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SYMPOSIUM

Assessing Postural Control and Postural Control Strategy in Diabetes Patients Using Innovative and Wearable Technology

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Abstract

Introduction:

Currently, diagnosis of patients with postural instability relies on a rudimentary clinical examination. This article suggests an innovative, portable, and cost-effective prototype to evaluate balance control objectively.

Methods:

The proposed system uses low-cost, microelectromechanical sensor, body-worn sensors (BalanSens™) to measure the motion of ankle and hip joints in three dimensions. We also integrated resulting data into a two-link biomechanical model of the human body for estimating the two-dimensional sway of the center of mass (COM) in anterior–posterior (AP) and medial–lateral (ML) directions. A new reciprocal compensatory index (RCI) was defined to quantify postural compensatory strategy (PCS) performance. To validate the accuracy of our algorithms in assessing balance, we investigated the two-dimensional sway of COM and RCI in 21 healthy subjects and 17 patients with diabetic peripheral neuropathic (DPN) complications using the system just explained. Two different conditions were examined: eyes open (EO) and eyes closed (EC) for duration of at least 30 seconds. Results were compared with center of pressure sway (COP) as measured by a pressure platform (Emed-x system, Novel Inc., Germany). To further investigate the contribution of the somatosensory (SOM) feedback to balance control, healthy subjects performed EO and EC trials while standing on both a rigid and a foam surface.

Results:

A relatively high correlation was observed between COM measured using BalanSens and COP measured using the pressure platform ($r = 0.92$). Results demonstrated that DPN patients exhibit significantly greater COM sway than healthy subjects for both EO and EC conditions ($p < 0.005$). The difference becomes highly pronounced while eyes are closed (197 ± 44 cm^2 vs 68 ± 56 cm^2). Furthermore, results showed that PCS assessed using RCI is significantly better in healthy subjects compared to DPN subjects for both EO and EC conditions, as well as in both ML and AP directions ($p < 0.05$). Alteration in SOM feedback in healthy subjects resulted in diminished RCI values that were similar to those seen in DPN subjects ($p > 0.05$).

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Abbreviations: (ADA) American Diabetes Association, (AP) anterior–posterior, (BMI) body mass index, (CI) confidence interval, (CNS) central nervous system, (COM) center of mass, (COP) center of pressure, (df) degree of freedom, (DPN) diabetic peripheral neuropathy, (EC) eyes closed, (EO) eyes open, (ICC) intraclass correlation, (ML) medial–lateral, (PCS) postural compensatory strategy, (RCI) reciprocal compensatory index, (SD) standard deviation, (SOM) somatosensory

Keywords: balance, body-worn sensor, diabetic peripheral neuropathy, postural compensatory strategy, sensory feedback

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Abstract cont.

Discussion/Conclusion:

This study suggested an innovative system that enables the investigation of COM as well as postural control compensatory strategy in humans. Results suggest that neuropathy significantly impacts PCS.

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