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ETIOLOGY AND FOOT ORTHOSIS TREATMENT OF MEDIAL TIBIAL STRESS SYNDROME

Medial tibial stress syndrome (MTSS) is one of the most common injuries seen within the legs of running and jumping athletes. Patients with MTSS will complain of pain along the medial tibial border, with the most common location of pain and tenderness being at the junction of the proximal two-thirds and distal one-third of the medial tibial border. In most cases of MTSS, the patient will report a recent increase in running mileage or running intensity and a gradual onset of medial tibial pain. As the medial tibial pain progresses over time, the patient will often state that their medial tibia has become so painful that running any distance is not possible. In the worse cases of MTSS, the pain can become so intense that even walking can cause medial tibial pain. In these patients reporting medial tibial pain even with walking, the podiatrist must be suspicious that a medial tibial stress fracture (MTSF) may have occurred.

Previous research has clearly shown that MTSS is much more common in female athletes than in male athletes. In a study of 125 high school cross-country runners from 2001, female runners were 6.5-times more likely to develop MTSS than their male-runner counterparts (Bennett JE, Reinking MF, Pluemer B, et al.: Factors contributing to the development of medial tibial stress syndrome in high school runners. J Ortho Sports Phys Ther, 31:504-511, 2001). In addition, in a military study from 1979 of over 1,000 male and female recruits undergoing basic training, the incidence of tibial stress reaction in recruits was .75/1000 in males vs 8.0/1000 in females. In other words, in this large-scale research study, female recruits were over 10-times more likely to develop tibial stress injuries than male recruits (Reinker KA, Ozburne S: A comparison of male and female orthopaedic pathology in basic training. Military Medicine, 144:532-536,1979.)

There also is an association between increased foot pronation and MTSS within the research literature. Prospective research on one hundred and twenty-four recruits (84 men and 40 women) over a 10-week basic training course, found that recruits with more pronated feet were much more likely to develop MTSS, with female recruits being about two-times more likely to develop MTSS than male recruits (Yates B, White S: The incidence and risk factors in the development of medial tibial stress syndrome among naval recruits. Am J Sp Med, 32:772-780, 2004). Another study from 1995 found that, in dancers and other athletes, there was an increased frequency of MTSS in those individuals that were measured to have a varus alignment of the forefoot and/or rearfoot (Sommer HM, Vallentyne: Effect of foot posture on the incidence of medial tibial stress syndrome. Med Sci Sp Exerc, 27:800-804, 1995). In my nearly four decades of treating running and jumping athletes, it has become clear to me that the vast majority of these individuals that develop MTSS have a pronated foot-type and/or a varus forefoot alignment upon clinical examination.

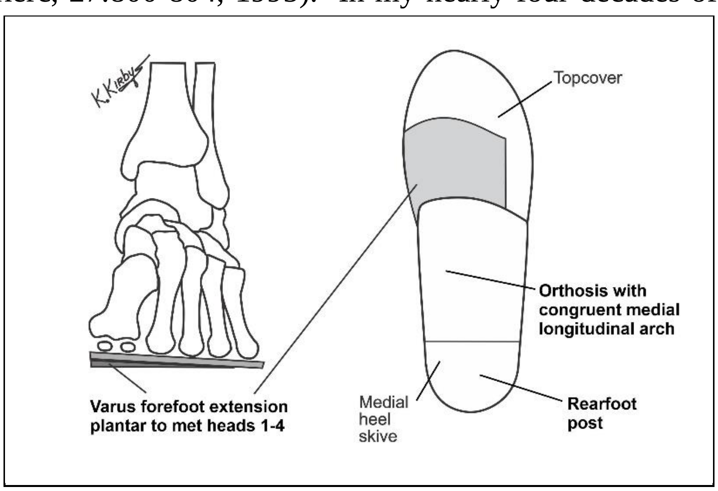

Figure 1. When a foot orthosis is specifically designed for treating medial tibial stress syndrome, the orthosis should have a varus forefoot extension, a well-formed medial arch, an inverted balancing position, a medial heel skive and a rearfoot post to reduce the valgus tibial bending moments and rearfoot pronation moments acting on the foot and lower extremity during running and jumping activities.

