CONTINUING EDUCATION
for Physical Therapists

COMMON LOWER LEG OVERUSE INJURIES IN RUNNERS

2.5 CE HOURS

Course Abstract

Despite its popularity and positive impact on health, running comes with a host of associated injuries which may treated by physical therapists. This course focuses on recognizing and rehabilitating overuse injuries commonly experienced by runners of both sexes, of all ages, and of all levels of running experience.

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Approvals

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Target Audience & Prerequisites

PT, PTA – no prerequisites

Learning Objectives

By the end of this course, learners will:

- ❑ Distinguish between extrinsic and intrinsic risk factors to overuse injuries
- ❑ Associate biomechanics with the phases of a running cycle
- ❑ Distinguish between biomechanical issues associated with overpronation and underpronation
- ❑ Recall considerations pertaining to examining, choosing, and fitting running footwear
- ❑ Identify common overuse injuries
- ❑ Recognize statistics, causes/symptoms, and management/treatment options relating to overuse injuries

Timed Topic Outline

I. Introduction and Foot Biomechanics During Running (15 minutes)

Contact Phase, Midstance Phase, Propulsion Phase

II. Overpronation, Underpronation, and Running Footwear (20 minutes)

III. Overuse Injuries and Syndromes (100 minutes)

Plantar fasciitis; Achilles tendinopathy (Achilles tendonitis); Posterior tibial tendon dysfunction/tendonitis; Patellofemoral pain syndrome; Metatarsalgia; Medial tibial stress syndrome; Iliotibial band syndrome

IV. References and Exam (15 minutes)

Delivery Method

Correspondence/internet self-study with a provider-graded multiple choice final exam. *To earn continuing education credit for this course, you must achieve a passing score of 80% on the final exam.*

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Course Author Bio and Disclosure

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DISCLOSURE: Financial – Jeffrey Larson receives a consulting fee as an author of continuing medical education for Northern Medical Informatics, and received a stipend as the author of this course. Nonfinancial – No relevant nonfinancial relationship exists.

INTRODUCTION

In line with a general increase in physical activity over the last three decades, the popularity of running has also escalated, placing it among the most popular sports: in the US alone, more than 40,000,000 people run on a regular basis (Videbæk 2015). But despite its demonstrated positive effects on the body's cardiovascular system, general health, and well-being, running also comes with a host of associated injuries treated by the physical therapist. Determining the exact number of injuries is difficult because different studies have provided results from using different measures of the prevalence and incidence. In a review from 2012 by Lopes et al. a large variation in incidence rates of injury per 1000 hours of running was reported: between 6.8 –59. This was explained by the potential difference in the subject's characteristics, as well as the definitions of running-related musculoskeletal injuries (RRMIs), which differ between studies. Researchers emphasize that standardization of the number of injuries per hour of exposure is highly needed in running-related injury research (Lopes, 2015).

Serious and recreational runners alike experience firsthand the high demands placed upon the lower extremities as the foot hits the ground. Taunton et al conducted a study of more than 2,000 individuals who attributed their injuries to running. It was found that injuries to the foot, ankle and lower leg were second in frequency only to the knee comprising almost 40% of all reported injuries. Such lower leg injuries seen in runners are mainly the result of repeated low-intensity mechanical overloads which characterize overuse injuries (Greve, 2015).

This course will focus on recognizing and rehabilitating overuse injuries commonly experienced by runners of both sexes, of all ages, and of all levels of running experience.

Overuse injuries have a multifactorial etiology, with contributing factors being intrinsic or extrinsic.

Extrinsic risk factors are defined as influences applied to the runner which may potentially increase the risk of injury. These factors may include training methods, equipment, and even the environment, as all may affect the amount of stress or force applied to the body. Training regimes are a primary example of such risks, and are a major potential link in the mechanism of overuse injuries.

Paterno et al refer to a study in which three scenarios were identified that can increase an individual's likelihood of developing an overuse injury. The first addresses the runner who attempts to rapidly increase his or her training load after a period of inactivity or decreased activity. In this situation, the body has an insufficient adaptation period to respond to a higher level of stress, and therefore is not adequately prepared to dissipate repetitive forces. Supporting this theory of overuse injuries are numerous investigations involving the frequency of stress fractures during the initial stages of training in the military. A second category includes runners who attempt to participate at a level which exceeds their individual skill. In this case the discrepancy of an individual's skill or fitness level to imposed stress and physical demands is speculated to potentially result in tissue breakdown. The third situation involves a continuous participation at an exceptionally high level. Here the runners in this group may suffer from excessive micro trauma over time with insufficient rest, eventually leading to tissue breakdown. Although current evidence is sparse, another population of runners thought to be included in this third high risk category are those who continuously participate in sports without rest or who specialize in one sport throughout the year (Paterno 2013).

Intrinsic factors, on the other hand, are those factors categorized as unique to the individual which may increase the likelihood of sustaining an injury. Maturity status, body mass index (BMI), gender, anatomic variations, and biomechanical movement patterns are all examples of intrinsic risk factors. Theoretically, these factors can affect the ability of the runner's tissue to respond to stress. Specific intrinsic risk factors, such as BMI, strength deficits, or altered movement patterns, are considered modifiable risk factors, which have the potential to improve with an injury prevention intervention (Paterno 2013).

To address and treat either intrinsic or extrinsic factors leading to overuse injuries of the lower extremity, it becomes essential that rehabilitative clinicians have a thorough understanding of the biomechanics of the foot during running.

FOOT BIOMECHANICS DURING RUNNING

Whether watching an experienced marathon runner or a recreational jogger, biomechanics of the foot during running appear smooth, fluid, and effortless. However, when a runner's foot hits the ground the feet and legs undergo stress resulting from the weight-bearing or stance portion of the running cycle. The clinician's increased understanding of the biomechanics of running has implications for the prevention of foot injuries.

The clinician will need to consider both functional and non-functional biomechanics during an initial evaluation. Functional biomechanics refers to joint motion and reactions during the gait cycle whereas nonfunctional biomechanics is the stationary observation of the joints involved with the gait cycle. Although functional biomechanical findings are more accurate predictors of injury than static findings, a correlation between the two is essential.

Clinicians who analyze and treat this population know very well that a runner's contact with the ground is brief yet during this short period of weight bearing, the foot makes a series of complex adaptations to the surface. While the breakdown of a gait analysis may vary somewhat among clinicians, the running cycle is commonly simplified by effectively subdividing into three phases known as contact, midstance, and propulsion.

Contact Phase

The contact phase with the ground translates the impact force through the foot on each step. In a walking gait, the heel strikes the ground first – this is referred to as heel strike. However, a running gait involves landing farther forward on the foot, resulting in a midfoot strike; as running speed increases – as in sprinting, for instance – the frequency of forefoot strike increases. While impact forces during walking are relatively minor, heel striking while running can cause significant loss of energy, stressing the overall mechanics of the foot, ankle, leg, and many body areas above the lower extremity. Mid- or forefoot running, in contrast, is associated with a more optimal gait that's usually not impact impaired.

(Note: Impact force is often seen as a negative aspect of running, associated with trauma and injury, but humans have evolved an effective gait mechanism: proper running gait compensates well for impact force. In fact, a proper gait is potentially related to better bone density, improved muscle and tendon function, better circulation, and other health benefits associated with exercise.)

When observing the beginning of the contact phase in more detail, it becomes evident that most runners strike the ground on the outside of their foot. This is because anatomically, the hips are wider than the distance between the feet as one runs, so the foot must strike the ground at an angle on the outside of the heel. Shortly thereafter, because the foot cannot support the body's weight at that initial angle, it will either roll outward or inward. For proper contact phase to occur, a normal subtalar joint is required and is a critical component of normal foot function producing supination and pronation. During this portion of the phase, the foot is pronating at the subtalar joint. Simultaneously, the tibia is internally rotating and the foot is absorbing shock, helping it adapt to the ground surface. A normal foot will pronate until the foot rests flat on the ground. (This is in contrast to the foot continuing to supinate without stopping, resulting in an inversion sprain.)

Midstance Phase

In the next phase, midstance, the foot must roll inward or pronate four or five degrees to allow it to completely contact the ground and support the body's entire weight (those runners who are insufficient in this motion, whose feet are unable to reach a flat position, often succumb to chronic ankle sprains). Rolling into pronation also mobilizes the tarsal bones and joints of the foot, altering the foot's alignment to a more flexible position. This allows it to better adapt to a rough or uneven ground surface, and to proprioceptive changes, helping to maintain balance and provide increased shock absorption.

Propulsion Phase

Propulsion, also known to clinicians as toe-off, results as the foot performs as a rigid lever and accepts body weight and pushes the runner forward. Propulsion of the foot is performed by rolling back toward the outside, causing the joints and bones to lock up. This motion is sometimes referred to as re-supination with respect to the initial contact with the ground also in a supinated position. Re-supination has exactly the opposite effect of pronation as it makes the foot rigid and ready for propulsion. Propulsion begins after the runner's heel leaves the surface and finishes with the toe leaving the ground surface. The subtalar joint must be in a supinated position in order for this phase to be normal and efficient. If abnormal pronation is occurring, the midstance phase and the propulsion phase will possibly be prolonged and weight transfer through the forefoot will not be normal (Norkin, 1992).

Compared to other gait analyses available to the clinician, this is a simplistic view of the foot during the weight-bearing portion of running. Yet one can still appreciate that any biomechanical imperfections and/or malalignment can have a significant impact on not only the foot, but other areas such as the knee, hip, and back. In general, when a runner's foot is on the ground, any motion occurring in one portion of the limb affects all other parts. A rotation inward of the tibia will cause the foot to pronate about the subtalar joint. Similarly, any pronation of the foot will cause the tibia, femur, and the entire leg to follow, rotating inward.

THE ROLE OF OVERPRONATION AND UNDERPRONATION IN OVERUSE INJURIES

At the subtalar joint, primary functions of supination and pronation are seen as interdependent in regards to the biomechanics of the remainder of the lower extremity. Subtalar pronation in weight bearing movement is accomplished by eversion of the calcaneus and plantar flexion and adduction of the talus. During running, the motion from this joint absorbs the compulsory lower extremity rotations that would otherwise either spin the foot on the ground or disrupt the ankle joint by rotating the mortise around a fixed talus.

As a result, there is a direct relationship between the degree of pronation and internal tibial rotation.

Pronation is a necessary – and a protective – mechanism during running, allowing impact forces to be reduced over a long period. Researchers have even suggested that a higher level of pronation is favorable during running, if it falls within normal physiological limits and does not continue beyond midstance.

OVERPRONATION

Excessive foot motion is seen in the runner who over pronates, resulting in excessive strain placed upon the lower leg muscles in an effort to stabilize hypermobility of the foot. Active individuals with this problem experience difficulty with the foot not having ample time to re-supinate adequately, leaving it more likely to be unstable at a time when it should be stable. This excessive pronation and hypermobility of the subtalar joint produces a significant amount of jarring to the bones of the foot and is a major cause of forefoot stress and other related problems for the runner. Some of the more common conditions seen by the clinician resulting from overpronation and discussed further in this course are plantar fasciitis, metatarsalgia and posterior tibial tendon tendonitis.

Excessive pronation of the foot also produces an excess torque of the knee. During overpronation, the runner's lower leg muscles attempt to stabilize the lower leg while undergoing a significant amount of strain. This results in the knee rotating in approximately the same number of degrees as pronation. The increase in internal rotation of the leg increases the Q angle and can contribute to lateral subluxation of the kneecap. This may result in cartilage deterioration, usually occurring on the medial aspect of the kneecap and is referred to as chondromalacia or runner's knee.

