Chapter 4

Algorithmic Analysis of Clinical, Neuropsychological, and Imaging Data in Localization–Related Epilepsy

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ABSTRACT

The current study examines algorithmic approaches for analysis of multimodal attributes in localization-related epilepsy (LRE), specifically, their impact on the selection of patients for surgical consideration. Invasive electrographic data is excluded here to concentrate upon the localized anatomical landmarks and identified/initialized brain structures in volumetric MR images as well as initial clinical presentation and the varied elements of the seizure history, ictal semiology, risk and seizure-precipitating factors and physical findings in addition to several features of the neuropsychological profile including various parameters of cognition and both speech and memory lateralization. First, the imaging modality data is excluded and just clinical, electrographic and neuropsychological data are investigated. Afterward, the imaging data are investigated and a comparison between the prediction results of the two types of data is done. In the case of using non-imaging multimodal data, 56% and using imaging features, about 71% of correct outcome prediction was obtained.

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INTRODUCTION

In the United States alone, there are approximately 250,000 medically refractory (i.e., interactable) epileptic patients (Elisevich et al., 1996). Previous studies on predictors of postoperative seizure freedom using multivariable analysis differ in both methodology and results, some including invasive tests or image modality data (Armon, Radtke, Friedman, & Dawson, 1996; Berg, Walczak, Hirsch, & Spencer, 1998; Clusmann et al., 2002; Hennessy et al., 2001; Janszky et al., 2005; Janszky et al., 2006; Jeha et al., 2006; Spencer et al., 2005; Tonini et al., 2004; Yun et al., 2006).

Uijl et al. (Uijl et al., 2008) proposed a model for prognosis after temporal lobe epilepsy surgery using a combination of predictors. The results of this study showed 85% seizure-freedom among patients with a high probability of seizure freedom, and 40% seizure-freedom among patients with a high risk of not becoming seizure-free. In another study, Antel et al. (Antel et al., 2002) predicted surgical outcome in temporal lobe epilepsy patients using MRI and MRSI. In the Antel study, 75% of patients predicted accurately to fall in Engel class 1 after surgery on the basis of imaging alone. In the present study, we have developed a new algorithm based solely upon clinical, electrographic and neuropsychological data to predict surgical outcome. The main purpose of the study is to examine standard non-imaging evaluations as means of prognostication without relying on extraoperative electrocorticography (eECoG) or the many different imaging techniques used in these investigations. Clustering of patients in categorical groups and identification of the most effective features for each cluster permits the selection of a suitable classifier for each cluster. In order to identify the best features related to output (i.e., Engel classification), a combination of different feature selections and ranking algorithms are used aside a genetic algorithm search approach. For this purpose, integration of acquired multimodality data is necessary to obtain new effective features that can predict surgical outcome. A method based on supervised data mining and classification of the some clinical, pathological and neuropsychological features of patients is proposed by Armañanzas et.al. (Armañanzas et.al. 2013). The results of this research showed the efficiency of clinical, pathological and neuropsychological features for surgical outcome prediction and necessary investigation of new features on an extended database. A simulation of the epileptogenicity of different brain regions in a mathematical model is proposed by Sinha et.al. (Sinha et.al. 2017) using interictal networks derived from ECoG data which is an invasive test. Feis et.al (Feis et.al, 2013) developed a support vector machine classifier to predict post-surgical seizure outcome using extracted features from brain T1-weighted magnetic resonance images. They investigated men and women patients separately.
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