A Literature Review of Shin Splints: Etiology, Treatment and Prevention

By
Mark Farthing

Advisor: Daryl Ridgeway, D.C.

Abstract

Recurrent pain in the lower leg cause by exercise is a common problem in athletes today, especially runners. This leg pain is often diagnosed by doctors as shin splints. Shin splints accounts for an estimated 60 percent of all overuse injuries of the leg. Shin splints are a common misdiagnosis though because it is technically not a diagnosis, but a symptom. The real culprits behind shin splints are usually one of three diagnoses: stress fracture, Medial Tibial Stress Syndrome (MTSS) and Lower Leg Compartment Syndrome. Many experts have advocated that the term "shin splints' be replaced by medial tibial stress syndrome, though the terms are not equivalent. MTSS has its own characteristic clinical presentation, as does stress fractures and compartment syndrome. For the purpose of this literature review, MTSS will compromise the bulk of the literature and information reviewed and discussed.

This literature review was performed using PubMed and EBSCO host to compile various peer reviewed journal articles to determine proper etiology, treatments, and prevention of MTSS as it applies to shin splints

Keywords: shin splints, overuse injuries, lower leg stress fractures, shin splints treatment, shin splint alternative care

Introduction

The purpose of this article is to describe and discuss the topic of shin splints. Exercise induced lower leg pain, often termed "shin splints" is a major problem that affects athletes, especially runners and jumping athletics. This overuse injury actually could be several different types of injury, as shin splints are a symptom, not a diagnosis. Most often chronic shin splints are due to Medial Tibial Stress Syndrome (MTSS), stress fracture, or less often Lower Leg Compartment Syndrome. Shin Splints accounts for almost 60 percent of all overuse injuries of the leg. This article will more accurately describe the etiology, treatment types, and prevention methods of shin splints, particularly as it applies to medial tibial stress syndrome,. This diagnoses was picked due to the fact that it is the most diagnosed cause of shin splints.

Discussion

Two causes of symptomatic shin splints

The most common causes of symptomatic shin splints are Medial Tibial Stress Syndrome (MTSS) and stress fractures. The amount of clinical evidence afforded by this diagnosis increases as the methods employed to conduct them become more detailed and elaborate..

