

The Value of Resting State-fMRI for Detecting Epileptogenic Zone in Patients with Focal Epilepsy

Jianzhong Yin^{1,2}, Bofeng Zhao¹, Zhijuan Chen³, Weidong Yang³, Yu Qing⁴, Li Cai⁵, Panli Zuo⁶, Hongyan Ni^{1,2}, and Wen Shen^{1,2}

¹Radiology Department, Tianjin First Central Hospital, Tianjin, China, ²Tianjin Medical Imaging Institution, Tianjin, China, ³Department of Neurosurgery, Tianjin Medical University General Hospital, Tianjin, China, ⁴Department of Neurology, Tianjin Medical University General Hospital, Tianjin, China, ⁵Clinical PET-CT Center, Tianjin Medical University General Hospital, Tianjin, China, ⁶MR Collaboration, Siemens Healthcare China, Beijing, China

Purpose:

To evaluate the value of resting state-fMRI (RS-fMRI) based on local analysis methods Regional homogeneity (ReHo), Amplitude of low-frequency fluctuation (ALFF) and fractional of ALFF (fALFF) for detecting epileptogenic zone (EZ).

Methods:

Forty-two patients (18 women, 24 men; mean age, 24 years; range, 5-50 years) with focal epilepsy, who all underwent comprehensive presurgical evaluation including clinical characteristic, VEEG, PET-CT, high-resolution epilepsy MRI protocol and RS-fMRI, were included. The sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) of EZ localization in RS-fMRI, MRI, MRS, video electroencephalogram (VEEG), and PET-CT were calculated and compared to assess the diagnostic ability. Those of ReHo, ALFF and fALFF were also assessed. The research protocol was approved by the local Institutional Review Board of Medical Ethics Committee.

Results:

After all the examinations, thirty-six patients (85.7%, 18 women, 18 men) identified the EZ, however, no EZ focus was found in the remaining six patients (14.3%, 6 men) who were diagnosed as idiopathic focal epilepsy. RS-fMRI shows a comparable diagnostic sensitivity to PET (83.3%) but specificity to VEEG (66.7%) for localizing EZ in patients with focal epilepsy. There was no significant difference between RS-fMRI and others localization techniques in sensitivity, specificity, PPV, and NPV for localizing EZ ($P>0.05$). The sensitivity of ReHo, ALFF and fALFF was 69.4%, 52.8% and 38.9%, respectively and the specificity was 66.7%, 83.3% and 66.7%, respectively. The comparison of ReHo, ALFF and fALFF showed no statistically significant difference ($P>0.05$), but the ReHo was more sensitive, at least in our cohort study, than fALFF ($\chi^2=6.77$, $P=0.0093$).

Discussion:

The advent of new methods for addressing spontaneous brain activity, as acquired with fMRI during the resting-state have grown dramatically over the past decade and enabled the investigation of previously overlooked aspects of intrinsic (abnormal) spontaneous brain activity. Among them, we focused on two local voxel-based measures within three analytic methods: ReHo, ALFF and fALFF. The ReHo analysis is a more stable voxel-based measure—rather than a linear statistical measure, which is based on the theory that the similarity of BOLD signal fluctuations in a local brain region may reflect homogeneity of neuronal activity at the same frequency, the value is thought to reflect the extent of temporal homogeneity and synchrony changes in neuronal activity¹. Whereas ALFF and fALFF are thought to reflect the magnitude of spontaneous activity of neurons². These regional enhanced coherent neuronal activity and fluctuation amplitude within spatially organized brain regions were thought to reflect the BOLD activation induced by epileptic activity^{3,4}.

The most value of our RS-fMRI works is at individual level for patients. To this purpose, using comprehensive evaluation-defined EZ result based on multimodal tests as reference standard, a larger cohort of partial epilepsy patients were investigated in our study.

Conclusion:

RS-fMRI could be an efficient tool for detecting EZ in epilepsy.

References:

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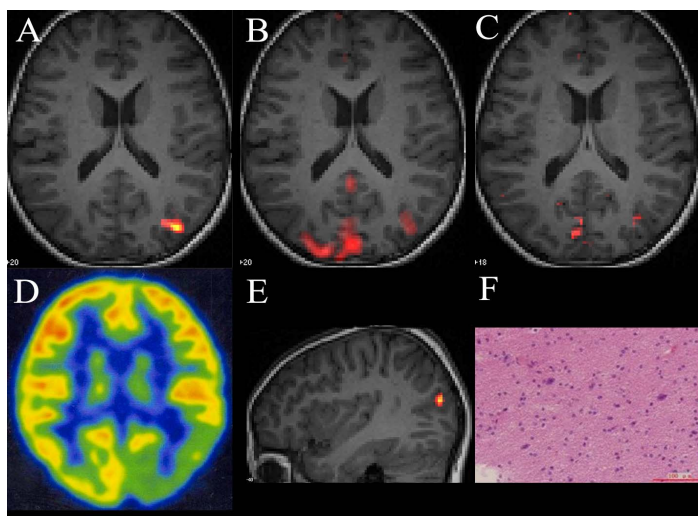


Fig. 1A-F. Left parietal-occipital lobe dysplasia in a 9-year-old patient. A Axial and E sagittal fALFF, B axial ALFF and C ReHo all reveal an abnormal activation on the left parietal-occipital lobe. D ¹⁸F-FDG PET/CT image demonstrates low FDG uptake in the left frontoparietal region. F Confirmed left parietal-occipital lobe focal cortical dysplasia on pathology.

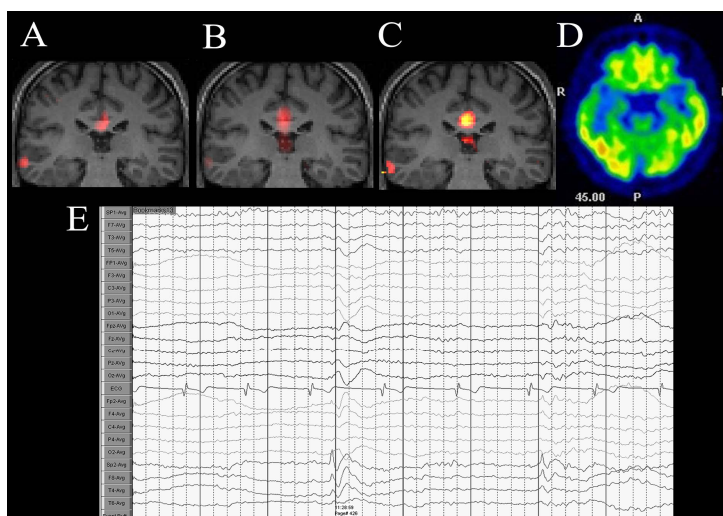


Fig. 2A-E. A 38-year-old man clinically diagnosed with epilepsy. A Coronal fALFF, B ALFF and C ReHo all reveal an abnormal activation on the right lateral temporal lobe. D ¹⁸F-FDG PET/CT image reveals low FDG uptake in the the right lateral temporal lobe region. E VEEG depiction of a right temporal lobe interictal epileptiform discharges at sphenoidal electrodes.