by Joshua Dubin, DC, CSCS

Conservative therapy stretches Iliotibial band for recovery

Iliotibial band friction syndrome (ITBFS) is an inflammatory nontraumatic overuse injury of the knee affecting predominantly long-distance runners.[1-5] Training modifications and a home exercise program that includes a flexibility and strength conditioning routine can aid in the treatment and prevention of further injury. Most cases of ITBFS can be treated successfully with conservative therapy. Recalcitrant cases of ITBFS may require other interventions, such as cortisone injections and/or surgery.

An estimated 30 million Americans run for exercise.[6] However, it has also been projected that one-half to two-thirds of those runners may sustain a nontraumatic repetitive strain injury at least once.[6,7] ITBFS may be caused by a multitude of factors including training errors, worn out running shoes, and/or lower leg misalignments.[1,8,9-14]

The main symptom of ITBFS is a sharp pain on the outer aspect of the knee that can radiate into the outer thigh or calf.[15-17] Knee pain usually occurs at a particular point in each training run, probably due to muscle fatigue,[1,10] and is more pronounced shortly after the foot contacts the ground surface.[18] Attempting to run through the pain will intensify the symptoms, eventually causing the athlete to shorten stride or slow to a walk.

The frustrated athlete, who may be training for a race, will not be able to progress his or her mileage appropriately. Unfortunately, the despondent runner may be unreceptive to advice to temporarily discontinue running and initiate therapy, which may result in a more severe grade of injury. Pain may now be present with walking—exacerbated by walking up or down stairs—and a stiff-legged gait may be adopted to relieve symptoms.[19]

Based on my experience, both clinical and as a recreational runner, I have identified several reasons why most athletes are unwilling to temporarily discontinue running: it is a time-efficient exercise, genuine friendships are formed in group training, no other cardiovascular exercise can beat the "runner's high," and there is fear of not attaining his or her training goal. Research and my experience show conservative therapy to be extremely successful in treating ITBFS.[3,20] A proper treatment protocol should include inflammation reduction, pain-free training modification, flexibility and endurance/ strength training of the muscles surrounding the pelvis and thigh, and correction of faulty training habits.[1-5, 9-11, 21-23]

The treating practitioner should have an understanding of the anatomy of the iliotibial tract (ITT), surrounding musculature of the outer thigh and pelvis, the extrinsic and intrinsic risk factors that predispose long-distance runners to ITBFS, and the biomechanics of the ankle, tibia, and knee during the stance phase of gait.

The repetitive motions of long-distance running leave these athletes susceptible to ITB injury.

Anatomy of the iliotibial tract

Fascia is a sheath-like tissue that surrounds muscles and muscle groups. The fascia lata femoris surrounds the hip and thigh. The ITT is a lateral thickening of the fascia lata, originating from the iliac crest of the pelvis. The ITT continues down the outer third of the

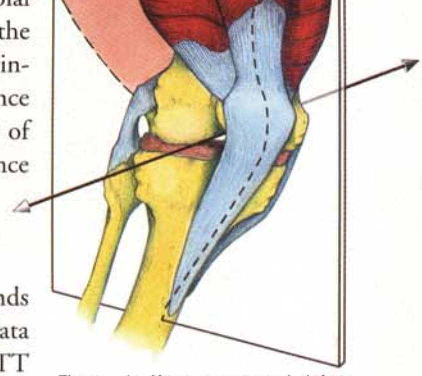

Figure 1. Knee movement takes place in all three planes of motion. Flexion and extension occur in the sagittal plane.

thigh at the femur bone, passing over a protuberance called the greater trochanter. At the level of the greater trochanter, fibers from the gluteus maximus and tensor fascia lata (TFL) musculature merge with the ITT posteriorly and anteriorly, respectively.

