

Medial Tibial Stress Syndrome: Evidence-Based Prevention

Debbie I. Craig, PhD, LAT, ATC

Northern Arizona University, Flagstaff, AZ

Reference: Thacker SB, Gilchrist J, Stroup DF, Kimsey CD. The prevention of shin splints in sports: a systematic review of literature. *Med Sci Sports Exerc.* 2002;34(1):32-40.

Clinical Question: Among physically active individuals, which medial tibial stress syndrome (MTSS) prevention methods are most effective to decrease injury rates?

Data Sources: Studies were identified by searching MEDLINE (1966-2000), Current Contents (1996-2000), Biomedical Collection (1993-1999), and Dissertation Abstracts. Reference lists of identified studies were searched manually until no further studies were identified. Experts in the field were contacted, including first authors of randomized controlled trials addressing prevention of MTSS. The Cochrane Collaboration (early stage of Cochrane Database of Systematic Reviews) was contacted.

Study Selection: Inclusion criteria included randomized controlled trials or clinical trials comparing different MTSS prevention methods with control groups. Excluded were studies that did not provide primary research data or that addressed treatment and rehabilitation rather than prevention of incident MTSS.

Data Extraction: A total of 199 citations were identified. Of these, 4 studies compared prevention methods for MTSS. Three reviewers independently scored the 4 studies. Reviewers were blinded to the authors' names and affiliations but not the results. Each study was evaluated independently for methodologic quality using a 100-point checklist. Final scores were averages of the 3 reviewers' scores.

Main Results: Prevention methods studied were shock-absorbent insoles, foam heel pads, Achilles tendon stretching, footwear, and graduated running programs. No statistically significant results were noted for any of the prevention methods. Median quality scores ranged from 29 to 47, revealing flaws in design, control for bias, and statistical methods.

Conclusions: No current evidence supports any single prevention method for MTSS. The most promising outcomes support the use of shock-absorbing insoles. Well-designed and controlled trials are critically needed to decrease the incidence of this common injury.

Key Words: shin splints, injury prevention methods, stress injuries, running injuries, tibial injuries

COMMENTARY

Medial tibial stress syndrome (MTSS) is one of the most common lower leg injuries in sports. Some studies show it accounting for 6% to 16% of all running injuries and also being responsible for as much as 50% of all lower leg injuries reported in select populations.^{1,2} Athletic trainers have been attempting to prevent MTSS through various methods for years. But which methods have worked? What exactly causes "shin splints"? Can we prevent MTSS? As clinicians working with running athletes or patients, we must thoroughly understand MTSS in order to develop effective prevention methods.

Thacker et al³ provided a high-quality review of the literature on prevention of MTSS. However, limitations were noted in the 4 studies included in the review. None of the 4 groups reported appropriate randomization procedures or whether participant assignment to groups was blinded. Extraneous variables (such as amount of outside physical activity, type of surface, and level of prestudy fitness) were not well controlled, compromising the ability to generalize results. Lastly, statistical analysis was inadequately reported in all 4 studies, ranging from a lack of description of the statistical testing methods to no report of power scores to a lack of multivariate analysis use when appropriate. The years of publication of the 4 studies were 1974, 1983, 1986, and 1990. Although these studies were more than 15 years

old, they were the only studies of the 199 total identified studies that compared prevention methods for MTSS.

Since the Thacker et al³ review was published, a significant amount of literature has been added on this topic. This additional literature will inform athletic training clinicians regarding the clinical relevance of the material and will suggest future research directions that may provide a better understanding of both the causes and prevention of MTSS.

Experts do not agree upon the cause of MTSS.⁴⁻¹⁰ With the cause unknown, prevention is very difficult. Proposed risk factors associated with MTSS are increased foot pronation, increased muscular strength of the plantar flexors, increased varus tendency of the forefoot or hindfoot (or both), an abrupt increase in training intensity, inadequate calcium intake, hard or inclined (or both) running surfaces, inadequate shoes, and previous injury.^{2,9,10} Most of these risk factors can be controlled. However, until we better understand the true causes of MTSS, attempting to control all of these risk factors for all of our athletes is nearly impossible.

Exactly how the soleus muscle is involved with medial tibial pain is unclear. Some researchers¹ attributed MTSS pain to the disruption of Sharpey fibers, which connect the medial soleus fascia through the periosteum of the tibia to insert into the bone. Others^{4,8} suggested that MTSS is a consequence of repetitive stress imposed by impact forces that eccentrically fatigue the soleus,

which creates repeated tibial bending or bowing, in turn overloading the bone-remodeling capabilities of the tibia. Stress microfractures might be created that present symptomatically as MTSS but are not confirmed with radiologic findings.¹¹ Many groups^{1,2,4,5,7-10} found that increased pronation was correlated with MTSS. Messier and Pittala¹² showed that not only was increased pronation significant in participants with MTSS, but the maximum velocity of pronation had a greater correlation in those with MTSS than did pronation alone.

Efforts have been made to determine the efficacy of certain prevention methods, but most of these studies have had serious design or control flaws, as noted in the reference article.³ The mean quality scores in the 4 studies included in the reference article ranged from 29 to 47 on a 100-point scale. Low ratings were due to design, bias, and statistical-method flaws. Thus, better-controlled prevention studies with large numbers of participants are needed. Many of the investigations with large numbers of participants focused on military recruits, as did all 4 studies cited in the reference article. These samples are helpful due to large numbers of participants in single studies and a moderate ability to generalize to some athletic populations.

