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Case Report

Spike Voltage Topography Predict the Ictal Patterns in Temporal Lobe Epilepsy- Case Report

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Abstract

Despite the remarkable progress recently in structural and functional neuroimaging, intracranial electroencephalography (EEG) recordings remain the gold standard for localizing the ictal onset zone. Since this procedure is invasive and involves risk of morbidity and mortality; non-invasive techniques like dipole modeling and voltage topography becomes relevant. On the basis of the configuration of this dipole source and the shape of the corresponding voltage field, estimations can be made concerning the localization of the dipole source and thereby the brain area required generating seizures. This case report demonstrates that voltage topographic analysis of Inter ictal epileptiform discharges (IEDs) in Temporal lobe epilepsy could help to predict the type of scalp ictal onset pattern.

Keywords: *Dipole; Temporal Lobe Epilepsy; Ictal Onset; IEDs*

Introduction

The main goal of presurgical evaluation of patients with drug-resistant epilepsy is to delineate the epileptogenic zone which is defined as the volume of tissue necessary for seizure generation and propagation, which has to be resected to stop the seizures [1,2]. Despite the remarkable progress recently in structural and functional neuroimaging, intracranial electroencephalography (EEG) recordings remain the gold standard for localizing the ictal onset zone [3,4]. Since this procedure is invasive and involves risk of morbidity and mortality; non-invasive techniques like dipole modeling and voltage topography becomes relevant [5]. On the basis of the configuration of this dipole source and the shape of the corresponding voltage field, estimations can be made concerning the localization of the dipole source and thereby the brain area required generating seizures [6,7]. This case report demonstrates that voltage topographic analysis of inter ictal epileptiform discharges (IEDs) in Temporal lobe epilepsy (TLE) could probably help to predict the type of scalp ictal onset pattern. By doing so one can reach at a reasonable conclusion regarding the type of TLE a) mesial b) neocortical by scalp EEG recording which can reasonably predict the seizure outcome after resective surgery for TLE i.e. anterior temporal lobectomy (ATL).

Case Report

Two male patients with TLE who had strictly unilateral mesial temporal sclerosis (MTS) in 1.5 T magnetic resonance imaging/epilepsy protocol (MRI) came for EEG monitoring. We categorized the interictal epileptiform discharges (IEDs) in temporal lobe epilepsy (TLE) using voltage topographic analysis and correlated with the ictal pattern. We hypothesized that voltage topographic analysis of IEDs in TLE could probably help to predict the type of scalp ictal onset pattern. By doing so one can reach at a reasonable conclusion regarding the type of TLE a) mesial b) neocortical by scalp EEG recording which can reasonably predict the seizure outcome after resective surgery for TLE i.e. anterior temporal lobectomy (ATL).

Principles of voltage topography

Spike dipole analysis is a quantitative analysis to determine spatial and temporal characteristics of spike voltage fields by utilizing voltage mapping and source modeling of individual spikes. Most IEDs are surface negative when recorded from electrodes at or above the cortical surface. Electrodes on the opposite side of the generating cortical layer would record a positive potential. The scalp voltage fields that we measure have dipolar configurations. They provide information about the location and orientation of its cerebral generator [8-10]. We characterized spike voltage topography in two patients with complex partial seizures (CPS) and subdivided them into two distinct patterns; 'Type A' and 'Type B'. Type A spikes possessed a dipolar field (tangential) with negativity over the infero-lateral temporal scalp and positivity over the contra lateral, centro-parietal scalp (Figure 1). Type B IEDs included all other IEDs other than Type A (Figure 2).

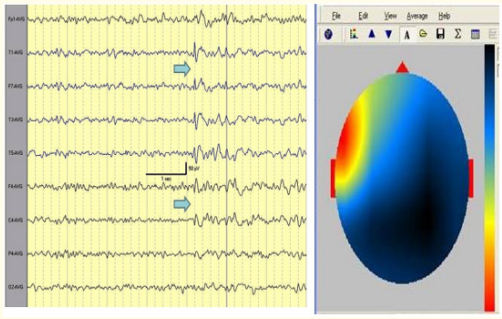

Figure 1: *Type A IEDs (In referential montage spike with maximum negativity over left anterior temporal area with positivity over contra lateral centro-parietal area).*

Figure 2: *Type B IEDs (Only negativity over ipsilateral temporal area ; no focused positivity over contra lateral centro-parietal area).*

Recording system, EEG data acquisition and analysis

EEG was performed by using a 32-channel digital video-EEG systems (Natus neurology, Canada) with scalp disk electrodes placed according to the International 10/20 system. Spike voltage topography was done for each spike and the dipolar field was plotted. We increased the low frequency filter to 3 or 5Hz to remove background slow wave activity to study the dipolar field of a spike in the common average referential montage. Brain mapping and voltage topography was done after narrow band pass filtering using eemagine medical imaging solutions, Gmbh, Berlin, Germany.

