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Are ultrasonographic findings like periosteal and tendinous edema associated with medial tibial stress syndrome? A case-control study

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ABSTRACT

Objectives: Medial tibial stress syndrome (MTSS) is one of the most common sporting injuries. As of yet, the development of effective therapeutic interventions to treat MTSS is hindered by the fact that its pathology is unknown. Our aim was to explore the pathology of MTSS, by assessing whether the presence of MTSS is related to periosteal, bony or tendinous abnormalities in the lower leg.
Design: Case-control study.
Methods: Participants with MTSS and athletic control participants were recruited from the same (high-risk) base population. Musculoskeletal ultrasonography was performed on the posteromedial tibial border and deep plantar flexor muscles by an experienced radiological specialist who was blinded to group membership. Associations between MTSS and tissue abnormalities were expressed in odds ratios (OR).
Results: A total of 42 participants, 15 MTSS cases and 27 control athletes completed the study. Overall, periosteal and tendinous abnormalities were common in cases with and without MTSS. Periosteal edema was present in 8 (53.3%) MTSS cases and in 10 (37.0%) control athletes, in specific painful spots in the distal 2/3 of the posteromedial tibial border OR = 1.9 (95% CI 0.54–6.99, $p = 0.35$). Also, tendinous abnormalities in the tibialis posterior muscle were frequently seen in MTSS cases ($N = 7$, 46.7%) and in control athletes ($N = 13$, 48.1%) (OR = 0.97, 95% CI 0.27–3.51, $p = 0.96$). No bone abnormalities were observed in either group.
Conclusions: Periosteal and tendinous findings seem to be common in both athletes with and without MTSS, and consequently are not associated with MTSS.

1. Introduction

Medial tibial stress syndrome (MTSS) is one of the most commonly seen exercise-induced leg injuries.[1] MTSS is clinically diagnosed when exercise-related pain is present along the posteromedial tibial border and, in addition, when pain is provoked on palpation of the posteromedial tibial border over 5 or more consecutive centimetres.[2]

Presently, there is no treatment proven to be effective for patients with MTSS. For the development of new interventions or preventive strategies it is important that the underlying pathology of MTSS is better understood.[3]

Conventionally, it is thought that MTSS is due to a traction-induced periostitis or to a local tibial bony overload.[4,5] With regard to the traction theory, the rationale is that the deep ankle plantar flexor muscles induce traction onto the periosteum by repetitive contraction. When this is of excessive nature this may lead to an inflammation or overload of the periosteum.[6–8] In concordance with this, a study by Moen et al. suggests that deep plantar flexor muscles play a role in pain perceived along the posteromedial tibial border. They found that 31.5% of their MTSS cases

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perceived pain on palpation of the muscles and tendons medial to the tibial border.[9] The bony overload theory is an alternative hypothesis for MTSS's pathology. This theory assumes that the tibial bone responds to (high-impact) loads exerted onto the bone during sports activities.[10,11] Bone strains cause micro damage in the cortical bone which under a certain threshold can be repaired, and consequently, the bone is strengthened.[12] Osteoclast may, however, outpace osteoblast activity when strains exceed this threshold.[11]

Hard evidence for any of the theories is lacking, as no high-quality studies investigating MTSS' pathology have been performed. Previous studies have assessed histological and imaging findings in relation to MTSS but none of these studies included a non-injured control group.[11] This could be important as some abnormalities (e.g. periosteal edema) are also common in asymptomatic legs.[13] Musculoskeletal ultrasonography (MSU) allows for valid and reliable assessment of pathological findings in the periosteum and tendons and enables comparison of its findings with pain locations identified through physical examination (i.e. palpation of the posteromedial aspects of the tibia).[14]

Our aim was to assess if the presence of MTSS could be related to periosteal, bony or tendinous abnormalities in the lower leg using MSU.

2. Methods

A case-control design was used to assess whether abnormalities in posteromedial tibial periosteum and bone, and the tendons of the deep ankle plantar flexor muscles were associated with MTSS. We also report on an adjacent cross-sectional study, in which we assessed the inter-observer reliability of the musculoskeletal ultrasonography methods used in this study (see Supplemental online material).