Located between the ITT and greater trochanter is a bursa, a fluid-filled sac that functions to reduce friction between two adjacent structures. The ITT attaches superficially to the fascia of the vastus lateralis musculature and passes through the intermuscular septa to the linea aspera, a linear ridge on the posterolateral aspect of the femur. As the ITT approaches the knee joint, it passes over a protuberance on the outer aspect of the femur, the lateral femoral epicondyle (LFE). A thin layer of fatty tissue is located between the ITT and LFE. As the ITT approaches the knee joint, it splits into two structures, the iliopatellar band and a distal extension of the ITT. The distal extension of the ITT crosses the knee joint and attaches to Gerdy's tubercle, a bump located on the proximal outer aspect of the tibia. The iliopatellar band migrates medially to join with the lateral retinaculum, a sheath-like tissue that attaches to the outer aspect of the patella.[14,17,18,24-30] The distal extension of the ITT provides lateral stabilization to the knee joint through its attachment to the distal femur and the proximal tibia; the iliopatellar branch of the ITT aids in decelerating medial glide of the patella and leg flexion.[31]

To properly diagnose, treat, and prevent ITBFS, a practitioner should understand the biomechanics of the ankle, tibia, and knee joint that this area experiences during a typical running gait, and how these movements dynamically affect the ITT.

Lower leg running biomechanics

Gait can be separated into stance and swing phases. During the swing phase, the leg accelerates forward and prepares for ground contact; during the stance phase, the foot contacts and adapts to the ground surface. Stance is the phase that relates most directly to ITBFS. The stance phase consists of initial contact, loading response, midstance, and terminal stance.[32] The ankle joint, tibia, and knee joint move synchronously during each stance phase, changing the lower extremity into a rigid lever (for initial ground contact and toe-off) or a mobile shock absorber (for loading response into early midstance).[33]

Two triplanar movements are particular to the ankle joint during the stance phase: supination and pronation. The ankle assumes a supinated position for stability during initial contact and in preparation for toe-off. Supination consists of calcaneal inversion (the heel is turned inwards), plantar flexion (the toes approach the ground surface), and adduction of the forefoot (it points toward the body's midline). Ankle pronation occurs throughout loading response and into early midstance, transforming the foot and ankle into a supple mobile adaptor that is efficient at absorbing ground reaction forces. Ankle pronation consists of eversion of the calcaneus (the heel turns outward), dorsiflexion (the tibia moves forward over the foot), and abduction of the forefoot (it turns away from the body's midline).[21,34]

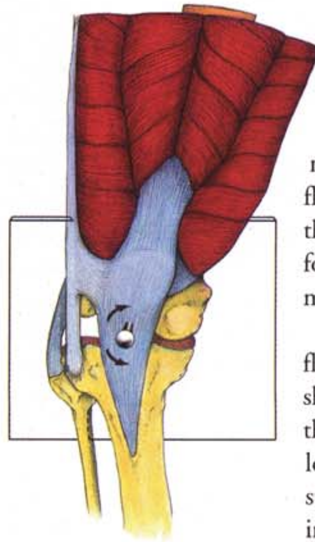

Figure 2. Movements in the frontal plane include varus (gapping of the lateral aspect of the knee joint) and adduction of the lower extremity toward the body's midline.

During initial contact the knee is flexed approximately 21°,[35] the ITT should be anterior to the LFE, and the ankle is supinated. Throughout loading response and early midstance, the ankle pronates, the tibia internally rotates, the knee joint flexes beyond 30°, and the ITT translates posterior to the LFE. From early midstance and continuing into terminal stance the ankle resupinates, the tibia rotates externally and the knee extends again.[32]

