Iliotibial Band Syndrome (ITBS) in Runners/Cyclists/Triathletes

Running is one of the oldest athletic activities in the world and is a primary constituent of training for many other sports. The International Association of Athletics Federations (IAAF), which includes sprinting, distance running and track and field events, includes 214 member countries and territories worldwide[1]. This makes the IAAF one of the most global organizations with more members than the United Nations (UN), and makes running one of the most global activities worldwide[1].

Although running and athletic activities that involve running are common worldwide, especially in the United States, most people in the US do not meet the recommended Physical Activity Guidelines set forth by the CDC of 2.5 hours of moderate-intense physical activity per week[3]. However, for the 21.7% that do meet the recommended guidelines in the US, running is the most common form of exercise[2,3]. The most common cause of lateral knee pain and one of the Top 7 injuries associated with running according to Runner's World is Iliotibial Band Syndrome (ITBS)[4]. With an active population increasing their training volume and a larger inactive population that are transitioning to running without proper progression, there is a high risk of injury in both populations. In addition to running, *Holmes et al.* indicates that ITBS constitutes 15% of all knee injuries in cyclists relating to overuse[8]. Therefore, running, cycling and triathlon are three specific populations where diagnosis of ITBS should be considered in the treatment of lateral knee pain.

As physical therapists, it is our responsibility to understand the anatomy, etiology, progression, differential diagnosis, treatment options and preventative measures that we can employ for both the elite athlete returning to competitive sport and the weekend warriors that are simply looking to increase their quality of life and decrease pain. Using evidence-based strategies outlined here, physical therapists will better be able to understand and treat ITBS.

The Iliotibial band or IT band (ITB) is a large strip of fibrous connective tissue, specifically dense regular connective tissue, oriented longitudinally along the lateral aspect of the upper leg (*See Appendix A)*. The majority of the fibrous component is collagen and the majority of the cellular component is fibroblasts making a dense matrix that is largely avascular[9]. The IT band originates from both the iliac crest and the tendons of the gluteus maximus and Tensor Fascia Latae (TFL) muscles[7]. This fibrous band then runs from the superior, lateral portion of the thigh distally and crosses the lateral knee joint to insert on the lateral tibial epicondyle at a point called Gerdy's tubercle[7]. The distal IT band fibers also mesh with the lateral patellar retinaculum to provide further stability to the lateral knee[9]. The IT band allows the TFL to act as a hip abductor, medial rotator, and hip flexor. The ITB also allows lateral stabilization of the knee in combination with the TFL and gluteus maximus during knee extension[7]. Therefore, in the repetitive action of running and cycling, the IT band acts to support the gluteus medius, minimus and maximus in providing repetitive hip flexion, hip abduction and hip internal rotation as well as providing lateral support to the knee[28].

There are two schools of thought on the mechanism of injury causing ITBS. The first is that it is caused by a repetitive rubbing of the IT band over the lateral femoral condyle, just superior to the lateral knee joint, in repetitive activities of knee flexion/extension such as biking and running. This would cause inflammation and a feed-forward mechanism of pain as the inflamed tissue becomes more likely to rub against the lateral femoral condyle[11]. This is why ITBS is sometimes referred to as iliotibial band friction syndrome (ITBFS). In the running cycle, this frictional force takes place just after foot strike as the knee moves into eccentric flexion[5]. Similarly, in biking, if the seat is too high, as the leg pushes the pedal into extension or down stroke, it forces the knee flexion angle to less than 30^{o} repetitively and pulls the IT band anteriorly over the lateral femoral condyle. At an angle of 20 to 30^{o} the posterior aspect of the ITB contacts the lateral femoral condyle and creates friction[5]. Because the knee requires about 60^{o} of flexion during the loading response for running, this contact between the posterior ITB and the lateral femoral condyle is unavoidable and takes place repetitively during a bout of running, especially at slower speeds, where the knee is less flexed during foot strike[13]. The other school of thought is that the tightening of the fascia, due to work being performed by surrounding musculature and knee extension providing internal tibial rotation creates a medial-lateral compressive force of the IT band. This compressive force acts on underlying innervated adipose tissue being pinned against the lateral femoral condyle or underlying bursa causing pain and swelling[10]. The same basic movements, repetitive flexion/extension, would be the MOI for both theories. The difference is that instead of a band rolling across a condyle at about 30^{o} of knee flexion, compression takes place as the tibia internally rotates 10° when the knee flexion angle approaches 30°. This theory is supported by the "screw home" mechanism, that as the knee approaches full extension, an accompanying internal rotation of the tibia occurs that creates tension within the ITB[10].