Another related knee condition that can be produced by excessive pronation and is discussed later in the course in more detail is iliotibial band syndrome. Because of the iliotibial band's attachment to the front and outside portions of the leg, this structure provides lateral stability to the knee resisting internal rotation of the lower leg. The more control needed for excess internal rotation of the lower leg from overpronation, the more strain placed upon the iliotibial band. The pain caused by the strained iliotibial band usually occurs at the head of the fibula where an attempt to resist excess motion pulls on the biceps femoris muscle. Clinicians should be cognizant of the stresses resulting from circular track running as it may contribute to this problem, since it stresses the body in a manner similar to that of crowned running surfaces and leg length differences. A change in training also frequently contributes to this problem making it necessary to inspect a runner's training program and determine what alterations have recently occurred.

UNDERPRONATION

Runners who underpronate in weightbearing have the opposite biomechanical tendencies seen with those exhibiting overpronation. Once the foot strikes the ground, the runner's subtalar joint does not have adequate eversion of the calcaneous and plantar flexion and adduction of the talus inward. Because of this insufficient motion the shock absorption effect of the lower extremity cannot perform as well. Runners with high-arched feet produce a smaller amount of motion and experience more shock-producing forces as the foot hits the ground. This increased shock radiates straight up the leg into the shin, knee, and hip.

Females have been documented to be three times more likely to develop hip and groin pain from running than men, primarily because of their broader pelvis. Not only are the leg bones at different angles initially but the angle of the leg when hitting the ground is greater and the foot must pronate inward even more. This is additionally aggravated when the female runner demonstrates inadequate pronation, which translates the forces into the hip and groin.

Examining the runner's shoes should be one of the clinician's first observations if suspecting a structural problem from either over or underpronation. Any overpronation or collapsing of the arch tends to excessively wear out the shoe under the big toe. In the runner with a high arch, it is common to see excessive shoe wear at the outside edge of the toe end of the shoe. This is the runner who cannot get the foot totally flat on the ground and produces more weight bearing on the outside edge of the entire foot.

RUNNING FOOTWEAR AND OVERUSE INJURIES: PREVENTION OR CURE?

Before moving on to an examination of specific overuse injuries, let's talk briefly about running footwear in the context of *preventing* them (its role in treating them will be discussed in the context of each condition).

Running footwear designs have experienced dramatic technical and engineering advances, and in response, the scientific literature has given considerable attention to footwear – particularly that which has been promoted by the running shoe industry as high-tech protection against overuse injuries. The shock-absorbing qualities of a running shoe are proposed as being particularly important, since they influence repetitive impact forces that could be responsible for microtrauma and overuse injuries (Nigg, 2015).

Yet, studies conflict as to what degree running shoes actually play a role in overuse injuries.

Many studies have focused on shoes and running overuse injury risk factors, but the knowledge of specific injury causes is still limited. Within a large-scale randomized controlled trial on 1200 Air Force recruits, Withnall et al investigated whether the use of shock-absorbing insoles would be beneficial in reducing lower limb repetitive injures. The study shoes were derived from an existing model that came in two versions, one with a more compliant midsole, termed soft study shoes (soft-SS), and one with a stiffer midsole, termed hard study shoes (hard-SS). Other than the midsole hardness, the two shoe versions were strictly identical. Within the study conditions, midsole hardness of modern cushioned shoes did not influence running-related injury (RRI) risk. However the authors did find previous injury was one of the factors that are most consistently associated with increased RRI risk. Individuals were also found to be a higher risk if they have a greater body mass index, engage newly into running activity or train at high intensities (Nigg, 2015).

It's recently been proposed that minimalist running shoes, one of the latest trends in running footwear, can strengthen the intrinsic foot muscles that are less active when wearing traditional running shoes. The result is thought to be a higher arch, helping reduce knee, soft tissue, and related injuries. One study looked at determining intrinsic muscle strength using minimalist and traditional footwear by measuring arch height. The researchers measured arch height before and after 10 weeks of transitioning to minimalist running shoes. The researchers noted no difference in arch height after the 10 weeks in either group, concluding that the effect of minimalist running shoes on arch height and/or injury rates is either negligible or requires a longer exposure time for significant effects. The authors of the study concluded the study creates an opportunity for future research on this topic and that currently there are no suggested guidelines for transitioning to minimalist running shoes (or barefoot running) (Ridge, 2013).

In general, researchers and medical professionals recommend a running shoe which provides the best foot and arch support as possible.

EXAMINING AND FITTING RUNNING FOOTWEAR

Pursuant to providing the best foot and arch support possible, the American Orthopaedic Foot and Ankle Society provides the following recommendations for getting a good shoe fit:

- Have feet measured when largest such as at the end of the day or after a run, walk, game, or practice.
- Wear workout socks.
- Have both feet measured.
- Try on the shoes as sizes vary by manufacturer.
- Make sure both shoes fit.
- Ensure that the shoe provides at least one thumb's width of space from the longest toe to the end of the toe box.

(The American Orthopaedic Foot and Ankle Society, 2015)

They further describe the characteristics of a good, safe running shoe as including a minimal heel-to-toe drop: this feature is the difference in the thickness of the heel cushion to the thickness in the forefoot cushion area. Shoes with minimal, or without any, drop (6mm or less) are the best choice for allowing the foot to normally support loading during each gait cycle. Ideally, the shoe should also be neutral, or contain no motion control or stability components – these interfere with normal foot motion during weight bearing. Finally, the shoe should also be light in weight: optimally 10 ounces or less for a men's size 9 and 8 ounces or less for a women's size 8.

Similarly, the American College of Sports Medicine describes the characteristics of a shoe to avoid. They, too, caution against shoes that have a high heel cushion and low forefoot cushion (often depicted as a "high profile shoe") which produce a high heel-to-toe-drop. In addition, they discourage the use of shoes with high, thick cushioning overall, as they may actually encourage runners to adopt poor biomechanics and land with greater impact than shoes with less cushioning.

(American College of Sports Medicine, 2014)

Normal wear of the runner's shoe should be seen at the center and outside edge of the heel; wear that should be even across the entire ball of the foot.

OVERUSE INJURIES AND SYNDROMES

Whether attempting to choose correct footwear, or selecting a range of stretching/ strengthening exercises to prevent and/or treat an overuse injury, it is important that the clinician has a thorough understanding of both the specific condition and its related anatomic structures. Following are several of the common overuse injuries resulting from running that physical therapists assess and treat.

PLANTAR FASCIITIS

The plantar fascia is a thick band of fibers originating from the base of the calcaneus to the metatarsal heads. While it is composed of several branches which may become injured, the most common area of the plantar fascia that is affected is the very base of the innermost bundle of fibers, right at the base of the calcaneus.

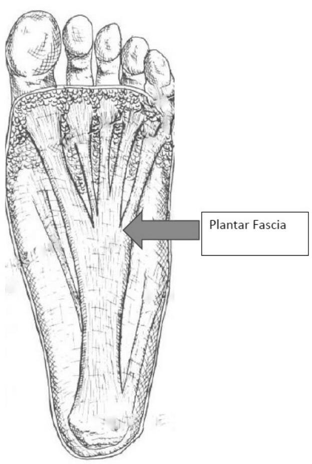
Plantar fasciitis, the result of an irritation to this tough, fibrous tissue, is common among runners of all ability levels and accounts for approximately eight percent of all running injuries (Nielsen, 2013). Due to its chronic nature, it is one of the most bothersome running injuries: some runners with plantar fasciitis have discomfort for months or even years before the fascia finally heals.

Causes, Signs, and Symptoms of Plantar Fasciitis

Unfortunately, the root causes of plantar fasciitis are still not fully understood, but a few potential contributors have been identified.

Some studies have found a connection between reduced ankle range of motion and plantar fasciitis, especially in dorsiflexion, suggesting that calf tightness plays a role in the development of plantar fasciitis (Nielsen, 2013). Anatomically the plantar fascia is a continuation of the Achilles tendon, which anchors the gastrocsoleus muscles to the calcaneus; a tight gastrocsoleus complex potentially places excessive tension on the plantar fascia.

Overpronation is also thought to be one of the leading causes of plantar fasciitis. Common throughout the demands of walking and running, excessive pronation causes the runner's arch to decrease or "collapse" upon weightbearing. This causes the broad band of fibrous tissue running along the bottom surface of the foot to stretch and/or tear away from the heel bone, resulting in pain and inflammation.



Other factors that may contribute to plantar fasciitis and heel spurs include dramatic increases in training intensity or duration, and a change of walking or running (Sho, 2012).

When diagnosing plantar fasciitis, it is important for the clinician to ascertain when the pain occurs: pain from plantar fasciitis will be most intense at the beginning of a run, but will gradually decrease as tissues are stretched. Pain can return again at the end of the run, and runners may complain of arch or heel pain after a long day on their feet, especially in hard or uncomfortable shoes. Pain can be also associated with swelling and is especially noticeable during push off during the propulsion phase of walking and running. When the plantar fascia is excessively stretched over a period of time, heel spurs very sensitive to pressure can develop.

Footwear examination is important for evaluating runners with heel pain and plantar fasciitis: it is well known that recent trends in athletic footwear have actually increased the frequency of plantar fasciitis due to the fact that running shoes have weaker midsoles with newer designs. The popular "two-piece" outsoles with an exposed midsole cause a hinge effect across the midfoot placing excessive strain on the plantar fascia in running.

Treatment and Management of Plantar Fasciitis

Since, as previously mentioned, footwear may be a contributing factor, it can also be utilized as a powerful treatment modality. Runners should be placed into shoes that have a minimal 1" heel height with a strong stable midfoot shank and relatively uninhibited forefoot flexibility. The American Academy of Podiatric Sports Medicine has a list of recommended footwear for the athlete that can be obtained on their website: www.aapsm.org and at http://www.aapsm.org/plantar_fasciitis.html#sthash.QyLn9Sfh.dpuf

Initially, various forms of cryotherapy can be used to help control pain and inflammation; to aid in achieving functional outcomes, other modalities – such as ultrasound and iontophoresis – are commonly also used.

> Although the literature on ultrasound and plantar fasciitis is limited, a study by Wong et al found that a survey of physical therapists with the OCS designation practicing in the Northeast and Mid-Atlantic region of the United States regularly use ultrasound and believe the modality is clinically important for managing selected musculoskeletal impairments. In this study, the 3 most common impairments that ultrasound was used to manage were soft tissue inflammation (83.6%), tissue extensibility (70.9%), and scar tissue remodeling (68.8%). All of these impairments can be observed as impairments seen in plantar fasciitis (Wong et al, 2007).

-One study found that the use of iontophoresis resulted in significant improvement after two weeks but no long-term differences at six weeks. The major disadvantages of iontophoresis are cost and time because, to be effective, it must be administered by an athletic trainer or physical therapist at least two to three times per week (Young, 2001).

Instruction on stretching exercises of the plantar fascia, gastrocnemius and soleus muscles is a critical component of the treatment plan to help increase flexibility of the fibrous tissue. In one study, 83 percent of patients involved in stretching programs were successfully treated, and 29 percent of patients in the study cited stretching as the treatment that had helped the most compared with use of orthotics, nonsteroidal anti-inflammatory drugs (NSAIDs), ice, steroid injection, heat, heel cups, night splints, walking, plantar strapping and shoe changes (Young, 2001).