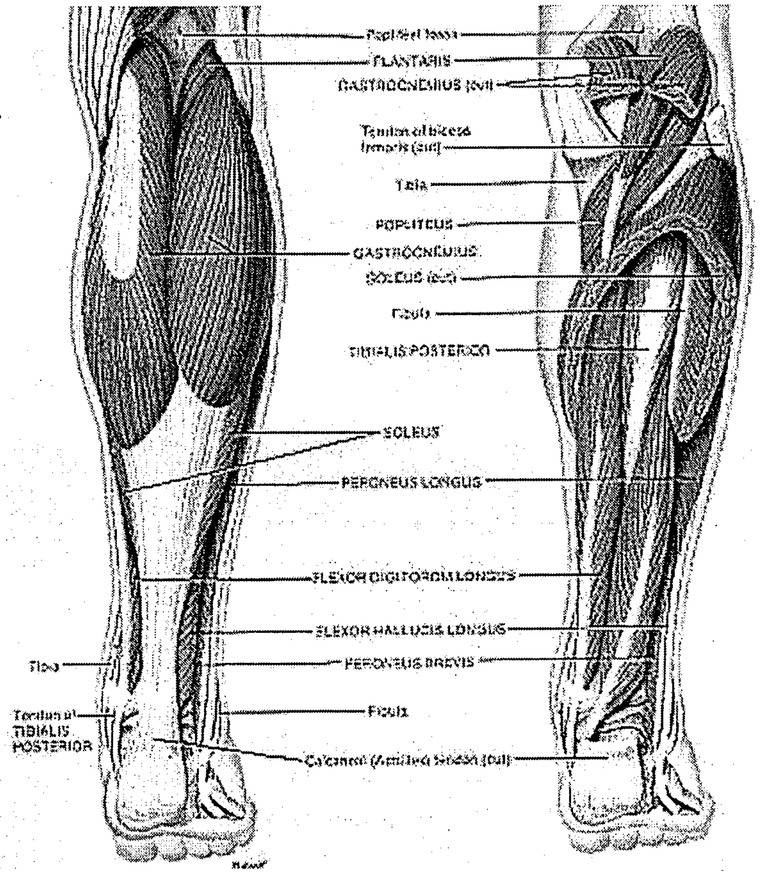
MTSS

Etiology

Medial Tibial Stress Syndrome (MTSS) is classified when the pain and tenderness is noted adjacent to the bone along the periosteal-fascial junction generally in the distal two-thirds of the tibia.(7) Occasionally, pain can also be elicited by maneuvers that contract or stretch the soleus, such as active plantar flexion against resistance, passive ankle dorsiflexion, standing on tiptoe, or jumping in place. Typically these patients are runners, although the condition is also seen in ballistic (i.e, jumping) activities such as basketball, dancing, or rackets sports.(7) Running places a tremendous stress on the lower extremities, as up to 250-300% of the runners body weight may need to be absorbed by the musculoskeletal system at heel strike. That can be the equivalent of absorbing 375-450 lbs. Per heel strike for a 150-pound runner.(13) Over the course of 1 mile, the feet must endure this process between 1200 and 1600 times. Overuse injuries often result.(14) Early in the disorder, pain occurs at the beginning of a run, may resolve as the workout continues, and then recurs after the workout; or is occurs only at the end of the run. In the early stages, the pain usually resolves with several minutes rest, while in later stages the pain becomes more severe, sharper, and more persistent(15). In advanced stages of MTSS, the pain can complicate activities of daily living or can occur at rest.

As you can see from the diagram to the right, there are many muscles and tendons that make up the lower leg, or calf region. It's quite a complex formation of inter-weaving and over-crossing muscles and tendons.

The main components of the lower leg that are affected by the pain associated with shin splints are:



The Tibia and Fibula.

The tibia is situated on the medial, or inside of the lower leg. While the fibula is situated on the lateral, or outside of the lower leg.(21)

There are also a large number of the muscles that attach to the tibia and fibula. It's these muscles, when overworked, that pull on the tibia and fibula and cause the pain associated with shin splints.(21)

Specifically, the pain associated with shin splints is a result of fatigue and trauma to the muscle's tendons where they attach themselves to the tibia. In an effort to keep the foot, ankle and lower leg stable, the muscles exert a great force on the tibia. This excessive force can result in the tendons being partially torn away from the bone.(8)

Detmer hypothesizes the pathogenesis of MTSS that the periosteum is traumatically disengaged from the bone either by ballistic avulsion of perisosteum off the bone or less frequently by subperiosteal bone stress on the tibia resulting in sufficient subperiosteal hemorrhage or inflammation to lift the periosteum away from the bone.(6) The powerful soleur muscle most probably causes these avulsions of periosteum, since it partially attaches medially into the fascia. He states that biopsy during this acute phase might reveal a periostitis with periosteal and fascial tissues still firmly attached to the tibia. However, detmer explains, in chronic cases, the periosteum will not be attached to the bone.(6) When performing fasciotomies on several patients with chronic MTSS symptoms, he noted that the periosteum was not attached to the bone, but consistently found adipose tissue between the periosteum and the underlying bone. In light of these observations, detmer described a better term for chronic MTSS would be a peristalgia rather than periositis.(6)

There can be several factors in going into the exact cause of MTSS. First, there are extrinsic factors. These extrinsic factors include training methods, surfaces and equipment, particularly shoes.(22) It is relatively easy to adjust the extrinsic factors, which may initiate stress reactions—improve and/or modify training technique, schedule, and intensity. With training methods, athletes tend to develop symptoms after training errors such as abrupt increases in frequency, duration, intensity, or changes in technique. Athletes and coaches should take care to initiate there training programs at a comfortable level or intensity, and institute changes gradually.(22)

