). The goal of every runner is optimizing kinematics and kinetics with each foot-strike. The most common malalignment associated with patellofemoral pain (PFP) is hip adduction [2]. This results in an exaggerated knee valgus alignment between the tibia and the femur, altering the patellofemoral contact profile and increasing contact pressures leading to pain. However, this runner did not present with any malalignments that needed to be addressed [3].

This individual is among the 95% of runners in modern cushioned shoes who land on their heels (RFS) [4]. RFS patterns are associated with an abrupt vertical impact force that is associated with significantly greater load rates compared with landing on the ball of the foot (FFS) [1]. Although these forces are best measured with the use of a force plate, this equipment is not readily available in clinical settings. However, a simple, inexpensive way to determine how hard one lands is to listen to the sound of the foot-strike while assessing running on a treadmill. Hard landings are associated with high load rates [5], which in turn have been related to running injuries [6]. This is especially true of those injuries that are more serious and have not responded to standard courses of physical therapy, as in the case presented here.

The most effective way to reduce vertical impact loading is to transition the runner to an FFS. Reducing

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impact loading through retraining has been shown to resolve injuries. A case series of patients with PFP reported a marked reduction in vertical load rates after transitioning to a FFS pattern [7]. A significant reduction in knee pain posttraining and at a 3-month follow-up also was found. In addition, a recent randomized controlled trial by Roper et al [8] involved transitioning runners with PFP to an FFS pattern. This resulted in reductions in knee pain from a VAS of 5.3 at baseline to a 1.0 posttraining and at the 1-month follow-up. These authors also reported a 50% reduction in patellofemoral contact stress posttraining, with a 62.5% reduction noted at the 1-month follow-up.

Contact stress is considered an important contributor to PFP and is related both the force as well as the area over which the force is distributed. In a FFS, the force in early stance is lower than a RFS due to the significantly lower rate of loading. In addition, an FFS is associated with greater knee flexion in early stance. This increases the patellofemoral contact area. A lower force distributed over a larger area results in a reduced contact stress. This is likely due to the lower force at the knee in early stance and greater knee flexion (thus greater PFJ contact area) at footstrike that is noted with a FFS pattern. Contact stress is considered an important contributor to PFP. Therefore, I would recommend a transition to a FFS pattern for this patient to optimally reduce her impacts and resolve her pain.

Running with a FFS is likely the most natural pattern, as habitual barefoot runners land this way. Our barefoot ancestors likely ran with a FFS pattern as landing on one's heel without cushioning is painful. Cushioning has only been added to the running shoe in the past 50 years [9], and the introduction of the cushioned shoe has promoted a RFS pattern that now is prevalent in 95% of traditionally shod runners [4]. Therefore, most runners need to go through a transition to run with a FFS pattern. This change alters the demands on the lower extremity by reducing the load to the knee but increasing the load to the foot and ankle [10]. In particular, the calf muscles, posterior tibialis, and foot intrinsic muscles need to be fortified to reduce the chance of an injury occurring during the transition. These muscles all contribute to a healthy foot core, as described by McKeon et al [11]. Therefore, a foot and ankle—strengthening component should be included in any transition program to a FFS pattern. This should include static exercises, such as foot doming and single-leg heel raises, followed by more dynamic activities such as single-leg hopping, jump-roping, hopping off steps, hopping from foot-to-foot, all while maintaining the domed foot position. Range of motion deficits and tissue restrictions also should be addressed through manual and instrumented therapies.

Early in the foot-strengthening program, patients are instructed to purchase a pair of minimal running shoes of their choice. These shoes should be light, flexible, and have no cushioning (midsole) or arch support. Basically, these are shoes that protect the bottom of the feet and have an upper to hold the shoe onto the foot. Minimal shoes promote a FFS pattern and are associated with foot strengthening [12]. They also result in significantly lower impacts than running with a FFS pattern in traditional shoes [1]. In addition, they are beneficial during walking, as they encourage lighter landings along with also facilitating foot muscle strengthening and hypertrophy [13]. This helps to further prepare the patient for running in these shoes, when ready. For these reasons, we would also recommend the patient transition to minimal shoes.

Once the patient can perform their exercises with good foot positioning and can perform 30 full range of motion single-leg heel raises, run retraining can commence. It is important that she does not run outside of the clinic during this period, as this will reinforce her old running pattern while she is trying to develop a new one. Motor control principles suggest that when one is developing a new motor pattern, they should be provided with extrinsic feedback on a predetermined schedule [14]. This allows the learner to associate the correct movement pattern with their internal kinesthesia. The extrinsic feedback should then be removed gradually so that the learner can execute the motor pattern relying on their kinesthetic sense alone.

I have developed a retraining program that incorporates these motor control principles. It has been applied to a variety of gait deviations and resulted in resolution of symptoms [7,8,15]. The program is composed of 8 treadmill sessions conducted over 3 weeks. The patient begins with 10-15 minutes of running and increases to 30 minutes over the 8 sessions. She will be provided verbal and visual feedback regarding her footstrike pattern for the first 4 sessions. The feedback will be removed gradually over the last 4 sessions. The retraining will be conducted barefoot to optimize the sensory feedback on her landing pattern. Minimal footwear will be added during the last couple of sessions of run retraining to be sure that she can maintain proper footstrike mechanics with diminished sensory input.

After completing the retraining, the patient will be permitted to run outside. However, she will be instructed to start at 20 minutes and work up to 30 minutes again over the first 2 weeks without increasing speed. She will not be permitted to run consecutive days. These instructions are given because runners become excited about running outside and tend to outrun their capacity in their new pattern (in either distance or speed), increasing their risk for injury. The patient will then return for a 2-week follow-up at which time we will video her gait review exercises and answer any questions. At this point, she will be running 9-10