Association between activation timing of knee and ankle extensors during gait and reactive balance in persons with stroke

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Summary

Stroke-related motor impairments contribute to poor balance control and increased fall risk. This study examined the relationship between the Peak Activation Interval (PAI) of quadriceps (VL) and gastrocnemius (GM) muscles during gait (PAI VL-GM) and center of mass (CoM) stability during reactive balance responses. Twenty-two people with stroke participated in this study. Results showed a significant association between PAI $_{VL\text{-}GM}$ and CoM stability. Fallers exhibited delayed step initiation and greater posterior CoM displacement. These findings suggest that neuromechanical deficits contribute to fall risk in persons with stroke.

Introduction

Stroke remains a significant cause of long-term disability globally, often leading to sensory, motor, and cognitive impairments that affect functional mobility and social participation [1]. Recovery of balance and independent walking is crucial for improving the quality of life in persons with stroke yet falls remain a prevalent complication post-rehabilitation [2]. Reactive balance control, particularly reactive stepping, plays a vital role in fall prevention but is frequently impaired in individuals with stroke due to asymmetrical muscle weakness and altered sensorimotor coordination [2].

This study aimed to investigate the relationship between the Peak Activation Interval (PAI) of quadriceps (VL) and gastrocnemius (GM) muscles during gait (PAI VL-GM) and center of mass (CoM) stability after a postural perturbation while walking. We hypothesized that PAI $_{VL\text{-}GM}$ during gait would be associated with CoM stability after balance perturbation.

Methods

Twenty-two people with stroke participated in this study (NCT06237972). Methods involved electromyographic (EMG) data collection using a Delsys EMG system, while kinematic data were obtained through a Vicon motion capture system and two Bertec force plates. After the gait assessment, participants were exposed to reactive balance perturbations during both gait and standing conditions using a customized 6 meters perturbation platform. Based on their ability to recover balance, and CoM stability after perturbation, they were categorized into fallers and non-fallers, and their PAI $_{VL\text{-}GM}$ and CoM stability were compared.

Results and Discussion

Results indicated a significant association between PAI $_{VL\text{-}GM}$ and CoM stability. Fallers demonstrated delayed step initiation, altered stepping responses, and greater posterior CoM displacement and instability.

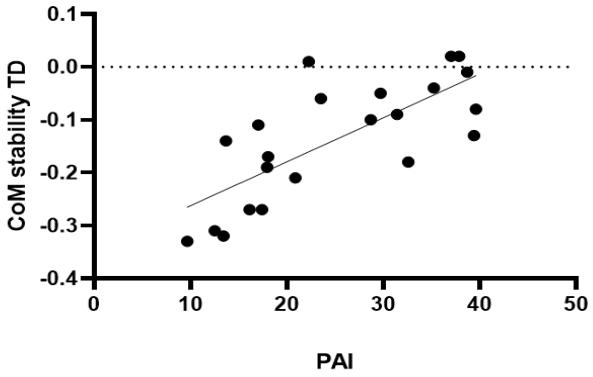

Figure 1: Pearson correlation between PAI $_{VL\text{-}GM}$ and CoM stability at the moment of the first recovery touch down (TD).

Conclusions

These findings highlight the neuromechanical deficits underlying impaired balance control in persons with stroke. The relationship between PAI $_{VL\text{-}GM}$ and CoM stability suggests that muscle coordination deficits contribute to fall risk. Rehabilitation strategies targeting muscle timing and CoM control may enhance balance recovery and reduce falls. Future research should explore targeted interventions to optimize PAI $_{VL\text{-}GM}$ and improve functional outcomes in this population.

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