Detecting Functional Fatigue Using Balance Measures in Chronic Ankle Instability

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Summary

Fatigue can impair postural control increasing the risk of ankle injuries, especially in individuals with chronic ankle instability (CAI). This study aimed to identify effective center-of-pressure (COP) measures for detecting fatigue in CAI, coper, and healthy groups during single-leg balance tests (SLBT) with and without vision. The results indicated that COP measures in the frontal plane, such as excursion, standard deviation, and range, were most effective for detecting fatigue under vision conditions. Participants with CAI and healthy controls relied heavily on visual input for balance during fatigue, while copers showed better adaptation by utilizing other sensory systems when vision was absent. The findings emphasize the importance of incorporating balance assessments without vision, particularly for individuals with CAI, to improve rehabilitation strategies and prevent recurrent injuries.

Introduction

Fatigue is a potential risk factor for injuries in both sports and daily activities, with evidence suggesting that it impairs postural stability, thereby increasing the likelihood of ankle injuries. Postural control is influenced by factors such as visual conditions, fatigue, and history of injury. In individuals with CAI following a lateral ankle sprain, balance deficits may persist, affecting performance and increasing injury risk. While several studies have explored postural control differences between CAI and coper groups (those who recover without recurrent injury), findings remain inconsistent regarding the COP measures to assess balance, particularly in fatigued states and under different visual conditions. This study aims to identify the most effective COP measures for detecting balance deficits induced by fatigue, with the goal of determining accurate cutoff values for CAI, coper, and healthy groups. Such measures are essential for improving rehabilitation strategies and preventing recurrent injuries.

Methods

Participants included 15 individuals with CAI, 15 copers, and 15 healthy controls. A fatigue treadmill running by following the Bruce protocol was performed until participants reported volitional exhaustion. Seventeen COP measures were assessed during SLBT with and without vision before and after the fatigue protocol. Receiver operating characteristic curves and diagnostic statistics were computed for each COP measure.

Results and Discussion

Center-of-pressure measures including anteroposterior and mediolateral mean excursion, mediolateral maximum excursion, mediolateral standard deviation, mediolateral range, and area identified fatigue in all groups but only in the vision conditions. The best measure for identifying fatigue in each ankle group were as follow: Anteroposterior (AP) mean excursion and mediolateral (ML) COP standard deviation for CAI with vision and without vision, respectively; ML excursion standard deviation and ML mean excursion for copers with and without vision, respectively; and ML excursion standard deviation with vision for healthy controls, while no COP measures without vision were able to identify fatigue in healthy controls.

Frontal plane measures, including COP excursion and standard deviation, were found to be the most effective indicators for detecting fatigue in participants during SLBT with vision. In contrast, sagittal plane measures exhibited limited sensitivity to fatigue, highlighting the importance of frontal plane motion in detecting postural control impairments under fatigued conditions. Additionally, the findings suggest that individuals with CAI and healthy participants heavily rely on visual information for maintaining postural control during fatigue, as evidenced by the significant changes in balance when vision was available. Conversely, copers demonstrated a greater ability to compensate for fatigue by reweighting other sensory systems, such as vestibular and somatosensory inputs, when visual information was absent, indicating a more adaptable postural control strategy in response to fatigue.

Conclusions

COP excursion, standard deviation, range, and area, especially in the frontal plane, are useful for detecting fatigue while balancing with vision. Additionally, vision-based measures were useful for identifying fatigue in individuals with CAI and healthy controls suggesting that they are reliant on vision. Therefore, incorporating balance training without vision may be beneficial for treating patients with CAI.

References

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