Vestibulo-spinal pathway contributes to alpha-band Intermuscular Coherence during rest, but not during voluntary reaching movements

Angelo Bartsch-Jimenez [1,3] **and Francisco J Valero-Cuevas** [1*,2]

[1] *Division of Biokinesiology and Physical Therapy, University of Southern California, Los Angeles, California, USA*
[2] *Biomedical Engineering Department, University of Southern California, Los Angeles, California, USA*
[3] *Escuela de Kinesiología, Facultad de Medicina, Universidad de Valparaíso, Valparaíso, Chile*

Correspondence*:
Corresponding Author
valero@usc.edu

ABSTRACT

Background: Intermuscular coherence (IMC) quantifies the degree of synchronization between two electromyography (EMG) signals to reveal their shared neural drive. As such, it is gaining popularity as a means to pinpoint the origin of neural drive causing upper extremity pathological synergies in stroke—as multiple pathways could be responsible. Purpose: While the imbalance of cortico- and reticulo-spinal tracts is thought to contribute to pathological synergies, this study aims to exclude the vestibulo-spinal tract as a potential contributor to arm muscle neural drive—as measured by IMC. Methods: As a first step, we recorded IMC during three conditions: No stimulation, Galvanic Vestibular Stimulation (GVS), and Sham. We tested 16 unimpaired young adults (mean age: 19.2, range: 18-27 years old) under three tasks: rest, isometric contraction, and voluntary reaching movement with their right arm. EMG signals were recorded from upper extremity muscles: Biceps (Bic) and Triceps Brachii (Tri), Anterior (ADelt), Middle (MDelt) and Posterior (PDelt) Heads of Deltoid, and Upper Trapezius (UTrap); and one neck muscle: Sternocleidomastoid (SCM), as a control for GVS. Magnitude-squared coherence from EMG was estimated across muscle pairs in the 8- 50Hz frequency range. Statistical Parametric Mapping (SPM) determined the specific frequencies at which there were differences across tasks and muscle pairs. Robust Statistical Methods were used to test for IMC changes after GVS and Sham under each Task (Rest, Isometric, and Reaching) for all muscle pairs. Results and Conclusion: As expected, GVS increased IMC in the SCM-UTrap muscle pair from 11 to 50Hz (spanning alpha-, beta-, and gamma-frequency bands), during the resting condition. In contrast, upper extremity IMC during isometric contraction and reaching movements did not increase under GVS— excluding the vestibulo-spinal tract as a contributor to neural drive to arm muscles during voluntary movement. This allows us to more confidently interpret the source of movement disorders in stroke survivors.

Keywords: vestibulospinal, voluntary reaching, galvanic vestibular stimulation