Multimodality localization of epileptic foci

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ABSTRACT

This paper presents a multimodality approach for the localization of epileptic foci using PET, MRI and EEG combined without the need of external markers.

Mutual Information algorithm is used for MRI-PET registration. Dipole coordinates (provided by BESA software) are projected onto the MRI using a specifically developed algorithm. The four anatomical references used for electrode positioning (nasion, inion and two preauricular points) are located on the MRI using a triplanar viewer combined with a surface-rendering tool. Geometric transformation using deformation of the ideal sphere used for dipole calculations is then applied to match the patient’s brain size and shape.

Eight treatment-refractory epileptic patients have been studied. The combination of the anatomical information from the MRI, hyperperfusion areas in PET and dipole position and orientation helped the physician in the diagnosis of epileptic focus location. Neurosurgery was not indicated for patients where PET and dipole results were inconsistent; in two cases it was clinically indicated despite the mismatch, showing a negative follow up.

The multimodality approach presented does not require external markers for dipole projection onto the MRI, this being the main difference with previous methods. The proposed method may play an important role in the indication of surgery for treatment-refractory epileptic patients.

Keywords: multimodality, registration, fusion, epilepsy, EEG, positron emission tomography, PET, magnetic resonance imaging, MRI, neurosurgery

1. INTRODUCTION

The accurate location of epileptic foci in treatment-refractory epileptic patients is an important issue as it determines the diagnosis and influences the decision of applying surgical treatment. Epileptic foci are identified with a good temporal resolution using non-invasive scalp recorded EEG signals, but these recordings have very poor spatial resolution and their relation to the underlying brain anatomy is not obvious. The analysis of EEG data is performed calculating magnetic dipoles on spherical or elliptical models of the patient’s head 1-3. With them a rough idea of the position of the dipoles on the brain of the patient can be obtained.

However, in order to obtain a more accurate localization of the dipoles, their position must be identified on 3D Magnetic Resonance Images (MRI) 4-9 where anatomical information has much higher resolution. Complementary information about activity or metabolism, such as that provided by Positron Emission Tomography (PET) is also important to validate the location of abnormal electrical activity provided by the dipole and head models. In this way, focal epileptogenic activity may be related to brain lesions observed in MRI and brain hipometabolism visualized with PET.