Repetitive action leading to increased friction or compression is one aspect of the etiology of ITBS; the other is anatomical imbalances throughout the lower extremity chain. These imbalances can include leg-length discrepancies, anterior/posterior innominate rotation, calcaneal varus, tibial varus, and pes cavus[12]. These imbalances can extend to muscle forces as well. Decreased quadriceps and hamstring strength can lead to decreased max braking forces during heel strike creating a higher speed at which the ITB strikes the lateral femoral condyle and thus a higher frictional force[5]. This type of injury can occur as mileage is increased too quickly and the body does not have time to recover to meet the greater demands of increased training. This can also occur from a transition to running downhill which increases the ground reaction force (GRF) creating a demand for a greater braking force that cannot be matched by an individual that has only been training on flat surfaces. Decreased hip abductor strength, such as in the gluteus medius, also puts more stress on the muscles that attach to the ITB, the gluteus maximus and tensor fascia lata[5]. Therefore, an imbalance between hip adductor strength and abductor strength can result in an increased risk of ITBS. This type of injury can result unilaterally from running around a track in one direction. Running gait that consists of long stride lengths can have a similar result to running downhill, and gait patterns that consist of footfall that crosses the midline result in increased tensile stress at the IT band and increased risk for ITBS[5].

There can be a variety of etiologies for lateral knee pain. These can include: stress fractures, degenerative joint disease (DJD), lateral meniscal tears, patellofemoral stress syndrome, superior tibiofibular joint sprain, popliteal tendinopathy, biceps femoris tendinopathy, peroneal nerve injury, lateral collateral ligament (LCL) injury or referred lumbar pain[5]. Radiographic imaging such as magnetic resonance imaging (MRI) can rule out soft-tissue injury such as meniscal tear, stress fractures or tendinitis, however, these more expensive diagnostic measures are not always necessary. MRI can show an inflamed distal ITB and fluid-filled bursa beneath the distal aspect of the band in cases of acute-onset ITBS, however this would need to be caught early in order to have clear validation[22].

The classic symptoms of ITBS include pain with palpation approximately 3cm above the lateral knee joint and an accompanying sound described as "rubbing your finger on a wet balloon" or "wet leather"[14]. Occasionally, swelling is also present at this location. Patients will typically have pain at about 30^{o} of knee flexion at the point where the ITB contacts the lateral femoral condyle or at a specific mileage in their training at the point where the inflamed ITB or surrounding tissue such as the bursa have become sufficiently inflamed to cause pain[5]. As symptoms worsen, this mileage will become shorter and shorter. ITBS can be further differentiated from other hip and thigh disorders because pain will be felt at the knee and not the hip or upper thigh. It can be differentiated from patellofemoral pain syndrome because ITBS pain will be on the lateral portion of the knee, approximately 3cm above the joint line, rather than the front of the knee around the knee "cap" or patella[5].

There are several tests that can be used to differentiate ITBS from other impairments of the lateral knee. The first is the Noble Test or Noble Compression Test which can be performed with the patient in supine or side-lying. The patients knee is first flexed to 90º, then the therapist applies pressure at the distal lateral femoral condyle and slowly extends the knee. This extension will bring the ITB anterior and create compression against the lateral femoral condyle at about 30º. If the patients primary pain is reproduced at this angle it is a positive test and indicative of ITBS (*See Appendix B for Special Tests)*[5,14]. A second, similar test that is tested actively by the patient is the Renne Test which is tested with the patient in single-leg stance on the affected leg. The therapist applies slight compression with their thumb to the lateral femoral condyle, as in the Noble Test, and has the patient do a single-leg squat. A positive test is pain at 30º of knee flexion similar to the Noble Test[15]. The third test is the Ober Test which is performed with the patient in side-lying on their unaffected side. With the patient's more affected leg in 90º of knee flexion, the therapist passively abducts and extends the patients hip while stabilizing the superior iliac crest, and slowly controls the leg into adduction caused by gravity. If the leg does not move into adduction it is a positive test and indicates ITB or TFL tightness[5,14]. The hip must be stabilized because if the iliac crest moves with the leg it can create a false negative. The fourth test is the Thomas test which can also be used to test iliopsoas and rectus femoris tightness. This test is performed with the patient in supine and their unaffected leg flexed at the knee and brought to their chest to eliminate lumbar lordosis. The affected leg is then slowly lowered passively by the therapist into hip extension. If the hip does not return to the table, it indicates tightness in the iliopsoas. If the leg reaches the table but knee flexion is less than 45° this would indicate rectus femoris tightness. If there is hip external rotation with either movement, it indicates ITB tightness [14,16].