The type and inclination of a training surface can influence tibial stress and strain. Stairs, sloped or banked surfaces, curbs, and irregular surfaces such as grass, sand, and gravel can increase strain. A level, uniform surface of moderate firmness is desirable but not always available. Athletes should vary training surfaces, avoiding abrupt changes.(1)

Footwear is the athletes most important ally in shock absorption. Good running shoes area also lightweight. Shoes lose the ability to absorb shock after 500 to 800 km (a bout 300 to 500 miles) of running. Worn-out shoes can predispose the athlete to injury and should be replaced.(11)

Intrinsic factors for causing MTSS are unique to individual athletes. Previous injury is perhaps the most important risk factor in acquiring MTSS.(6)

Anatomic malalignment or asymmetry is a common source of excessive biomechanical stress to ligaments, muscles, and bones of the lower extremity.(20)

Excessive pronation, which is the rolling inward of the hindfoot and midfoot beyond the normal acceptable parameters during standing, walking, or running tends to play a major role in shin splints.(14) This may be caused by either arch collapse (acquired) or poor arch development (developmental). In either case, excessive torsional forces are transmitted form the overpronated foot into the leg with each step taken.(14) During the gait cycle of a normal, healthy foot, there should be a rolling inward of the foot/ankle complex, with internal rotational the leg upon contact and a rolling outward with external rotation as the foot moves into midstance and toe off. Both are required to effectively dissipate heel strike shock at the subtalar joint and knee. Prolonged internal rotation of the lower extremity caused by excessive pronation transmits stress up to the pelvic region. There is increased stress at the knee. Inward rotation of the femur brings the greater trochanter forward and outward, stretching the piriformis muscle.(14) Because the piriformis muscle originates at the anterolateral aspect of the S2-S4 segments, the hip/pelvis/sacrum rotation patterns commonly associated with myofascial back pain.(14)

Pelvic unleveling may develop because of excessive pronation. The presenting condition of leg length inequality is usually revealed during the clinical examination, postural evaluation, or an anteroposterior lumbosacral radiographs.(14) It must be determined if the discrepancy is attributed to an anatomical/structural short leg or from a functional short leg caused by a biomechanical deficit in the biostatic chain of the lower extremity and or pelvis.(14)

Inadequate rehabilitation from another injury, or a tendency toward poor technique may contribute to a patient's injury pattern. Poor training technique, such as downhill or uphill running, or running on one side of the road or a banked track only, where angulation of the road increases the weight bearing stress and shear forces to one side of the lower extremity more than to the other.(15)

Muscle strength and flexibility is a somewhat controversial issue on the effect muscle has on bone. Contraction of the gastocnemius and soleus muscle group can bend the tibia in much the same way that a taut bowstring bends a bow. Thus, high plantar flexion strength and decreased range of motion in dorsiflexion have been demonstrated in patients with tibial stress injuries. Conversely, a weak or fatigued muscle cannot dissipate mechanical stress effectively, so the stress is transmitted to the bone, thereby increasing the risk of injury. This phenomenon may occur more quickly in athletes who have underlying anatomic malalignments.(14)

Diagnostic Testing

Various types of diagnostic imaging has been done to differentiate between stress fracture and MTSS, including MRI, plain x-ray, myleography, and triple phase bone scan, and the thought to be the most important, the physical exam. Studies done using MRI for acute symptom MTSS show changes with bone stress injury, though images tend to be normal in patients with more chronic symptoms.

A study done be Batt et al. on the prospective controlled diagnostic imaging for acute shins splints, physical examination revealed that hyperpronation was the most frequent abnormality (6 out of 23 people), followed by genu varus (4/23), cavoid feet (2/23), femoral anteversion (2/23), 1/23 with leg length discrepancy, and on subject with decreased hip range of motion ipsilateral to shin pain. This study showed that biomechanical abnormalities played a part in the symptomatology of shin splints.(5)

Williams states clinical evaluation of stress reactions is challenging; clear objective findings are usually not evident. Palpable pain within the muscle and pain with resisted activity suggest a myositis or tendonitis. However, deep palpation that discovers pinpoint tenderness directly over the bone may reveal a stress reaction worthy of following up with more advanced diagnostic imaging.

