Studying the Relation Between Medial Tibial Stress Syndrome and Anatomic and Anthropometric Characteristics of Military Male Personnel

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Background: Medial Tibial Stress Syndrome (MTSS) is common among military recruits and to our knowledge; the factors that might put the military recruits at higher risk of incidence of MTSS are not well known.

Objectives: This study was done to investigate the association between some anthropometric and anatomical factors and the prevalence of MTSS among military recruits.

Patients and Methods: One hundred and eighty one randomly selected military recruits were included in this cross sectional study. Using history taking and physical examinations they were tested for MTSS. Accordingly the subjects were assigned to the case (those with MTSS) and control groups (normal healthy subjects). Using standard guidelines, the anthropometric and anatomical criteria of the subjects were measured. The correlation between the measurements and the prevalence of MTSS was tested using statistical analysis.

Results: Data of all the 181 subjects with the mean age of 30.7 ± 4.68 years were included in the final analysis. The prevalence of MTSS was found to be 16.6% (30 people). Internal and external rotation range of motion, iliospinale height, the score of navicular drop test, and the tibial length were significantly different between healthy subjects and patients with MTSS (P < 0.05).

Discussion: The prevalence of MTSS was relatively lower in this study comparing to other studies on military personnel. It was not probably due to type of military shoes or exercise area surface (none of them were standardized); it could be due to low intensity trainings and the long intervals between training sessions.

Keywords: Lower extremity; Injury; Risk Factors

1. Background

Medial tibial stress syndrome (MTSS) is a very common injury to lower leg in both athletic and military populations (1); with an incidence rate between 4% and 35% reported in the past four decades (2-4). MTSS is a common exercise induced injury that causes a tender and painful area in the distal two-third of the posterior medial edge of tibia, the pain is relieved with rest but it reappears with exercise (5, 6). So far, the characteristic signs and symptoms of MTSS are fully defined, but the pathophysiology of this disorder is not exactly known. Most of previous studies define MTSS as an inflammation in posterior or medial edge of tibia due to repeated tension to lower extremity and bone overload (7). Other theories suggest periostalgia (8), periostatitis (9, 10), bone stress reaction (11-14), and low bone mineral density (15, 16). There are also different theories to describe the pathomechanism of this syndrome; Sommer and Vallentyne proposed pronation of foot at subtalal joint due to a varus malformation induced by posterior tibialis tightness or peroneus longus weakness as a cause for MTSS (17). Viitasalo and Kvist found out that over-inversion/eversion of subtalar joint and also significant increase in calcaneal angles is present in people with MTSS (18). Raissi et al. (19) and Bennett et al. (3) in separate studies revealed that navicular drop test is related to MTSS and this syndrome is more prevalent in females. White and Yates showed that those with MTSS have less dorsiflexion due to tightness of soleus and gastrocnemius muscles (4); Beck and colleagues used the same theory to explain tibial bending by sharpy’s fibers that leads to MTSS. Viitasalo and Kvist found out that over-inversion/eversion of subtalar joint and also significant increase in calcaneal angles is present in people with MTSS (18).
compartment muscles is the reason of MTSS (21). Bar-
tosik et al. revealed that limb length discrepancy might
be responsible for MTSS. The shorter side could have foot
equinus, hip joint drop, over-extension of knee joint,
while the longer side might have over-flexion of hip and
knee joint, and over-pronation at subtalar joint (22). The
same study showed that those with MTSS have lower an-
kle dorsiflexion. Messier and Pittala showed that in those
with MTSS foot pronation and the speed of this action
both are increased (23). MTSS is one of the most common
injuries between military recruits (4). Different studies
have shown different associations and risk factors such
as over-pronation of midfoot (4), high BMI (24), female
gender, lower calf girth, increased internal and external
rotation (25), and higher range of planter flexion (26).
These risk factors are not the same in all the studies and
there is contradiction. Imaging studies of MTSS with MRI
have shown a high signal line in posterior edge of tibia
in MTSS patients (27). Thacker and colleagues showed
that strengthening soleus, controlling over-pronation,
using appropriate insole, and low tension exercise can
help preventing MTSS (28). It is reported that patients
with MTSS have lower bone density compared to normal
subjects (15), it is also shown that after treatment of MTSS
bone density was normal again (16); so it could be the
cause or result of MTSS.