It has been proposed that ITBFS is secondary to repetitive knee movement through an impingement zone of 30° of leg flexion.[4,5,15] The injury is most common in long-distance runners because the activity involves repetitive leg flexion and extension, approximately 800 times per mile.[36,37] The onset of pain associated with ITBFS will cause an athlete to shorten his or her stride, thereby limiting leg flexion and minimizing friction of the ITT over the inflamed fatty tissue and periosteal layer of the LFE. This altered gait will temporarily allow the athlete to continue running, but may exacerbate the condition. A study performed on athletes who had acute or subacute clinical symptoms of ITBFS revealed MRI findings of fluid accumulation in the fatty tissue deep to the ITT.[15,38,39] Secondary bursa or thickening of the ITT may be more common in chronic stages of ITBFS.[40]

Repetitive flexion and extension of the leg through the 30° impingement zone may be one risk factor; but the causes of ITBFS are multifaceted. Other risk factors include training errors and structural malalignments.

Training errors and risk factors for ITBFS

Training errors contribute to most overuse running injuries. Properly progressed training programs allow the supporting structures of the pelvis and knee to adapt to increased stresses. Inappropriately increasing the intensity, duration, and frequency of training runs, as well as incorporating hills on the training routes too soon, may overload the supporting structures of the knee, eventually leading to injury.[3,4,9,10,21]

Structural malalignments that cause altered movement patterns of the ankle, tibia, and knee joint can also contribute to ITBFS. Knee movement occurs in all three planes of motion. Flexion and extension of the leg take place in the sagittal plane (Figure 1). Frontal plane movements include varus (gapping of the lateral aspect of the knee joint) (Figure 2) and adduction of the lower extremity toward the body's midline. Internal rotation of the tibia on the fixed femur takes place in the transverse plane (Figure 3). Excessive repetitive movement patterns of the knee in these planes are risk factors for ITBFS.[15,16,18,19] Studies have suggested two factors that lead to excessive adduction of the stance leg in the frontal plane, causing increased tension on the ITT: weakness of the muscles that abduct and support the pelvis, and running on a cambered (arched) surface.[18] Contraction of the gluteus medius, gluteus maximus, and TFL occur predominantly during the first 35% of stance.[4] Long-distance runners with ITBFS have weaker hip abduction strength in the affected leg than in their unaffected leg.[5] Fatigue and weakness of the gluteus maximus, TFL, and gluteus medius may occur later during a run, resulting in a Trendelenberg gait, raised ipsilateral hip, and increased frontal plane adduction of the thigh and leg.[1,41] This modified gait has been shown to increase tension on the ITT and is a risk factor for ITBFS.[1,18] Pronounced adduction of the stance leg due to muscle fatigue leads to increased tension on the ITT that may initiate or exacerbate symptoms related to ITBFS.

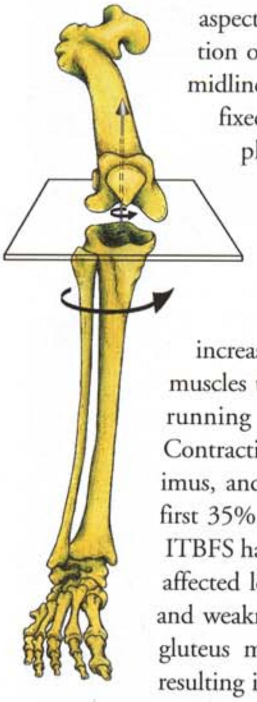

Figure 3. Internal rotation of the tibia on the fixed femur takes place in the transverse plane.