The ultimate goal of treatment is to reduce the frictional force or compressional force of the ITB on the lateral femoral condyle. This can be accomplished through various conservative methods, however, if the lateral femoral epicondyle is excessively prominent, conservative treatments and pharmacotherapy fail to improve symptoms or the situation becomes chronic, surgical interventions may be warranted. One type of surgery involves a surgical excision of a triangular piece of ITB at the distal posterior aspect. This is where the ITB contacts the lateral femoral condyle and relieves some of the pressure at that problematic area by reducing contact area (*See Appendix C for Surgical interventions of* ITBS)[17]. In a study by *Martens et al.* this triangular cut surgery was successful in that all 19 patients were satisfied with the surgery, none of the patients had any negative functional damage, and all returned to sport, which included football, running and cycling, at a mean of 7 weeks[17]. A second type of surgery, is the "Z-lengthening" procedure. This involves exposing and separating the ITB from other tissue at the area around the lateral femoral condyle, then creating a longitudinal incision near the center of the band and two transverse cuts at alternate ends of the longitudinal cut to make a Z-shaped incision[18]. This creates two parallel strips of ITB that, when overlapped and sutured, create a thinner overall section that is less restrictive, again, at the problematic distal area near the lateral femoral condyle[18]. There was little follow-up data in this study by *Richards et al.*, however it did mention all patients' symptoms resolved after surgery[18].

These are two common surgical interventions for chronic ITBS that are used when the symptoms of ITBS cannot be resolved using conservative treatment. Both studies mention that surgical techniques should not be attempted until at least 6 months to a year of conservative treatment have been tried and symptoms still persist. These are not the only surgical interventions, but two that have been used with successful outcomes. Although these surgical techniques are successful, as physical therapists, it is our goal to avoid this outcome, by using conservative treatment options, in order to save the patient time, money and allow a faster return to activity.

Fredericson and Wolf, at Stanford, break down the ITBS conservative treatment into three phases: Acute, Subacute, and Recovery Strengthening[5]. During the Acute Phase, which is defined as the time during which inflammation and swelling are still present, the main goal is to modify or even stop activity that may be causing irritation[5]. This can be carried out by stopping running in one-direction on a track, stopping running downhill, or simply decreasing volume. However, if this does not work, a complete cessation of the repetitive activity should occur. Similar treatment to muscle strains outlined by *Jarvinen et al* should be utilized.[19] This can include decreased mobilization, ice, phonophoresis, and iontophoresis to decrease swelling[5,19]. NSAIDs can be an alternative method to reduce inflammation after 1-2 days of natural immune cell response. *Fredericson and Wolf* even go so far as to recommend a corticosteroid shot if symptoms have not begun to improve after 3 days[5].

During this Acute Phase, it is important to assess for regional interdependence and perform a review of systems to define the best underlying cause. An evaluation of gait mechanics can also provide information on muscle imbalances (i.e. excessive adduction may indicate relatively weak abductors on one side)[21]. A review and comparison of muscle tone bilaterally in the lumbar spine, hips, as well as bony malalignments at the sacrum and innominates of the pelvis, can also provide evidence for underlying causes of ITB tightness[21]. These abnormalities can be addressed with soft-tissue mobilizations and muscle energy techniques as outlined by *Shamus et al.* that are used to reduce tone and correct mechanical alignment (See Appendix F)[21].