Radiographs initially are nearly always normal. If the duration of the pain exceeds three to four weeks, hypertrophy of the cortex may be noted.

Intramuscular pressure testing has been done to differentiate MTSS from compartment syndrome. A study done by Mubarak et. al did just this with 12 patients that demonstrated MTSS symptoms (shin splints) , and that where non-responsive to conservative therapy. The physical findings in all patients were specific. There was a well-localized area of tenderness over the posterior-medial edge of the distal on-third of the tibia. No motor, sensory, or circulatory disturbance was found. The patients frequently exhibited excess pronation of their feet. The wick catheter technique were used to measure intramuscular pressure in the superficial and deep posterior compartments before exercise, during exercise, and for 15 minutes after exercise. The deep compartment pressures at rest, pre-exercise, and post-excercise were within the normal limits of the control subjects. (4)Only the exercise pressures were slightly elevated. All of the measurements were considered below the levels in patients with the chronic anterior compartment syndrome. Their data led them to believe that the medial tibial stress syndrome does not represent a compartment syndrome. (4)

Triple-phase bone scintigraphy has shown to be an easy way to differentiate MTSS from tibial stress fracture. The classic longitudinally oriented diffuse tracer uptake, visible only on delayed-phase images, virtually guarantees the diagnosis of MTSS. In contrast, a tibial stress fracture appears as a focal, fusiform tracer uptake. According to a study by Batt et al., Triple Phase Bone Scan findings were found in 30 of 46 symptomatic tibia. In contrast MRI had 3 of 30 positive findings in symptomatic tibia. Triple phase bone scans are typically positive within 3 days of symptom onset and are highly sensitive (reportedly between 84% and 100% accurate) for tibial stress injuries. (10)

Treatment

The mainstay of treatment for any stress injury is to remove the inciting stresses. Relative rest, including avoiding the activity that provoked the symptoms, is essential. Rest continues until the patient is pain free- while walking, and patients may require the short-term use of casting or crutches. Alternatively, use of a tibial walking boot allows for ambulation while reducing some of the stress on the leg. Mild MTSS may require only a few days of rest.

Acutely, some effective adjunctive treatment is ice massage. Ultrasound, therapeutic massage, phonophoresis, anesthetic injection, and whirlpool baths may also offer some benefit. Analgesia can be obtained with nonsteroidal anti-inflammatory drugs, but these drugs likely do not alter the course of the patients disorder. Some clinicians use applied electrical fields to stimulate the rate of stress fracture healing and to reduce recovery time from MTSS.

Specific muscle strengthening exercises are often prescribed immediately after the diagnosis of a tibial stress injury, although it appears that acutely injured patients should avoid excessively stretching the triceps surae or engaging in leg muscle strengthening exercises because these actions may exacerbate tibial stress. The anterior tibialis stretch is recommended by Gardner, this puts the foot in plantar flexion and, with gentle pressure leaning back, stretches the soft tissue in front of the shin. Pain free lower extremity strengthening can be used to strengthen the anterior tibialis, and heel raises will strengthen the gastrocnemius. Gradual progression of these exercises is necessary to prevent further irritation of the tissues. Once training resume, an adequate stretching regime with warm-op and cool down is essential.

As the athlete resumes training, the initial intensity, duration, and distance should be approximately 50% of pre-injury levels. These parameters can gradually increase by 10%to 15% per week if the patient remains a symptomatic, thus progressing to pre-injury levels in approximately 3 to 6 weeks. Cross training can reduce stress in a previously injured area and reduce the chance of recurrence. Aerobic fitness can be maintained by continuing participation in non-or reduced weight bearing exercises such as swimming, cycling, or pool running.