2. Objectives

Since factors inducing MTSS are not fully known based
on the previous studies and also the pathomechanical
theories that are already presented, it was needed that
we study anthropometric and anatomic factors and their
relations with MTSS in military recruits, a population in
which MTSS is reported to be high.

3. Patients and Methods

In this retrospective cross-sectional study 200 male
military personnel were randomly selected from an ex-
pert training brigade. Nineteen subjects with previous
history of lower extremity fracture or surgery were ex-
cluded from the study which left us 181 subjects to per-
form the study on. All the subjects were informed about
the study and they signed the written consent form. The
study was approved by the Ethical Committee of Bagh-
atallah University of Medical Sciences, Tehran, Iran. Di-
agnostic criteria for MTSS were based on the description
by Yates and White that includes a pain history which
is induced by exercise and lasts for a couple of hours to
several days after exercise. This pain is located on the
distal two-thirds of posteromedial border of tibia. The
patient must not have any history of paresthesia or neu-
rovascular symptoms. The pain must cover an area of at
least 5 cm and palpation of this area could cause a dif-
fuse vague pain. The measures were taken two times with
a one-week interval; the mean of these two measurements
was recorded for each parameter. Demographic data of
each subject (age, weight, and height) were collected by
four skilled examiners (with an average of 4 years of ex-
perience). Weight was measured by a digital Seca scale
(Germany, 100 grams accuracy) with light clothing and
bare feet. Height was measured with Seca stadiometer
(Germany, to the nearest 0.1 cm) with bare feet. Then,
the patient was examined by an experienced sports
medicine specialist in order to gather the following data
based on the studies by Moen et al. and Raisii et al. All
angles were measured by one goniometer and all static
measurements of lower extremity were taken using a
tape meter to the nearest 0.5 cm. Leg length discrepan-
cy: using a tape meter (nearest 0.5 cm), lower extremity
length was measured from the anterior superior iliac
spine to the most prominent part of medial malleolus (7,
19). Hip range of motion: the subject was in sitting posi-
tion with knee and hip joints flexed at 90°; hip joint was
rotated internally and externally to a firm end feel. The
angles were measured in degrees relative to the initial
position (19). Intercondylar interval: the interval was
measured with a gauge (accuracy of 0.1 mm) while the
subject was standing upright and the feet were paired
and in one direction (19). Quadriceps (Q) angle: the sub-
ject was standing with its knee and hip joints extended
and quadriceps muscle at rest. The center of goniometer
was at patella with lower hand at tibial tubercle (which
was found with palpation), and the other hand was to-
ward anterior superior iliac spine (ASIS). The angle was
measured in degrees (19).

Calf girth: the subject was standing relaxed and up-
right. Using a tape meter the maximum circumference of
the relaxed calf was measured and recorded (20).

Ankle girth: in the same position as for the calf girth mea-
surement, proximal to the internal malleolus, the mini-
mum circumference was measured and recorded (29).

Navicular drop test: while the subject was in a sitting
position, with knees flexed at 90° and ankle joint in a
neutral position, the tuberosity of navicular bone was
marked with a non-toxic marker. Then the individual was
asked to stand without changing the position of the foot.
The difference between heights of the tuberosity of navic-
ular bone in these two positions was referred as navicular
drop and was measured in mm (20).

Iliospinale height, lateral tibial height, and trochanter-
ic-lateral tibial height were measured based on Kinan-
thropometric Assessments; Guidelines for Athlete Assess-
ment in New Zealand Sport (29).

Body composition: the proportion of fat tissue mass to
lean body mass was measured based on bioelectrical im-
pedance analysis method using Tanita BF 350 (Japan).

Intratest reliability: in order to determine the intratest
reliability a pilot study was performed (kappa = 0.75).
Based on the measurement methods described above, we
measured 30 lower extremities of 20 subjects 3 times dur-
ing one week which were randomly selected; these mea-
surements were blinded to the subjects.

