Sports Medicine and Rehabilitation Journal

Review Article
Published: 20 Oct, 2016

Advances in Understanding Medial Tibial Stress Syndrome

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Abstract

Medial tibial stress syndrome occurs across many types of sports that involve running. It is a common injury with an unclear etiology. Thus, it is difficult to prevent and to treat when we do not yet understand how the injury occurs. Since 2012, there have been several research studies investigating different aspects of MTSS. The purpose of this paper is present the most impactful research evidence to date regarding the etiology, diagnosis, risk factors, and treatment of MTSS.

Keywords: Tibia; Bone stress injury; Shin splints; Running injuries

Background

Medial tibial stress syndrome (MTSS) is a common injury in athletes that run. It can occur regardless of surface type or shoe type. It is characterized by distal medial tibial pain that is often worse in the mornings and again in the evenings. If not treated at least by rest and unloading the tibia, it can lead to debilitating functional loss not only in the patients' sport but also affecting their work in recalcitrant cases. While the symptomology of MTSS is fairly well understood, the etiology of the injury is still unclear. This creates problems with differential diagnosis and treatment plans. Recently, we have gained a better understanding of what happens within the tibia to cause the symptoms of MTSS, though we still are not clear about the forces that create the injury [1]. The purpose of this article is to present the latest research findings in our search for the true etiology and appropriate treatments of MTSS. Specifically, etiological studies, diagnostic studies, risk factor studies and treatment studies are presented.

Etiology

Etiology is one of the most important areas to consider for any injury. We cannot provide the most efficacious prevention, treatment, or rehabilitation programs if we do not yet clearly understand the true etiology of the injury. In a review manuscript in 20151, the authors repeat that we are still unclear on the true etiology of MTSS, despite several high quality research studies published on the injury recently. For years, common opinion was that the etiology of MTSS involved a muscular/tendon strain-induced periostitis at the bone/muscle interface. Yet anatomical research studies have demonstrated that there is little muscle attachment in the central 1/3 of the posterior medial tibia (including only part of the soleus and flexor digitorum longus), and none directly into the distal 1/3 of the posterior medial tibia [2-4]. In this distal 1/3 area where most symptoms present, the deep crural fascia has the only anatomical structure attachment. In no recent studies has the posterior tibialis muscle been found to attach in any related area of symptoms of MTSS [2].

Biopsy studies have been a valuable tool in defining aspects of MTSS for decades. With fair consistency, bone biopsy studies have demonstrated that only 23-54% of MTSS cases actually present with periostitis [5,6]. In a recent study, the authors reported that in 52 athletes with MTSS, bone marrow or periosteal edema was seen on MRI in only 43.5% of the symptomatic legs, while the absence of periosteal and bone marrow edema on MRI was associated with longer recovery from MTSS [7]. This suggests that MTSS is not defined by periosteal edema. In 2016, a case-control study involving 42 participants demonstrated that periosteal edema was present in only 53.3% of MTSS cases - but also present in 37% of the control athletes [8]. The authors' conclusion was that periosteal and tendinous findings seem to be common in both athletes with and without MTSS, and consequently are not associated with MTSS. Since the late 1980's, common opinion has been that MTSS is a precursor to tibial stress fracture, meaning if left untreated then MTSS would develop into a stress fracture. Recently however, Vicente et al. [9], reported a case of one patient having both MTSS and a tibial stress fracture concurrently in the same limb, which would discredit previous opinions that MTSS is a precursor to stress fracture. Indeed, these may not be on an injury continuum. In a 2014 etiological review article, the authors argue that cortical bone geometry and

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Received Date: *19 Sep 2016*
Accepted Date*: 18 Oct 2016*
Published Date*: 20 Oct 2016*

Citation:
Craig D. Advances in Understanding Medial Tibial Stress Syndrome. Sports Med Rehabil J. 2016; 1(1): 1005.

bone mineral density (BMD) differ between tibial stress fracture and MTSS patients, indicating there may be a different specific etiology involved in each injury [1].

It has been proposed that MTSS is a tension injury either from soleus, deep crural fascia, or flexor digitorum longus tension and/or from tibial bending [6,11]. What is known is that bone microtrauma occurs when bone is cyclically over-loaded over time. Because this process begins prior to injury signs and symptoms, it may proceed unnoticed. Eventually, the microtrauma occurring from tensile failure occurs at a level that our bone remodeling/repair process cannot keep pace with, and micro fractures occur within the microscopic lamellae structure in the superficial cortical bone [1]. Cortical bone under this cyclic loading may then fail in both tension and compression, with tension failure occurring first [1]. The unanswered etiological question is if the tension is occurring because of tibial bending/bowing (which could involve velocity of navicular drop type of issues), geometric size/shape of the tibia, and/or low BMD.

Clinical Diagnosis

Most research evidence regarding diagnosis of MTSS agrees that clinical diagnosis nor imaging should be used independently. Rather, they should both compliment the evaluation toward a concrete diagnosis. Clinical evaluation relies in majority with palpation along the central to distal thirds of the medial border of the tibia, which elicits sharp pain in affected patients. Pain with weight bearing is typically worse in the mornings and exacerbated by the end of a sport practice or full work day. The patient may have a pronated foot type, excessive navicular drop, medial calcaneal tilt, high body mass index (BMI), or may conversely have none of those risk factors, among others. MTSS can occur in inexperienced runners who have increased their mileage too quickly, but also occurs in trained distance runners.