There are a number of ways to stretch the plantar fascia and the Achilles tendon. For patients who report that the most severe symptoms occur with the first steps after awakening, stretches should be performed before the patient even gets out of bed. Upon awakening, the patient can stretch the plantar fascia by using a towel to cause passive dorsiflexion of the ankle: with each hand pulling one end of the towel, use the midportion of the towel to pull on the plantar aspect of the forefoot region.

Plantar fascia stretch with towel

Passive stretching of the plantar fascia also can be achieved by using one hand at the plantar aspect of the forefoot region, then dorsiflexing the foot. Other effective techniques include use of a slant board or placing a two-inch × four-inch piece of wood in areas where the patient stands for a prolonged time (such as workplace, office, kitchen etc.) to use in stretching the gastrocsoleus complex (Mohammad, 2012).

Additional plantar fascia stretches

A study by DiGiovanni and other researchers compared the results of a non–weight-bearing stretching exercise program specific to the plantar fascia to the standard program of weight-bearing Achilles tendon-stretching. One hundred and one patients who had chronic proximal plantar fasciitis for at least ten months were randomized and instructed into one of two treatment groups either a plantar fascia tissue-stretching program or an Achilles tendon-stretching program. The patients were reevaluated after eight week and completed the pain subscale of the Foot Function Index and a subject-relevant outcome survey that related to pain, function, and satisfaction with treatment outcome. The researchers found the pain subscale scores of the Foot Function Index indicated significantly better results for the patients managed with the plantar fascia-stretching program (DiGiovanni, 2003).

Another study by Sharma and Loudon looked at the effectiveness of static brace stretching compared to active stretching programs. The researchers used a randomized, single-blinded trial consisting of thirteen subjects with plantar fasciitis. The individuals were randomly grouped to either an exercise group with static stretches or a brace group using a static progressive stretch. Both groups also received a basic off-the-shelf foot orthoses and each person had an 8-week treatment period and 1-month follow up. Pain and functional limitations were evaluated with the Foot Functional Index pain subscale, the American Orthopaedic Foot and Ankle Society Ankle-Hindfoot Scale, and measurement of the great toe extension motion (an indicator of fascia tightness). Overall pain and functional rating improved in both groups. No changes were found in either group with great toe extension range of motion. The researchers concluded that both static exercise and brace stretching were beneficial for treating pain and functional limitations, and also suggested that static progressive stretch brace is an effective alternative option to static stretching exercises for people with plantar fasciitis (Sharma, 2010).

Soft tissue mobilization by manipulating the fascia (also referred to as dynamic stretching) is a popular approach: runners are shown how to use a golf ball or other hard, round object, to "roll out" the fascia. The plantar fascia also can be mobilized and stretched by instructing a seated patient seated to roll a cold soda can or bottle between the sole of his/her foot and the floor. In this technique the cold can or bottle of soda may provide additional symptomatic relief through local cooling.


Soft tissue mobilization of plantar fascia

Strengthening programs have been cited as a helpful treatment compared with other exercise, night splints, orthotics, heel cups, NSAIDs, steroid injection or surgery. Strengthening programs should focus on intrinsic muscles of the foot: examples are towel curls, toe taps, and picking up marbles and coins. Towel curls are performed by instructing the seated patient to have their foot flat on the end of a towel which is placed on a smooth surface. Keeping the heel on the floor, the patient then pulls the towel toward their body by curling the towel with the toes. To do toe taps, all the toes are lifted off the floor and, keeping the heel on the floor and the outside four toes in the air, the big toe is tapped to the floor repetitively. Next, the process is reversed, and the outside four toes are repetitively tapped to the floor while keeping the big toe in the air (Young, 2001).

Injections of corticosteroids are a common second-line treatment used by podiatrists. While some research has shown that they may help other experts have urged caution, since the success rate is fairly low and there is a risk of complete rupture of the plantar fascia. The application of a corticosteroid like dexamethasone through iontophoresis lowers the risk of this complication.

A major goal of treatment should be to protect the plantar fascia from additional strain while it is injured. Night splints can be very helpful in this regard, as can taping: several studies support arch taping, such as the "low-Dye taping" proposed by Ralph W. Dye. There are several ways clinicians can perform this technique; however, even its most basic form is can be effective (Podolsky, 2014).

Educating the runner is key to recovery: avoiding running on hard or uneven surfaces until the symptoms become manageable, wearing shoes with a cushioned heel to absorb shock, and elevating the heel with the use of a heel cup to reduce the amount of shock and shear forces placed during athletics and everyday activities are all standard pieces of advice.

How quickly the clinician should advise returning to running depends on the severity of the plantar fasciitis and how efficient the healing process. Some runners find that they can work their way back into running even while some residual arch stiffness persists, but if running is making the arch pain worse, the runner should allow more time off and more time for the rehab program to do its job. As the individual returns to running, the clinician can advise the runner to consider increasing stride frequency by approximately 10% to reduce the impact loading rate. The runner needs to remain compliant with stretching to help prevent any future episodes of plantar fasciitis.

ACHILLES TENDINOPATHY (TENDONITIS)

Achilles tendinopathy, also referred to as Achilles tendonitis (AT), is the inflammation and/or degenerative change of the Achilles tendon. AT is a clinical diagnosis characterized by symptoms of the involved tendon and further divided into a tendonitis or tendinosis based on examination.

Achilles tendinopathies commonly occur at the mid-portion of the tendon where the cross-sectional area is smallest and also where collagen fibers from the soleus, medial gastrocnemius and lateral gastrocnemius come together at this portion of the tendon. Another common site is where the tendon inserts onto the calcaneus.

Significantly more males than females develop AT, and the injury rate seems to rise with increasing age and increasing running experience. One study found that the middle to long distance running population were at higher risk of Achilles injuries and that athletes who had experienced Achilles injuries had more ongoing orthopedic issues later in life (Lorimer, 2014). In another instance, Nielsen and fellow researchers participated in a clinical commentary presenting a theoretical framework for the assumption that some running-related injuries among rear-foot strikers develop due to rapidly changing running volume, while others develop due to rapidly changing running pace. They found previous studies showing that runners with AT had trained at a higher average training pace before injury onset than healthy controls. No differences in average weekly running volume were found between groups (Nielsen, 2013).

Causes, Signs, and Symptoms of Achilles Tendonitis

During the contact phase of the running cycle forces are transferred up the kinetic chain by way of the joints. At the foot, forces are transferred through the ankle to the shank structures, particularly the Achilles tendon and calf muscles, and the tendon stretches, storing potential energy returned in the second half of the stance. The Achilles is intrinsically linked to the direct muscle actions of the gastrocnemius and soleus and joint movements of the ankle and foot.

As a soft tissue structure encountering forces early in the absorption process, the Achilles tendon is subject to high loads – up to six times body weight.

Achilles overuse injuries are likely to be multifactorial in nature, resulting from a combination of risk factors rather than one specific issue. A number of extrinsic and intrinsic risk factors have been identified for running-related Achilles injuries, including demographic, training, environmental, static alignment, strength, joint motion and ground reaction forces. Any excessive collapse of the arch from overpronation adds a great amount of stress upon the foot and in this particular condition. This is further aggravated by activities repeatedly placing stress on the tendon. As a common problem experienced by distance runners, overpronation causing the stress and pain of the Achilles tendonitis can develop gradually without a history of trauma and is often described by the individual as intense shooting or burning.

AT causes disability and compromised sport performance, with pain typically located 2 to 6 cm proximal to the insertion of the tendon – this is the area where the fibers from the gastrocnemius and the soleus (calf muscles) weave together to form the substance of the tendon. It has been hypothesized that the triceps surae undergo quicker muscle tension alternations as the tibia rotates over the foot during stance and then shortens during the forward propulsion phase. The Achilles tendon would therefore be prone to develop microtears as pace increased. Based upon this, researchers also hypothesized that the triceps surae undergo quicker muscle tension alternations as the tibia rotates over the foot during stance and then shortens during the forward propulsion phase. Also, since elite runners train at faster paces, it has been documented that this population of runners could be more likely to develop AT than recreational runners (Nielsen, 2013).

The symptoms are usually eased with rest, and are at their worst at the start of exercise or on rising from rest, although as the condition progresses pain may be felt throughout exercise. Resisted plantarflexion and passive dorsiflexion at the ankle typically worsen the pain, making it difficult for the patient to stand on tiptoe or ascend and descend stairs (Burbidge, 2008).

In the acute phase, edema, reduced ankle dorsiflexion, and tenderness will be present and crepitus felt in the tendon. Literature states that when gently squeezing or palpating the tendon while the patient actively plantarflexes and dorsiflexes the foot, the examiner's fingers feel the crepitus as an area of sponginess, similar to what one would expect with wet leather (Burbidge, 2008).

Once the injury progresses to the chronic phase the crepitus reduces. A tender nodular swelling is usually present in chronic cases and is believed to signify tendonosis. It can be difficult to identify the location of the swelling. The painful arc test can aid in determining its exact location. As the foot is moved through full dorsiflexion to full plantarflexion, see if the swelling remains fixed in reference to the malleoli. If this is the case, the swelling is contained within the paratendon and you are dealing with paratendonitis. However, if the swelling moves proximal and distal with reference to the medial and lateral malleoli, this is a sign of tendinitis or tendinosis.

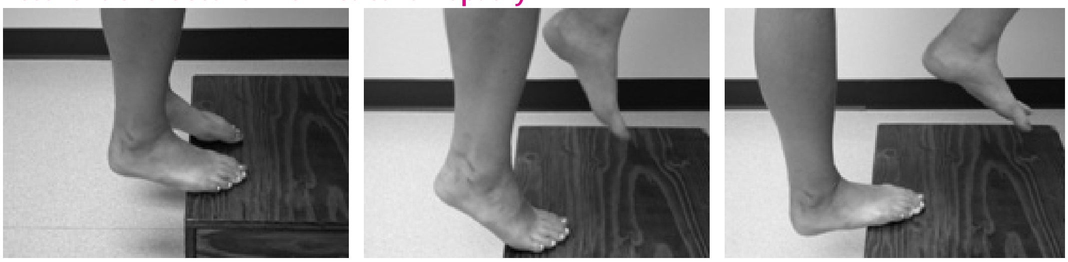
Treatment and Management of Achilles Tendonitis

Achilles tendonitis becomes a difficult injury to treat in some runners due to their high level of activity and reluctance to stop or slow down their training. The therapist needs to be mindful of, and to convey that, the Achilles tendon may be permanently weakened, or even ruptured, if the condition is left untreated.

While the literature is inconsistent as far as tactics for helping patients achieve long-term return to function, similar modalities as those used to treat plantar fasciitis – such as ultrasound, electrical stimulation, iontophoresis – are used to reduce the inflammation characteristic to Achillies tendonitis. Modalities are commonly used in conjunction with a good thorough stretching program to properly warm up key muscles such as the quadriceps and hamstring muscles, with additional emphasis placed upon the gastrocnemius and soleus muscles. Some therapists will also choose various manual approaches such as deep friction massage to address scar tissue formation and to help promote the healing process.

The most common conservative approach to the treatment of Achilles injuries is eccentric loading; therefore, strength deficiencies have been hypothesized to be involved in the pathomechanics. Improving both eccentric and concentric strength in the runner utilizing functional movement patterns and typical running muscle lengths may assist in rehabilitation and prevention of relapse. Good-quality randomized controlled trials indicate that eccentric strengthening programs provide 60 to 90 percent improvement in pain and function (Childress, 2013). The basic protocol for eccentric rehabilitation of the Achilles tendon is detailed and demonstrated below:

Eccentric exercises for Achilles tendinopathy



Three sets of 15 exercises, twice daily (total of 90 repetitions). Use same weight for first 1 to 2 weeks to achieve relative comfort with recommended daily frequency, then add weight (e.g., loaded backpacks, weighted vests) as comfort allows. Typical regimens last 12 weeks. Goal is a return to pain-free function with provocative activities, such as running.