Statistics: Using SPSS software for Windows, version 19
(SPSS, Chicago, IL, USA), we performed the statistical analyses. Data was expressed as mean ± SD and normal distribution was determined by Kolmogrov-Smirnov method. Then using independent sample test and Kolmogorov-Smirnov test data was analyzed. Statistical significance was accepted if P value ≤ 0.05.

4. Results

Of 181 army recruits who were included in this study with a mean age of 30.7 ± 4.68 years, 30 participants (16.6%) were in MTSS group (age: 29.52 ± 3.88 years, height: 173.76 ± 6.57 cm, and weight: 80.20 ± 11.63 kg) and the other 151 participants (83.4%) were in control group (age: 30.26 ± 4.83 years, height: 174.40 ± 7.84 cm, and weight: 83.10 ± 17.48 kg). Factors like lower extremity length, intercondylar interval, Q angle, tibial lateral height, calf girth, ankle girth, and fat mass of the subject were measured and analyzed but there were no significant differences between the two groups. There was significant difference in other factors like navicular drop test, internal and external rotation, iliospinale height, and trochanteric tibial lateral length. Mean ± SD of all of the studied factors and also the P values are shown in Table 1.

Table 1. Anatomic and Anthropometric Data of MTSS and Control Group

<table>
<thead>
<tr>
<th>Variable</th>
<th>Normal Group</th>
<th>MTSS Group</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, y</td>
<td>30.26 ± 4.83</td>
<td>29.52 ± 3.88</td>
<td>0.154</td>
</tr>
<tr>
<td>Height, cm</td>
<td>174.40 ± 7.84</td>
<td>173.76 ± 6.58</td>
<td>0.298</td>
</tr>
<tr>
<td>Weight, kg</td>
<td>83.10 ± 17.48</td>
<td>80.20 ± 11.63</td>
<td>0.337</td>
</tr>
<tr>
<td>Right leg length, cm</td>
<td>87.53 ± 3.54</td>
<td>88.84 ± 4.29</td>
<td>0.448</td>
</tr>
<tr>
<td>Left leg length, cm</td>
<td>87.65 ± 3.59</td>
<td>88.91 ± 4.36</td>
<td>0.463</td>
</tr>
<tr>
<td>Intercondylar interval, mm</td>
<td>1.08 ± 1.46</td>
<td>1.29 ± 1.56</td>
<td>0.475</td>
</tr>
<tr>
<td>Q angle, degree</td>
<td>14.56 ± 5.89</td>
<td>14.51 ± 5.61</td>
<td>0.809</td>
</tr>
<tr>
<td>Hip external rotation, degree</td>
<td>45.23 ± 3.34</td>
<td>41.42 ± 3.82</td>
<td>0.000</td>
</tr>
<tr>
<td>Hip internal rotation, degree</td>
<td>38.80 ± 4.61</td>
<td>37.07 ± 2.80</td>
<td>0.004</td>
</tr>
<tr>
<td>Navicular drop test, mm</td>
<td>6.24 ± 2.79</td>
<td>4.22 ± 3.22</td>
<td>0.015</td>
</tr>
<tr>
<td>Iliospinale height, cm</td>
<td>51.07 ± 3.02</td>
<td>53.14 ± 3.07</td>
<td>0.017</td>
</tr>
<tr>
<td>Trochanteric tibiale lateral height, cm</td>
<td>43.22 ± 2.53</td>
<td>44.69 ± 1.68</td>
<td>0.022</td>
</tr>
<tr>
<td>Tibiale lateral height, cm</td>
<td>45.26 ± 2.61</td>
<td>45.80 ± 2.10</td>
<td>0.360</td>
</tr>
<tr>
<td>Calf girth, cm</td>
<td>38.01 ± 3.25</td>
<td>38.35 ± 3.23</td>
<td>0.691</td>
</tr>
<tr>
<td>Ankle girth, cm</td>
<td>22.87 ± 1.53</td>
<td>22.83 ± 1.37</td>
<td>0.575</td>
</tr>
<tr>
<td>Body fat mass, percent</td>
<td>20.09 ± 5.27</td>
<td>19.97 ± 4.83</td>
<td>0.677</td>
</tr>
</tbody>
</table>

Figure 1. The Difference Between Heights of the Tuberosity of Navicular Bone in Sitting and Standing Positions