A total of 4 seizures were analyzed. Ictal onset and pattern were analyzed systematically in each seizure. All scalp ictal electrographic patterns showed rhythms confined to temporal lobe ipsilateral to MTS (Figure 3). Both patients showed bilateral temporal IEDs. Each spike was carefully analyzed on bipolar and common average referential montage. According to the dipolar field obtained by voltage topographic mapping; Type A IEDs were found to ipsilateral to side of MTS.

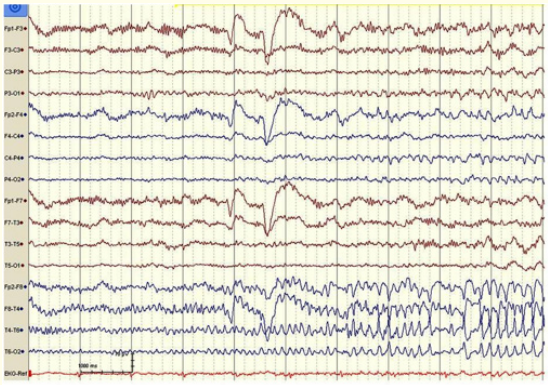

Figure 3: *Focal ictal onset; rhythmic theta followed by sharp waves confined to temporal area.*

Seizure analysis showed only temporal ictal onset "focal" pattern in these two patients. None of them showed ictal onset on the contra lateral side of MTS ("discordant") or non-localized ictal onset "diffuse" pattern.

Discussion

Merlet., *et al.* reported that dipole modeling of interictal and ictal EEG signals can represent cerebral sources of epileptiform activity in a fairly accurate and non-invasive way [11]. Gotman., *et al.* showed dipole orientation can define cortical areas and source potentials can suggest the presence and direction of propagation of the electric activity [12]. World-over, epileptologists and electrophysiologists rely on analysis of IEDs and ictal patterns recorded by scalp EEG for functional localization as the first crucial step in any video EEG telemetry unit as part of presurgical work up in patients with drug resistant TLE [13]. Although considered as the first basic step, a careful analysis of it can deliver substantial information.

There were several studies in the past addressing the interictal dipole orientation. The association of the finding of oblique dipoles to mesial temporal EEG activation was clearly demonstrated earlier-Type 1 dipole (tangential dipole) and a Type 2 dipole (radial dipole) have been described [14]. They reflect a mesial temporal and a lateral temporal neocortical seizure onset respectively. Ebersole's classification of dipoles in TLE signifies Type 1 spikes which possess an inferior temporal negative field maxima and a vertex positive field maxima. They were modeled by a similarly located single equivalent dipole that had an oblique orientation. The horizontal, radial nature of Type 2 spike dipoles suggested sources in lateral temporal cortex, whereas the more vertical and tangential orientation of Type 1 spike dipoles suggested inferior and basal temporal cortex (Ebersole 1994, 2000).

We went one step further by carefully analyzing dipolar fields of IEDs in TLE and categorizing them in to two groups: Type A and Type B. The features of Type A IEDs are similar to Type 1 spikes described earlier by various studies and presumably are of mesial temporal origin. Our primary aim was to classify and categorize IEDs according to the side of MTS. We looked for the presence or absence of Type A IEDs (Type 1 spikes) in relation to the side of MTS in MRI. We then analyzed the ictal pattern and correlated the relation between the spike voltage topography.

This two patients had focal ictal onset to the ipsilateral side of MTS. None of the patients showed ictal onset on the contra lateral hemisphere as described in wasted hippocampus syndrome; unilateral hippocampal atrophy with contralateral ictal onset of seizures [15].

Conclusion

Careful analysis of inter ictal voltage topography and dipole modeling may contribute to a better localization of the underlying brain source in patients with temporal lobe epilepsy. However; more number of patients and studies are required to validate.

Conflict of Interest

No conflict of interest.

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