Even though the mechanical etiology of MTSS is still being researched, the bulk of the research evidence to date tends to point to MTSS being caused by excessive bending of the tibia during running and jumping activities, and not necessarily by a “soft-tissue traction” type of injury, as previously believed. First of all, contrary to popular podiatric folklore, the posterior tibial muscle does not originate from the area of the tibia where MTSS symptoms occur. In a classic dissection study of 50 cadaver legs, Beck and Osternig found that the flexor digitorum longus (FDL) and the deep crural fascia were the only soft tissue structures that attached to the medial tibial border where MTSS symptoms occur, and not the posterior tibial muscle (Beck BR, Osternig LR: Medial tibial stress syndrome. The location of muscles in the leg in relation to symptoms. JBJS, 76(7):1057-1061, 1994). Even though the medial soft-tissue structures may have a minor role in MTSS, this "soft-tissue traction" theory of the FDL or the deep crural fascia pulling too hard on the medial tibial does not explain why female athletes develop MTSS up to 10-times more commonly than their male counterparts.

The more likely biomechanical explanation for MTSS is the "bone-bending theory" where the impact force of the foot striking the ground during running and jumping activities causes a sudden and excessive bending of the tibia, where the tibia bends so that the medial tibial border temporarily becomes more convex and the lateral tibial border becomes more concave. Other than the above-mentioned research studies showing that thinner-boned females are much more likely to develop MTSS than their thicker-boned male counterparts, Milgrom et al. prospectively studied a group of 295 male recruits from selected infantry units in the Israeli Army to see if there was any correlation between tibial bone thickness and the incidence of MTSF. These researchers used both x-ray and computerized tomography (CT) to determine the "moment area of inertia" of the tibia, which is a measure of the resistance of a structure to bending loads. They found that the recruits with a higher area moment of inertia were about half as likely to develop MTSF as those recruits with a lower area moment of inertia in their tibia, and that the section of the tibia where MTSF most commonly occurred was also the part of the tibia where the thinnest tibial cortical walls were located (Milgrom C, Giladi M, Simkin A, et al.: The area moment of inertia of the tibia: A risk factor for stress fractures. J. Biomech, 21:1243-1248, 1989). In another prospective study of 626 male US Marine Corps recruits undergoing a 12-week basic training program, Beck et al. found that recruits with a small tibial diaphyseal dimensions (i.e. smaller tibial cross-sectional areas and widths) had a significantly increased the risk of developing MTSF (Beck TJ, Ruff CB, Mourtada FA, et al.: Dual-energy x-ray absorptiometry derived structural geometry for stress fracture prediction in male US Marine Corp recruits. J Bone Miner Res, 11:645-653, 1996).

With this research evidence in mind, designing custom foot orthoses for MTSS should be directed at reducing excessive frontal plane bending of the tibia with a varus-wedged foot orthosis in order to effectively "bring the ground up to" the varus-angulated plantar forefoot striking the ground during running and jumping activities. In addition, since there is still a possibility that excessive traction on the medial tibial soft tissue structures may be responsible for some of the pain and injury associated with MTSS, the custom foot orthosis should also be designed to limit excessive pronation of the foot during running and jumping activities.

In effect, custom foot orthoses for patients with MTSS should be designed to produce a relative "varus platform" for the foot which will not only reduce the valgus tibial bending moments, but will also limit rearfoot pronation during running and jumping activities. For over 30 years, I have successfully used orthoses with an inverted balancing position, a 2-4 mm medial heel skive, well-formed medial longitudinal arch (MLA) that exactly matches the MLA of the patient's foot, a 16-18 mm heel cup, rearfoot post, a full-length topcover and, very importantly, a varus korex forefoot extension plantar to 1st-4th metatarsal heads (Fig. 1).

With a custom foot orthosis of this type of design, ground reaction force (GRF) acting on the plantar foot will be shifted from a more lateral position to a more medial position. In other words, GRF force will be shifted medially within the plantar forefoot, midfoot and rearfoot, all of which will reduce the valgus bending moments on the tibia and reduce rearfoot pronation moments acting on the foot and lower extremity during the first half of the support phase of running. By increasing the "medial support" of the heel, medial longitudinal arch and metatarsal heads, not only will the STJ pronation moments be reduced but the valgus tibial bending moments will also be reduced. The reduction of these internal forces acting on the medial tibia during running and jumping activities is a highly reliable and effective method of not only treating MTSS and MTSF, but also helping to prevent these painful injuries from recurring in the future.

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