This phase does not have any defined amount of time, however, several studies have shown that within the first 2 weeks after acute onset of symptoms, use of anti-inflammatory medication and corticosteroid use was effective at decreased pain and increased function[24,25]. In a RCT by *Schwellnus et al.,* 43 runners were divided into 3 groups: one group received a placebo, the second an anti-inflammatory (Voltaren), and the third group a combination anti-inflammatory and analgesic (Myprodol). The group with the combination anti-inflammatory and analgesic had the best outcomes of decreased pain and increased running distance in the first week of treatment[24]. In another RCT by *Gunter et al.,* 18 runners were divided into 2 groups: one group received a placebo injection, and the second group received a corticosteroid injection of 40mg methylprednisolone. The group receiving the corticosteroid injection had a 53.6% decrease in pain over the first 2 weeks[25].

During the Subacute Phase, defined as the point in time directly after inflammation has subsided, emphasis shifts to stretching and myofascial release[5]. Like the Acute Phase, there is no specific amount of time that has been agreed upon in the literature, and some authors have shown positive results from initiating stretching within the Acute Phase[21]. *Fredericson and Wolf* found that a standing, arm-overhead ITB stretch was superior to other standing ITB stretches in tissue lengthening and increased adduction moment (see Appendix D for a visual reference to this ITB stretch)[5]. This stretch is performed by extending and adducting the affected leg across the midline and behind the unaffected leg. The stretch is completed by pronating the foot on the affected leg[5]. Beyond stretching, myofascial release, either through manual therapy or a foam roller, can be effective at breaking up adhesions that contribute to increased friction and compression at the lateral femoral condyle[5]. The use of a foam roller for self-myofascial release has been shown to significantly increase knee joint ROM through this process[20]. Similarly, foam rolling combined with static stretching was shown to be effective at increasing joint ROM at the hip joint[20]. The use of a handheld roller massager for the break-up of adhesions has been shown to be effective at the knee joint in increasing joint ROM and neuromuscular efficiency, but less effective at the hip joint[20]. Therefore, both of these tools could be good, affordable recommendations for self-myofascial release (*See Appendix E)*.

After sufficient time has been spent decreasing inflammation, stretching and releasing myofascial tension, the individual should begin strength training exercises to gradually resume activity and to make adjustments for muscle imbalances. *Fredericson and Wolf* describe this as the *Strength Recovery Phase*[5]. There is no specific protocol that has been proven better than others in rehabilitating the ITB at this stage, however, general consensus in the literature is that most individuals respond well to strengthening of the glutes and hip abductors in order to decrease excessive adduction moment during the running cycle[22,23]. Runners prone to ITBS typically have underdeveloped hip abduction torque and weak hip abductors compared to runners who do not get ITBS and strengthening of these hip abductors has been shown to reverse the symptoms associated with ITBS[23]. Some sample exercises that can address these hip abductor weaknesses and that have been shown to be effective are:

1. Clam Shells: These can be performed in supine or sidelying using gravity or elastic bands for resistance. This isolates the gluteus medius for hip abduction and is performed with hips at 45 degrees and knees at 90 degrees. Feet are kept together and the knees are drawn apart[29.] (*See Appendix G*).

2. Bridging (Single & Double Leg support): This exercise addresses both the glute muscles and the abdominal core muscles. This is performed in supine with knees flexed to 90 degrees. The person presses into the mat with their feet and raises their pelvis using their glute and core musculature. Single-leg support can add opposing quadriceps engagement on the extended leg and hamstring activation on the supporting leg that mimic running biomechanics[29]. (*See Appendix G*).

3. Step Downs: This exercise addresses quadriceps weakness that may be present ITBS etiology stemming from downhill running. By increasing the eccentric quadriceps strength this will increase Delta-T and decrease the GRF, diminishing soft tissue force demand throughout the knee. This exercise is performed with a small step and can be performed in the mirror to prevent varus/valgus motion during the action of stepping down off of the stair. Although this exercise targets the leg remaining on the step, this exercise should be performed with both legs to avoid muscle imbalances due to training[29]. (*See Appendix G)*.

4. Lateral walking/Lunging: With or without the use of a Theraband the patient performs side-stepping which addresses hip abduction strengthening as well as balance. Like the *Step-down* exercise, this can be performed laterally or forward/backward[30]. This exercise can be further progressed with forward/backward/lateral lunges. (*See Appendix G)*.

