Thalamocortical Dysrhythmia

Thalamocortical Dysrhythmia (TCD) is a theoretical framework in which neuroscientists try to explain the positive and negative symptoms induced by neuropsychiatric disorders like Parkinson's Disease, neurogenic pain, tinnitus, schizophrenia, obsessive-compulsive disorder, depressive disorder, and epilepsy. In TCD, normal thalamocortical resonance is disrupted by changes in the behavior of neurons in the thalamus. TCD can be treated with neurosurgical methods like the central lateral thalamotomy, which due to its invasiveness is only used on patients that have proven resistant to conventional therapies.

How spinal cord stimulation (SCS) in its different modes suppresses pain is poorly understood. Mechanisms of action may reside locally in the spinal cord, but also involve a larger network including subcortical and cortical brain structures. Tonic, burst, and high-frequency modes of SCS can, in principle, entrain distinct temporal activity patterns in this network, but finally have to yield specific effects on pain suppression. Here, we employ high-density electroencephalography (EEG) and recently developed spatial filtering techniques to reduce SCS artifacts and to enhance EEG signals specifically related to neuromodulation by SCS.

Materials and methods: We recorded high-density resting-state EEGs in patients suffering from pain of various etiologies under different modes of SCS. We established a pipeline for the robust spectral analysis of oscillatory brain activity during SCS, which includes spatial filtering for attenuation of pulse artifacts and enhancement of brain activity potentially modulated by SCS.

Results: In sensor regions responsive to SCS, neuromodulation strongly reduced activity in the theta and low alpha range (6-10 Hz) in all SCS modes. Results were consistent in all patients, and in accordance with the thalamocortical dysrhythmia hypothesis of pain. Only in the tonic mode showing paresthesia as side effect, SCS also consistently and strongly reduced high-gamma activity (>84 Hz).

Conclusions: EEG spectral analysis combined with spatial filtering allows for a spatially and temporally specific assessment of SCS-related, neuromodulatory EEG activity, and may help to disentangle therapeutic and side effects of SCS [1].

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Buentjen L, Vicheva P, Chander BS, Beccard SA, Coutts C, Azañón E, Stenner MP, Deliano M. Spatial Filtering of Electroencephalography Reduces Artifacts and Enhances Signals Related to Spinal Cord Stimulation (SCS). Neuromodulation. 2020 Sep 24. doi: 10.1111/ner.13266. Epub ahead of print. PMID: 32969569.