Orthotic intervention is a consideration for athletes with low arches to assist in supporting the structures of the feet, and potentially reduce stress and strain to structures further up the lower-limb kinetic chain. Heel lifts are helpful because they can move the heel away from the back of the shoe, where rubbing can occur, and take some strain off the tendon (Kadakia, 2010). Specific footwear can also be helpful in treating Achilles tendonitis: the American Academy of Orthopedic Surgeons (AAOS) recommends shoes that are softer at the back of the heel to reduce irritation of the tendon.

Runners who are recovering from Achilles tendon injuries should limit the amount of training they do on soft surfaces, such as a synthetic track or grass, and should not run on surfaces such as sand. Runners should further be advised about the risk associated with running endurance and recovery runs too close to race pace. Modifying pronation should be viewed with caution as the results are contradictory; however, retraining the gait pattern of runners who show large braking forces or rapid loading rates could be beneficial (Lorimer, 2011).

POSTERIOR TIBIAL TENDON DYSFUNCTION/TENDONITIS

Posterior tibial tendon dysfunction (PTTD) is a progressive and potentially debilitating condition that is estimated to affect nearly 5 million people in the United States (Rabbito, 2011). In its early stages, PTTD is a common running-related injury which may also be referred to as posterior tibial tendonitis. Although the conditions are actually separate in terms of a diagnosis, both posterior tibial tendon dysfunction and posterior tibial tendonitis are foot tendon conditions placing individuals (runners and nonrunners alike) at risk for tenosynovitis, partial tendon tears, or complete rupture of the tendon.

Similar to Achilles tendonitis and plantar fasciitis, posterior tibial tendonitis can afflict runners due to an inflammatory response at the tendon of the posterior tibialis muscle, which originates on the posterior aspect of the tibia and fibula. This muscle lies underneath the soleus muscle, which itself rests beneath the gastrocnemius. The tendon of the tibialis posterior muscle passes behind the medial malleolus and then inserts on the bottom surfaces of the navicular, cuboid cuneiform bones, and the second, third, and fourth metatarsals. The tibialis posterior muscle and its tendon also provide support for the arch of the foot.

Tendons can be slow to heal, as most of their nutritional support comes from synovial fluid produced by the outer lining of the tendon. There are also extremely small blood vessels that permeate the tendon sheath to reach the tendon. The area of the posterior tibial tendon just below or distal to the medial malleolous is an area of especially poor blood flow that intensifies the problem in this particular tendon.

Causes, Signs, and Symptoms of Posterior Tibial Tendon Dysfunction/Tendonitis

In general, tendons are susceptible to fatigue and failure at locations where they change direction.

In the case of the posterior tibial tendon, after the tendon comes downward medially to the ankle and follows a well-defined groove in the back of the tibia, it then takes a dramatic turn towards the arch of the foot. At this location where this tendon changes course, the tibia acts as a wedge: if the tendon is under conditions where significant load and repetitive stress are applied to the foot, this tendon responds by pulling upward and opposite of the forces pushing downward. Body weight also contributes to this opposing force on the tendon. If this tendon becomes inflamed and/or overstretched, the support for the arch of the foot is affected, leading to a condition referred to as progressive flatfoot: the tibia applies enough force to gradually eliminate the medial arch on the bottom of the foot.

PTTD can originally be caused by overpronation over long periods of time (which is actually the reason for the classification as a dysfunction). Overpronation in the runner causes the posterior tibialis muscle to become overused, along with the associated tendon becoming strained. Overpronation disrupts the tendon's function to support the arch properly and can result in heel pain, arch pain, and symptoms of plantar fasciitis which later can possibly produce heel spurs, and may eventually progress into posterior tibial tendonitis.

Another contributing factor to PTTD is the inflexibility of the gastrocsoleus muscle complex. This tightness forces the posterior tibial tendon to accept additional load during gait.

Although aging is not a cause of PTTD, it does contribute to this condition – the tendon becomes subject to degeneration because of wear and tear. Degeneration in the tendon usually presents as a loss of the normal arrangement of the tendon fibers. This disorder of fibers can cause other fibers to break, weakening the tendon. As the tendon tries to repair itself, thick scar tissue forms. If this process continues to the extent that a nodule forms within the tendon, producing a tendonosis, this area in the tendon becomes weaker than normal, increasing the potential for the possibility of tendon rupture.

A classification system developed by Johnson and Strom in 1989 describes the progression of tibialis posterior dysfunction, and also serves as a guide to management. In stage I dysfunction, the tendon is still intact and functioning, but it is inflamed. In stage II dysfunction, the tendon has become dysfunctional and the foot has developed acquired flatfoot, but the deformity can be passively correctable. (Stage I and II are more commonly seen in runners, as the progression of dysfunction eventually inhibits activities such as running.) In stage III dysfunction, the foot deformity has become fixed, and degenerative changes are seen in the subtalar joint. Stage IV dysfunction was later described as occurring when degenerative changes are also present in the ankle joint (Abousayed, 2015).

Runners and non-runners alike initially complain of intermittent pain which later becomes permanent and more severe upon weight bearing activities, especially while walking or running. Pain with or without swelling is described along the inside of the foot and ankle, in the area where the tendon lies. As the condition advances, pain can be also on the outside of the ankle: if the foot collapses, the heel bone may shift to a new position outwards, placing pressure on the outside ankle bone. Running and related activities will be painful and very difficult. Some individuals will even find walking or standing for a long time challenging.

The clinician can perform the single limb heel rise test: the patient is asked to stand on one leg and tiptoes, which requires a healthy posterior tibial tendon. A potential problem with the posterior tibial tendon is evident if he or she cannot stand on one leg and raise the heel.

Treatment and Management of Posterior Tibial Tendon Dysfunction /Tendonitis

Physical therapists should inform patients that they may need to reduce any activities that worsen the pain, such as running, until pain and inflammation begin to subside. Particularly if the patient is an avid runner, it is critical that he or she understands that decreasing or even stopping their running regime is the important initial step in treatment. Switching to low-impact exercise, such as biking, elliptical machines, or swimming, is helpful and generally tolerated by most patients.

Similar modalities as those used to treat other conditions of tendonitis, including ultrasound, electrical stimulation, and iontophoresis, are incorporated to reduce inflammation. These modalities are commonly used in conjunction with a good thorough stretching and strengthening program once pain and inflammation have subsided; including strengthening and stretching exercises with focus placed upon inversion and plantar flexion strengthening and overall lower leg flexibility can help reduce future strain on the medial aspect of the ankle. Variation in exercise routines is always good advice for conditions of posterior tibial tendonitis, as the variety will keep one set of muscles in the lower leg from being under continuous stress. However, literature is inconsistent as to the effectiveness of these modalities in helping patients achieve long-term return to function.

Management of PTTD is based on the stage and symptoms the individual is experiencing.

Conservative management is preferred for stages I and II, usually consisting of calf stretching, strengthening the posterior tibial tendon, and foot orthotics (patients with stage II receive treatment similar to stage I, but the individual may require a more rigid foot orthotic).

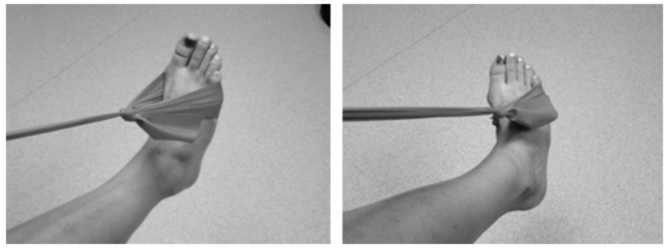
Most people can be helped with orthotics and braces in the treatment of PTTD: an over-the-counter orthotic may be sufficient for patients with a mild change in the shape of the arch and foot; a custom orthotic is required in patients who have moderate to severe changes in the shape of the arch and foot (the custom orthotic is more costly, but it allows the doctor to better control the position of the foot). (http://orthoinfo.aaos.org/topic.cfm?topic=A00166) In regards to footwear and PTTD, a shoe optimally should have a natural shape, contain sufficient room at the ends of the toes, and be flexible to allow for natural alignment and relative relaxation of the tibialis posterior muscle and tendon.

In addition, calf flexibility is important – as inadequate dorsiflexion may promote pronation and further stress to the tendon – and concentric and eccentric strengthening can be instructed by the physical therapist with focus on the posterior tibial tendon. For example, the posterior tibialis is preferentially recruited during a resisted foot adduction exercise in persons with pes planus; this muscle is selectively activated when flat-footed patients perform the exercise while wearing arch-supporting orthoses and shoes.

Kulig and a team of researchers examined the effectiveness of orthoses and resistance exercise in the early management of tibialis posterior tendinopathy. In this study thirty-six adults with stage I or II tibialis posterior tendinopathy were randomly assigned to 1 of 3 groups to complete a 12-week program. The first group was exposed to orthoses wear and stretching, the second to orthoses wear, stretching, and concentric progressive resistive exercise, the third to orthoses wear, stretching, and eccentric progressive resistive exercise. Pre-intervention and post-intervention data (Foot Functional Index, distance traveled in the 5-Minute Walk Test, and pain immediately after the 5-Minute Walk Test) were collected. The researchers found that adults with stage I and II tibialis posterior tendinopathy exhibited significant increases in function and reductions in pain after participation in a 3-month intervention program that emphasized education and the use of custom-made orthoses. Simultaneous involvement in exercise that specifically targeted the tibialis posterior tendon furthered the improvements (Kulig, 2009).

Another study investigated the differences in arch height, ankle muscle strength, and kinematic factors in individuals presenting with stage I PTTD in comparison to healthy individuals. Williams et al conducted a retrospective analysis of running injuries in runners with high and low plantar arch and reported that the low-arch group had a 3-fold higher incidence of stage I PTTD compared to the high-arch group. The results of the study suggested that runners with stage I PTTD are likely to present with normal inversion ankle muscle strength, significant differences in rearfoot pronation during walking gait, and no differences in foot posture as compared to healthy controls. The increased foot pronation is hypothesized to place greater strain on the posterior tibialis muscle, which may partially explain the progressive nature of this condition (Williams, 2015).

Stage III and IV individuals usually require surgery in order to fix the deformity.



Strengthening posterior tibialis using Theraband: plantar flexion and inversion

Strengthening toe flexors using towel: toe curls

PATELLOFEMORAL PAIN SYNDROME

The knee is a common site for overuse injury in runners, and the condition referred to as patellofemoral pain syndrome (PFPS) is one of the most common musculoskeletal disorders – it has been documented as the most frequent complaint of athletes who have knee problems. In a 2007 study by Wilson, a group of 2002 individuals with running injuries were reviewed, with patellofemoral pain syndrome found as the most common disorder comprising 17% of the cases.

It is described as an abnormality occurring with the tracking of the patella during knee flexion and extension: the repetitive contractions of the quadriceps femoris during running are thought to produce high compressive loads in the patellofemoral joint, increasing the likelihood of the development of patellofemoral syndrome. The most reported complaint is retropatellar pain or diffuse peripatellar pain during activities such as running (Clijsen, 2014).

