

GAIT Kinematics in Athletes With and Without Medial Tibial Stress Syndrome

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Abstract: ***Background:** Medial tibial stress syndrome (MTSS) is a common complaint that may stop an athlete from running and other sports activities. No previous study has identified deficits in force distribution, the center of pressure, cadence, and foot rotation as potential contributing factors to Medial tibial stress syndrome (MTSS). The purpose of this study was to investigate the differences in kinematics during normal locomotion between uninjured athletes and those with Medial tibial stress syndrome. **Method:** This case-control observational study investigated 20 athletes aged 18-35 years old with a history of unilateral/bilateral Medial tibial stress syndrome (MTSS) and 20 subjects in the control group. They were made to walk on the Zebris FDMT, with the force plate which helps to measure ground reaction force as the subject walks. It specifically measure force distribution of foot, center of pressure, cadence, and foot rotation. **Results:** Significant difference was observed in the force distribution on the left and the right forefoot (for left $p=0.001$, right $p=0.03$) and heels (for left $p = 0.028$, right $p= 0.03$) when subjects with MTSS were compared with subjects without MTSS. **Conclusion:** There increased forces on the forefoot and heel while walking in the persons suffering from MTSS.*

Keywords: medial tibial stress syndrome, gait kinematics, force distribution, center of pressure, foot rotation

1. Introduction

Medial tibial stress syndrome (MTSS) is common and often an overuse injury seen among athletes, military personnel, and recreational sports participants. MTSS is the most common exercise-induced leg pain, most people who suffer from it complain of pain at the onset of exercise which can be felt on the postero-medial border of the tibia in the middle or distal third of bone (Broun, 2016). Running is a popular pass-time for millions of fitness enthusiasts. Running is an important part of other sports. Although considerable cardiovascular training benefit is gained from a running program, the development of an overuse injury is relatively common. The knee is the most common site of a running-related injury, followed by the lower leg and the foot. The development and pattern of overuse injury in running is interesting from in the biomechanics perspective and the effect of shoes and surfaces on the development of injury, suggests that the nature of loading is important in developing an injury, intrinsic and extrinsic factor (M.Mcginnis, 2005).

MTSS is often diagnosed as shin splint, shin pain, periostitis, and exercise-related lower leg pain. In serious conditions it may lead to tibial stress fracture (Jagannath sharma, 2010). Aetiology may involve the following: fascia, bones, muscle (inflammation may occur at the point of insertion. Chronic traction may occur at muscles origin can lead to chronic medial tibial periostitis mainly in tibialis posterior and flexor hallucis longus muscle (Khan, 2012). MTSS can be recognized in, patient history when exercise-induced diffuse pain is present along the aspect of the lower leg (Bramah, 2018)

Poor or false biomechanics can lead to MTSS. When the foot should be supinated during the phase of gait and pronation occurs it can be termed as abnormal pronation or excessive pronation. Excessive pronation causes increased ground reaction forces on the medial aspect of the foot. This

contributes to the development of first metatarsophalangeal joint abnormalities including exostoses and hallux valgus. Excessive pronation causes an increased load on the medial longitudinal arch and increased strain on the plantar fascia and plantar musculature. Gastrocnemius- soleus complex and tibialis posterior may eccentrically contract harder and longer to decelerate rotation of the leg and pronation of the foot. This may contribute to tendinopathy of the Achilles tendon and tibialis posterior tendon. Overload of the long flexor of the leg may result in tibial periostitis presenting as medial shin pain. Overuse of the tibialis posterior muscle and long flexor tendon may contribute to traction on periosteum and bending of the tibia. Researchers have studied about the risk factors and prognostic indicators in MTSS. In the case of MTSS there is increase hip internal ROM and increase ankle plantar flexion and positive navicular drop. Reports have studied about inversion and eversion strength dysbalance in patients with MTSS. Researchers have studied the relationship between non-MTSS and muscle stiffness of posterior lower leg muscle with a history of MTSS, done by measuring shear wave elastography. Many studies investigated the number of kinematic differences between injured and healthy runners that affect the pattern of gait in running. (Khan, 2012)

Kinematics is further subdivided into two subtopics according to the specific focus of motion- osteokinematics, and arthrokinematics. Osteokinematics concerns the movements of the bony partners or segments that make up a joint, and arthrokinematics focuses specifically on the minute movements occurring within the joint and between the joint surfaces. (Peggy A. Houglum, 2012). Kinematic is the measurement of movement or more specifically, the geometric description of motion, in terms of displacements, velocities and accelerations. Kinematic systems are used in gait analysis to record the position and orientation of the body segments, the angle of the joints and the corresponding linear and angular velocities and accelerations. (Whittle, 2007) As the literature on the kinematics of gait in athletes

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with MTSS in Indian scenario is not available, the main purpose is to study the gait kinematics in the athletes with MTSS in comparison to athletes without MTSS to contribute to the scanty literature available.

