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Shin Splints - a hidden epidemic among runners and athletes: a review of the current state of knowledge

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ABSTRACT

Shin splints, also known as medial tibial stress syndrome (MTSS), are a common occurrence for runners and other athletes. It is characterized by pain along the inner edge of the shinbone, usually brought on by an excessive amount of strain on the muscles and bone. The purpose of this review paper is to analyze the current state of knowledge on the etiology, risk factors, diagnosis and treatment of shin splints. The paper discusses key risk factors, such as biomechanical abnormalities in foot alignment, training intensity, nutritional factors, as well as gender and body mass index. The importance of excessive foot pronation and rapid increases in training volume in the development of MTSS is pointed out. Pathophysiological theories, such as periosteal inflammation and overload bone damage, are also presented to explain the mechanisms of injury. Clinical history and imaging studies, particularly magnetic resonance imaging (MRI), which shows high sensitivity in detecting tibial lesions, play a key role in the diagnosis of MTSS. Treatment of shin splints requires a multifaceted approach, including rest, modification of training loads, physiotherapy and pharmacotherapy. Modern methods such as shock wave therapy and laser therapy are gaining ground, offering the possibility of faster tissue recovery. MTSS prophylaxis involves a gradual increase in training intensity, proper warm-up and optimization of running technique. The work points to the need for further research to improve diagnostic and therapeutic methods and more effective prevention in the athlete population.

Keywords: shin splints, medial tibial stress syndrome, runners

1. INTRODUCTION

Pain along the inner part of the tibia, known as "shin splints," is the result of inflammation of the tissue in this area. It is also often referred to as medial tibial stress syndrome (MTSS). Individuals such as military recruits, runners and dancers are particularly prone to this problem. Athletes who have recently changed or increased the intensity of their training, as well as those who have not

performed an adequate warm-up, suddenly increased their training distance or tend to hyperpronate their feet, are at risk. Among athletes, this condition may impair physical performance and restrict full participation in training or competition (Bhusari & Deshmukh, 2023). Medial tibial stress syndrome (MTSS) has been reported to affect between 13.6% and 20% of runners, and its prevalence can reach as high as 35% in military personnel. Increased loads and intensity of exercise can lead to MTSS and other bone injuries. Intrinsic risk factors include female gender, previous MTSS, high BMI, scaphoid bone subsidence, limited ankle and hip range of motion. Studies also indicate a link between vitamin D deficiency and a higher risk of stress injuries in recruits (Moen et al., 2009; Hamstra-Wright et al., 2014).

1.1. Aim of study

The purpose of this review paper is to make a comprehensive analysis of the current state of knowledge on medial tibial stress syndrome (shin splints), with particular emphasis on its etiology, risk factors, diagnostic methods, and treatment and rehabilitation strategies. The goal of the study is to systematically collect the knowledge that is currently accessible on this disease entity, which is a serious health issue for varsity athletes and runners. The objective is also to evaluate the efficacy of current treatment approaches and draw attention to current research gaps. This will assist direct further research and aid in the creation of better methods for athletes to avoid and treat the condition.

2. METHODS

Between January 1994 and January 2025, we searched PubMed, Embase, Scopus, Web of Science and Google Scholar for English-language papers on medial tibial stress syndrome (shin splints) using combinations of the terms “medial tibial stress syndrome”, “shin splints”, “runner”, “athlete”, “diagnosis”, “treatment” and “prevention”. Two reviewers independently screened titles, abstracts and then full texts. We included peer-reviewed human studies that examined causes, risk factors, diagnosis, treatment or prevention of the condition, and excluded animal work, non-English articles and very small case reports. For each eligible study we recorded basic design, population and main findings, and assessed quality with standard critical-appraisal tools. Because the studies were diverse, results were summarised narratively. No new ethical approval was required, as the review used only previously published data.

