CHANGES IN VARIABILITY OF NAVICULA DROP AND CALCANEUS ANGLE IN SUBJECTS WITH MEDIAL TIBIAL STRESS SYNDROM

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INTRODUCTION

Medial Tibial Stress Syndrome (MTSS) is a common diagnosis. Studies show it accounts for 6% to 16% of all running injuries and are responsible for as much as 50% of all lower leg injuries reported in select populations [1]. MTSS presents as pain on palpation over the distal two-thirds of the posterior medial tibia. Pain may be described as a dull ache to intense pain that is exacerbated by repetitive weight bearing activities and may be continuous or intermittent.

Traditionally gait analysis in patients with MTSS has used discrete measures such as mean navicula drop (ΔNH) or change in calcaneus angle (ΔCA) during quiet standing or walking. Mean values obtained from gait analysis and static examinations does not fully show the complex nature of movement. Another method of examining foot movement is by analyzing the variability of the movement using sample entropy (SaEn). Using this approach it is possible to examine every data point in the recorded time series, and not just limit findings to mean values. It is believed that excessively high or low motion variability may indicate a degree of system dysfunction [2]. A hypothesis has been proposed, where variability is described as healthy flexibility [3]. A lack of variability is associated with an inability to adapt to stress. This is called the "loss of complexity hypothesis".

The purpose of this study is to examine the complexity of ΔNH and ΔCA in subjects diagnosed with MTSS at baseline and after 3 month of lower leg strength training. We hypothesized that the variability of ΔNH and ΔCA would increase if VAS decreased.

METHODS

10 subjects, all diagnosed with MTSS were sequentially included from a local orthopedic clinic. A custom designed three-dimensional Multi Video Sequence Analysis procedure was employed to assess ΔNH and ΔCA. Markers on the medial side of the foot were placed on 1) center of the caput of the first metatars, 2) tuberositas navicula, and 3) medial side of calcaneus. Four markers were placed on the posterior part of calcaneus and tibia 2, 6, 13 and 17cm above the floor. ΔNH was calculated as the difference between navicula height at heel strike and the minimal height during stance phase. ΔCA was calculated as the difference between calcaneus angle at heel strike and maximal calcaneus angle during stance phase. If subjects experienced pain in both legs, the leg with the highest amount of pain was analyzed.

The training program consisted of 5 exercises focusing on muscle strength in the lower leg. Participants were instructed to perform exercises every second day with 15 repetitions and 3 sets. All subjects had 2 training sessions with a physiotherapist to ensure appropriate form while performing the 5 exercises.

SaEn was calculated for ΔNH and ΔCA during stand phase (N > 1000 samples) as an expression of the complexity. SaEn is the negative logarithm of the relationship between the probabilities that two sequences coincide for m+1 and for m points. The embedding dimension, m, and the tolerance distance, r, were set to m=2 and r=0.2×SD of the time series [4].

RESULTS AND DISCUSSION

	Before training, Mean (SD)	After training. Mean (SD)	P-value
ΔNH, SaEn	0,78 (0,15)	0,85 (0,17)	0,12
ΔCA, SaEn	1,10 (0,36)	1,10 (0,27)	0,91
VAS*	6,5 (5 - 7)	3 (2 - 6)	0,05*
Duration of symptoms at baseline (months)*	30 (12 - 60)		

*presented as median (interquartil range)

The main finding in the study was that subjects had a significant decrease in VAS-score. The decrease in VAS is not associated with a significant increase in complexity of ΔNH and ΔCA. The complexity of ΔNH did increase in several subjects, but the changes were not significant. We hypothesized that there would be an equal decrease in both ΔNH and ΔCA as these two segments of the foot is described as closely related. We speculate that MTSS is related to a dysfunction in mid foot kinematics. Future large scale studies should investigate if SaEn of ΔNH and ΔCA are able to identify subjects with increased risk of MTSS.

CONCLUSIONS

Subjects with MTSS had a significant decrease in VAS. Variability of ΔNH and ΔCA did not increase significantly, however a trend towards a larger variability of ΔNH was observed.

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