Patients with hyperpronated ankles may benefit form orthoses. In-shoe orthotics has been called "the only method of controlling overpronation at the subtaler joint".(12) Blake and Denton performed a retrospective study of 180 patients (primarily runners) who received functional foot orthotics. The diagnosis included foot/ankle, knee, leg, and hip conditions. The success rate was greater than 70%. Orthotics designed to correct excessive pronation will need an effective, built in, shock absorbing material to help dissipate shock forces. It has been found that Zorbacel can dissipate more than 90% of the energy of deformation, yet fully return to shape on removal of the force well within the interval between steps.(1,12) A study done by Dross et al. on the effectiveness of orthotic shoe inserts in the long-distance runner found that orthotic inserts are very effective in the treatment of lower leg overuse injuries, especially shin splints. Of the 17 runners reporting shin splint symptoms, 11 stated to have a complete cure or greater improvement with orthotic inserts. 3 runners reported slight or no improvement, and zero reported the orthotics making the pain worse. 2 runners did state developing a new problem. Gross concluded that when used correctly, orthotic shoe inserts are beneficial for a broad range of disorders (due to biomechanical variables) experienced by long-distance runners.(1) Standard off the shelf three quarter length orthoses or shoe inserts designed to support medial longitudinal arch will often-correct hyperpronation associated with pes planus. Depending on the degree of pronation and its effect on the forefoot, the orthotic may have a medial post or wedge built into the heel to help stabilize the calcaneus from rolling too far inward. Creating bilateral symmetrical foundation in the correct physiologic range for weight bearing feet will aid in natural balancing and stabilization of the spine. More marked malalignments caused by forefoot varus or hindfoot varus may require custom orthoses designed with medial forefoot or heel posting. Misalignment of the knee, hip, or pelvis may benefit from the institution of appropriate physical therapy or manipulative techniques as those from a chiropractor.(1)

William Austin D.C did a case report on shin splints and underlying posterior tibial tendonitis. His approach to treatment was slightly different than the medical doctors and physical therapists. His first patient was 42 y.o. male recreational middle distance runner weighing 167 pounds, and suffering from chronic right anterior low leg pain. The patient was a well-conditioned athlete accustomed to running a base of 20-25 miles/wk. 3 months before treatment; he abruptly increased his mileage to 40-60 miles/wk in preparation for an upcoming marathon. The onset of pain manifested approximately 2 weeks after mileage increase. The patient consulted his family M.D., who diagnosed the condition as shin splints and prescribed rest and NSAIDS. Symptoms returned with full intensity within one week.(12)

Upon examination, the right anterior compartment of the lower leg was tender to palpation along the lateral border of the tibia. The belly of the anterior tibialias muscle was felt to be swollen in comparison with the left. No palpable pain was elicited on the medial border of the tibia. Acute pain was elicited on palpation of the ankle inferoposterior to the medial malleolus. Though no obvious weakness was noted, an increase of pain and compensatory flexion of the toes was noted with manual muscle testing of the posterior tibialis muscle. These two signs—palpable pain inferior.posterior to the medial malleolus and pain with active resisted ankle inversion—are suggestive of posterior tibial tendonitis. Moderate pelvic unleveling was suspected via palpation but standing radiographs were taken to confirm this. Extreme asymmetric flexible hyperpronation was noted bilaterally. The apparent medial longitudinal arch, noted when the patient placed no weight on his foot, clearly "flattened" upon weight bearing because of excessive motion of the mid-and hind-foot medial rotation.(12)

A multifaceted treatment approach was used. Custom-made, flexible orthotics to support the skeletal alignment in a more appropriate range for weightbearing posture-provided increased heel-strike shock absorption and enhanced afferent-motor response. A long axis distraction adjustive technique was administered to enhance muscle relaxation, circulation and pain reduction. Manipulation of the navicular, cuboid, and metatarsal heads was administered bilaterally to prepare the feet for the custom –made orthotics, and to reduce the break in period. Ice massages were recommended every 2 hr while the pain was acute, with an increase in the time interval as indicated by pain reduction. Specific chiropractic adjustments to the knees, hips, and spine were administered as required. Rehabilitation of the invertors (primarily the posterior tibialis) and the evertors were strengthened with low-tech resistive exercises. The protocol consisted of three sets to fatigue, starting with the unaffected side first to institute neurologic facilitation via the cross over mechanism. The exercise was done in the pain free range of motion.(12)

