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Review

Medial Tibial Stress Syndrome: Focused on Tibial Fascial-traction Theory and Prevention Strategies

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ABSTRACT

PURPOSE This review article purpose to define and clarify the mechanism of MTSS, especially the tibial fascial-traction theory of MTSS. Additionally, the effectiveness of prevention strategies based on the tibial fascial-traction theory of MTSS was also assessed.

BODY Shin splints is a well-known name of MTSS. It is commonly described as pain which occurs in the posteromedial border of the tibia caused by repetitive stresses. Some studies have addressed the tibial fascial-traction theory of MTSS as a possible mechanism in which traction forces are applied on the tibial periosteum though the soleal aponeurosis. Also, traction forces are applied on connective tissues by the soleus, tibialis posterior, and flexor digitorum longus. Prevention strategies are an avoidance of the repetitive stresses, running re-education such as an avoidance the forefoot strike patterns in runners who have risk factors for MTSS. Additionally, shoe modification such as motion control and stability shoes, and strengthening the ankle invertors are recommended.

CONCLUSIONS This review article provided an overall review of the tibial-fascial traction theory of MTSS and recommendations for prevention strategies based on this theory.

Introduction

This review article focused on medial tibial stress syndrome (MTSS) which is a common cause of running related injuries. MTSS is defined as "*a symptom complex seen in athletes who complain of exercise induced pain along the distal posterior-medial aspect of the tibia*" (Mubarak, Gould, Lee, Schmidt, & Hargens, 1982). Clanton and reported that MTSS is one of the most common causes of exercise-induced leg pain during running Solcher (Clanton & Solcher, 1994).

Numerous previous studies have addressed the tibial fascial-traction theory of MTSS (Bouche & Johnson, 2007; Devas, 1958). In order to verify this theory, this review article focused on two factors affecting the development of MTSS: excessive navicular drop and plantar flexor abnormality. These two factors may cause traction force on the tibial periosteum. The first factor, excessive navicular drop may cause traction force during running which was selected from several intrinsic risk factors of MTSS (M. Moen et al., 2012). Secondly, traction force in the connective tissue could be generated by strong muscle activation or forces during sports activities that involve running (Devas, 1958; Reshef & Guelich, 2012). It is in response to structural deformation of longitudinal arches during running which was investigated by fluoroscopy in a previous study (Noh, Masunari, et al., 2015).

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According to Stickley et al. (2009), soleus muscle activity applies traction forces to the tibial periosteum through the soleal aponeurosis. Therefore, a previous investigated plantar flexor activation as a provided factor of traction force directly on connective tissues during running study (Noh, Ishii, Masunari, Harada, & Miyakawa, 2015). However, the etiology of MTSS is still being debated. In addition, mechanism of MTSS and prevention study is still lacking, whereas the occurrence of MTSS are on the rise. Therefore, it is necessary to clarify what the possible mechanism of MTSS are and how the tibial fascial-traction theory of MTSS occurred. Also, prevention strategies for MTSS are required based on the tibial fascial-traction theory. The purpose of this review was to provide the knowledge about the one of the mechanism of MTSS. In company with prevention strategies in accordance with this mechanism also provided.

Definition of medial tibial stress syndrome

Prior to the definition of MTSS, it should be noted that several types of MTSS have been proposed. Detmer (1986) classified MTSS into 3 types as follows in table 1. This review article was based on Type 2 of MTSS which is commonly caused by overuse in athletes who participate in running. However, how MTSS mechanisms cause inflammation on the tibial site remains controversial (Mubarak et al., 1982).

In 1966, the American Medical Association defined MTSS as "pain and discomfort in the leg from repetitive running on hard surfaces or forcible excessive use of the foot flexors; diagnosis should be limited to musculotendinous inflammations, excluding fatigue fracture or ischemic disorder" (Association, 1966). 'Shin splint' is the most popular name, but it is also called medial tibial stress syndrome, tibial stress syndrome, posterior tibial syndrome, and soleus syndrome. These names have derived from the site of pain which appears in the posteromedial aspect of the tibia caused by exercise or running movements. Palpation pain is present along the posteromedial border of the tibia for at least 5 cm for at least 2 weeks (Yates & White, 2004). The definition of MTSS is clear but its etiology is still unclear.

Table 1. The classification of MTSS

Type	Definition
Type 1	The primary problem is a tibial bone stress reaction or cortical fracture
Type 2	The symptoms are typically noted perisotalgia from chronic avulsion of the periosteum at the periosteal fascial junction
Type 3	The symptoms are localized over the distal and deep posterior compartment syndrome

Among running related injuries, MTSS is one of the most common injuries experienced by running athletes (Clanton & Solcher, 1994). The incidence rate of this injury varied from 4% to 35% in physically active populations (Bennett et al., 2001; Clanton & Solcher, 1994). The incidence rates of MTSS were especially high in runners. Lastly, Plisky et al. (2007) reported that MTSS occurred 2.8 times per 1000 athletic exposures.

