Localization of Deep Focal Epileptogenecity Using Intracranial Electrocorticogram and Independent Component Analysis

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Abstract

Visual inspection of intracranial electrocorticogram (ECoG) topography that involves qualitative and subjective steps does not provide an adequate result for localization of epileptogenic foci in the case of deep brain epileptic sources. An inadequate localization makes the subjects goes under a number of unsuccessful, costly surgeries that can even be mortal. We propose a quantitative analysis approach for detection and localization of deep sources that requires short records of interictal signals. The proposed method is cost effective and does not require long time monitoring of ECoG signals by a neurologist. It can be used along with other available data prior to invasive therapies or surgeries. Our method applies an independent component analysis (ICA) algorithm known as joint approximate diagonalization of eigen-matrices (JADE) to extract temporal patterns of the epileptic sources. It also uses positions of the ECoC electrodes to estimate locations of the sources. To this end, the coordinates of the ECoG electrodes are estimated by a co-registration of pre-implantation three-dimensional (3D) magnetic resonance (MR) and post-implantation computed tomography (CT) images. The proposed method is tested using computer simulations and applied to interictal spikes from EcoG signals of patients with mesial temporal lobe epilepsy. Localization accuracy of the proposed method is found to be in the order of the voxel dimensions. Moreover, the collaborating physicians have considered the localization results reliable and sufficiently accurate for surgical planning of the patients studied so far. Alternative approaches like directed differential connectivity graphs may be used to generate further confidence regarding the source localization results. In addition, physiologically motivated models may be integrated into the above methods to reduce sensitivity of the results to the measurement noise.