After 2 weeks of care, the patient was able to begin the return to activity as described above, with strict precautions to stop if pain increased at all. After 3 weeks of care, he was able to resume running at a moderate pace and distance (2 to 3 miles every other day). After 6 weeks, he was running 40 miles/wk without pain and was released from care. Approximately 3 months after being released form care, this patient was able to complete the marathon without re-injury.(12)

For female athletes with menstrual disturbances, regulating estrogen levels with oral contraceptive pills may be attempted. Research to date has provided conflicting results regarding the impact of oral contraceptives on bone mineral density and the incidence of stress fracture, although the potential advantages of this hormonal therapy appear to outweigh the risks for most women.

In rare cases, when symptoms of MTSS persist for months to years despite conservative treatment, surgery is an option. Posterior fasciotomy can improve symptoms by reducing the pull of the soleus and deep compartment muscles, but patients should be informed that results are variable. Complete resolution of symptoms and uninhibited return to pre-injury activity for all patients is probably unrealistic. Surgical fixation may also be required for tibial stress fractures that progress to nonunion despite of this hormonal therapy appropriate conservative therapy.

The role of surgery has been studied by Abramowitz et al. involving MTSS. He describes his results with 5 patients with seven affected limbs that eventually required surgery for the MTSS condition. Abromowitz defined MTSS as a clinical entity that as most commonly identified in long-distance runners and athletes involved in jumping sports.(24) The patients typically complained of exercise induced pain along the distal and/or middle third of the posteromedial tibia. The patients who eventually required surgery had experienced pain with the activities of daily living. All patients has a complete workup, including roentgenogram studies, bone scans, and compartment pressure measurements to rule out other entities. Overall, 4 women and 1 man in age from 16 to 44 years, and on physical exam had palpable tenderness over the area of posteromedial tibia. All patients had bone scans and three limbs demonstrated mildly increased uptake diffusely along the distal third of the posteromedial tibia. No patient had scan results consistent with stress fracture. The average duration of symptoms was 1.5 years.(24)

Surgical treatment was performed as follows: the fascia and periosteal attachments of the deep posterior compartment, namely the tibialis posterior and flexor digitorum communis attachments, were subperiosteally elevated and detached from the distal posteromedial third of the tibia. This was taken proximally as far as the soleus bridge. The fascial sheath of the posterior tibialis muscle was identified as far as the approach would allow. Finally, a standard fasciotomy was also performed for the superficial and deep posterior compartment. No biopsies were performed at surgery.(24)

For the next 4 to 6 weeks, patients performed stretching and strengthening exercises and were allowed to return to jogging at 6 weeks post-op. Full return to activity was allowed between 2 and 3 months.(24)

Follow up to these patients was within in a range of 2-6.5 years. For the 7 limbs that underwent surgery, none of them reported feeling excellent. 2 were good, and 5 were fair. This corresponded to a 71% unsatisfactory rate.(24)

Conclusion

Shin splints, when associated with MTSS can be very complicated to diagnose, treat, and even explain. Diagnosing is best done with examination of foot and lower extremities and observing the biomechanics and gait of these joints. Scintigraphy also allows you to distinguish between MTSS and stress fractures. Many treatments have been attempted, but holistic chiropractic and rehab treatment seemed to be the most affective. Etiology of MTSS shin splints appears to be from biomechanical abnormalities, weather it be in the foot, or even the hip and knee. Orthotic shoe inserts seem to correct these biomechanical problems, along with chiropractic manipulation of the lower extremity joints. Muscular rehabbing of imbalanced structures also showed to help in correcting the biomechanical errors. Proper training and training surfaces, and wearing decent shoes also showed to be effective in preventing shin splints. Historic treatment of ice, rest, and NSAIDS is still good for acute symptoms, but will not cure any underlying problems, and pain can still persist. Surgery showed to not be a good option in the role of MTSS, and should be avoided. Surgery may give relief in compartment syndrome shin splints.

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