3. RESULTS AND DISCUSSION

Risk factors

Running biomechanics

Shin splint formation is greatly affected by biomechanical issues. One of the most commonly cited factors is excessive foot pronation, which leads to increased stress on the medial aspect of the tibia. It was shown that runners with excessive foot pronation were more likely to develop MTSS than those with neutral foot alignment (Willems et al., 2007). In addition, improper running technique, such as excessive heel strike or too much amplitude of lateral movement, can increase tibial stress (Milner et al., 2006).

Training volume

Training intensity and volume are important risk factors for developing shin splints. Sudden increases in running distance or intensity can lead to overloading of bone and muscle structures. The study was conducted on a group of Navy recruits, in whom the relationship between training volume and intensity and medial tibial stress syndrome was analyzed. The results indicate that those increasing their weekly running distance by more than 30% were significantly more likely to develop MTSS compared to those who gradually increased their training load. A significant factor in the development of this disease, according to Yates and White (2004), is a sudden increase in training load and intensity.

Nutritional factors

The role of calcium and vitamin D supplementation may be beneficial in helping to prevent overuse injuries such as medial tibial stress syndrome (MTSS). A study of U.S. Navy recruits found that women receiving 2,000 mg of calcium and 800 IU of vitamin D daily had a 20% lower risk of stress fractures compared to a placebo group. These results indicate that a sufficient mineral supply can strengthen bone structure. It can also reduce the risk of overload fractures from increased physical activity. Avoiding medial tibial stress syndrome may involve implementing dietary strategies that promote healthy bone mineral density (Lappe et al., 2008).

Other risk factors

Body mass index (BMI) is considered a potential factor that may influence the likelihood of developing medial tibial stress syndrome (MTSS). A study on a group of cross-country runners found that higher BMI was significantly associated with a higher risk of MTSS, while parameters such as foot arch height and foot length had no significant effect. In addition, there was a higher injury rate among women compared to men. The results suggest that prevention of MTSS should include monitoring body weight and an individualized approach to training loads (Plisky et al., 2007). Additionally, the type of surface on which running training was performed appears to be a significant risk factor. Exercising on rigid surfaces, such as concrete, can increase the impact forces on the lower limbs, potentially causing microscopic bone injuries (Azierski et al., 2024).

Pathophysiological theories

Theory of periostitis

The theory of periostitis posits that shin splints are the result of inflammation of the periosteum, the membrane covering the bone, caused by repeated microtrauma and strain. The periosteum is richly innervated and vascularized, which means that its irritation can lead to pain and inflammation. A study by Beck (1998) demonstrated that runners with MTSS exhibit histopathological changes in the periosteum, including inflammatory infiltrates and increased osteoblast activity, indicating an inflammatory response to overload.

Theory of overload bone damage

According to a widely accepted notion, medial tibial stress syndrome (MTSS) arises from recurrent microtrauma to the tibia brought on by mechanical pressures that are greater than the bone tissue's capacity to adjust. The body's natural healing mechanisms may not be able to completely heal the microfractures caused by this cyclical stress over time.

A study by Winters (2017), showed that runners with MTSS exhibit structural changes in the tibia, including an increase in its density as a response to overloading, which can promote microcracks and osteoclast activation. If exercise continues, a fatigue fracture may develop. The basis of fatigue fractures is an imbalance between the mechanical load and the bone's ability to withstand these loads.

According to Wolff's law, bone adapts to stresses by deforming within the limits of its elasticity, but when these limits are exceeded, microfractures and permanent damage occur. Osteocytes, acting as mechanoreceptors, respond to biomechanical stress by releasing signaling molecules such as VEGF, TGF-beta, COX-2 and IL-6, which initiate the process of bone remodeling through the recruitment of osteoclasts. Repeated stresses lead to excessive osteoclast activity, which weakens bone, and if there is an imbalance between resorption and new bone formation, complete bone disruption can occur (Azierski et al., 2024).