Figure 2. The Height of Navicular Tuberosity in Neutral and Relaxed Sitting Position
5. Discussion

Based on this study the prevalence of MTSS in these 181 military recruits was 16.6% (30 participants). Navicular drop test, internal and external rotation, iliospinale height, and trochanteric tibial lateral length were the only five factors that were significantly different between the two groups. The results of this study were in concordance with those of Raissi et al. (19), Bennett et al. (3), Moen et al. (7) and Yates and White (4). However, the findings of this study about navicular drop test is different from those of Plisky et al. (24), who found no association between navicular drop and MTSS in competitive adult runners. The difference between some findings of this study and the previous ones (and also between the previous ones) might be due to variation in target groups (expert military recruits, runners, female, or male participants) and measurement techniques. Navicular drop test is an indicator of pronation of foot. In our study mean of NDT was significantly lower in MTSS group (NDT: 4.22 ± 3.22 mm) than in control group (NDT: 6.24 ± 2.79 mm); although both were in normal ranges (P value: 0.015). So far, NDT has been investigated in seven studies, five of them found association between positive NDT and MTSS (3, 4, 19, 20, 30), while the other two have found no association (24, 25). We found a significant decrease in range of hip internal and external rotation in association with MTSS in this study (P value: 0.004 and 0.000 respectively). This finding was in agreement with that of Moen et al. (7) and in contrast with Burne et al. (31). No obvious mechanism is established to define the relation between MTSS and hip range of motion. Burne et al. stated a mechanism in which those with increased hip internal range of motion have a specific pattern of running which causes extra load on their tibia that might lead to MTSS. The same pathomechanism might be induced by increased hip external range of motion (31).

In this study there was no association between weight, calf girth, and ankle girth with MTSS (P value: 0.337, 0.691, and 0.579, respectively), despite the results of Hubbard’s study (25). Plisky et al. found that BMI > 20.2 was associated with MTSS (24). Another study found that in those with MTSS lean calf girth was significantly lower in their right leg (P value: 0.044) (20). Moen et al. found a relation between higher BMI and longer time to full recovery (P value: 0.005) (32). We found no significant difference between BMI in the two groups (P value > 0.05); the reason might be that all the personnel involved in this study were in shape and had no significant difference in their BMIs.

In a cohort study on 77 cross country runners in the united states, runners with navicular drop score of more than 10 mm were almost 7 times more likely to incur medial exercise related leg pain (ERLP) than those with with a less than 10mm navicular drop score (OR:6.6, 95% CI = 1.2-38.0) (33). Navicular drop test (NDT) which is a valid measure of foot pronation (26, 34), is defined as the difference between height of navicular tuberosity at neutral position of subtalar joint and its height in relaxed stance. It was measures based on description by Brody et al. (35). Relatively low prevalence rate of MTSS in our target group was not probably due to type of military shoes or exercise area surface (none of them were standardized); it could be due to low intensity trainings and the long intervals between training sessions. One more logical hypothesis was mentioned by Bouche and Johnson as tibial fasciitis, which proposes that this syndrome is due to the tension on the site of deep crural fascia insertion to tibia; that is mainly from posterior compartment muscles especially the soleus muscle (21). One evidence in favor of this theory is that the most effective surgical procedures involve release of the deep posterior compartment, including the soleus sling and removal of a strip of posteromedial tibia periosteum (36). This tension on insertion site of deep crural fascia to tibia caused by posterior compartment muscles could be due to the different growth rate of muscles and deep crural fascia and flexibility of this fascia. Since muscle growth rate is probably more than fascial growth rate and collagen synthesis by fibroblasts, a tension is introduced to deep crural fascia and guided to its insertion site on tibia from posterior compartment muscles; especially in those who have recently started exercise and had no time for adaptation of their deep crural fascia to the relatively rapid growth rate of calf muscles. In this study we found that MTSS is associated with some of the investigated factors but in order to fully understand the pathomechanism of MTSS further research with new methods is needed to investigate the possible risk factors of MTSS among military recruits with focus on the tension induced by hypertrophy of the posterior compartment muscles to insertion site of deep crural fascia.

References