Overuse syndromes such as patellar tendonitis and runner's knee are examples of diagnoses associated with patellar tracking problems. Runner's knee exists as tendonitis of the patellar or quadriceps tendon at either the inferior or superior pole of the patella; the condition is common among athletes with presenting symptoms of anterior knee pain after activity. Quadriceps tendonitis, which is the most common and represents 80% of all cases, occurs mainly in the older athlete; it is characterized by tenderness along the superior margin of the patella and pain upon resisted quadriceps contraction.

PFPS affects a wide range of age groups: while it frequently occurs in physically active individuals aged 15 to 30 years, the prevalence ranges from 21% to 45% in active adolescents and from 15% to 33% in adults and is higher in females than in males. Wilson concluded that females were at significantly higher risk of experiencing patellofemoral pain syndrome than men with a 62% vs.38% difference in incidence. It has been suggested that anatomic, hormonal, and neuromuscular factors contribute to this greater incidence in females (Wilson, 2007).

Causes, Signs, and Symptoms of Patellofemoral Pain Syndrome

A study of enrolled marathon runners concluded that participating in a marathon race for the first time, use of medication, and running few kilometers per week were considered to be risk factors for the development of patellofemoral syndrome (Lopez, 2012).

PFPS is often related to the patient's anatomical alignment and/or trauma to this particular joint. Hip abductor and external rotator muscles must act eccentrically to control or resist excessive femoral adduction and internal rotation during functional weight-bearing activities. Recently more attention has been placed upon the neuromuscular factor, with researchers looking at deficits in hip muscle strength.

> Dierks et al in 2008 compared hip abduction and external rotation isometric strength in runners with and without PFPS after a prolonged run. The authors concluded that runners with patellofemoral pain syndrome displayed weaker hip abductor muscles and demonstrated increased hip adduction during running, especially at the end of the run (Dieks, 2008).
>
> Baldon et al used a cross sectional study design to assess differences in eccentric hip muscle function in females with PFPS and compared the findings to a healthy control group which were all matched in regards to age, body type, body mass and height. Participants with patellofemoral pain syndrome exhibited less in hip abductor and adductor torque compared to the healthy aged-matched counterparts. The patellofemoral pain syndrome group showed 28% lower eccentric hip abductor torque and 14% lower eccentric hip adductor torque. In this particular study no differences were found between eccentric internal and external torque values (Baldon, 2009).

In a recent study by Powers it was suggested that poor hip adduction and internal rotation control during weight-bearing activities is related to PFPS in female athletes. This excessive femoral adduction and internal rotation produced a greater lateral displacement of the patella resulting in increased lateral patellar contact pressure (Powers, 2003).

Overuse syndromes causing chronic inflammation/tendonitis can also decrease the efficiency of the vastus medialis oblique (VMO) muscle as well as the quadriceps collectively.

Runners as well as non-runners are often unable to pinpoint the location of pain and typically describe discomfort as diffuse and poorly localized over the anterior aspect of the knee. Many patients report knee swelling and fullness, especially over the infrapatellar area. Knee buckling and/or episodes of instability are often noted with more pain upon descending stairs rather than ascending often due to pain inhibition of the quadriceps that is more notable with eccentric work of the quadriceps. Patients will sometimes report "locking" or "catching" yet this must be differentiated from the true mechanical block indicative of meniscal injury or loose intra-articular bodies. Because of the biomechanical component of this condition, bilateral pain is very common and should not be over looked in the treatment plan.

Examination may also include the presence of quadriceps atrophy and crepitus of the patellofemoral joint both actively and passively. This can be in conjunction with complaints of pain upon compression of the patella and pain on resisted knee extension.

Treatment and Management of Patellofemoral Pain Syndrome

Until pain and inflammation begin to subside, patients are instructed to reduce any running that exacerbates the pain. Similarly to the treatment plan for other overuse injuries, transitioning to low-impact exercise, such as elliptical machines or swimming, is helpful: general conditioning and cross training such as aquatic exercises and deep pool running are an important part of any patellofemoral pain syndrome protocol. Bicycling is usually avoided in the early phases of rehabilitation because of the potential of knee flexion within the painful range of motion.

The modalities used to treat other overuse injuries are also incorporated with PFPS to reduce inflammation, commonly used in conjunction with a stretching and strengthening program; however, evidence is lacking regarding effectiveness.

It must be recognized that generally weak quadriceps muscles, both trauma and non- trauma related, potentially cause mechanical problems of the knee: this is a result of insufficient forces needed to equalize the lateral patellar pull during flexion and extension of the knee. Thus, physical therapists should assess the strength of the quadriceps and hip muscles, using eccentric isokinetic testing if available, and should include eccentric strengthening exercises for the hip as part of PFPS rehabilitation programs: Quadriceps strengthening is one of the key components in reducing symptoms and improving long-term outcomes in PFPS.

As previously mentioned, hip abductor weakness has been linked to PFPS, especially in female athletes. In one particular study, researchers have found that runners with patellofemoral pain and tight iliotibial bands (IT band) also had significant weakness in the hip abductors of the affected limb. Following six weeks of rehabilitation directed at strengthening the gluteus medius, 92% of the runners were pain-free (Fredericson et al, 2000). Examples of how this muscle group may be strengthened are exercises such as single leg step-ups, multi-hip machine and side lying leg raises.

Studies have also investigated whether excessive femoral adduction and internal rotation could produce a greater lateral displacement of the patella with associated lateral patellar contact pressure. In a related study by Prins and van der Wurff, researchers retrieved and examined 12 patellofemoral research reports that documented objective hip strength measurements in individuals with patellofemoral pain syndrome. When looking at involved and noninvolved limb, a 7-21 % deficit in hip external rotation strength was found in addition to a hip abduction strength deficit of 12-22%. Hip extension was also observed to have a 2-29% deficit. In comparing hip strength in individuals with PFPS and a healthy control group, external rotation was found to have a deficit of 5-36%, abduction 12-27% and extension 16-25% respectively. This study supports strong evidence for a need to eccentrically strengthen all three of these muscle groups (Prins and van der Wurff, 2009).

Hip abductors and extensors can be strengthened while in a side lying and prone position respectively using the straight leg raise technique with emphasis on slow return to beginning position. Hip external rotators can be strengthened eccentrically by placing the involved knee flexed to 90 degrees and on a clinic stool that rotates. Theraband or the use of a cable system with resistance is applied at the level of the ankle with the resistance of force perpendicular top to the lower leg. The individual externally rotates the hip keeping the knee flexed at 90 degrees and then very slowly returns to the starting position.

Exercises targeting the vastus medialis oblique are commonly used in the rehabilitation of PFPS. Although no one specific exercise has been found to isolate the VMO, studies have shown leg press, lateral step ups, isometric quadriceps setting and hip adduction exercises produce high EMG activity of the VMO.

While straight-leg raises and other open-chain exercises are popular, many clinicians find patients may progress better with closed-chain exercises such as partial squats or step-downs. Interestingly, some studies have found that closed-chain knee extension, such as using a leg press, generated less patellofemoral joint force than open-chain knee extension from approximately 45° to full extension. This contradicts earlier thoughts that the strengthening phase of the condition should be treated with open chain exercises only. Therefore, in some patients, leg press exercise is thought to be better tolerated than traditional open-chain knee extension exercises

Incorporating hip adduction with knee extension is a popular approach for strengthening the VMO. This intervention takes into consideration the fact that the VMO is connected to the adductor muscles. Training of the adductor muscles uses this anatomical link to supply a more-stable proximal attachment and transfers physiological stretch to the VMO, thereby increasing the contraction force. However, controversy exits on this approach and there is a need for further research to support benefits of adding hip adduction with knee extension exercises.

In a recent study by Song et al, researchers investigated the additional effect of hip adduction to the seated leg press exercise on patients with PFPS. The authors of the study hypothesized that adding hip adduction with leg-press training would result in greater beneficial effects on VMO hypertrophy, pain, and functional improvement compared with leg press training alone. The findings suggested that an 8-week exercise program involving simple leg press training from 45 degrees of knee flexion to full extension and stretching can induce significant VMO hypertrophy, improve knee function, and reduce pain in patients with patellofemoral pain syndrome. However, the study found that adding a force of 50 N of hip adduction to the leg press exercise had no further beneficial effects on the outcome compared with leg press exercise alone after an 8-week intervention in patients with PFPS. Potential limitations of the study included that the use of 50 N of force for hip adduction may have been inadequate to stimulate a training effect (Song et al, 2009). More research is needed to make a clinical decision whether or not to incorporate hip adduction with the leg press when treating patellofemoral pain syndrome; however, the study should remind the physical therapist to become more cognizant of whether or not they are using adequate force of adduction when applying this technique.

Stretching specific tight structures of the lower extremity is important in the treatment of PFPS. Problem muscle and ligamentous tissues are often the quadriceps, hamstrings and gastrocnemius-soleus complex and the iliotibial tract, and lateral retinaculum.

Stretching of the quadriceps is addressed in several ways, among them the two man quad stretch, considered effective by many clinicians: IT band stretching is performed by placing the patient in the Ober's position. The lateral retinaculum is placed under a stretch by medial patellar mobilization techniques performed passively by the clinician and/or patient. (This technique is also used in the diagnosis of a tight IT band.)

Biofeedback is helpful for strengthening an unbalanced quadriceps contraction. This form of strengthening and muscle reeducation can be as simple as asking the patient to palpate the quadriceps during the muscle contraction. This method helps the patient experience the look and feel of the muscle contraction in addition to observing the quality of his or her own patella tracking. More complex biofeedback techniques aid in quadriceps retraining and are useful by providing visual and auditory feedback on muscle contraction.

Braces are not a substitute for rehabilitation, and should only be considered a useful adjunct to the treatment of PFPS. They may significantly enhance comfort for some patients, which in turn can allow for more effective rehabilitation. Cost and design of knee braces vary widely, and evidence does not support any particular type.

In general, patellofemoral braces are designed to minimize lateral patellar subluxation and dislocation and ultimately improve patellofemoral tracking. Many of these braces are designed to help the patient continue their recreational and/or athletic activities while participating in a rehabilitation program. In addition to reducing anterior knee pain during activities, braces are also believed to provide proprioceptive feedback to activate the vastus medialis muscle. Because many braces are composed of a type of neoprene sleeve, they may also provide warmth to the patellofemoral joint and thereby increase general circulation to the area. Many individuals who have worn patellofemoral braces report benefits that exceed the objective effects noted by researchers. The clinician needs to keep in mind that patellofemoral braces do not appear to alter the underlying biomechanical dysfunction. However, the brace provides a static restraint that applies a medially directed force to the lateral patella, thereby decreasing abnormal patellofemoral tracking. In some cases that alone may be very beneficial to the patient.

Recommendations for foot orthotics are common in the treatment of patellofemoral pain syndrome. This appears largely based on theoretic grounds of their effects on kinetic-chain alignment. Although evidence based research is limited, some patients with increased pronation and pes planus may benefit from over-the-counter orthotics that increase the support of the medial arch. These commercially available premolded foot orthosis are usually made from thermoplastic materials, which are lightweight, comfortable and durable. However, disadvantages of the thermoplastic premolded devices are the lack of breathability and the poor ability to absorb moisture. Because of this, the patient is instructed to wear cotton socks with the orthosis to aid the absorption of moisture and enhance air exchange. Even with these disadvantages, premolded foot orthosis permit the clinician to purchase "ready to fit" orthosis or fabricate an effective inexpensive device in a short period of time. In many cases, if the trial period of using over the counter orthotics is beneficial, the patient may be a candidate for custom orthotics which are usually constructed and fitted by a podiatrist.

