Real-time visual feedback influence on posturography indicators

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Summary

At the University of the Basque Country, the OREKA platform was designed and developed as a mobile dynamometric platform based on a 3-PRS parallel mechanism, capable of generating two horizontal rotations and one vertical translation. This system includes a real-time visual feedback screen, which displays the user's centre of pressure position. In collaboration with medical professionals from Gorliz Hospital, a series of controlled perturbations were programmed to evaluate postural control strategies under different conditions.

Introduction

Body balance is essential for performing everyday tasks such as walking, running, or standing, allowing individuals to maintain autonomy in their daily activities [1]. Posturography, a widely used method for balance assessment, can be categorised into static and dynamic paradigms. Static posturography evaluates postural control under controlled conditions, while dynamic posturography introduces controlled perturbations to assess adaptive postural responses [2]. Studies have shown that the presence or absence of visual feedback plays a significant role in postural control, influencing both stability and movement patterns during balance assessments [3]. This study analyses variations in different centre of pressure (CoP) indices using OREKA platform (Fig. 1), to measure the impact of real-time visual feedback (Rt-VF) on balance indicators among healthy individuals.

Methods

28 volunteers participated in this study, all of whom provided their written informed consent in accordance with the Declaration of Helsinki. The study included rotations of varying amplitudes in anteroposterior (AP) and mediolateral (ML) directions ([-5°A, 3°P], [-8°A, 4°P], [±4°ML]) and three different speeds (2, 10, and 20 deg/s) to assess how individuals respond to rotational balance disturbances. Participants completed the exercises with and without Rt-VF, with a duration of 1 min each. Ground reaction forces were recorded using four piezoresistive sensors, and a 30-second data sample was used to compute the selected postural control indicators. The acquired signals were filtered using a zero-phase Butterworth filter with a cutoff frequency of 7 Hz. Additionally, a Savitzky-Golay filter was applied for the computation of velocity. The analysis included AP and ML displacements and velocities, as well as statokinesigram (Prediction Ellipse Area) and Poincaré diagrams.

Results and Discussion

As a general trend, the magnitude of the indicators tends to be lower when Rt-VF is absent. This can be explained by the change in task demands for the participants. When Rt-VF is provided, users are required to keep the markers in a fixed initial position, demanding continuous adjustments to maintain balance. This active response to visual stimuli results in larger CoP displacements.

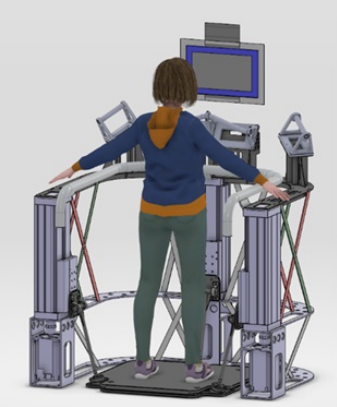

Figure 1: OREKA platform.

When Rt-VF is removed, the nature of the task changes. In this condition, participants are only required to maintain an upright posture without specific alignment targets. Without the need to respond actively to Rt-VF, participants adopt a natural postural control strategy.

Conclusions

This study provides evidence of the influence of Rt-VF on postural control strategies. When Rt-VF is removed, global positions and velocities decrease, suggesting a more adaptive and natural approach to maintaining stability during platform rotations. The reduction in PEA further supports this observation, indicating a more controlled postural sway. Additionally, OREKA demonstrates sufficient resolution to detect individual differences that would not be distinguishable using traditional clinical tests. Further research is needed to explore the underlying mechanisms of these adaptations and their potential implications for personalised rehabilitation and balance training programmes.

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