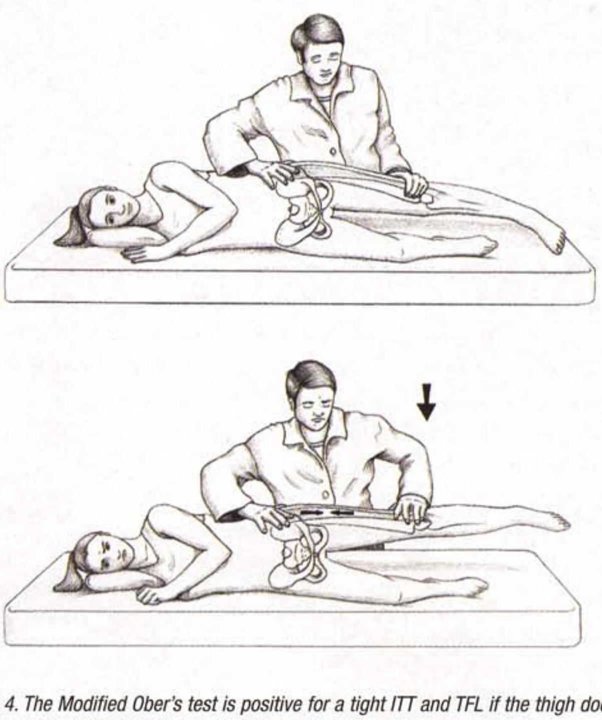

Figure 4. The Modified Ober's test is positive for a tight ITT and TFL if the thigh does not descend to or beyond 10° in the horizontal plane.

Excessive internal rotation of the tibia in the transverse plane may be caused by structural malalignments and can contribute to ITBFS. Anatomical malalignments such as rearfoot varus, forefoot varus, and pes planus may cause excessive or prolonged pronation of the ankle joint through the stance phase of gait. Abnormal pronation of the ankle joint may cause greater than normal internal rotation of the tibia, accompanied by increased tension on the ITT at its insertion point on Gerdy's tubercle during each foot strike, predisposing it to injury.[1,10,37,42-44]

Risk factors for ITBFS

Both extrinsic and intrinsic factors may put a runner at risk for ITBFS.

Extrinsic risk factors may include:

- *Worn-out running shoes.* A sneaker loses approximately 50% of its ability to absorb ground reaction forces after 300 to 500 miles.[12] The more worn-out the shoe, the more ground reaction forces are transferred to the knee.
- *Training programs that increase mileage or incorporate hills inappropriately.* Mileage should not be increased more than 5% to 10% per week to let the muscles, tendons, ligaments, and bone adapt to increased stress.[45-47]
- *Running at an improper pace.* Placing too much strain on untrained legs may lead to fatigue and injury. Long runs to improve aerobic conditioning should be slow, at 65% to 70% maximum heart rate. Anaerobic threshold training can be conducted with shorter runs at 85% to 100% maximum heart rate.[45]
- *Running on a cambered or slippery surface.*[9]

Intrinsic risk factors may include:

- *Genu varum/bow leg.*[48]
- *Rearfoot and forefoot varum.*[49]
- *Pes cavus/high arch.* A pes cavus foot has limited ability to absorb ground reaction forces, placing more stress on the knee.
- *A prominent LFE and tight TFL.*
- *Weak gluteus medius, gluteus maximus, and TFL.*[41]
- *Tightness and weakness in the quadriceps, ITT, and lateral retinaculum.* This may lead to excessive lateral tracking of the patella and decreased deceleration forces acting on leg flexion, leading to increased stress on the lateral stabilizing structures of the knee.[46,50]

Diagnosing ITBFS

A practitioner can diagnose ITBFS and discover extrinsic and intrinsic risk factors for the condition through a detailed history and physical examination. A history should include current symptoms; first notice of the injury; progression of the frequency, duration, and intensity of weekly training runs; whether training routes include hills or cambered surfaces; age of running shoes; and training goals.

Two orthopedic tests that aid the clinician in diagnosing ITBFS are the modified Ober's test (Figure 4)[41,51] and Noble's test.[13,15,51] The modified Ober's test is an assessment tool for evaluating tightness of the ITT and TFL. With the patient lying on the noninjured side, the practitioner raises the upper hip and thigh into slight abduction, extends the hip and thigh, and allows the leg to drop into adduction. The tester should stabilize the pelvis and thigh with one hand to keep the pelvis from flexing and the thigh from rotating internally, movements that may lead to false negative findings. The modified Ober's test is positive for a tight ITT and TFL if the leg does not descend to horizontal.