> A number of studies from recent literature offer support of orthotics in the treatment of PFPS.
>
> In one particular study Sutlive et al. proposed there may be patient characteristics that might predict success with the use of orthotics (orthotic devices can be somewhat expensive and therefore determining which patients are most likely to benefit from the use of orthotics is an important consideration for the physical therapist).
>
> The authors noted previous literature stating that customized foot orthotics are often prescribed for patients with patellofemoral pain syndrome demonstrating excessive foot and ankle motion: the navicular drop test is described as a convenient test for estimating the amount of foot pronation; values greater than 15mm is considered excessive and grounds to consider foot orthotics (Sutlive et al, 2004). However, participants in the study by Sutlive et al who responded favorably to orthotics had minimal motion in the navicular drop test, a lesser amount of passive extension of the first MTP joint, and generally less forefoot varus compared to an unsuccessful group tested wearing orthotics. It was postulated that inflexible feet have a limited ability to become flexible during the loading response phase of gait. Forces introduced at the foot will be transmitted up the lower extremity and absorbed by the knee and patellofemoral joints.
>
> The researchers' findings suggested that if there was a therapeutic effect from orthotic intervention within their study, it may have been achieved by shock attenuation rather than motion control. The study concluded that physical therapists may find benefits in reducing patient pain in patellofemoral pain syndrome by using the shock absorbing effect of the orthotic as well as or more than the ability for the orthotic to correct alignment.

Generally speaking, the quality and age of footwear is important when addressing PFPS: a new, quality shoe can help reduce knee pain caused by PFPS. More specifically, one particular feature of footwear technology, referred to as "motion control," purports to reduce excessive movements of the rear foot during running – as previously mentioned, the risks of PFPS can increase with factors of malalignment of the lower extremities, including excessive foot pronation, tibial and femoral rotations.

Patellar taping may enhance earlier muscle contraction of the vastus medialis oblique, and most benefits seem to occur when taping is used as part of a comprehensive rehabilitation regimen.

The popular McConnell taping method is intended to control lateral patellar maltracking, rotation, lateral tilt, and relieve pain. This method is also viewed as an adjunct to accompany muscle strengthening and stretching activities. Much literature is available regarding McConnell taping techniques helping guide the clinician become efficient and effective with this avenue of treatment.

Patellar taping is usually performed with the patient's knee fully extended, with Leukotape being a common material used. The patellar correction is established upon the individual's malalignment and with each specific component (i.e. tilt, glide, and rotation) corrected. If the clinician is attempting to correct an excessive lateral glide, the tape is started at the midlateal border of the patella. Next, the tape brought across the anterior aspect of the patella and secured to the medial border of the medial hamstring tendons while the patella is pulled simultaneously in a medial direction. The medial tissues are physically lifted by one hand and brought over the medial femoral condyle toward the patella to obtain a more secure final position.

There are several considerations that need be taken when applying patellofemoral taping techniques. Tape should not be worn for periods greater than 24 hours and it is best not to wear the tape during nighttime sleep. Some first time patients may have an allergic reaction presenting as an itchy rash beginning seven to ten days after initiating the technique. Topical creams can also help resolve this condition followed by the use of hypoallergenic tape if this method of treatment is to be continued.

Opinions may vary with regards to how long taping should be attempted to correct any patellar deviation. Many clinicians feel that two weeks is enough time to hopefully see positive results with a weaning time to follow but not to exceed a total of six weeks.

Athletes such as runners of any caliber are encouraged to modify their regime by continuing pain-free activity and maintaining aerobic conditioning. This patient population often experiences a reprieve of pain by decreasing training intensity and volume by approximately 50%. If symptoms continue, alternative activities should be incorporated into the program. For example, runners with patellofemoral pain can tolerate freestyle swimming, bicycling (with the seat elevated to avoid excessive knee flexion), or elliptical trainers without discomfort. Athletes who cannot tolerate continued activity and those with acute injury may have to accept the fact that rest is needed for up to eight weeks, or at least until activities of daily living are pain free.

METATARSALGIA

Metatarsalgia is a general term is used to denote a painful foot condition that is associated with increased stress over the metatarsal head region. It is often located under the 2nd, 3rd, and 4th metatarsal heads; it can also be seen as more isolated at the first metatarsal head. This common overuse injury is often referred to as a symptom, rather than as a specific disease. It is a frequent complaint in any physical therapy setting treating runners and foot pain: nearly 80% of the normal population present some form of pain in the metatarsal region over their lifetime (Arie, 2012).

Causes, Signs, and Symptoms of Metatarsalgia

Runners and other athletes who participate in sports that are high-impact to the lower extremity commonly present with forefoot pain referred to as metatarsalgia. Common causes of metatarsalgia include Morton neuroma, metatarsophalangeal synovitis, avascular necrosis, sesamoiditis, and inflammatory arthritis; however, these causes are often diagnosed separately.

In running, the transfer of force is increased to the forefoot region during the mid-stance and push-off phases. The first and second metatarsal heads within the forefoot region receive the greatest amount of energy transfer. Forces can reach up to 275% of body weight during running, and a one mile run may result in the runner absorbing up to 110 tons per foot (Hockenbury, 1999).

Factors that can contribute to excessive localized pressure over the forefoot include a high level of activity such as mid to long distance running, prominent metatarsal heads, tight toe extensors, weak toe flexors, a tight Achilles tendon, and overpronation: hypermobility at the subtalar joint, commonly seen in overpronation during running, can cause jarring to the forefoot bones and result in metatarsalgia; likewise, if normal forefoot balance is disturbed by Hallux valgus or other reasons, an abnormality in foot biomechanics may result in atypical subtalar joint pronation, which in turn can place an increased amount of weight on the second metatarsal. A high arch can cause stress to the forefoot, leading to pain in the metatarsal region. Hammertoe deformity can also cause metatarsalgia since the top of the shoe pushes the toe down, depressing the metatarsal head (Durham, 2015).

The primary symptom of metatarsalgia is pain at one or more of the metatarsal heads. Diffuse forefoot pain and midfoot pain are often present in runners with combinations of high-impact inflammatory conditions during the mid-stance and propulsion phases of walking or running. The runner will likely describe a history of a gradual, chronic onset rather than an acute episode. Chronic symptoms may be of gradual onset over six months.

If metatarsalgia is associated with a Morton neuroma, the runner may complain of toe numbness in addition to pain in the forefoot. The neuroma is a lesion resulting from a mechanical entrapment neuropathy which can be painful when palpated at the distal end of the plantar metatarsal fat pad. A true Morton's neuroma is painful with tight shoes and relief is obtained by removing the shoe.

Treatment and Management of Metatarsalgia

The primary focus of treatment is restoration of normal foot biomechanics and relief of pressure in the symptomatic area. Physical therapy allows the inflammation to subside or resolve, relieving the repeated excessive pressure by recommending non–weight-bearing ambulation for the first 24 hours in conjunction with cold compresses. The use of metatarsal pads may also provide relief in the early phases of treatment.

Once the individual is pain free and inflammation has resolved, passive ROM exercises initiated at the onset can now progress to active exercises and the therapist can begin isometric, isotonic, and isokinetic strengthening exercises. Therapy to increase dorsiflexion ROM allows improved forward progression of the tibia over the foot, with reduced stress on the forefoot. Strengthening the toe flexor muscles may allow for greater weight-bearing capacity on the toes. Swimming is an excellent exercise for maintaining physical conditioning while the patient is in a restricted weight-bearing phase of healing.

Calf stretches to increase dorsiflexion

In many cases, shoe modification with an orthosis may be the only treatment required for metatarsalgia. Orthotics designed to relieve ball-of-foot pain usually feature a metatarsal pad placed behind the ball of the foot to relieve pressure, and redistribute weight from the painful area to more tolerant areas. Other products often recommended include gel metatarsal cushions and metatarsal bandages.

The high pressure under the metatarsal heads can be reduced by applying metatarsal pads. In a double-blind study, tear-drop shaped, polyurethane metatarsal pads were applied by experienced physiatrists to a total of 18 feet. As a result, there were significantly decreased maximal peak pressures and pressure time intervals during exercise which correlated in better pain and function outcomes (Durham 2015).

In severe cases, surgical realignment of the metatarsal bones may be required to balance weight bearing among the metatarsal heads.

Patients should be made aware that metatarsalgia is frustrating for runners, and usually becomes more debilitating if one chooses to ignore symptoms and continue to run. However, if it is recognized and treated early, most runners return to pain free running within 4-6 weeks.

MEDIAL TIBIAL STRESS SYNDROME

Sports medicine literature shows that the term "shin splints" is no longer the choice of terminology for medical personal: the shin refers to the anterior aspect of the tibia, while "shin splints" describes multiple clinical conditions without clearly defining the location or cause of the problem. The term "medial tibial stress syndrome (MTSS)," initially used as a general term for overuse syndrome of the lower leg, is more appropriate and accurate for this condition, because the location of this overuse related pathology is actually along the middle to distal aspect of the posterior medial tibia. (Periositis of the tibia has been proposed to be an even more accurate description and diagnosis to help explain the pathophysiology of MTSS.) To help avoid additional confusion, this diagnosis is to be limited to musculotendonous inflammation and not to be associated with stress fractures or other disorders that are ischemic in origin such as compartment syndromes of the lower leg.

MTSS occurs in 4% to 35% of athletic and military populations (Kudo, 2015).

Causes, Signs, and Symptoms of Medial Tibial Stress Syndrome

Extrinsic risk factors can be training volume, training surface, and shoes, whereas intrinsic factors are related to. Rearfoot strike runners have a higher rate of repetitive stress injuries than forefoot strike runners, as forefoot strike runners have better function to buffer the loading stress. Flat foot deformity is also an intrinsic factor of MTSS but the association between flat foot and MTSS remains controversial (Kudo, 2015).

Presently it is believed that MTSS is a bony overload injury, as the tibia bends during weight-bearing activities, causing strain in the bone. The strain on the tibia normally causes micro damage in the bone, which leads to bone adaptation to strengthen the bone in order to resist tibial bending. However when this strain exceeds a certain threshold and becomes overloaded, the osteoclast activity may outpace osteoblast activity, leading to local tibial osteopenia.

> A study by Ozgurbuz et al compared tibial bone density with dual energy x-ray absorptiometry (DXA) measurements of athletes with MTSS in an early stage of the injury with those of their healthy athletic counterparts. A possible difference in calcium intake between the two groups was also investigated in this study. Eleven athletes (7 males, 4 females) with MTSS were included in the study. The control group consisted of 11 (7 males, 4 females) subjects regularly exercising in weight bearing activities. After the DXA measurements were recorded and analyzed the study revealed no differences in tibial bone mineral density (BMD) in athletes with shorter (3-10 weeks) history of MTSS. The researchers concluded that longitudinal studies with regular tibial BMD measurements in athletes carrying out intensive training programs would be needed and most accurate to investigate changes in tibial BMD and complaints in athletes developing MTSS. In the same article, Ozgurbuz and colleagues refer to earlier studies by Magnusson et al. where a lower tibial bone density was found in long-standing (average duration 31 months) MTSS patients. In a follow up on the Magnusson study the bone density was reported to have returned to normal levels after recovery (Ozgurbuz, 2011).

Clinical observations revealed that overpronation may be a risk factor for MTSS: a strength imbalance between the evertor and invertor muscles may promote pronation of the foot which in turn is an intrinsic risk factor in MTSS (Yuksel, 2011).

