MEDIAL TIBIAL STRESS SYNDROME ('SHIN SPLINTS')

Galbraith and Lavalee (2009) reported that medial tibial stress syndrome (MTSS), commonly known as 'shin splints', is a frequent injury of the lower extremity and one of the most common causes of exercise-related leg pain in athletes (Korkola and Amendola, 2001; Hreljac, 2004; Willems, 2007). Reinking (2011) reported that "indiscriminate use of the popular term 'shin splints' has led to confusion about the true complexities of exercise related leg pain in athletes", which can include MTSS, chronic exertional compartment syndrome (CECS), stress fractures, and tendinopathies. The generic descriptive term 'exercise-related leg pain', or ERLP, includes the following conditions: MTSS, CECS, stress fractures, tendinopathies, nerve entrapment syndromes, and vascular syndromes. For this paper, the focus will be on MTSS, as it is one of the most prevalent forms of ERLP. Future technical papers will focus on some of the other forms of ERLP such as tendinopathies of the lower leg, which are often referred to as 'shin splints'.

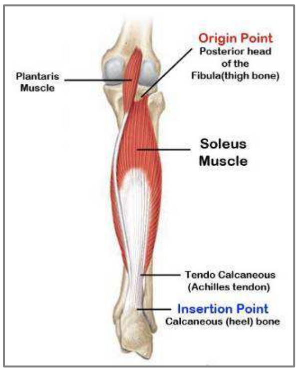
Medial Tibial Stress Syndrome is described as pain along the distal two-thirds of the posterior medial border of the tibia (see image #1), as a result of periostitis (i.e. inflammation of the periosteum) (Bennett et al, 2001). Pain is often described by patients as a dull ache to intense pain that is exacerbated with repetitive weight-bearing activities, and may be continuous or intermittent (Bennett et al, 2001). Examination reveals diffuse pain along the medial tibial border, minimal to no swelling, and no neurological symptoms (Kortebein et al, 2000).

Yüksel et al (2011) reported that MTSS is one of the most common causes of exercise-related leg pain. It has been reported that MTSS injuries comprised 13.1% of all running injuries (n = 1800) and 22% of all aerobic dance injuries (n = 385) (Clement et al., 1981; Taunton et al., 1988).

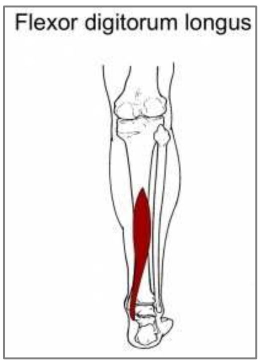
Anatomical Source

Reinking (2007) reported that the anatomical source of medial leg pain in MTSS was originally thought to be the tibialis posterior muscle (James et al, 1978). However, results of a large anatomical study (Beck and Osternig, 1994) (n = 50) revealed that the soleus, which is deep to gastrocnemius (see image #2) and flexor digitorum longus (FDL), an extrinsic toe flexor (see image #3), were found to attach most frequently to the site where symptoms of MTSS occurred, while in no specimen was the tibialis posterior found to attach to that site. This data supports previous reports (Michael and Holder, 1985) that the soleus is most likely the major contributor to traction-induced MTSS, with possible contribution from FDL. This data also contradicts the contention that the tibialis posterior may contribute to MTSS.

