World Academy of Science, Engineering and Technology
International Journal of Medical and Health Sciences
Vol:15, No:07, 2021

Exploring the Relationship between Mediolateral Center of Pressure and Galvanic Skin Response during Balance Tasks

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Abstract : Balance training is a common part of physiotherapy treatment and often involves a set of proprioceptive exercises which the patient carries out in the clinic and as part of their exercise program. Understanding all contributing factors to altered balance is of utmost importance to the clinical success of treatment of balance dysfunctions. A critical role for the autonomic nervous system (ANS) in the control of balance reactions has been proposed previously, with evidence for potential involvement being inferred from the observation of phasic galvanic skin responses (GSR) evoked by external balance perturbations. The current study explored whether the coupling between ANS reactivity and balance reactions would be observed during spontaneously occurring instability while standing, including standard positions typical of physiotherapy balance assessments. It was hypothesized that time-varying changes in GSR (ANS reactivity) would be associated with time-varying changes in the mediolateral center of pressure (ML-COP) (somatomotor reactivity). Nine individuals (5 females, 4 males, aged 19-37 years) were recruited. To induce varying balance demands during standing, the study compared ML-COP and GSR data across different task conditions varying the availability of vision and width of the base of support. Subjects completed 3, 30-second trials for each of the following stance conditions: standard, narrow, and tandem eyes closed, tandem eyes open, tandem eyes open with dome to shield visual input, and restricted peripheral visual field. ANS activity was evaluated by measures of GSR recorded from Ag-AgCl electrodes on the middle phalanges of digits 2 and 4 on the left hand; balance measures include ML-COP excursion frequency and amplitude recorded from two force plates embedded in the floor underneath each foot. Subjects were instructed to stand as still as possible with arms crossed in front of their chest. When comparing mean task differences across subjects, there was an expected increase in postural sway from tasks with a wide stance and no sensory restrictions (least challenging) to those with a narrow stance and no vision (most challenging). The correlation analysis revealed a significant positive relationship between ML-COP variability and GSR variability when comparing across tasks ($r=0.94$, $df=5$, $p < 0.05$). In addition, correlations coincided within each subject and revealed a significant positive correlation in 7 participants ($r= 0.47, 0.57, 0.62, 0.62, 0.81, 0.64, 0.69$ respectively, $df=19$, $p < 0.05$) and no significant relationship in 2 participants ($r=0.36, 0.29$ respectively, $df=19$, $p > 0.05$). The current study revealed a significant relationship between ML-COP and GSR during balance tasks, revealing the ANS reactivity associated with naturally occurring instability when standing still, which is proportional to the degree of instability. Understanding the link between ANS activity and control of COP is an important step forward in the enhancement of assessment of contributing factors to poor balance and treatment of balance dysfunctions. The next steps will explore the temporal association between the time-varying changes in COP and GSR to establish if the ANS reactivity phase leads or lags the evoked motor reactions, as well as exploration of potential biomarkers for use in screening of ANS activity as a contributing factor to altered balance control clinically.

Keywords : autonomic nervous system, balance control, center of pressure, somatic nervous system
Conference Title : ICPTR 2021 : International Conference on Physical Therapy and Rehabilitation
Conference Location : Toronto, Canada
Conference Dates : July 19-20, 2021