Influence of Compression on Muscle Activation and Muscle Shape in the Calf Muscles

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Summary

This study aimed to determine the influence of compression on muscle activation, architecture, and shape in the gastrocnemius medialis (GM) using high-density surface electromyography (HDsEMG) and B-mode ultrasound during activation and torque matched trials. We hypothesized that compression would lead to decreases in torque, increases in activation, and limit changes in muscle architecture during contraction. Contrary to our hypotheses, compression did not significantly affect torque or global muscle activation, but muscle activation showed differences across regions of the muscle during the compressed contractions. Compression also influenced muscle architecture, with decreases in the change in fascicle length and pennation angle changes during a contraction, though its effects on muscle thickness and overall architecture were highly variable.

Introduction

Compression garments are commonly used by athletes to enhance recovery and performance [1]. While previous studies have examined the effects of unidirectional and multidirectional transverse loading on muscle mechanics and architecture, experimental studies providing insights into the underlying muscle activation patterns and resulting mechanical performance owing to compression during submaximal tasks remain limited [2,3]. The aim of this study was to determine the influence of compression on muscle activation, architecture, and shape changes in the GM during isometric plantar flexion contractions that were matched for either activation level or torque level, in healthy young adults.

Methods

Fifteen healthy participants (26±5y) were fitted with a custom-fit compression calf sleeve (2XU) on their dominant leg and asked to perform isometric ankle plantar flexions in a custom-made dynamometer while laying prone. Contractions were performed by following a biofeedback trace of either real-time GM muscle activation or ankle torque at 20% and 40% of maximum voluntary contraction (MVC). Global and regional GM activation was measured using HDsEMG (OTBio Electronica). Simultaneously, B-mode ultrasound (ArtUS, Telemed) was used to characterize fascicle length, pennation angle, and muscle thickness (UltraTrack v5.3). Linear mixed effects models were used to examine the main effect of compression (significance level: $p < 0.05$).

Results and Discussion

There was no main effect of compression on torque or global activation. When compressed, activation significantly increased in the distal medial ($p = 0.048$) and proximal lateral ($p = 0.021$) regions of the GM during the low torque matched condition. Fascicle shortening and rotation were significantly reduced under the influence of compression (all: $p \leq 0.023$) which is consistent with predictions from finite element models [4]. The change in muscle thickness increased (i.e., the muscle got thicker) when compressed compared to uncompressed in the high activation and torque matched conditions, but decreased (i.e., the muscle got thinner) in the low torque matched condition (all: $p < 0.001$).

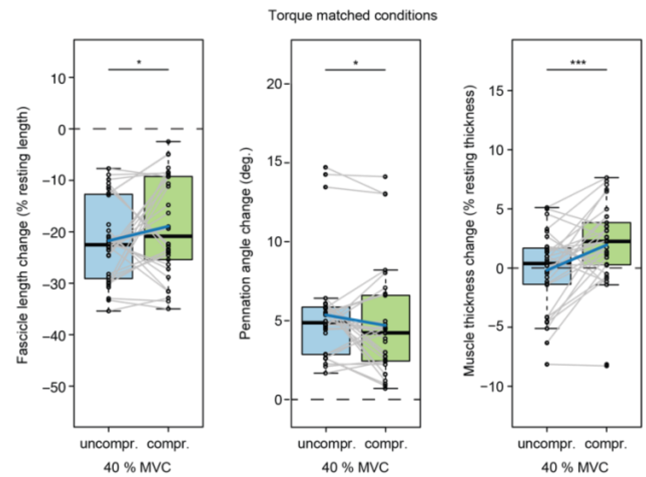

Figure 1: Compression resulted in reduced fascicle shortening and rotation, accompanied by an increase in muscle thickness under the torque-matched condition at 40% MVC. Grey lines represent data from the same contractions of individual participants.

Conclusions

This study highlights the potential of compression garments to influence regional muscle activation and muscle shape changes which may have implications for compression garment design, and athletic recovery. However, further analysis is needed to understand these effects during dynamic movements such as walking and running.

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References

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