1. Source: Mayo Clinic (2012)



2. Source: Muscles Used (2012)



3. Source: Study Droid (2012)

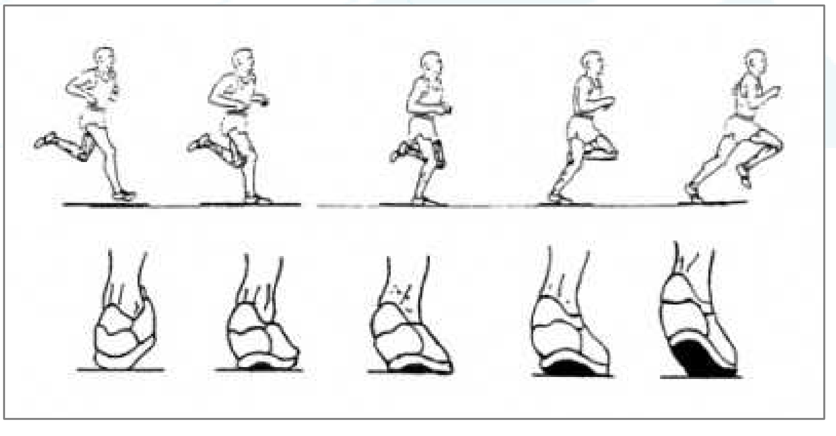
Intrinsic Risk Factors

The following intrinsic risk factors for MTSS have been identified:

- increased pronation of the midfoot while standing (Bennett et al, 2001; Yates & White, 2004; Bandholm et al., 2008; Raissi et al., 2009);
- Lower inversion/eversion strength ratio (Yüksel et al., 2011);
- higher body mass index (BMI) (Plisky et al., 2007);
- lean calf girth (Burne et al., 2004);
- increased hip internal and external rotation (Burne et al., 2004);
- increased plantar flexion range of motion (Hubbard et al., 2009).

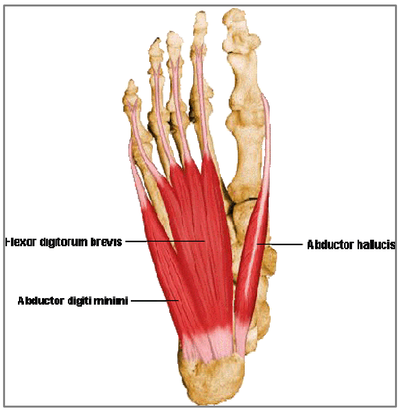
Physiological mechanisms

During the running stride, the foot contacts the ground in slight supination during the foot strike phase, regardless of the type of foot strike (e.g. mid-foot vs. heel strike). When progressing to the mid-stance phase, the foot motion changes to pronation to absorb impact forces. In this phase, the soleus muscle contracts eccentrically to decelerate pronation (Michael and Holder, 1985), along with flexor digitorum longus (Hertling, 2005). Yüksel et al (2011) reported that an inversion/eversion strength imbalance was found between athletic subjects who suffered from MTSS (patient group) and those who did not suffer from MTSS (control group) – the patient group was found to have a significantly lower inversion/eversion strength ratio than the control group. Eversion strength was found to be higher in the patient group, whereas inversion strength scores were similar between the two groups. The authors suggested that the greater eversion strength moment during foot contact may cause excessive pronation (see image #4), which may result in eccentric overloading of the soleus muscle. Repetitive eccentric contractions of the soleus muscle can cause fasciitis or periostitis along the insertion site (Michael and Holder, 1985). It is believed that long-term excessive exposure to this stress produces MTSS (Kortebein et al., 2000).

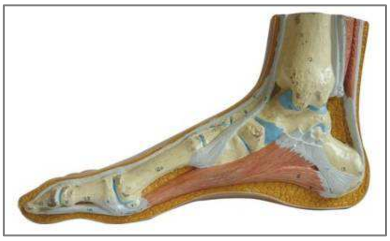


4. Source: Tan (2008)

Flexor digitorum brevis (see image #5) has been shown to contribute to arch support during gait (Mann and Inman, 1964), while EMG studies have shown that abductor hallucis, an abductor and flexor of the big toe (see image #5) contracts to support the medial longitudinal arch (see image #6) and control pronation during static stance (navicular drop was found to increase when the abductor hallucis was fatigued) (Headlee et al, 2008). A relative weakness of flexor digitorum brevis and abductor hallucis may therefore lead to early muscle fatigue, along with increased pronation during the running stride, which may increase the risk of MTSS.