Other pathophysiological theories

In addition to mainstream theories, such as periostitis and overload bone damage, there are hypotheses that point to the role of muscles and fascia in the development of shin splints (MTSS). Anatomical studies have shown that the soleus muscle, the toe flexor longus (flexor digitorum longus), and the deep fascia of the lower leg attach at the site of typical MTSS symptoms, while the posterior tibialis posterior muscle shows no such attachment. This suggests that the tibialis posterior muscle may be a significant contributor to MTSS through a traction mechanism, resulting in microdamage and inflammation. The deep fascia of the lower leg may also play a role in transmitting mechanical loads. This theory underscores the complexity of MTSS pathophysiology, linking muscle and fascial overload (Beck & Osternig, 1994).

Diagnostics

Clinical manifestations and differential diagnosis

Pain in the tibia can occur in various locations, most commonly in the distal third of the tibia on the medial side, although it can involve the entire leg. In MTSS, pain is common in the medial part of the medial tibia, intensifies during movement, and subsides at rest, although in severe cases it can persist even at rest. The discomfort can radiate to the foot, and is sometimes dull and persistent in nature, especially worsening the day after exercise. It is crucial to differentiate MTSS from fatigue fractures and other overload injuries, which cause more localized pain and swelling. Diagnosis includes evaluation of posterior-medial tibial soreness, examination for tendonitis, fascial compartment syndrome or nerve compression (Deshmukh & Phansopkar, 2022). Pain along the posterior-medial

tibial margin may suggest medial tibial stress syndrome or a fatigue fracture. Palpation tenderness in an area ≥ 5 cm usually indicates medial tibial stress syndrome, while tenderness in an area < 5 cm suggests a fatigue fracture (Milgrom et al., 2020).

Diagnostic methods

Available imaging methods for diagnosing shin splints include x-rays (X-rays), computed tomography (CT), magnetic resonance imaging (MRI) and bone scintigraphy. X-rays, while often failing to show early-stage changes, are commonly used to rule out fatigue fractures, which may not become apparent until several weeks later, when ossification begins to form (Deshmukh & Phansopkar, 2022). In one study, 42 athletes with tibial pain were evaluated to assess the diagnostic capabilities of computed tomography (CT), magnetic resonance imaging (MRI), and bone scintigraphy for early tibial stress injuries. MRI showed the highest sensitivity (88%) and accuracy (90%) in detecting lesions, while CT and bone scintigraphy had sensitivities of 42% and 74%, respectively. MRI identified bone marrow edema and periosteal lesions, while CT was helpful in detecting osteopenia, the earliest sign of cortical damage. The findings indicate that MRI is the most effective diagnostic method, although CT may be helpful in cases with negative MRI results (Gaeta et al., 2005).

Treatment

The treatment of Shin splints requires a multifaceted therapeutic approach. In the initial phase of treatment, it is recommended that conservative methods be implemented, including rest and modification of training intensity to reduce inflammation and alleviate pain (Bhusari & Deshmukh, 2023). At the same time, physiotherapy plays a crucial role, with rehabilitation programs that incorporate stretching and strengthening exercises for the lower limb muscles, as well as manual therapy to enhance blood supply and tissue elasticity (Deshmukh & Phansopkar, 2022; Winters et al., 2013).

Pharmacotherapy, used mainly for short-term symptom relief, includes non-steroidal anti-inflammatory drugs (NSAIDs) to reduce pain and swelling. In the present context, it should be emphasized that the selection of NSAIDs must be individually controlled to minimize the risk of side effects, such as damage to the gastrointestinal mucosa, as confirmed by recent studies (Murphy et al., 2023). Contemporary treatment approaches, such as shockwave and laser therapies, are gaining prominence for their potential to promote tissue regeneration. The use of acoustic pulses in shock wave therapy accelerates the healing of muscle and bone tissues, while laser therapy utilizes light to enhance microcirculation and promote regeneration (Speed, 2014). Comprehensive rehabilitation programs include the sequential introduction of strengthening, stretching and eccentric exercises to improve muscle stability and flexibility of muscle-tendinous structures. Eccentric exercises, which involve controlled muscle elongation under load, increase tissue resistance to overload, a key factor in preventing the recurrence of MTSS (table 1). Return to sports activity should be gradual, while monitoring the biomechanics of movement and possibly correcting running technique to prevent recurrence (Winters et al., 2013; Murphy et al., 2023; Speed, 2014).

