Analysis of soft tissue vibration behaviour in the thigh during running

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Summary

This study analyzed the vibration of soft tissue of the thigh during running without the influence of compression. The medial area exhibited a greater movement in all directions and a longer combined trajectory length than the lateral area. In addition, differences in vibration patterns were observed across areas in both the normal and rotational directions. In the normal direction, the soft tissue in the posterior area depressed while the anterior bulged simultaneously. In the rotational direction, the entire tissue moved in the same direction, with greater displacement towards the lateral side.

Introduction

The impact of landing during exercise causes soft tissue vibration in the leg. Soft tissue vibrations are thought to cause reduced muscle contraction [1] and increased muscle activity during running [2]. Sports compression garments have been reported to reduce soft tissue vibrations caused by landing impact, reduce muscle activity during running [2] and improve endurance running performance [3]. However, the detailed mechanisms behind how compression garment suppresses soft tissue vibration and even the basic dynamics of soft tissue vibration in the leg without compression garment have not been sufficiently studied. Thus, the aim of this study was to analyze the characteristics of soft tissue vibration in the leg during running by area and vibration component.

Methods

Three male marathon runners with sub-3-hour personal bests participated in this study (mean ± SD: 172.5 ± 3.1 cm, 57.7 ± 2.3 kg). Each subject wore short shorts that did not compress the thighs and performed running trials on a treadmill at a pace of 3'30"/km. 3D marker coordinate data (VICON Motion System, UK) were collected using single retro-reflective markers placed on the right thigh and over anatomical landmarks on the skin, and rigid four-marker cluster plates on the right lower leg serving as tracking markers. The soft tissue markers were placed on the right thigh in a grid pattern comprising 21 points (Figure 1), arranged in three rows (Upper, Middle, Lower) and seven columns (1 to 7). The trajectory length, difference in the rotational direction and displacement in the normal direction were calculated at each measurement point during the stance phase, using the standing position as the reference.

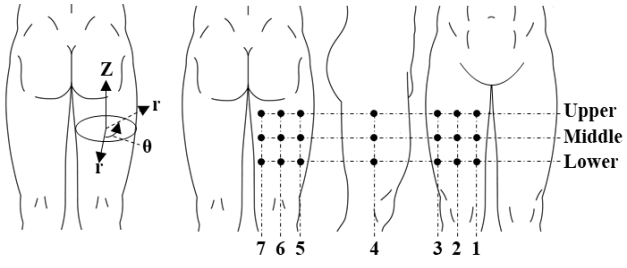

Figure 1: Measurement points on the right thigh.

Results and Discussion

The results of a two-way ANOVA (row × column) on the trajectory lengths, the range of displacement in the normal direction and the range of difference in the rotational direction showed that the medial side had higher values than the lateral side for in all indicators. Thus, the greater trajectory lengths on the medial side compared to the lateral side were considered to be due to greater ranges of displacement and difference in all directions. The maximum and minimum displacements and differences were also analyzed (Figure 2). In the normal direction, the maximum displacement was greater in the posterior medial area (6, 7) compared to the lateral areas (3-5), while the minimum displacement was smaller in the anterior medial area (1, 2). These occurred simultaneously in the early stance phase, suggesting that soft tissues depress at the anterior thigh and bulge at the posterior thigh at the same time. In the rotational direction, the maximum (counter-clockwise) difference was greater in the posterior medial area compared to other areas, while the minimum (clockwise) difference was smaller in the anterior medial area. The time series data showed that each marker rotated in the same direction simultaneously. Therefore, it was assumed that soft tissues tended to rotate in the same direction overall while moving more laterally.

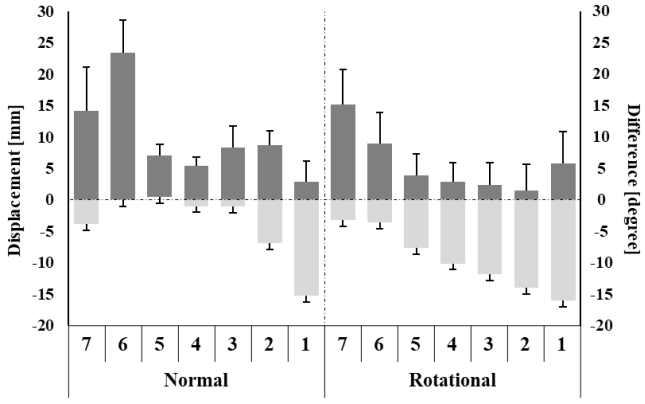

Figure 2: Range of displacement and difference in each direction.

Conclusions

Soft tissue vibration during running was greater in the medial area than in the lateral area, due to greater displacement or difference ranges in both directions. In addition, the soft tissues in the medial area exhibited a behaviour of inferior and superior movement in the normal direction. In the rotational direction, the difference tended to occur more laterally.

References

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[3] Lee et al. Appl. Sci. (2023). **13**: 24.