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Postural control: the influence of vision to multi-muscle synergies

Adriana Degani

Alex Danna-dos-Santos
University of Montana

Charles Leonard
University of Montana - Missoula

TITLE: Postural control: the influence of vision to multi-muscle synergies

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AUTHORS/INSTITUTIONS:

A. Degani[1], A. Danna-dos-Santos[1], C. Leonard[1].

[1]School of Physical Therapy and Rehabilitation Science, University of Montana, Missoula, MT.

Significance:

Falls are the leading cause of injury, deaths, and hospital admissions for traumatic injuries among people aged 65 years and older (Centers for Disease Control and Prevention, 2013). The costs related to the morbidity resulting from these falls are increasing dramatically. In order to reduce costs, increase quality of life, and prolong the longevity of the US work force, several studies are currently focusing on how to assess the risk of falls and prevent their occurrence. However, very little efforts is concentrated to the understanding of the neurophysiological mechanisms associated with upright postural control. Posture and postural reactions to mechanical perturbations require a precise harmonic modulation of the activity of multiple muscles. It is our premise that a comprehensive understanding of such neurophysiological mechanisms may improve current methods and/or result in the development of new approaches of assessing the risk and managing comorbidities generated by fall-related injuries. This study was designed to investigate the role of common neural inputs to the organization of multi-muscle synergies and the possible effects of disruption of visual input to this mechanism of control.

Hypotheses:

We hypothesize that (1) the central nervous system uses correlated neural inputs to coordinate the formation of postural muscle synergies, and (2) this mechanism is affected by the interruption of visual input.

Methods:

Our hypotheses were investigated by analyzing the strength and distribution of correlated neural inputs to postural muscles, as measured by electromyography (EMG) coherence, during the execution of a quiet stance tasks. Nine healthy participants, five females and four males with mean age of 26 years (± 6.1 SD) performed the task of maintaining a quiet stance on a force platform for 30 seconds under two experimental conditions: availability or absence of visual information (open eyes and closed eyes respectively). Center of pressure displacement were recorded by the force platform, and the activity of six postural muscles (*soleus*, *biceps femoris*, *lumbar erector spinae*, *tibialis anterior*, *rectus femoris*, and *rectus abdominis*) were recorded by surface electrodes. Intermuscular EMG-EMG coherence estimates were computed for all possible muscle pairs formed by these muscles. Pooled coherence estimations were also computed for anterior and posterior muscles.

Results:

Intermuscular coherence was found only to be significant within a distinct frequency band bounded between 1-10 Hz; and when visual information was available ("*open eyes*" trials). This significant coherence occurred only for muscle pairs formed solely by either posterior or anterior muscles. No synchronization patterns were observed for pairs of muscles formed by one anterior and one posterior muscle. In addition, the absence of visual information caused a significant decrease in intermuscular coherence estimates profiles within this same frequency band of 1-10Hz.

Conclusion:

These findings are consistent with the hypothesis that synchronization patterns of postural muscular activation are organized by correlated neural inputs. Moreover, the intermuscular coherence decreases significantly when the same task was performed under short-term absence of visual information.

Clinical Relevance:

Increased risk of falls is possibly linked to impairments in the ability of the neuromuscular system to generate optimal multi-muscle synergies. This impairment can result from several factors, such as poor vision caused by maculopathies. This study has provided a step forward towards the understanding of the mechanisms involved in coordination of multiple postural muscles, and the role of the vision on balance control. In addition, this study prepares the foundation for future clinical studies focusing on balance interventions for individuals with postural control disorders and/or visual impairments.