> Yuksel, et al measured inversion and eversion strength levels to evaluate potential strength imbalance. In this study, a total of 11 athletes with MTSS were compared to a control group consisting of 11 subjects exercising at least 3 days a week, 1.5 hours. The authors found eversion strength was higher in the patient group, whereas inversion strength scores were similar in the two groups. While the foot is contacting the ground, the greater eversion strength moment will pronate the foot and excessive pronation may result in overloading of the soleus muscle. This may provide physical therapists additional insight in the prevention and therapy of MTSS.

The most common complaint is diffuse pain in the distal posteromedial tibia caused by repetitive loading stress during running and jumping. The clinician finds tenderness upon palpation in a diffuse area for at least 5 centimeters in the distal 2/3 of the posteromedial tibia. Discomfort may begin at the onset of a running workout and decrease throughout the workout, only to return at the conclusion of the cool down portion of the workout. The underlying periostitis of the tibia in this condition is secondary to tibial strain as well as other tibial stress injuries including tendinopathy, periostitis, periosteal remodeling, and stress reaction of the tibia.

Treatment and Management of Medial Tibial Stress Syndrome

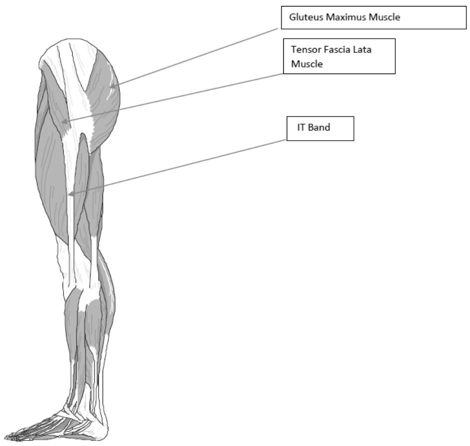
Winters and researchers conducted a systematic review assessing the effectiveness of any intervention in the treatment of MTSS. They found studies suggesting that iontophoresis, phonophoresis, ice massage, ultrasound, periosteal pecking and extracorporeal shockwave therapy are effective with a Level 3 to 4 evidence. However, none of the studies were sufficiently free from methodological bias to recommend any of the treatments investigated. Of those examined by the researchers, extracorporeal shockwave therapy appeared to have the most promise. The authors also speculated that since MTSS is most likely a bony overload injury, rehabilitation programs that focus on bone recovery would seem most appropriate and that several days of nonweight bearing should be a consideration after which weight bearing is gradually increased until full function level has been achieved (Winters, 2013).

The previously–mentioned study conducted by Yuksel et al may provide physical therapists additional insight in the prevention and therapy of MTSS: generic or custom orthotic supports can be beneficial if the cause of MTSS is overpronation. However, rest is still the most common choice of initial treatment for MTSS. Avoiding running for a few days to several weeks will help allow the inflammation at the muscle to subside. Clinicians need to be cognizant that the required amount of rest does not need to be unconditional (i.e. complete exclusion of running). This factor will depend upon the runner and needs to be individualized in accordance to the runner's intensity, mileage, and often terrain. Aquatic exercise as well as a stationary bike are possible alterative activities to help maintain the runner's cardiac conditioning while the symptoms subside.

Unfortunately reoccurrence of the symptoms is not uncommon, and often happens within a few weeks after returning to the previous running regimen. Current sports medicine texts state this can be usually avoided by looking at the possibility of training errors and should consider a gradual return of running over a four to six week period.

ILIOTIBIAL BAND SYNDROME

The iliotibial band (ITB) is a dense fibrous band originating from the anterior superior iliac spine region and extending down the lateral portion of the thigh to the knee. The insertions are on the lateral tibial condyle anatomically referred to as the Gerdy tubercle, and into the distal portion of the femur.



Upon knee extension, the ITB is anterior to the lateral femoral condyle and when the knee is flexed more than 30º, the ITB is posterior to the lateral femoral condyle. This thick structure functions to stabilize the lateral hip and knee, as well as limit hip adduction and knee internal rotation.

Iliotibial band syndrome (ITBS) is the result of inflammation and irritation of the distal portion of the iliotibial tendon as it rubs against the lateral femoral condyle or greater tuberosity with repetitive flexion and extension of the knee.

ITBS is the leading cause of lateral knee pain and the second leading cause of overall knee pain in the running population (van der Worp, 2012). This overuse condition is common in athletes who participate in long-distance running with studies indicating an occurrence rate of 5% to 14% in these runners. ITBS is less common in shorter distance runners, including sprinters, primarily because less time is required for the stance phase during the running cycle compared to a longer stance time needed for distance runners. ITBS has also been reported in military recruits, cyclists, tennis players, and adolescents undergoing a rapid growth phase.

In the past, ITBS has been reported in men and women equally, however, women may be more susceptible to developing the syndrome because of anatomical differences of the thigh and knee. Yet in other recent literature men have been reported to comprise 50% to 81% of the general population (runners and non-runners) suffering from ITBS (Noehren, 2014). Usually ITBS is seen in individuals aged 15-50 years, a wide age range that generally includes active athletes (Aderem, 2015).

Causes, Signs, and Symptoms of Iliotibial Band Syndrome

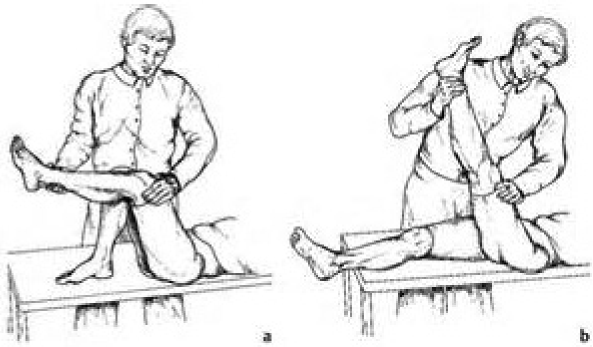
Lack of flexibility of the iliotibial band (ITB) can cause inflammation and irritation resulting from in an increase in tension during the stance phase of running. Other causes or factors believed to predispose an athlete to ITBS include excessive internal tibial rotation, genu varum, and increased pronation of the foot. Abnormal gait or running biomechanics also have been implicated in this syndrome.

Weakness of muscle groups in the kinetic chain may also result in the development of ITBS. Of special concern are the hip abductor muscles, such as the gluteus medius, where weakness may result in higher forces on the ITB. A recent study evaluated the association between isokinetic hip strength and 3-D running kinematics to determine if a lack of hip strength is suggested to contribute to abnormal running mechanics. The authors concluded a decrease in hip strength may lead to altered hip mechanics in a young, competitive running population leading to a variety of lower extremity injuries including iliotibial band syndrome (Taylor-Haas, 2014).

The key to preventing ITBS is having a well-balanced approach to training. Runners need to limit their uphill/downhill training and to run on level surfaces as much as possible. When training on a track, it is helpful to alternate the direction of running from clockwise to counterclockwise regularly to avoid repetitive stress to a single leg. Preventative stretching and wearing proper shoes and orthotics to correct faulty biomechanics is an important aspect of prevention.

Patients with ITBS typically report pain at the lateral aspect of the knee that usually worsens with physical activity, such as running. Walking up and down stairs can become painful and there may be an audible, repetitive popping noise in the knee with walking or running. Once the clinician has examined the entire lower extremity and ruled out other causes of lateral knee or hip pain, palpation findings should be documented. Usually, there is point tenderness at the lateral femoral condyle or lateral tibial condyle, especially when flexing or extending the knee, as the ITB slides across the lateral femoral condyle. Other patients may complain of tenderness over the greater trochanteric region of the hip.

Excessive tightness of the ITB also may be noted upon examination with the Ober test. A modified Thomas test can be performed to assess flexibility of the hip flexors, hamstrings, and ITB. In many studies, the Noble compression test is used to confirm the diagnosis of ITBS. The patient's knee is flexed to 90° then pressure is applied to the lateral epicondyle or a 1-2 cm proximal to it and then the knee is gradually extended. At 30° flexion the patient will complain of severe pain over the lateral epicondyle that is comparable to that experienced when running.



Noble compression test for IT band syndrome


Quad stretch

Treatment and Management of Iliotibial Band Syndrome

Treatment for ITBS usually is conservative and physical therapy is one of the cornerstones of the care plan. Until pain and inflammation begin to subside, patients are instructed to reduce any running that exacerbates the symptoms; cycling is also advised to be decreased or avoided to prevent further repetitive stress to the ITB.

Similar to the treatment plan of other overuse injuries, the physical therapist can advise the athlete about ways to modify his/her training program to aid in earlier results of treatment.

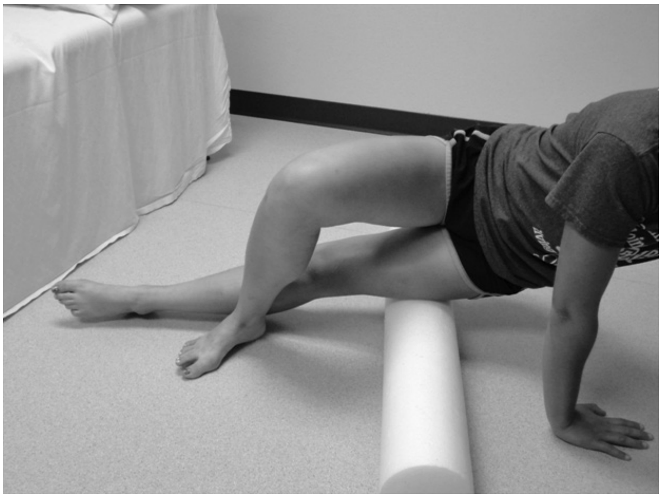
Physical therapy treatment in the acute stage may include modalities such as electrotherapy, phonophoresis, or iontophoresis, in addition to cryotherapy, to decrease the inflammation.

Since some cases of ITBS are caused by excessive tension on the ITB, physical therapy can help to incorporate proper stretching techniques that focus on increasing flexibility of the ITB and of the gluteus hamstrings, quadriceps, gastrocnemius, and soleus muscles.


Hamstring stretch

Soft-tissue mobilization and massage techniques may be used to assist with reducing excessive tension on the ITB. Foam rolling is particularly popular and helpful to address the IT-band since it is difficult for some individuals to stretch.


IT band stretch for R leg


Soft tissue mobilization of IT band

Prior to mobilizing the tissues, ultrasound can be applied over the ITB to increase blood flow and prepare the tissues to be stretched.

The physical therapist should evaluate the patient's biomechanics during walking and running as such alterations may be related to ITBS in runners: findings of recent systematic reviews have suggested biomechanical differences in runners with ITBS compared to healthy runners.

> One quantitative analysis from cross-sectional studies showed that female runners with ITBS appeared to have increased peak knee internal rotation and increased peak trunk ipsilateral flexion during the stance phase of running compared to healthy runners. Due to the proximal origin of the ITB at the hip and its distal insertion onto Gerdys tubercle at the knee, patterns of increased hip adduction and knee internal rotation may increase the amount of strain and tension on the ITB. (The clinician can assess possible knee and hip compensation patterns by instructing the patient to perform squatting motions and observe whether the knees move inward with hip adduction.) The ITB assists in hip abduction and is stretched in adduction. Increased hip adduction and knee internal rotation may be due to weak and poor neuromuscular control of the hip abductor muscles, hip and knee joint stiffness, myofascial restrictions of surrounding musculature or altered somatosensory control. Because of this, clinicians should consider screening for increased knee internal rotation and hip adduction to prevent the development of ITBS among female runners (Aderem, 2015).

