Comparison of Medial and Lateral Marker Clusters for Tracking Talar Motion During Slow Running

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Summary

Musculoskeletal models tend to simplify motion at the talus due to the complexities of tracking motion at the talus. A marker cluster was proposed to track motion at the talus. Fifty subjects were recruited. Kinematic and kinetic data during slow-running trials were collected and analyzed. Subtalar and tibiotalar angles were calculated using a cluster on the medial, lateral, or both sides of the ankle. Tibiotalar angles varied less than 2.5° between clusters, and subtalar angles varied less than 2° between clusters in all planes of motion. The medial cluster is more likely to have tracking issues with cameras, but group differences do not currently indicate one is better at tracking than the other. Further testing with a broader variety of conditions may reveal more significant differences between the angles measured by each cluster.

Introduction

Musculoskeletal models simplify foot motion by treating the hindfoot as a rigid body [1]. This may lead to inaccurate estimations of ankle ligament strains when investigating ankle sprains or injuries because some ligaments are inserted on the talus. The anatomical position of the talus makes placement of traditional markers for motion capture difficult. Markers to potentially track talar motion during gait were designed and produced for this research. The purpose of this project was to investigate if the proposed marker cluster would be better placed on the lateral side of the talus, the medial side, or on both sides.

Methods

Fifty healthy adult subjects (25 males, 25 females; age 25.4 ± 7.9 years; height 172.5 ± 9.4 cm; weight 76.6 ± 18.6 kg) were recruited for this study. Triads were placed just above the lateral and medial malleolus of the right foot and on the calcaneus. A modified triad designed to fit the curvature of the talus was placed just inferior to the lateral and medial malleolus. Ground reaction forces (AMTI, 1125 Hz) and 3D kinematics (12-camera Qualisys system, 225 Hz) were collected during seven trials of bare-foot slow running at a self-selected pace. Trials were trimmed to 10 frames before the first measurement of a ground reaction force and 10 frames following the last ground reaction force reading and later filtered using a low-pass filter with a cutoff frequency of 10 Hz. Subtalar and tibiotalar angles were calculated based on the relative motion of their respective segments using helical angles. Each angle was calculated and compared using the medial marker cluster, lateral cluster, or both clusters simultaneously.

Results and Discussion

Minimal differences were seen when calculating plantar flexion/dorsiflexion at the tibiotalar joint (Figure 1). Internal/external rotations at the tibiotalar joint varied between clusters until about 60% of stance with the lateral cluster resulting in the highest rotations and the medial the lowest – a 2.5° difference. The overall angles were similar for tibiotalar inversion/eversion. The largest difference occurred near the end of stance at a 1.5° increase in the medial cluster relative to the lateral cluster. The largest subtalar inversion/eversion difference was 1.75° at 77% of stance. Subtalar internal/external rotations varied more at the start of stance (~2°) and showed internal rotation with the medial cluster yet external rotation with the lateral cluster. Dorsiflexion/plantar flexion at the subtalar varied between markers by less than 1° until near the end of stance.

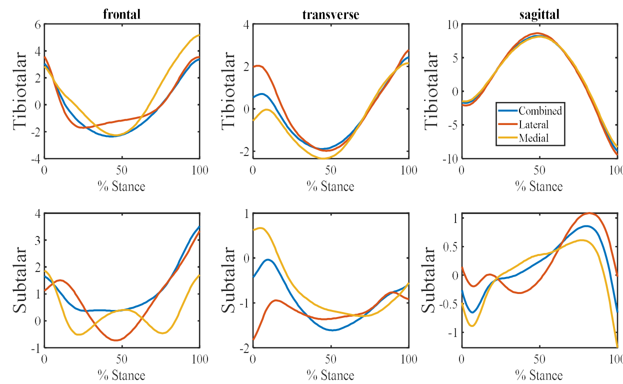

Figure 1: Tibiotalar and subtalar joint angles based on cluster. Medial yellow, lateral red, and combined blue.

Cluster differences appear larger at the subtalar joint, however the relative scale of the angles compared to the tibiotalar angles is smaller. The medial cluster may be more likely to have difficulties with camera tracking or being hit with the opposing limb. One size cluster was used for both sides of the talus and all participants. Additionally, the running speed was not dictated by the researchers. Either of these or a different condition may result in more significant variability between angles reported by one cluster or the other.

Conclusions

Minimal differences were seen between angles calculated using medial, lateral, or both clusters. Further testing with other cluster sizes and a greater variety of conditions may help elucidate calculated angle differences between the clusters and help determine the cluster with the highest reliability to track motion at the talus.

References

[1] Rankine L et al. (2008). *Crit Rev Biomed Eng,* **36**: 127-181.