

Differential Interictal Activity of the Precuneus/Posterior Cingulate Cortex Revealed by Resting State fMRI at 3T in Generalized versus Partial Seizure

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Introduction

Previous EEG-fMRI studies have shown deactivation of precuneus/PCC and vACC followed a typical S&W discharge in patients with idiopathic GS [1, 2] and secondarily GS [3]. However, there have been no studies of brain activity in the resting state in the interictal period. Thus question arises whether the functional alteration of precuneus/PCC exists throughout the interictal period in patients with GS, and if so, whether the functional abnormality of precuneus/PCC also exists in patients with PS. Present study aims to characterize, using functional MRI, the pattern of active brain regions in resting state in patients with epilepsy.

Method

The study was approved by the local ethical committee and written informed consent was obtained from all subjects. We studied 28 patients with epilepsy, divided into a partial seizure (PS; n=9) and a generalized seizure group (GS; n=19), and 34 control subjects. Resting state functional MRI was performed using a GE 3T scanner by collecting 200 volumes of EPI images with subjects relaxed, eyes closed. Data were processed using the method of Fransson [4], which reveals information on regional low-frequency BOLD signal oscillations in the resting state without any a priori hypothesis. Data processing using SPM2 included: (1) head-motion correction; (2) re-sampling ($3 \times 3 \times 3 \text{mm}^3$) and spatial normalization to Talairach space; (3) spatially smoothing (FWHM = 8mm). Low-frequency spontaneous fluctuations in BOLD signal levels were modeled using a discrete cosine basis set containing 10 regressors spanned the frequency range of 0-0.1 Hz. Individual statistical parametrical maps were created using F test containing the frequency range of 0.01-0.08 Hz and thresholded at $P < 0.05$ corrected for multiple comparisons. The significant active areas in brain were identified with both individual and group analysis.

Results

By analyzing the statistical parametrical maps of each subject, regions of significant activation were observed in all controls mainly involving the bilateral precuneus/PCC, the bilateral MPFC/vACC, bilateral medial frontal lobes and bilateral temporal lobes. All PS patients showed similar active clusters mainly involving the bilateral precuneus/PCC; bilateral MPFC/vACC and bilateral temporal lobes. However, no GS patients showed significant active clusters in the bilateral precuneus/PCC, although 5 of 7 patients with idiopathic GS and 7 of 12 with secondarily GS showed significant active clusters in bilateral MPFC/vACC areas, other active clusters being scattered across bilateral frontal, parietal and temporal lobes. These findings are supported by the one-sample t-test performed for each of the three groups. The control group showed active areas in the resting state which included the bilateral precuneus/PCC and the MPFC/vACC areas (Fig. 1a), and PS showed similar results (Fig. 1b). In contrast, the active regions in GS mainly involved MPFC/vACC and bilateral occipital lobes, and there were no significant active clusters in bilateral precuneus/PCC (Fig. 1c). Both idiopathic and secondary GS subgroups (not shown) showed similar results.

Discussion

We have shown for the first time that the lack of resting state spontaneous low-frequency activation in the precuneus/PCC areas in the resting state was observed in patients with GS, not PS. This may be clinically useful as a bio-marker for this disease. Our findings may partly explain why patients with GS have severer impairment of concentration and memory in the interictal period than patients with PS [5, 6]. However, it remains to be shown how antiepileptic medication affects brain during resting state, especially in patients with secondary GS who are usually resistant to antiepileptic medication. Further studies on a large cohort of epileptic patients before and after antiepileptic medication, particularly combining real time EEG recording with fMRI (EEG-fMRI), will help to provide further insight into the pathophysiology of the epilepsy.

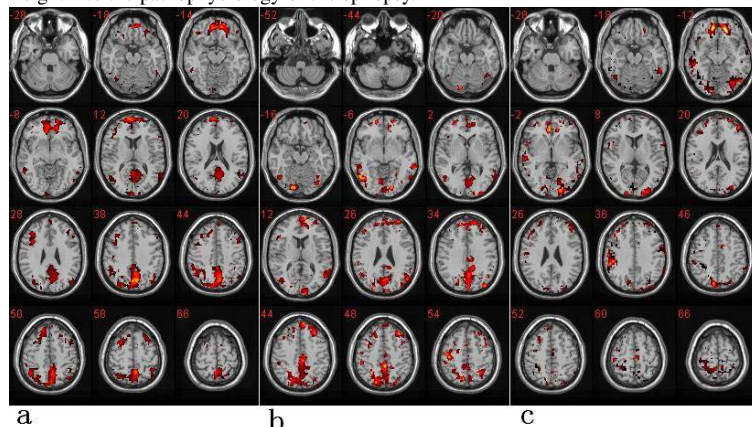


Figure 1. Within-group analysis showing the active patterns of (a) controls, (b) the partial seizure (PS) and (c) the generalized seizure (GS) group. Significant active areas in controls and PS include mainly precuneus/PCC and vACC/MPFC, while GS showed no active voxels in precuneus/PCC.

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