5. Source: Center for Podiatric Care and Sports Medicine (2012)



6. Source: The Foot Trainer (2012)

Reinking (2007) reported that there is accumulating evidence that MTSS also involves changes in bone density. For example, Magnusson et al (2001) reported lower tibial bone density in a group of male soccer players with MTSS compared to a group of non-athletic control subjects and a group of athletic control subjects. In a follow-up study (Magnusson et al, 2003), these researchers found that the lower bone density returned to normal levels following recovery from pain symptoms. Mubarak et al (1982) reported that radiographs are initially negative for a stress fracture in patients with MTSS, and bone scans will not be consistent with findings for a stress fracture. These findings indicate that the pain associated with MTSS is not the result of stress fractures, although the reduction in bone density could potentially result in a stress fracture. The reduction in tibial bone density found to be associated with MTSS may be the result of a reduction in load-bearing of the affected leg, as a result of pain-limiting activity.

Prevention and Treatment

Strength and endurance training for the abductor hallucis and flexor digitorum longus and brevis muscles, along with balanced strengthening of the sub-talar inverters and evertors, may help to reduce over-pronation and subsequent risk for MTSS.

Strengthening of the soleus muscle can be accomplished by performing plantarflexion exercises with the knee flexed to 90 degrees (to minimize involvement of the gastrocnemius muscle). It is recommended that eccentric loading of the soleus be performed to increase its eccentric strength tolerance, due to the physiological mechanism of injury discussed previously, to minimize the risk of recurrent injury to this muscle. This can be accomplished by performing seated calf raises (see image #7), to isolate the soleus muscle. Eccentric loading of the soleus can be accomplished by raising the resistance with both legs, and then lowering the resistance with only one leg - this will effectively double the resistance during the eccentric contraction.

7. Source: Robbins Sports (2011)

How AFX Helps

The AFX resistance system and techniques that are illustrated in the images below have been designed to provide balanced strengthening between the inverters and evertors, while incorporating eccentric loading (see images #8 to #13). Strengthening of the abductor hallucis muscle can be accomplished by performing toe flexion exercises, while arching the foot and focusing on flexion of the hallux (i.e. big toe) (see image #14). It is recommended that both strength and endurance of the abductor hallucis muscle be improved, to reduce risk of over-pronation during weight bearing activity. Strengthening of flexor digitorum longus may also be of benefit, due to the finding that it attaches to the tibia at a location consistent with symptoms of MTSS. Strengthening of flexor digitorum longus and brevis can be accomplished with the same exercise that is recommended for strengthening of abductor hallucis (see image #14). Eccentric loading of abductor hallucis and flexor digitorum longus can be accomplished by pulling back on the handles of the AFX during the eccentric contraction.

Eccentric loading of foot/ankle inverters

8. Inversion – start position

9. Inversion – end position / start of eccentric loading

10. Eccentric Inversion – mid position

Eccentric loading of foot/ankle evertors

11. Eversion – start position

12. Eversion – end position / start of eccentric loading

13. Eccentric eversion – mid position

Toe flexor strengthening

14. Toe flexor strengthening

Additional preventative measures:

- Ensure that training shoes have shock-absorbing insoles to minimize impact forces;
- Increase the intensity and duration of exercise gradually. If running, do not increase distance by more than 10% per week;
- Whenever possible, run on dirt, grass, cinder or a rubberized track to minimize impact forces;
- Avoid running on uneven ground;
- Initiate a complete strengthening program in order to avoid long-term use of orthotics to control over-pronation, as orthotic use will lead to further weakening of the muscles that control over-pronation, which may lead to an increased risk of MTSS;
- Decrease the amount of inclined treadmill or uphill/downhill walking or running;
- If the sport involves high-impact activities, ensure that there are alternate days that are low-impact (e.g. cycling or swimming) with no running or jumping;
- In an aerobics class, make sure the floor is either rubberized or wooden and slightly raised off of the ground so it will "give" during exercise, to reduce impact forces.

~ Rick Hall, M.Sc.

Rick is the Principal Scientist for Progressive Health Innovations, and co-inventor of the AFX. Rick has a M.Sc. in Biomechanics, and has conducted research in athletic performance enhancement, exercise physiology, and injury prevention for over 20 years. He is a member of the International Foot and Ankle Biomechanics Community, and is also a reviewer for the Journal of Biomechanics.

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IMAGES

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