The study was performed at the Inholland University of Applied Sciences in Haarlem, The Netherlands. Athletes were recruited from the adjacent Dance College (Nova, Haarlem, The Netherlands) where they are schooled/educated to become dancers (or dance teachers). The study program involves many pivoting and plyometric activities. The average amount of weekly sports activities may add-up to around 25 h. Existing and new cases with MTSS, and control athletes from the same base population (all dance students) were informed about the study and requested to participate through oral presentations, flyers, email and by phone prior to the study's start. Between the 1st of March 2015 and the 10th of April 2015, one physiotherapist (MW) assessed whether participants were eligible to participate in the study based on our inclusion and exclusion criteria. Candidates without lower leg pain (controls) were eligible if they were ≥16 year of age, not injured and involved in sporting activities for ≥5 h a week. Those candidates with lower leg pain were further screened for the presence of MTSS. Patients were classified as MTSS patients if exercise-induced pain was present for ≥3 weeks along the posteromedial border of the tibia and pain could be provoked on palpation over 5 or more consecutive centimetres along the posteromedial tibial border.[2] All athletes with a history of crural fracture were excluded. Also, a tibial stress fracture or MTSS in the previous 6 months, a concurrent sporting injury, or a clinical suspicion of (concurrent) chronic compartment syndrome or stress fracture was reason for exclusion.[15] Healthy control athletes were eligible for participation when they performed sporting activities for ≥5 h a week, and if they had not suffered a lower leg injury in the previous 6 months. Athletes who met our inclusion criteria were included in the study after signing informed consent. The Medical Research Ethics Committees United, Nieuwegein, The Netherlands (W15.029), provided approval before the study's commencement.

Background information was obtained regarding participants' age (years), height (centimetres), weight (kg), body mass index (calculated as kilograms/(length in metres)^2), sport that they were involved in next to their academic sports activities, hours of weekly sports activities, and, in case of presence of MTSS, duration of complaints (months) and side of complaints. In addition, cases with MTSS were asked to fill out the MTSS score. This is a recently validated disease-specific outcome measure with good validity, reliability and responsiveness.[16,17] In athletes with MTSS, the two most painful spots along the diffusely painful distal 2/3 of the posteromedial tibial border were identified through palpation by one physiotherapist (MW). In control athletes, two spots along the posteromedial tibial border were randomly selected by a computer. Next, athletes were referred to a MSU specialist to have their lower leg assessed.

One investigator (PB) who was educated for 4 years to become a medical imaging and radiation specialist, performed an extensive familiarization session of five hours to adopt the protocol. This investigator performed the musculoskeletal ultrasonography (MSU) assessment. We kept the specialist blinded to the participant to be assessed (case or control).

- For all athletes, the physiotherapist briefed the medical imaging and radiation specialist on the leg to assess and which specific spots to assess (see *painful/specific spots to be assessed*—section):

• In case the participant had bilateral complaints the most painful leg was assessed.
• In case of equally affected legs, a computer randomly picked a leg to assess.
• For the healthy, non-injured athletes, the leg to assess was similarly allocated, with the computer randomly allocating a leg for MSU assessment.

- Participants were asked not to reveal whether they had lower leg pain to the specialists.

The posteromedial tibial periosteum and cortical bone, and the tendons of the deep ankle plantar flexor muscles (tibialis posterior, flexor hallucis longus and flexor digitorum longus) were assessed with a musculoskeletal ultrasonography device (Siemens, ACUSON S1000, linear transducer 14L5). To this end, the posteromedial tibial border was divided into three equal parts: the proximal, middle and distal third, as follows: a tape measure assisted in determining tibial length, defined as the distance between the upper edge of the tibial plateau, palpated in the medial aspect of the articular knee joint space (directly distal to the femoral epicondyle), and the most distal palpable aspects of the medial malleolus. The total tibial length was taken as the reference and the tibia was divided into three parts of 33%. At 33% and 67% of the total tibial length the borders for each third of the posteromedial tibial border were marked with a water-resistant marker. A layer of ultrasound gel (Parker Aquasonic® Clear® Ultrasound gel) was applied onto the area to be investigated. We placed a musculoskeletal probe (14 MHz) perpendicular onto the middle and distal third of the posteromedial border to be scanned. We used the following settings to optimize contrast and depth: dynamic range: 55, space time: 2, edge: 4, tint 1, maps B, Dynamic TCE: high, Sie clear: 5, and image: detail of contrast. Settings were adjusted to enhance contrast and depth.

First, the ultrasonographic specialist assessed the two specific spots on palpation along the distal 2/3 of the posteromedial tibial border – as identified by the physiotherapist beforehand – for periosteal and bony abnormalities. For control athletes, a computer generated two random percentages (as set between 15 and 50%) of the tibial length to be investigated specifically, along the posteromedial tibial border. To assure blinding of the medical imaging and