# Electrocortical changes due to vibro-tactile stimulation in patients with cervical dystonia

Giulia Ruocco[1], G. Leodori[1], M. Costanzo[1], F. Martino[1], D. Maccarrone[1], B. Sellani[1], G. Ferrazzano[1], D. Belvisi[1], G. Fabbrini[1], J. Konczak[2], A.Berardelli[1], A. Conte[1]

[1] Department of Human Neurosciences - Sapienza University of Rome – Rome
[2] School of Kinesiology, Human Sensorimotor Control Laboratory - University of Minnesota Minneapolis

**Objectives** Cervical Dystonia (CD) is characterized by involuntary, sustained or intermittent movements of the neck muscles(1). Although its pathophysiological mechanisms remain unclear, increasing evidence points to altered sensory processing, particularly in the tactile and proprioceptive domains(2). Preliminary evidence suggests that vibro-tactile stimulation (VTS) of cervical muscles may serve as a non-invasive neuromodulatory treatment for CD. In this study, we aimed to replicate the therapeutic effects of VTS in CD and to identify the cortico-muscular correlates of VTS-induced clinical improvement.

## Materials and methods

**Sample**: We studied 9 patients with CD

**Measurements:**

- Kinematic data of head position, acquired through a wireless inclinometer
- 64-channel electroencephalographic(EEG)
- surface electromyography (EMG) from bilateral sternocleidomastoid (SCM) muscles and bilateral trapezium(TPZ) muscles.

**Outcome measures**:

1. **Head Angle Index (HAI):** mean head angular deviation from 0° across the 3 spatial planes.

EEG and EMG signals were simultaneously recorded and analyzed for

2. **intermuscular coherence (IMC)** between stimulated and contralateral muscle
3. **power spectrum (PWR)** (θ, α, β bands): focusing on mean values within a region of interest (ROI) covering channels over the sensorimotor cortex contralateral to the stimulated muscle (C1/2, C3/C4)
4. **cortico-muscular (CMC)** between the ROI and the stimulated muscle

*To evaluate the effect of VTS on outcome measures, the progressive change for each condition was calculated as*

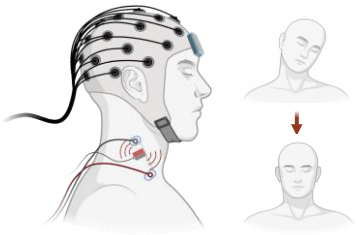
*(Last 30'' – First 30'') / First 30''*

**Experimental protocol**

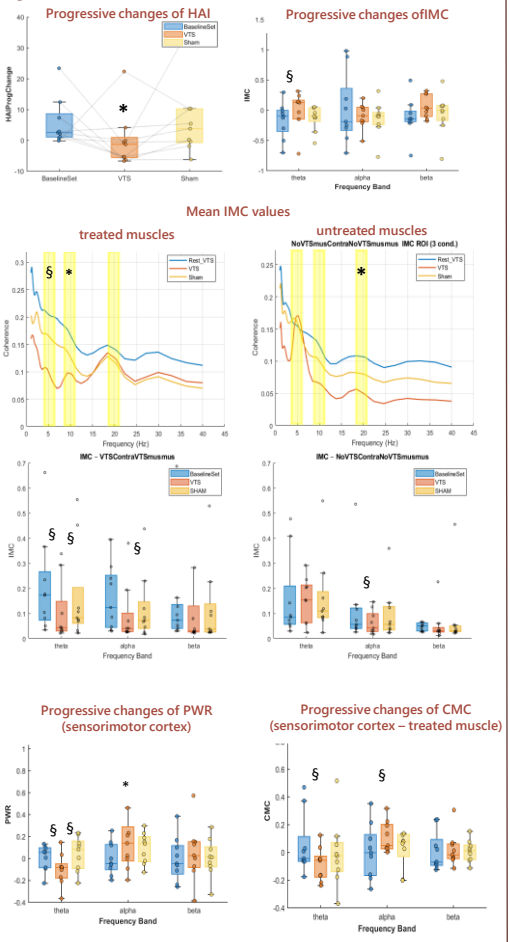
Each patient underwent a preliminary evaluation during which VTS was applied for 1 minute to each of four cervical muscles. The muscle eliciting the greatest improvement in HAI was selected as the target.

Patients then underwent a randomized cross-over protocol with 3 conditions lasting 5 minutes each:

- rest with inactive VTS device
- active VTS
- sham VTS (VTS on for 5 seconds each minute)



## Figures:




## Results

1. **HAI:** VTS resulted in a progressive reduction in HAI relative to Baseline that was significantly larger than Sham.
2. **IMC:** showed a non-significant progressive increase in θ during VTS compared to baseline.
3. **Power:** EEG power showed a significant increase in α and a trend toward reduced θ during VTS.
4. **CMC:** There was a smaller progressive increase in α CMC and trend toward larger progressive reduction in θ CMC during VTS compared to baseline.

**Discussion**: These findings confirms that VTS progressively reduces head deviation in CD patients. Increased θ-band IMC during VTS is consistent with similar changes previously observed during sensory trick (ST) and suggests a compensatory, rather than pathogenic, role of VTS in CD.

PWR and CMC findings during stimulation indicate that VTS may induce cortico-muscular desynchronization and disconnection in the theta band, while promoting corticospinal activity and drive in the alpha range. This aligns with the hypothesis that θ-band oscillatory activity plays a pathological role, and that its reduction or suppression is associated with clinical improvement. The observed increase in α-band PWR and CMC within the sensorimotor cortex, during VTS, may reflect a shift toward more physiological oscillatory activity supporting motor control.

**Conclusion**: VTS applied to cervical muscles produces progressive amelioration of dystonic posture in CD, paralleled by modulation of α/θ cortical rhythms, cortico-muscular coupling, and intermuscular coupling. These results support VTS as a promising non-invasive neuromodulation strategy targeting sensory dysfunctions in CD

**BIBLIOGRAPHY**:

(1) Albanese A, Bhatia KP, Fung VSC, Hallett M, Jankovic J, Klein C, et al. Definition and Classification of Dystonia. Mov Disord Off J Mov Disord Soc. 2025 May 6

(2) Conte A, Defazio G, Hallett M, Fabbrini G, Berardelli A. The role of sensory information in the pathophysiology of focal dystonias. Nat Rev Neurol. 2019