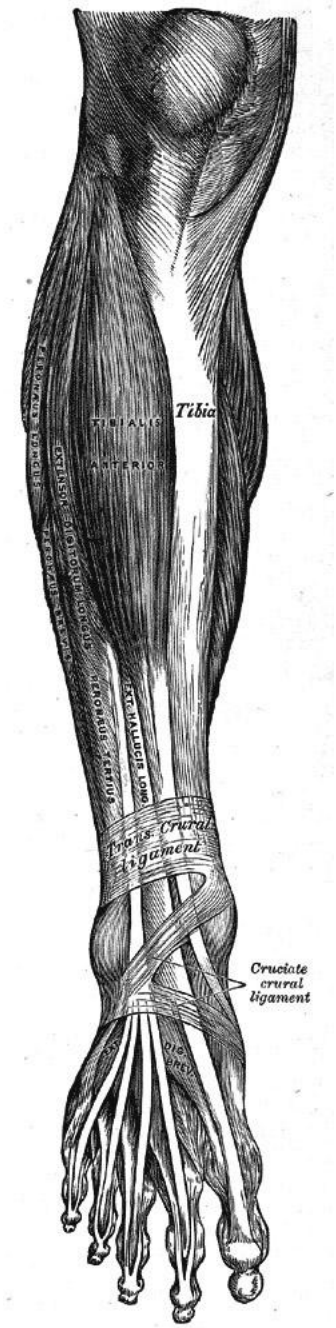
MTSS & Stress fractures and exercise therapy a discussion worth.



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Introduction.
In this essay a description is given of the Medial Tibial Stress Syndrome and of stress fractures of the tibiae. The aim of the essay is to give a contribution to the discussion related to the treatment of tibial injuries. To start the discussion the following strong and debatable statement is made:
"MTSS becomes chronic as a result of non-optimal treatment, therefore the behavior of the patient is not tuned to the injury."

First the definition of shin splints is discussed in the essay. Secondly the epidemiology is given, next the causes are mentioned. Fourthly the risk factors and the diagnostics are discussed. Finally a hypothesis for the treatment and the conclusion are given.

Definitions
MTSS is described in 1966 by the American Medical Association as: "pain and discomfort in the leg from repetitive running on hard surface or forcible excessive use of the foot flexors; diagnosis should be limited to musculotendinous inflammation, excluding fracture and ischemic disorders" (1). De current Dutch definition of MTSS is pain along the posteromedial border of the tibia that occurs during exercise and decreased by rest, with palpable pain over more than 5 centimeters, excluding pain from ischemic origin or signs of fracture (2). This is also supported by Yates and White (3)
During setting the differential diagnose this syndrome should be distinguished from stress fractures and the loge syndrome (2). The loge syndrome is an injury with pain and function loss of the lower leg during muscle activity. De pain is caused by not-physiological intramuscular pressure in a muscle loge as a result of exercise, which causes a reduction in blood supply (4).
A stress fracture is described as a partial or complete fracture that is caused by cyclic stress on the normal bone with a force that normally would not cause a fracture when the force would occur only one time (2).

Epidemiological
According to a literature research study that is published in the British Journal of Sports Medicine in 2007 the incidence of an injury at lower extremity among runners is between the 19,4% and 79,3% (depending on the study) (5). One of the most common localization of these injuries is the lower leg (from 9,0% to 32%, depending on the study) (5). According to Moen and colleagues the incidence of MTSS is 4-35% and this encloses exercise related pain to the posterior medial side of the tibia. This injury occurs mostly in gymnastics, long distance running, basketball, soccer, tennis and ice hockey (2). Of all diagnoses in sports medicine practice up to 10-15% are stress fractures. About 10% of the stress fractures are stress fractures of the tibia (6). Therefore the conclusion can be taken that MTSS and stress fractures are common injuries.

Causes
There are various theories about the causes of MTSS. There are researchers who thought that the most important cause of MTSS is inflammation of the tibial periost. This would be caused by traction of the plantair-flexion muscles and inversion muscles of the ankle, like the m. tibialis posterior. As a result of this traction periositis of the tibia would develop (3) (2) (7). However the periosteum seldom give evidence for inflammation cells (8) (7) (2) (3). After a dissection of 50 legs Beck en Osternig concluded in 1994 that not the m. tibialis posterior, but the m. soleus and the m. flexor digitorum longus could cause MTSS (9). However to this explanation there are some limitations because the complaints are not always presented at the distal insertion of these muscles.
Another explanation is the remodeling of the tibia (10). During repeatedly and excessively stress on the bone a disturbed balance between bone degradation and bone synthesis develops. Because of this the strength of the bone decreases. At MTSS there appears to be a higher activity of the osteoclasts and vascularisation of the tibia. In the same study from Magnusson and colleagues the bone mineral density is 23% lower in athletes who suffer from MTSS than in athletes with no complaints (11). The following conclusion can be made: MTSS is caused by a non-functional adaption of the tibial cortex as a reaction on repeated physical stress on the bone. The imbalance between the osteoclast cells and the osteoblast cells can eventually lead to stress fractures. This means that the outside ply of the tibia was not able to adapt to the stress it had to endure which eventually leads to a stress fracture.

