Functional mapping in epilepsy surgery patients

ABSTRACT

Intracranial electroencephalography (iEEG) is one of the methods used in presurgical evaluation for epilepsy surgery patients. Due to its high spatial specificity, signal quality, and temporal resolution, this technique offers a unique opportunity not only for analyzing epileptogenic networks but also for basic research into human cognition. The aim of this thesis was to gain new insights into the functional organization of the human brain using iEEG in combination with modern digital signal processing and neuroimaging techniques. As a marker of cognitive activity, we used high-frequency gamma-band (HGB) activity, which, according to previous studies, correlates with both single-neuron activity and functional magnetic resonance imaging (fMRI) signals.

In my research, I focused on three distinct neurocognitive paradigms: the processing of complex visual stimuli, social cognition, and attentional shifts, while also addressing fundamental methodological aspects such as localizing sources of electrical activity with iEEG. Our findings demonstrate that iEEG enables detailed mapping of activations and interactions between different functional brain areas. When its advantages and limitations are understood, iEEG can complement other functional imaging methods. The results of this study, along with future developments, could lead to the routine use of HGB activity in functional mapping prior to epilepsy surgery, helping to minimize the risk of post-resection cognitive deficits.

Keywords: intracranial EEG, SEEG, functional mapping, epilepsy surgery, digital signal processing, somatosensory evoked potentials, high-gamma band activity, electrical source imaging, emotion recognition, visual processing of scenes and objects, attention