In addition to directly addressing biomechanical abnormalities with muscle-energy techniques, stretching, myofascial release and strengthening, one needs to also address shoe wear. Shoes can play a major role in complications leading to ITBS, therefore by acknowledging this factor early, symptoms can be reduced quicker. As shoes become worn biomechanical abnormalities can become exaggerated as the sole of the shoe molds to the foot, which in turn aids the abnormal movement. Movements such as over-pronation leading to internal tibial rotation can lead to the exacerbation of ITBS because as Gerdy's Tubercle moves medially it wraps the ITB tighter around the lateral femoral condyle[26]. This creates longitudinal tension along the ITB and medial-lateral compression of the ITB against the lateral femoral condyle[26]. In a case series by *Pinshaw et al.,* the use of "softer" shoes, insoles, and heel flare removal had positive effects at reducing biomechanical errors that increased ITBS symptoms[26]. Insoles can be used both along the medial border to prevent over-pronation or as a heel lift to correct for limb-length discrepancy. The reduction of lateral flare of the running shoes decreases pronation during heel-strike and loading response, specifically initial pronation by diminishing upward GRF at the lateral border of the foot and medial rotational torque[27]. Rounding the heel of the shoe decreases this lateral upward GRF, leading to decreased pronation, tibial internal rotation and decreased tension force at the ITB[27]. In addition to transitioning to more cushioned shoes, running on softer surfaces can also help increase the time of joint loading. Increasing Δt, decreases the GRF, thereby increasing the time it takes the ITB to pass the lateral femoral condyle, and ultimately decreasing the frictional, compressional force at the location of pain[32].

A return to running or cycling is considered the fourth and final stage, although patients have shown improvement in ITBS with a return to run/sport within the first several days[21]. It is important that the patient avoid hard surfaces during their initial return and keep distances short, avoiding any pain associated with ITBS. The progression and goals for the volume of running will be determined by the patient's prior level of function, however, in the literature, patients initial return to running in the first several days did not exceed 2 miles and increases in distance were in increments of a ½ mile if the patient maintained an absence of pain[21]. Running frequency was recommended no more than every other day[21]. Additional preventative measures for patients returning-to-run, is to pick routes on even ground so as to avoid over-pronation from uneven surfaces during foot fall. Finally, running at faster speeds and with increased cadence has also been shown to reduce the symptoms of ITBS[32].

There are not many outcome measures mentioned relating to ITBS rehabilitation, however, two that may be useful for this population, that are easy and quick to administer, are the Visual Analog Scale (VAS) for pain and the Lower Extremity Functional Scale (LEFS) for functional movements and ADLs[21,31]. The VAS is a simple scale ranging from 0-10 in which the patient rates the severity of pain from 0, no pain, to 10, excruciating pain. The LEFS is a 20-item self-reported questionnaire that ranks each item on a 5-point Likert scale of 0, “extreme difficulty/unable to perform” to 4, “No Difficulty”[31]. The LEFS measures the difficulty of specific activities such as “putting on shoes”, “walking a mile”, “running on uneven ground”, and “going up or down 10 stairs” that may be affected by ITBS[31]. An improvement of nine points on this scale would represent a minimum level of detectable change and may be a good goal for monitoring improvement with rehabilitation in this population[31].

Iliotibial Band Syndrome is a very treatable impairment that tends to respond well to conservative treatment with physical therapy. Very rarely will individuals with this syndrome need surgical interventions. However, it is important to differentially diagnose for other pathologies of the hip or knee in order to rule out other degenerative disorders and stress fractures. As these injuries are also common in distance athletes that put themselves under a lot of repetitive lower-extremity stress. It is important to first determine the underlying cause of ITBS. Regional interdependence can play a major role for this type of injury. Therefore, differential diagnosis should include screening the length of the lower-extremity chain from gait dynamics of the foot to muscle and bony abnormalities of the lower back. Once ITBS is determined, management of inflammation and correction of the root cause should be the first goal of treatment. Some of these underlying abnormalities include innominate tilt, sacral rotation on the ilium, leg-length discrepancies, foot pronation, excessive hip adduction due to inadequate hip abduction strength, and tibial internal rotation. These can be caused by poor footwear, running downhill, running one-direction around a track, having the seat to high on a bicycle, or increasing the volume of training too quickly. By addressing one or more of these root causes, decreasing inflammation, incorporating stretching, myofascial release, and re-strengthening hip abductors, a return to running and cycling after ITBS can be achieved successfully.

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