Noble's test can be used to differentiate between ITBFS and other conditions that refer pain to the outside of the knee, such as bicipital tendinitis, popliteus tendinitis, lateral collateral ligament strain, lateral meniscal tear or cyst, and osteoarthritis.[52-57] The patient is supine with the affected leg hanging off the side of the bench, the knee flexed to 90°. With the clinician's thumb over the LFE, the patient extends his or her leg to approximately 30° as the ITT translates anteriorly under the tester's thumb. If the patient complains of lateral knee pain that is similar to pain present while running, Noble's test is positive for ITBFS.

The creak test[15] is analogous to Noble's test. The athlete stands on the fully extended injured leg and is instructed to flex it to approximately 30°. As the leg flexes, the ITT tracks over and posterior to the LFE. If lateral knee pain is present at approximately 30° of leg flexion, the test is positive for ITBFS.

Further examination should include a strength and flexibility assessment of the musculature surrounding the thigh and pelvis, and observation of the athlete's lower extremity standing and walking biomechanics.

Therapies

Initial goals of therapy are to reduce swelling and inflammation. Pain-free modified training can then be implemented to improve strength and flexibility of the hip, thigh, and calf musculature, as well as cardiovascular fitness. The end goal is to return the athlete to a pain-free running routine. Grading the injury helps to determine the plan of treatment (see table on page 52).[2,42]

Appropriate treatment of a grade 1 or grade 2 ITBFS injury would consist of manual adjustments to the ankle and foot, as well as medial glide mobilization of the patella to free up joint motion and improve tracking of the patella,[44] and deep tissue procedures, such as the Graston Technique (manual therapy that utilizes specially designed devices) and Active Release Technique (a patented manual therapy method), to break up scar tissue and restore soft tissue motion.[58] There is considerable clinical evidence to support the effectiveness of deep tissue procedures in treatment of strain/sprain injuries.[59,60] A home exercise program on a foam roller can be taught for myofascial release.

Combination ultrasound and electrical muscle stimulation therapy may help restore normal muscle tone, help in the healing process, and reduce pain.[51,61] Iontophoresis with dexamethasone is also a useful modality to decrease inflammation.[62]

The patient should be prescribed nonsteroidal anti-inflammatory drugs to reduce inflammation, and should apply a cold pack to the lateral aspect of the knee for 20 minutes at a time with one hour off between applications, repeated throughout the day.

A strength training program for the gluteus medius, gluteus maximus, and quadriceps musculature should be implemented. Components should include squats, abduction exercises, and a supine bridge with single leg lifts. Strengthening the gluteus muscles has been shown to be instrumental in returning athletes to pain-free running.[5,50] Strengthening exercises should be progressed with no or little discomfort.[63] When pain-free training resumes, it is my opinion that a leg workout can be included once a week, with at least 48 hours rest before or after a long run.

A 15 to 20-minute flexibility routine with a resistance band helps to decrease delayed-onset muscle soreness, as well as improve flexibility through hysteresis/creep. The routine should include stretching of the hamstrings, quadriceps, adductors, ITT, and external rotators of the thigh.[64-66] Longer stretches (30 to 60 seconds), with short intermittent contractions of the antagonist muscle, has been shown to be one of the best mobilization techniques for a painful muscle or tendon.[9]

Running shoes should be changed every 300 to 500 miles of use.[3,12]

Appropriate arch supports as necessary should be recommended. A runner with pes planus will usually overpronate, leading to increased internal rotation of the tibia, a risk factor for ITBFS. A good sneaker with a firm heel counter and an inside arch support will help correct overpronation. If necessary, a semirigid orthosis with a medial arch support no higher then 5/8-inch can be used to further control pronation. A runner with pes cavus has limited pronation and poor shock-absorbing capabilities. The high-arch runner should get a sneaker with good cushioning; if necessary, a semirigid orthosis or cushioned liner can be added.[1,3]