Tabel 1. Comparison of treatment methods of medial tibial stress syndrome (shin splints, MTSS)

Treatment method	Description
Conservative methods	Rest and modification of training intensity help reduce inflammation and alleviate pain.
Physiotherapy	Exercises to stretch and strengthen the muscles of the lower limb, along with manual therapy, to improve blood circulation and tissue elasticity.
Pharmacotherapy	Short-term use of nonsteroidal anti-inflammatory drugs (NSAIDs) to reduce pain and swelling, with individual drug choice to minimize the risk of side effects.
New methods	Shock wave therapy (stimulation of bone and muscle structure repair) and laser therapy (improvement of microcirculation and acceleration of regeneration).
Rehabilitation program	Sequential introduction of strengthening, stretching and eccentric exercises that improve muscle stability; gradual return to sports activity while monitoring the movement's biomechanics..

Prevention

For runners and athletes, preventing medial tibial stress syndrome (MTSS), also known as "shin splints," is crucial in reducing their risk of injury. By gradually increasing training intensity, core preventive measures reduce the risk of microtrauma, allowing the musculoskeletal system to adjust. Creating a customized training regimen that meticulously adjusts exercise volume and intensity helps ensure that physical demands remain within the body's adaptive range (Warden et al., 2014). Properly selected footwear reduces the uneven distribution of forces acting on the lower limbs, which reduces overloads in the shin area (Lavigne et al., 2023).

Exercise programs that aim to strengthen the shin muscles and improve overall biomechanics of movement are also important. Regular training, including strength, stabilization, and proprioceptive exercises, contributes to increasing the resistance of muscle-tendinous structures to loads and promotes proper movement dynamics, resulting in a lower chance of injury (Warden et al., 2014; Leppänen et al., 2014). Equally important is the education of athletes and coaches, the aim of which is to raise awareness of proper training techniques, load progression principles and injury prevention methods. Providing knowledge on movement ergonomics and regeneration principles is the foundation for creating preventive strategies that enable long-term, safe return to physical activity and minimize the risk of MTSS recurrence (Jimenez-Garcia et al., 2023).

4. CONCLUSIONS

Analysis of medial tibial stress syndrome (MTSS) reveals that this condition arises from the accumulation of micro-injuries resulting from improper biomechanics of movement and a rapid increase in training loads. The complexity of the pathophysiological mechanisms underlying the development of MTSS is highlighted by the hypothesis of periostitis and the mechanisms of bone overload damage. The exact identification of structural alterations in the bone and surrounding tissues is made possible by early diagnosis with magnetic resonance imaging. A complete approach is required to manage medial tibial stress syndrome, which usually includes modifying training intensity, combining physiotherapy, and, if required, utilizing non-steroidal anti-inflammatory medicines for temporary relief. Shock wave and laser therapy are examples of advanced treatment methods that have demonstrated potential in accelerating tissue recovery. Using orthopaedic insoles, wearing properly fitting shoes, and gradually increasing exercise loads are crucial preventative measures. Early detection of MTSS symptoms and prompt administration of focused therapy are made possible by regular patient monitoring. Due to their significantly increased risk of MTSS, athletes and military recruits should pay particular attention to this issue. Identifying new risk factors and enhancing preventive and treatment methods should be the primary goals of future studies. To effectively avoid overuse injuries and improve the standard of medical care, more research in the field of MTSS is essential.

Author's Contribution

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Informed consent

Not applicable.

Ethical approval

Not applicable.

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Conflict of interest
The authors declare that there is no conflict of interest.

Data and materials availability
All data sets collected during this study are available upon reasonable request from the corresponding author.

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