

BOLD EEG-fMRI of focal temporal lobe epilepsy

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Objective: Focal temporal lobe epilepsy patients were studied by simultaneous electroencephalogram (EEG) and functional magnetic resonance imaging (fMRI), aiming to investigate the spatial correspondence between epileptiform spikes and BOLD responses. In order to do that, we have compared the clinical investigation of hippocampus atrophy patients with the BOLD statistical maps individually for all patients.

Methods: We have studied thirty two patients with mesial temporal lobe epilepsy. All patients have hippocampus atrophy and were under clinical investigation during the last five years by EEG, video EEG, neuropsychological evaluation, ictal and interictal SPECT, and MRI. In the last two years, EEG-fMRI measurements were acquired in a 2T Elscint Prestige MR scanner (Elscint, Haifa, Israel) using a cap with 32 scalp MRI-compatible electrodes, and a BrainAmp 32 MR amplifier (Brain Products, Munich, Germany). MRI artifacts were removed and filtered from EEG records by the Vision Analyzer software. Epileptiform spikes were identified by an experienced neurophysiologist. By using the EEG timing of the interictal epileptiform discharges (IEDs), the EPI images were analyzed with the SPM2 software package (<http://www.fil.ion.ucl.ac.uk/spm/>) in order to search for corresponding BOLD responses. We have acquired EPI in an interleaved mode in 6 minutes runs, and have performed the same image pre-processing in all of them: slice timing correction, motion correction, normalization and spatial smoothing. The statistical analysis was performed using T-test with no corrected p-value of 0.001 (T-value threshold was $T > 3.1$). The total images analyzed were acquired during 22 hours, which represents an average exam time of 42 minutes per patient. The average IED per exam was 14, calculated from a total of almost 450 marked EEG activities.

Results: From thirty two EEG-fMRI studies, four did not present any spike (12%). IEDs were identified in the EEG of twenty eight patients, being that twenty six of them showed positive BOLD responses as well as twenty two showed negative BOLD responses. This result corresponds to 81% and 69% of the total patients investigated, respectively for positive and negative BOLD responses. From the patients that presented positive BOLD responses (twenty six), thirteen (50%) exhibited good agreement, eight (31%) regular agreement and five (19%) no agreement in terms of spatial localization by comparing the previous clinical investigation and the fMRI outcomes. To illustrate one of these successful findings, Fig. 1 shows BOLD responses of one case

diagnosed by EEG as right mesial temporal lobe epilepsy with right hippocampal atrophy revealed by MRI. In this case, a clear consistency was found between the clinical evaluation and the activation area by BOLD contrast, shown in the figure as highlighted voxels in the parahippocampal gyrus.

Conclusion: This study has shown an elevate rate of effective BOLD responses associated with focal epileptic activity. In 40% of the cases (13/32) a good spatial agreement has been found among previous clinical investigation and positive BOLD responses.

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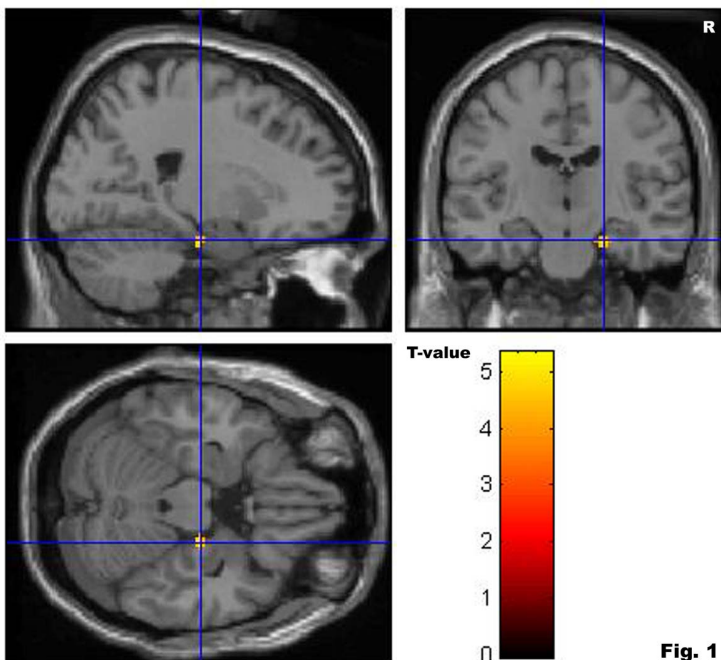


Fig. 1