2. Methodology

The study was approved by the institutional ethical committee. Subjects were informed about the purpose of the study and had to give their signed informed consent before being enrolled for the study. This case-control observational study investigated 40 athletes aged 18-35 years, 20 subjects with a history of MTSS in which 10 unilateral (5 right, 5 left)/ 10 bilateral are included, 20 subjects without medial tibial stress syndrome in control group. Inclusion criteria include both male and female athletes with and without MTSS. Subjects were excluded from the study if athletes with any past history of lower limb fracture, and athletes suffering from any lower limb fracture. Subject with a history of MTSS was recruited first, and then the control group was recruited to match the MTSS for a force distribution center of pressure, cadence, and foot rotation. They were made to walk on the Zebris FDM 1.12, (Zebris

Medical GmbH Max- Eyth-Weg 43 D-88316 Isny im Allgäu Germany) with the force plate which measures Gait kinematics. The procedure was explained to the subject before to the walk on the treadmill. 5 minutes warm up exercise was done. Subject was asked to remove the shoes, and then subject was instructed to walk on treadmill with a prior set speed. Data was collected after the 30-sec walk on the Zebris treadmill and the gait kinematics (force distribution, center of pressure, cadence, and rotation of foot) data were extracted for the analysis.

Statistical Analysis

Participant characteristics were analyzed using independent t-tests and Mann-whitney for the controlled group and MTSS group comparison. In all tests, the 95% ($p < 0.05$) level of confidence was used for the rejection of the null hypothesis. A fried's man analysis was also performed to determine if an adequate sample size was used for assuming a clinically/kinesiological and biomechanical significant difference between MTSS and non-MTSS groups while walking on the treadmill.

	Normal		MTSS		P-value
	Mean/Median [#]	Std/IQR*	Mean/median [#]	Std/IQR*	t-test
FD L FF	904.6	257.6	1178.6	382.5	0.011
COP L LGL	183.2	37.8	214.6	25.2	0.004
COP L SSL	100.9	37.9	116.9	19.6	0.104
COP R LGL	176.1	41.1	214	24.1	0.001
COP R SSL	100.5	27.5	116.5	21.2	0.045
COP AP	165.8	18.1	166.6	18.4	0.889
CADENCE	122.4	10.7	117.9	11.6	0.205
FR L	8.2	3.4	9.2	3	0.32
FR R	10	3.6	9.6	3.6	0.725
	Median [#]	IQR*	Median [#]	IQR*	Mann-Whitney
FD L MF	206.9	112.5	189	61.9	0.265
FD L Heel	400.9	71	461	134.4	0.028
FD R FF	986.7	428.2	1220.6	635.4	0.03
FD R MF	200	124.2	179.7	66.5	0.512
FD R Heel	397.1	111.6	441.3	91.7	0.033
COP Lat	0.9	7.8	1.4	5	0.758

3. Results

From Analysis Significant difference was observed in the force distribution on left and right forefeet (for left $p=0.001$, right $p=0.03$) and heels (for left $p = 0.028$, right $p= 0.03$) when subjects with MTSS were compared with subjects without MTSS. Independent t- test found that there is no significant difference in the foot rotation (left and right), cadence, and centre of pressure (COP-AP).

4. Discussion

This study identified several kinematic differences between the controlled and MTSS group. In particular, the MTSS athlete was found to demonstrate significantly greater peak force distribution, forefoot, and heel as well as centre of pressure (length of gait line). The primary purpose of this study was to determine the relationship between the kinematics of uninjured athletes and in those with MTSS during running.

Kinoshita et al., 2017 investigated in his study that in the normal group, the center of pressure (COP) path was generally located on the outside, at the central part, and moved toward the inside of the forefoot. However, in the MTSS group, the COP path was linear and shifted medially. The present study showed that the COP R LGL (center of pressure Right Length of the Gait Line) and COP R SSL parameter are shifted medially in case of MTSS rather than shifting laterally as in normal group because the parameter "Length of the gait line" which is characterized by the position of the center of pressure (COP).

W O Zimmermann et al., 2017 reported that a single session of gait retraining leads to changes in most parameters of running measured. The changes in cadence are relatively small; the changes in force (N) on the heels are relatively large. In the present study the subjects with MTSS had shown with increased force on the forefoot and heel whereas decreased force on the midfoot. Moen et al., 2012 reported that participants with Grade 3 or 4 MTSS have feet significantly everted even in the standing position. The

present study showed no significant changes in the cadence for both groups (Normal group = 122.4 and MTSS group = 117.9). The present study also investigated the foot rotation, there was no significant difference between the two groups for both legs (Normal group FR L (Degree) = 8.2, FR R (Degree) = 10 and MTSS group FR L (Degree) = 9.2, FR R (Degree) = 9.6).

5. Conclusion

There were increased forces on the forefoot and heel while walking in the persons suffering from MTSS. Evidence found for dynamic loading being higher with outdoor running fatigue in runners with the previous MTSS compared to uninjured controls. The present study showed that the COP R LGL (center of pressure Right, Length of the Gait Line) and COP R SSL parameter are shifted medially in case of MTSS rather than shifting laterally as in a normal group. There were increased forces on the forefoot and heel and center of pressure (length of gait line) shifted medially while walking in the persons suffering from MTSS as compared to the normal group. There was no evidence that was found for significant changes in the cadence and foot rotation for both legs in the MTSS group.

6. Limitation of the Study

- 1) The small sample size. The study can be done with a large sample size for more accurate and betterment of the results.
- 2) The study data was collected from a limited area which can be collected from a larger geographical area.
- 3) The study was performed with male subjects. Thus, this result can be generalized to female subjects.

7. Clinical Implications

More methods can be applied to the study, for example including the stride length, stride time, step length, step time, etc. The age criteria for the evaluation of subjects with MTSS can be increased. The study may provide sports scientists for valuable strategies for developing training program to improve overall fitness in healthy individuals. This study also helps the physiotherapists in the evaluation of gait pattern during the involvement of MTSS and Provide a guide for preventing the occurrence of MTSS in athletes.

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