Strengthening of the knee flexors and extensors is also an important component of rehabilitation for ITBS. Studies suggest excessive hip and knee movement patterns during running are associated with ITBS and may play a role in its etiology; thus, runners with ITBS who do exhibit greater hip and knee motion than healthy runners may potentially benefit from strength training. The hip external rotators are also important in maintaining control of the hip as hip external rotator weakness can result in a decreased ability to limit hip internal rotation, thereby increasing iliotibial band strain (Martinez, 2016).

The National Academy of Sports Medicine (NASM) has listed a Corrective Exercise Continuum program strategy useful in addressing potential muscle imbalances contributing to movement compensations leading to ITBS. The initial step is to inhibit muscles that may be overactive with self-myofascial release methods such as the foam roll technique. Important regions to address include the calves, ITB, and hip adductors. This is followed by lengthening the calves and adductors with static stretching. Once the overactive muscles have been addressed strengthening weak underactive muscles is important. Areas to target are the posterior tibialis with single-leg heel raises, the gluteus medius with side-lying wall slides, and the gluteus maximus using ball bridges. The clinician can later integrate and improve muscle synergy of the key areas by having the patient perform a squat exercise during an overhead press while keeping the feet in line with the toes.

Running shoes with proper arch support are important when dealing with IT Band syndrome. Maintaining shoes within their recommended mileage is critical. Excessively worn shoes can cause the foot to land at awkward angles transferring an increase in stress up to the knee and hip.

It can be up to 4 to 6 weeks before symptoms of IT band syndrome have subsided. At this point the runner may cautiously return to running in a gradual manner. If pain exists, they will need to decrease running mileage, cross-train or rest to reduce the risk of further irritation. Runners should avoid adding speed or hill workouts until they are symptom free and have rebuilt an adequate base of mileage.

CONCLUSION

The popularity of running continues to increase, and so does the number of serious and recreational runners alike experiencing firsthand the high demands placed upon the lower extremities as the foot hits the ground. Physical therapists understand that the foot and ankle is an intricate and complex structure whose function during running requires proper care to minimize and avoid overuse injuries.

Some runners are more prone than others to overuse injuries, and clinicians often discover imbalances between strength and flexibility around certain joints, explaining this predisposition. Body alignment, such as knock-knees (genu valgus), bowlegs (genu varus), and flat or high arched feet also impact overuse injuries. Likewise, overpronation and underpronation at the subtalar joint can cause numerous overuse injuries, often resulting in chronic inflammation and loss of the runner's performance. Having the ability to perform a complete and thorough running evaluation focusing on the main phases of the gait cycle is an important skill a clinician needs to possess, and being able to address each runner's needs at the subtalar joint – through prescribed exercise, proper footwear and education – can help runners of all ages continue to enjoy their sport in a pain-free manner.

Training errors, such as rapid acceleration of the intensity, duration, or frequency of the running activity, are found to be a common cause of overuse injuries. Overuse injuries also can happen in runners who are returning to their activity after an injury and try to make up for lost time by pushing themselves to achieve the level of participation they were at before injury. Clinicians should remind runners to warm up and cool down properly before and after the running activity. By incorporating strength training, increasing flexibility, and improving hip stability clinicians can make a significant impact on minimizing overuse injuries.

Overuse injuries from running can result in damage to the lower leg's bones, muscles, ligaments, and/or tendons due to repetitive stress without allowing time for the body to heal. The micro-trauma characteristic of overuse injuries is common, subtle, and usually occurs over time, making them challenging to diagnose and treat.

This course reviewed hallmark features of several common overuse injuries, and discussed the modifications that can help this patient/client population maintain their overall fitness and recover in a safe manner. By accomplishing this task, physical therapists allow runners of any age, talent and experience level continue to enjoy their sport.

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COMMON LOWER LEG OVERUSE INJURIES IN RUNNERS
(2.5 CE Hours)
FINAL EXAM

1. **Extrinsic risk factors to overuse injuries, defined as influences applied to the runner which may potentially increase the risk of injury, include _______.**
   a. Biomechanical movement patterns
   b. Gender
   c. Maturity status
   d. Training methods

2. **Anatomically, the hips are wider than the distance between the feet as one runs. Thus, during the beginning of the contact phase of a running cycle, most runners strike the ground _______.**
   a. Evenly balanced between the inside and outside of their foot
   b. On the inside of their foot
   c. On the outside of their foot
   d. None of the above

3. **_______ may be seen in the runner who over pronates.**
   a. Excessive foot motion
   b. Inadequate eversion of the calcaneous and plantar flexion and adduction of the talus inward
   c. Limited shock absorption by the lower extremity
   d. All of the above

4. **The _______ of a running shoe are proposed as being particularly important to protect against overuse injuries, since they influence repetitive impact forces that could be responsible for microtrauma and overuse injuries**
   a. Aerodynamics
   b. Dimensions
   c. Fasteners and treads
   d. Shock-absorbing qualities

5. **When diagnosing plantar fasciitis, it is important for the clinician to ascertain when the pain occurs: pain from plantar fasciitis will be _______.**
   a. Absent at the beginning of a run, gradually increase as tissues are stretched, and culminate in a stabbing sensation at the end of the run
   b. Least intense at the beginning of a run, gradually increase as tissues are stretched, and peak at the end of the run
   c. Most intense at the beginning of a run, gradually decrease as tissues are stretched, and may return again at the end of the run
   d. None of the above

6. **29% of patients in a study (Young, 2001) cited _______ as the treatment that had helped the most with plantar fasciitis.**
   a. Heel cups
   b. Nonsteroidal anti-inflammatory drugs (NSAIDs)
   c. Plantar strapping
   d. Stretching

7. **Pain related to Achilles tendinopathy/tendonitis (AT) is typically located _______ to the insertion of the tendon – this is the area where the fibers from the gastrocnemius and the soleus (calf muscles) weave together to form the substance of the tendon.**
   a. 2 to 6 cm distal
   b. 2 to 6 cm proximal
   c. 6 to 12 cm distal
   d. 6 to 12 cm proximal

8. **The most common conservative approach to the treatment of Achilles injuries is _______.**
   a. Eccentric loading
   b. Electrical stimulation
   c. Iontophoresis
   d. Ultrasound

9. **Regarding the classification system developed by Johnson and Strom in 1989 to describe the progression of tibialis posterior dysfunction, "the tendon has become dysfunctional and the foot has developed acquired flatfoot, but the deformity can be passively correctable" is characteristic of which stage?**
   a. Stage I
   b. Stage II
   c. Stage III
   d. Stage IV

10. **Conservative management is preferred for stages I and II of PTTD, usually consisting of calf stretching, strengthening the posterior tibial tendon, and foot orthotics (patients with stage II receive treatment similar to stage I, but the individual may require _______).**
    a. A more rigid foot orthotic
    b. A more supple foot orthotic
    c. Calf surgery
    d. Quad stretching

11. **Patients presenting with patellofemoral pain syndrome (PFPS) _______.**
    a. Often unable to pinpoint the location of pain
    b. Note knee buckling and/or episodes of instability
    c. Report knee swelling and fullness, especially over the infrapatellar area
    d. All of the above

12. **Stretching specific tight structures of the lower extremity is important in the treatment of patellofemoral pain syndrome (PFPS). The _______, for example, is placed under a stretch by medial patellar mobilization techniques performed passively by the clinician and/or patient.**
    a. Hamstrings
    b. Iliotibial tract
    c. Lateral retinaculum
    d. Quadriceps

13. **Standard treatments for metatarsalgia do NOT include _______.**
    a. Isometric, isotonic, and isokinetic strengthening exercises
    b. Non–weight-bearing ambulation for the first 24 hours in conjunction with cold compresses
    c. Patellar taping, particularly the McConnell taping method
    d. Shoe modification with an orthosis, such as a metatarsal pad placed behind the ball of the foot

14. **Metatarsalgia usually becomes more debilitating if one chooses to ignore symptoms and continue to run; however, if it is recognized and treated early, most runners return to pain free running _______.**
    a. After 3 months
    b. After 6 months
    c. Within 1-3 weeks
    d. Within 4-6 weeks

15. **In diagnosing for Medial Tibial Stress Syndrome (MTSS), the clinician finds _______ in a diffuse area for at least 5 centimeters in the distal 2/3 of the posteromedial tibia.**
    a. Nodes upon palpation
    b. Numbness upon palpitation
    c. Tenderness upon palpation
    d. None of the above

16. **The most common choice of initial treatment for Medial Tibial Stress Syndrome (MTSS) is _______.**
    a. Ice massage
    b. Orthotics
    c. Phonophoresis
    d. Rest

17. **Which of the following is NOT a test used in the diagnosis of iliotibial band syndrome (ITBS)?**
    a. Modified Thomas test
    b. Noble compression test
    c. Ober test
    d. Phelps torque test

18. **The National Academy of Sports Medicine (NASM) has listed a Corrective Exercise Continuum program strategy useful in addressing potential muscle imbalances contributing to movement compensations leading to ITBS. The initial step is to inhibit muscles that may be overactive with self-myofascial release methods such as the foam roll technique. Important regions to address include the _______.**
    a. Gluteus maximus
    b. Gluteus medius
    c. Hip adductors
    d. Posterior tibialis

ANSWER SHEET

First Name: ____________________ Last Name: ____________________ Date: __________

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By submitting this final exam for grading, I hereby certify that I have spent the required time to study this course material and that I have personally completed each module/session of instruction.

Common Lower Leg Overuse Injuries In Runners
Final Exam

1. Ⓐ Ⓑ Ⓒ Ⓓ	5. Ⓐ Ⓑ Ⓒ Ⓓ	9. Ⓐ Ⓑ Ⓒ Ⓓ	13. Ⓐ Ⓑ Ⓒ Ⓓ	17. Ⓐ Ⓑ Ⓒ Ⓓ
2. Ⓐ Ⓑ Ⓒ Ⓓ	6. Ⓐ Ⓑ Ⓒ Ⓓ	10. Ⓐ Ⓑ Ⓒ Ⓓ	14. Ⓐ Ⓑ Ⓒ Ⓓ	18. Ⓐ Ⓑ Ⓒ Ⓓ
3. Ⓐ Ⓑ Ⓒ Ⓓ	7. Ⓐ Ⓑ Ⓒ Ⓓ	11. Ⓐ Ⓑ Ⓒ Ⓓ	15. Ⓐ Ⓑ Ⓒ Ⓓ	
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Learner Name: ____

	Disagree				Agree	
Orientation was thorough and clear	1	2	3	4	5	
Instructional personnel disclosures were readily available and clearly stated	1	2	3	4	5	
Learning objectives were clearly stated	1	2	3	4	5	
Completion requirements were clearly stated	1	2	3	4	5	
Content was well-organized	1	2	3	4	5	
Content was at or above entry-level knowledge	1	2	3	4	5	
Content was substantiated through use of references, footnotes, etc.	1	2	3	4	5	
Content reflected stated learning objectives	1	2	3	4	5	
Exam assessed stated learning objectives	1	2	3	4	5	
Exam was graded promptly	1	2	3	4	5	
Satisfied with learning experience	1	2	3	4	5	
Satisfied with customer service (if applicable)	1	2	3	4	5	n/a

What suggestions do you have to improve this program, if any?

____

____

What educational needs do you currently have?

____

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What other courses or topics are of interest to you?

____