Although no single prevention method has been proven consistently effective for MTSS, several methods have proved useful: shock-absorbent insoles,¹³ pronation-control insoles (specifically controlling navicular drop),¹⁰ and graduated running programs.^{14,15} Stretching of the lower leg musculature has been consistently proven to not prevent MTSS.^{13,14,16,17}

Shock-absorbent insoles are one of the few prevention methods that have shown promise.^{3,13} A systematic review¹³ noted that in 4 trials evaluating the use of shock-absorbing insoles versus control groups, fewer tibial stress injuries occurred in the shock-absorbent insole groups. Because a weak or fatigued muscle cannot absorb shock and dissipate ground reaction forces as well as a strong, rested muscle, ground reaction forces are transmitted to the bone, increasing the risk of injury.^{4,18,19} However, no authors to date have determined the percentage of shock absorption that shoe insoles need to aid in dissipating force sufficiently to prevent MTSS. The mileage on a running shoe may have similar effects on shock absorption. Running shoes should be replaced when worn between 300 and 600 miles, depending on a multitude of factors, including body weight, running style, and training surface.⁴

Pronation control to prevent MTSS has been studied extensively, although with various results.^{1-4,7,9,10,20} In a study involving 63 cross-country athletes, 52% of whom reported a history of exercise-related lower leg pain, the investigators measured navicular drop. The athletes were followed through a full year and were monitored for MTSS symptoms. Athletes with a history of exercise-related lower leg pain did not have greater pronation as measured by navicular drop.⁹ In 2007, Plisky et al²⁰ followed high school cross-country runners through a season and recorded factors possibly associated with MTSS: navicular drop, foot length, height, body mass index, previous running injury, running experience, and

orthotic or tape use. Only body mass index was correlated with MTSS. The authors noted no association between MTSS and navicular drop. Conversely, when athletes who developed MTSS during a cross-country season ($n = 15$) were compared with an uninjured group ($n = 21$), a difference in navicular drop was noted.¹⁰ Yet another group⁷ found that a standing foot angle of less than 140° predicted a previous history of MTSS.

Graduated running programs, including preseason conditioning, are accepted methods of prevention for many injuries.^{1,4,13,15} In one study,¹⁵ training errors were the cause of MTSS in nearly 60% of participants.¹⁵ Training errors include an abrupt increase in intensity, duration or frequency of training (measured as an increase of more than 30% of initial training mileage within 1 year); hill training; and a change in running surface to a harder or tilted type.¹ In 12 trials involving 8806 participants,¹⁴ the prevention methods of stretching, use of insoles, footwear modifications, and training program alterations were studied. The only method that had some evidence (although it was not statistically significant) for preventing MTSS was training program alterations—reduction in the distance, frequency, and duration of running bouts.

Thacker et al³ reported that none of the prevention programs were effective, so what does this mean for athletic training clinicians? Experts appear to agree on 2 etiologic components: the soleus muscle is involved in MTSS somehow, and bone-remodeling capabilities are insufficient to compensate for persistent insults to the tibia. The clinical relevance of these components directs clinicians to (1) increase the strength and endurance of the soleus muscle in their athletes, (2) control overpronation, which may alleviate some stress on the medial fascial attachment of the soleus, (3) promote adequate shock absorption via insoles, new shoes, and maintenance of proper foot biomechanics, and (4) work with coaches to commit at least 1 day per week to a pool workout or some other form of cross-training that unloads the tibia and allows the bone remodeling response to catch up.

In conclusion, Thacker et al³ provided an excellent and critical systematic review, illustrating that the evidence available concerning prevention of MTSS is limited and inconclusive. Until the causes of MTSS are understood more clearly, consistently effective MTSS prevention methods may be elusive. Prevention methods showing promise through limited research are shock-absorbent insoles, pronation-control insoles, and graduated running programs. However, these methods have not been proven consistently to be effective. Thus, athletic training clinicians should be sensitive to this lack of consistent outcomes when interpreting research articles concerning MTSS prevention. To date, no evidence suggests that a specific prevention program will be effective.

Well-controlled trials involving multiple sites and multiple-year comparison studies of various isolated prevention techniques on injury rate outcomes are critically needed. Randomized controlled trials comparing prevention methods with control groups would be ideal. For instance, comparing a pronation-control

orthotic group, a shock-absorption insole group, a soleus strength and endurance training group, and a control group would be a valuable addition to the MTSS prevention literature. Studies of military recruits are valuable, but studies of larger numbers of athletes

are needed. Athletic trainers are in an optimal position to perform this research and contribute to this body of knowledge. With further research, perhaps we can reduce the incidence of this common lower leg injury in athletic populations.

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Debbie I. Craig, PhD, LAT, ATC, provided conception and design; acquisition and analysis and interpretation of the data; and drafting, critical revision, and final approval of the article.

Address correspondence to Debbie I. Craig, PhD, LAT, ATC, Department of Physical Therapy and Athletic Training, Northern Arizona University, PO Box 15094, Flagstaff, AZ 86011-5094. Address e-mail to Debbie.Craig@nau.edu.