Appropriate training limits should be observed. For marathon runners, an initial training base of four miles at 65% to 75% maximum heart rate needs to be established. Later, a progressive training schedule should be followed that allows for adaptation of the supporting structures of the knee to withstand future increased stress loads. Long training runs, usually done on the weekend, should be limited to a pace that requires 65% to 75% maximum heart rate to improve aerobic capacity. During the week, a shorter 4 to 8-mile interval run at 85% to 90% maximum heart rate is recommended to improve anaerobic capacity. Hill training should be added gradually to allow the body to adapt to the increased load placed on the knee joint. The average

GRADES OF ITBFS AND PHASES OF TISSUE REPAIR AND TREATMENT	
Grade 1	Pain does not occur during normal activity, but generalized pain is felt about 1 to 3 hours after sport-specific training has ended. Tenderness usually resolves within 24 hours without intervention.
Grade 2	Minimal pain is present towards the end of a training run; performance is not affected. Appropriate treatment may be necessary to prevent a grade 3 injury.
Grade 3	Pain onset is at an earlier point in training and interferes with the speed and duration of a training session. Treatment and training modification are necessary to prevent a grade 3 injury from progressing to a grade 4 injury.
Grade 4	Pain restricts training and is also noticeable during activities of daily living; the athlete can no longer continue sport-specific training.
Grade 5	Pain interferes with training as well as ADLs. Aggressive therapy is required and surgery may be necessary.

marathon training schedule consists of three shorter runs during the week and one longer run on the weekend. Total mileage should not be increased by more then 10% per week.[32,45,49]

Early therapy and intervention (as outlined above) are important to prevent a grade 3 ITBFS injury from progressing to a grade 4 or 5 injury. In the early stages of a grade 3 injury, one week of activity modification from the offending training regimen is recommended, as well as treatment procedures similar to those used to treat a grade 1 or 2 injury. Modified activity, including swimming, running in the pool, bicycling, or using an elliptical machine, will help in maintaining aerobic fitness and will allow for proper healing. Treating a more advanced grade 3 or a grade 4 ITBFS injury would involve a longer bout of modified activity and rest from any offending activity, and a slower progression of weight training and stretching.[67-69]

Chronic ITBFS may not always resolve with conservative therapy. In recalcitrant ITBFS, other treatment methods may need to be considered, such as steroid injection therapy and surgical procedures. Steroid injections, used judiciously, have been shown to reduce symptoms and inflammation.[1,9-11] Steroid injection therapy should be followed by a properly progressed strength, flexibility, and cardiovascular program to restore function before training resumes. Surgery should be considered only if all other means of therapy fail and the athlete is not willing to give up the offending sports activity.[22]

Conclusion

ITBFS is a common nontraumatic overuse injury that often affects long-distance runners. Certain biomechanical malalignments predispose runners to ITBFS including rearfoot varus; forefoot varus; genu varum; pes cavus; a prominent LFE; weak gluteus maximus, gluteus medius, and quadriceps musculature; and tight TFL, ITT, and lateral retinaculum. The risk of ITBFS can be reduced if athletes follow a properly progressed training program that allows the structures supporting the pelvis, thigh, and knee to adapt gradually. To prevent injury, these athletes should incorporate proper footwear, semirigid orthoses as necessary, a lower body flexibility and strength training routine, and cross-training into their workouts.

ITBFS can usually be treated successfully with a conservative rehabilitation program that includes modified training and a home flexibility and strength exercise program. When the athlete can run three to four miles pain-free on a treadmill, he or she can progress the training program carefully to prevent reinjury. Sometimes ITBFS resists conservative therapy and a cortisone injection or surgery may need to be considered as alternative treatment options. Surgery, when necessary, may involve lengthening the ITT and removing a section of the posterior aspect of the ITT that is impinging on the LFE.

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