Risk factors.

In several studies the intrinsic and extrinsic factors are given that increase the risk of developing MTSS. This is shown in table 1. There is high evidence for two intrinsic factors; 1) over pronation of the foot and the 2) female sex (2).

Table 1: Intrinsic and extrinsic risk factors for developing MTSS

Article	Intrinsic factors	Extrinsic factors
Galbraith en Lavellee,2009 (7)	- Over pronation ankle - Female sex - Muscle weakness - Muscle tension of the m. triceps surae	- Hard surface - Uneven terrain - Progressive training load - Changing shoes
Moen et al. 2009 (2)	- Positive navicular drop test (see figure 1.) - Positive foot posture index - Increased passive ROM inversion and eversion - Increased BMI > 20,2 - Female sex	- MTSS in the medical history - Increased running intensity - Increased running distance - Change in running surface - Change in running shoes - Running with old shoes
Yates and White, 2004 (3)	- Female sex - Positive foot posture index	- Hard surface - Uneven terrain - Progressive increased training intensity - MTSS in the medical history

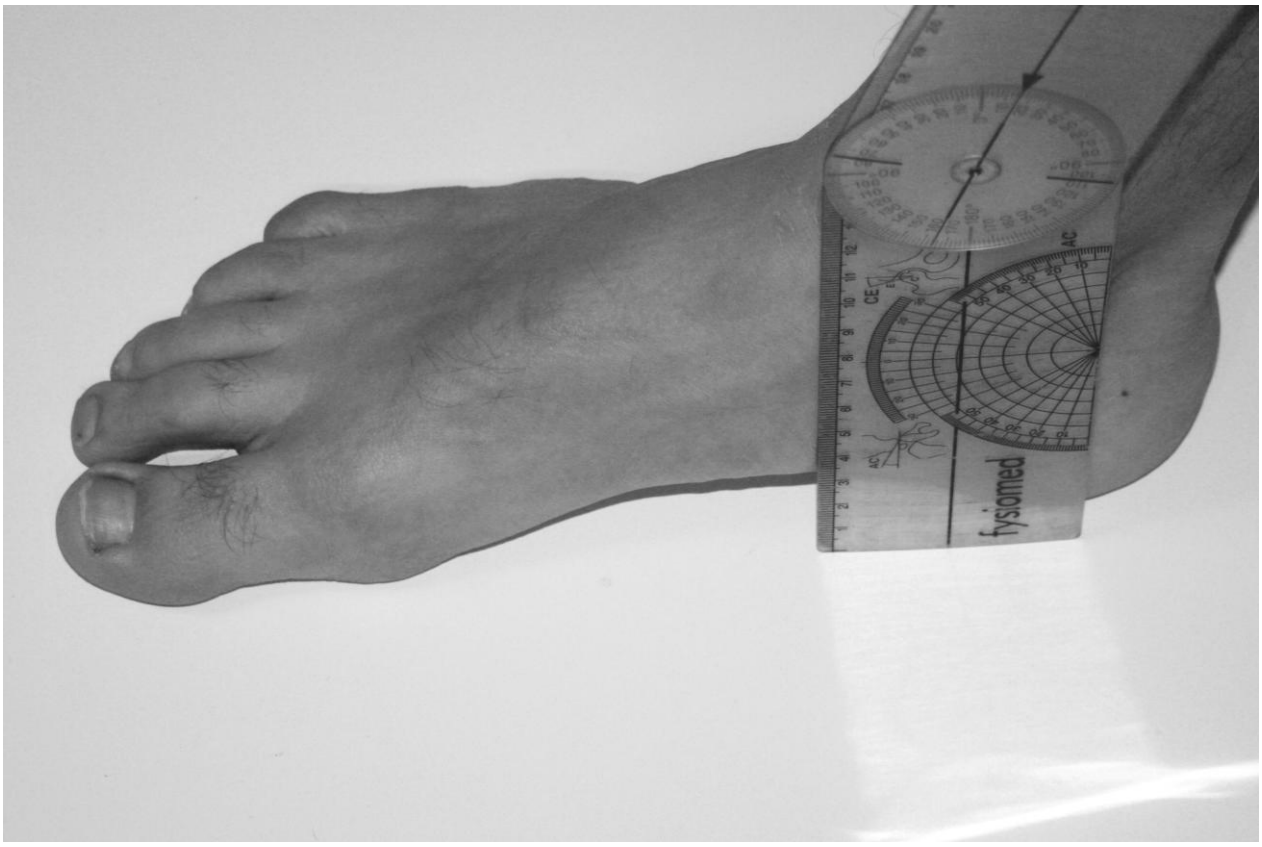

Figure 1: The navicular drop test

Diagnostics.
Most patients with MTSS present their complaints as a result of exercise and the pain is a nagging and diffuse located at the distal or the middle medial side of the tibia (5). At the beginning the complaints occur during the first phase of the exercise, but disappear during the exercise again. In the later stadium the existing complaints can even occur during walking or even in daily life. With stress fractures the pain develops more focal and progressively develops in intensity. De pain often remains after training, in daily life and even during the night. But according to Veder the MTSS, loge syndrome and stress fractures cannot be distinguished by a anamneses or physical examination, it needs CT-scan or a three-phase bone scan (12). To determine the diagnose MTSS a high resolution CT-scan seems to most indicated. According to Keyaerts the three-phase bone scan is seen as the golden standard to prove stress fractures (6).

Treatment
There is hardly any research of high quality done on the treatment of MTSS. There are only 8 RCT's published on MTSS. These study's are only done on military. In the systematic review of Thacker et al and the critical review of Moen and colleagues are these 8 RCT's summarized (13) (2). The passive treatments have no significant results compared to rest. There are no RCT's done who researched exercise therapy in MTSS.
Therefore in this essay a pure theoretical exercise program will be presented later in this paragraph. Earlier in the article the conclusion is drawn that MTSS is caused by a non-functional adaption of the tibial cortex as a reaction on repeated physical stress on the bone. Also the imbalance between the osteoclast cells and the osteoblast cells can eventually lead to stress fractures. Therefore it would be reasonable to the author if MTSS is considered as pre-stage of a stress fracture. Since a stress fracture is also caused by a misbalance between the activity of the osteoclasts and the osteoblasts. It would also explain why the differential