In the early 2000's, triple-phase bone scans were the imaging test of choice for diagnosing MTSS. More recently, imaging studies have moved away from triple-phase bone scans toward MRI, given improved resolution with MRI technology [7]. The MRI or bone scan of a patient with MTSS will demonstrate diffuse bony injury, as compared to scans of tibial stress fractures which demonstrate very focal defined bony injury. These imaging tests along with the clinical evaluation can reliably diagnose a patient with MTSS. Indeed, research studies that include subjects with MTSS and a control group without MTSS often use both the clinical evaluation and imaging test in combination to define those participant groups.

Risk Factors

The most studied aspect of MTSS is risk factors. Since 2012 alone, numerous risk factor studies have been conducted [11-20]. While this would seem helpful toward understanding MTSS in greater detail, in fact each of these studies offers varying results. Some point to not only the degree of navicular drop, but the velocity of that drop correlating with MTSS [15-20]. Some point to higher body mass index (BMI), while others found no correlation between BMI and MTSS [14,18,20]. Some studies point to plantar flexor endurance and/or flexibility [15]. Bone mineral density and the geometry/size of the tibia have also been studied with demonstrated correlation to MTSS [12,21-23]. BMD, however, has been shown to be local to the injured area during the duration of the injury, yet returns to normal values after recovery from MTSS [21,22].

A significant limitation of many risk factor studies is the number of subjects, with some being as low as 5-6 per group. Thus, MTSS risk factor systematic reviews published in 2013, 2014, and 2015 each point out this limitation [18-20]. This may contribute to risk factor study outcomes being so variable. An example of this variability lies in that there are roughly as many pronation risk factor studies that demonstrate a correlation with MTSS as there are that demonstrate no correlation between the two. For the clinician, this is confounding.

Treatment

To date, few well-designed studies of MTSS treatments have been conducted [24-28]. This is understandable given that we do not yet clearly understand the etiology. It is more difficult to treat something when the cause is unknown. In a 2013 systematic review of MTSS treatments, the authors found none of the eleven included studies were sufficiently free from bias to make any recommendations [24]. The only treatments shown to potentially improve the condition beyond rest itself were extracorporeal shockwave therapy (ESWT) and fascial distortion model manual therapy [25-26]. The study investigating ESWT included 42 participants with MTSS divided into two groups. A significant difference was found between groups (p=0.008), with the ESWT group demonstrating a faster time to full recovery [25]. However, no randomization nor blinding was utilized. The fascial distortion model manual therapy investigation included 32 participants with MTSS with no control group or randomization. A significantly improved time to exercise tolerance and reduced pain scores (both with $p<0.001$) occurred within the average treatment time of 6.3 days [26]. It would be beneficial for both of these studies to be repeated with randomization and double-blinding in the future.

Treatments investigated but shown to have no significant effect on MTSS recovery include low-energy laser, iontophoresis, phonophoresis, stretching nor strengthening of lower leg muscles, compression stockings, lower leg braces, circumferential taping, pulsed electromagnetic fields, and pretibial corticosteriod injection [24-28]. Unfortunately then, treatment of MTSS remains an inexact science.

Discussion

We must gain a better understanding of the etiology of MTSS. The Winters et al. [24], study suggests that periosteal edema exists in athletes with and without MTSS [8]. Therefore, focusing on periostitis alone may limit our progress in understanding the etiology. Franklyn and Oakes suggest that cortical bone microtrauma occurs prior to presentation of clinical symptoms and could be a precursor to periostitis [1]. Perhaps we have been focused on the wrong potential etiological factors regarding tendon involvement at the site of signs and symptoms. Perhaps this involves only the tibia bone – either from repetitive bending/bowing, low BMD, and/or bone geometry/size. Tibial bending could be associated with or exacerbated by high-velocity, high-magnitude navicular drop, which also involves tibial rotation. Correlational studies between measurable tibial bending during loading and navicular drop magnitude and/or velocity may provide valuable insights into etiological factors of MTSS. Bone fatigue studies performed in the 1980's demonstrated that the number of cycles to failure in cortical bone was affected by the strain amplitude but not by the mean strain or maximum strain [29,30]. This may correlate with more recent similar studies demonstrating that both the velocity and magnitude of navicular drop was associated with MTSS [17]. If a high velocity navicular drop occurs, this would be transmitted up the kinetic chain through the cortical bone of the tibia, potentially creating a higher strain amplitude through the bone. This is an intriguing area for future research studies.

While MTSS risk factor studies are prominent in the literature, these studies have yet to help direct clinicians toward understanding how to prevent or treat MTSS. Not all athletes who have navicular drop incur MTSS. Not all athletes who incur MTSS have high BMIs. Athletes with low BMD do not all incur MTSS. For example, it is less clinically useful for the practicing clinician to know that BMD might be a risk factor, when they have no means or time to test every athlete on their cross country team for bone density. While the utility of risk factor studies serves to inform etiological theories of MTSS, investigations of true MTSS etiological factors would be more useful for the practicing clinician. A greater focus on etiological studies is warranted so that we may better understand the cause of this common injury, thus allowing better prevention, diagnosis, and treatment efforts.

Future Research Directions

There is clearly a paucity of well-controlled etiological research studies. These studies are needed in the form of prospective longitudinal studies, involving both imaging and biopsy elements. Velocity of navicular drop along with tibial bending/bowing studies may help illuminate etiological factors. Treatment studies are needed, but difficult to design, given we do not clearly understand the etiology of MTSS to date.

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