Muscle Activation in Balance Tasks during Rehabilitation of Chronic Ankle Instability

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Summary

In chronic ankle instability (CAI), patients suffer from reduced self-reported functioning, feelings of 'giving' away, lower limb muscle loss and abnormal muscle activation during, e.g., balance and gait. While training improves several of the above impairments, the mechanisms behind it are studied in an isolate manner. In this study, we observed muscle activation of 15 lower limb muscles in CAI during different balance tasks and compared them to healthy participants. The results indicate, that in both groups, muscles become more active and are more correlated with more challenging balancing tasks. The largest variance in activity is explained by co-activation (35%) and 20% is explained by individual agonist or antagonist activation.

Introduction

Patients with chronic ankle instability (CAI) show intrinsic and extrinsic foot muscle atrophy, decreased ankle strength and abnormal joint torque ratios [1,2]. Also, proximally, hip muscle strength is impaired [3]. All these muscles play an important role in maintaining balance, and in CAI, different activation patterns, such as delayed onset of peroneus muscles or abnormal co-activation have been reported [4-6]. Rehabilitation programmes strengthen extrinsic foot muscles, enhance balance, and improve static and dynamic postural control in CAI [7,8]. While such studies have focused on the role of the leg muscles in balance, limited attention has been paid to the role of proximal (hip) and especially distal (intrinsic foot) muscles in maintaining balance [9]. This study observes muscle activity in the impaired limb in CAI, before and after rehabilitation, while maintaining balance in tasks with increasing difficulty. The study aims to improve understanding mechanisms of balance control and impairments, such as co-activation levels, compared to healthy participants.

Methods

After informed consent, 20 healthy control and 15 patients with CAI were asked to perform 2-limb stance and 1-limb stance balance tasks, with and without eyes closed. Each task was repeated twice for 60 seconds. The patients were measured before (T1) and after (T2) a 12-weeks rehabilitation program. Muscle activity of the Gluteus medius and maximus, Rectus femoris, Vastus medialis and lateralis, Biceps femoris, Semitendinosus, Gastrocnemius medialis and lateralis, Peroneus longus and brevis, Tibialis anterior, Extensor digitorum and Hallux abductor was assessed. The average muscle activity was normalized using Maximum Voluntary Contraction (MVC). Correlation analysis between muscles and a principal component (PC) analysis was performed.

Results and Discussion

Overall, average muscle activity and correlations between muscles increased with increasing task difficulty. The first and second PC explained around 35% and 20%, respectively, of the variance in muscle activity for all 1-limbs stances, and this % increased with task difficulty (Fig.1). PC1 represents co-activation of all muscles. PC2 represents individual contributions of (ant-)agonists. Interestingly, the Gast lat and Gast med activate with other muscle groups. No differences were observed between groups.

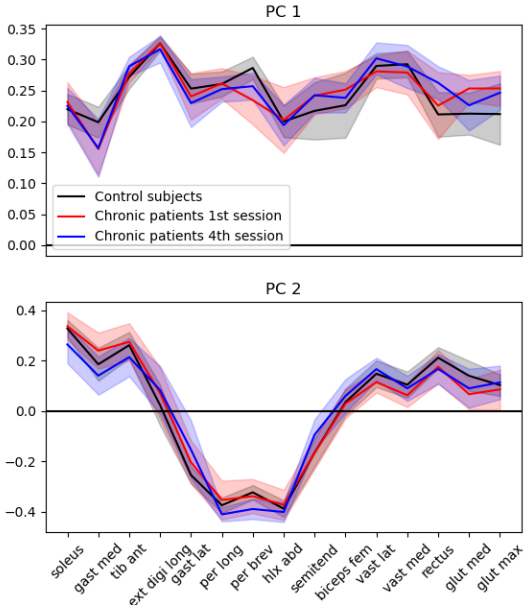

Figure 1: Weights of muscle activity for the two main PCs.

Conclusions

Muscle activity and related parameters increase with task difficulty, but not significantly more so for patients compared to healthy participants. In a next step, the individual balance performance, i.e., based on Balance Error Scoring System and center of mass motion, will be considered.

References

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