Etiology of medial tibial stress syndrome

The first etiology of MTSS was published by Devas in the 1950s, and it was he who introduced the tibial fascial-traction theory. Devas asserted that traction forces could occur in the periosteum of the tibia due to strong calf muscle activation in people with MTSS (Devas, 1958). After this study, numerous theories for the cause have been proposed. The theories such as in response to pressure by the intersection point of the tibialis posterior and flexor hallucis longus (Saxena, O'Brien, & Bunce, 1989), repetitive stress on the distal tibial cortex (Gaeta et al., 2006), decreased bone density (Magnusson, Ahlborg, Karlsson, Nyquist, & Karlsson, 2003), and also repetitive bending loads (by micro damage) in the tibia (Frost, 2001, 2004). However, these theories (aside from the tibial fascial-traction theory) are fairly, but not entirely, persuasive for the explanation of the onset of MTSS. In addition, there is not enough anatomical evidence to support these theories.

Recently, studies have been conducted on cadaveric specimens to better understand MTSS. Traction forces were applied on the tibial periosteum though the soleal aponeurosis by soleus muscle activity (Stickley et al., 2009), and traction to connective tissues by the soleus, tibialis posterior, and flexor digitorum longus (Bouche & Johnson, 2007). However, as aforementioned, the etiology of MTSS is still under debate. It

is necessary to further establish the etiology of MTSS clearly in accordance with the influential claims of the tibial fascial-traction theory.

There is also a lack of consensus for the etiology of MTSS which is caused during sports movement such as running. Hence, we should understand running to understand the onset of MTSS. In addition, we should understand running based on anatomical structures for understanding biomechanical evidence regarding how to run safely and comfortably, why MTSS occurs, and to enhance running performance.

The tibial fascial-traction theory of MTSS

Most literature has addressed that plantar flexion muscles including the soleus, tibialis posterior, and flexor digitorum longus muscles were involved in the development of MTSS as mechanical factors (Beck & Osternig, 1994; Bouche & Johnson, 2007; Jones & James, 1987; Saxena et al., 1989). These plantar flexors, especially the soleus, are connected with the deep crural fascia (DCF) attached to the tibia bone. It is possible that traction-induced injury is caused by the DCF (Stickley et al., 2009). Meanwhile, a well-known theory by Devas had addressed traction to the periosteum by any strong force exerted by calf muscles (Devas, 1958). This theory was considered as the most apparent etiology of MTSS. However, not enough anatomical evidence exists to show the development of MTSS, and its causes are still under debate. Hence, more research is needed to determine its mechanisms.

Prevention strategies based on tribial fasial-traction theory

Fundamentally, the significance of MTSS studies are to prevent the injury. A previous study reported that repetitive loading could create microscopic damage in tissues (Adams, 2004). Furthermore, MTSS was caused by comparatively greater plantar flexor tension (Bouche & Johnson, 2007; Detmer, 1986), and even though there was a relatively small difference between groups, repetitive stress could generate significant traction force overtime on the periosteum of the tibia in subjects with MTSS. Based on this tibial fascial-traction theory of MTSS, the key of prevention is to avoid the repetitive stress. In this review article recommend training to avoid the repetitive stress of training that does not involve a lot of eccentric contractions of the plantar flexors. Simultaneously, running re-education such as an avoidance of the forefoot strike patterns. The forefoot pattern can generate greater traction forces than rearfoot strike pattern at initial contact on the tibial periosteum (Noh, Ishii, et al., 2015). Hence, the strike pattern of running that uses the forefoot is not suggested for runners who have risk factors for MTSS. Also, the training program for preventing MTSS should involve running that increases distance slowly and gradually.

A number of studies have recommended that shoe modifications such as shock absorbing insoles may reduce the repetitive stress (M. H. Moen, Tol, Weir, Steunebrink, & De Winter, 2009; Noh, Masunari, et al., 2015). Several risk factors for MTSS have been addressed in previous studies. However, for recommend shoe modifications, this review focused on the excessive navicular drop among risk factors (M. Moen et al., 2012). A risk factor for MTSS can be running in shoes that have lost cushioning and have no arch support. Thus, look for a supportive shoe that has motion control and stability. Also, this review recommend that the shoes should replace every 500-800 km, or every six months to ensure enough cushion and support.

Neuromuscular training programs should be designed to address excessive navicular drop and plantar flexor abnormalities. Previous studies reported that they considered the relationship between MTSS and ankle strength, inversion strength was relatively weaker than eversion strength as well as a plantar flexor muscle endurance was low in MTSS (Madeley, Munteanu, & Bonanno, 2007; Saeki et al., 2017). These results should relate to the abnormalities of plantar flexor muscles and induced excessive navicular drop during the stance phase of running. As a consequence, dysfunction of the muscles such as abnormalities, weaker strength, and low endurance have been suggested to contribute to the develop of MTSS (Burne et al., 2004; Clement, 1974). Namely, it may lead to the tibial fascial-traction theory of MTSS. Therefore, correction of neuromuscular abnormalities is important for improving athletic performance and reduction of MTSS incidence.

Conclusions

In this review we provided an overall review of the tibial-fascial traction theory of MTSS and recommendations for prevention strategies based on this theory. However, there is still a lack of consensus about the mechanism of MTSS whereas it should be the one of the main points of focus to understand this disorder. Despite the debate of the mechanism, further study is needed to focus on neuromuscular fatigue of the plantar flexor muscle induced by repeated eccentric contractions to determine the fundamental pathway of development for MTSS to understand the mechanism of MTSS.

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Conflicts of Interest

The authors declare no conflict of interest.

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