Investigation of neuromuscular control of individuals with chronic ankle instability in isometric ankle tasks using High-Density Surface EMG

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Summary

This study aimed to investigate neuromuscular control in individuals with chronic ankle instability (CAI) by comparing muscle fiber conduction velocity (MFCV) and its variability with healthy controls. High-density electromyography (HD-EMG) recorded tibialis anterior (TA), peroneus longus (PL), and lateral gastrocnemius (LG) activity during isometric contractions at 10%, 30%, and 50% of max force. The results showed that MFCV of TA and LG increased with force levels in both groups, with no significant differences. However, the CAI group exhibited significantly greater MFCV variability for all muscles, particularly in PL. These findings suggest inconsistent neuromuscular activation patterns, potentially indicating reduced motor control precision and less predictable neuromuscular control in CAI, which may contribute to reduced stability and functional performance in sports.

Introduction

Lateral ankle sprain can lead to CAI, characterized by deficits in stability, functionality, and motor control of the ankle muscles during dynamic tasks. This condition results from various sensorimotor and mechanical impairments, including alterations in muscle activation timing and force production, particularly in the PL [1], compromising its role in controlling inversion torque. MFCV assessment may provide insights into neuromuscular patterns and control in CAI. Thus, this study aimed to compare MFCV patterns and intra-group variability of ankle muscles during isometric contractions at different force levels between individuals with CAI and healthy controls.

Methods

This pilot cross-sectional study included 10 physically active individuals, divided equally into a CAI group (28±8yrs old, 24.12±8.2) and a control group (CG, 24±5yrs old, 23.9±2.0kg/m²). CAI was defined based on the International Ankle Consortium criteria, as well as in the instability (CAIT) and functionality (FAAM) questionnaires, both lower in the CAI group (p<0.005). HD-EMG recorded TA, PL and LG activity during isometric contractions at 10%, 30%, and 50% of max force (256-channel EMG-USB2+, OT Bioelettronica) with linear electrode arrays (4 electrodes 5 x 1mm, IED 10mm). MFCV was estimated as in frequency domain [2] and its coefficient of variation (CV) was calculated for each muscle and force level. Data were compared between groups using a two-way mixed ANOVA (p<.05).

Results and Discussion

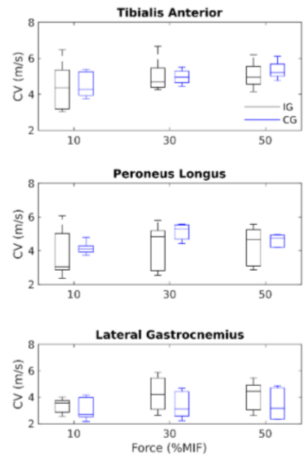

Figure 1. MFCV of TA, PL and LG during isometric tasks in different levels of max force for the CAI (IG) and CG groups.

MFCV varied across force level conditions for TA (p=0.003) and GL (p=0.013), but not for PL. For TA and GL, MFCV was lower in the 10% force level compared to the other two conditions. No group differences were found. CV was higher in the CAI group (mean diff: 10.1%, p=.002). Between-group differences were observed for PL (mean diff: 24.5%, p=.002), regardless of force level (Figure 1). These findings suggest that individuals with CAI tend to exhibit less predictable neuromuscular control and greater neuromuscular variability than healthy controls, particularly in PL. This unpredictability may indicate less consistent recruitment patterns, potentially affecting functionality and perceived stability.

Conclusions

The preliminary results showed high variability in CAI individuals, especially in the PL muscle, indicating an altered neuromuscular recruitment pattern to counteract inversion torques. These findings may explain the lower stability and functionality questionnaire scores in CAI group.

Acknowledgments

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References

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