diagnose between MTSS and a stress fracture is difficult to make. So it seems to be that MTSS and stressfractures are caused by a decreased strength of the tibial cortex, because the activity of the osteoclasts are larger than the osteoblasts. Therefore rest would be the most logical intervention in the acute stage, possibly with a external bone stimulator. During the first 3 weeks the misbalance between the osteoblasts and the osteoclasts is rebalanced. After the first three week a exercise program is started. Repeated load on the tibial is given with the exercises. The load on the tibiae will result in microdamage. The microdamage will be repaired and therefore the tibial bone will adapt to the exercises. The structure and the bone density will theoretically adapt to these exercises. A progressive exercise program will lead to bone adaption.
The programme needs impact to the bone, jump exercises seems to be the most logical to do this. To make a transition between rest en jumping, running type exercises are the most obvious. Running type exercises are (triplings, skippings et cetera, et cetera) done for two weeks (week 4&5). The next phase are jumping exercises. The jumping exercises start with 2-legged jumps (week 6-8) and thereafter single leg jumps will follow during three weeks (week 9-11). The last phase are plyometric jumps (week 12-13). Plyometric jumps are jumps that start with a optimal eccentric contraction of the muscles and are followed by a maximal concentric contraction. So these are maximal jumps (example: counter movement jumps). The program is schematic shown in figure 2. The balanced structure of the program will lead to a progressive load on the tibial bone. The bone will adapt to this progressive load. The structure and the bone density will adapt to a level that the bone is able to resist the forces that occur during sports.

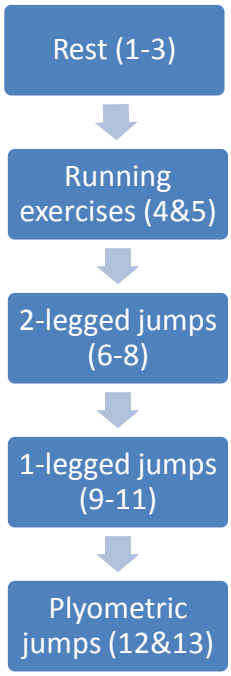

Figure 2: Flowchart for the treatment of MTSS and stress fractures

Conclusion

It seems to be that MTSS is caused by a insufficient strength of the tibial cortex, because the activity of the osteoclasts is larger than the osteoblasts. For both injuries the passive treatments have no significant result compared to rest. Therefore a active rehabilitation program would be logical. Nevertheless no RCT's are done on exercise therapy and MTSS. A theoretical exercise program is presented in this essay. The program starts with rest at first and has a transition to plyometric jumps.
The statement that is made at the start of the essay is debatable since there is no strong evidence what the treatment of MTSS should be.

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