Time-shift Resting-state Functional Connectivity MRI in Supratentorial glioma, a preliminary study

Jianrui Li[1], Qiang Xu[2], Zhiqiang Zhang[1], and Guangming Lu[1]

[1]Medical Imaging, Jingling Hospital, School of Medicine, Nanjing University, Nanjing, Jiangsu, China, [2]Medical Imaging, Jingling Hospital, School of Medicine, Nanjing, Jiangsu, China

Purposes:

Time-shift functional connectivity based resting-state fMRI has proven a non-invasive and effective tool for measuring hemodynamic property of brain, and has been applied to reflect perfusion abnormality in cerebral diseases, such as ischemic stroke [1], moya-moya disease [2] and epilepsy [3]. In this work, we preliminarily assessed the feasibility of this approach on diagnosis assessment of supratentorial glioma.

Methods

A total of 6 patients with supratentorial glioma (ages: 12-64 yrs, age at 36yrs; genders: 2 females and 4 males; WHO grade II=2, grade III=2, grade IV=2) were involved in the study. MRI data were obtained on 3 T MRI scanner (GE Discovery 750, Milwaukee, USA) in each patient prior to surgery: Blood oxygenation level-dependent (BOLD) functional data were acquired using a T2*-weighted single-shot echo planar imaging sequence (TR/TE = 2,000 ms/40 ms, FA=x0º, matrix=64×64, field of view =22×22 cm, thickness/gap= 3.0mm/0.3mm, xx transverse slices, 200 volume measurements, after excluding the first five volumes). In line with previous study, averaged signals from an ROI (sagittal sinus close to the tumor) and was extracted as referential time series. Voxel-based correlation ($p<0.05$) was calculated with referential time series with 0, 1, 2 and 3 TR shift delays for time-shift functional connectivity. head motions were regressed. The result was compared with cerebral blood flow measured by Arterial-spin-labeling (ASL)(TR/TE=5310/10ms, PLD 2.5s, Nex=3) and dynamic susceptibility contrast (DSC) (TR/TE=1500/19.9ms, Nex=1, Gd-DTPA 15ml, 4ml/s intravenous injection) perfusion techniques.

Results: Visual inspection revealed that higher grade glioma shows more significant result in time-shift functional connectivity map (glioma grade IV > III > II). Results of the 3TR-shift connectivity mapping was more significant. Spatial pattern of time-shift functional connectivity maps was more similar with DCE perfusion map than ASL map.

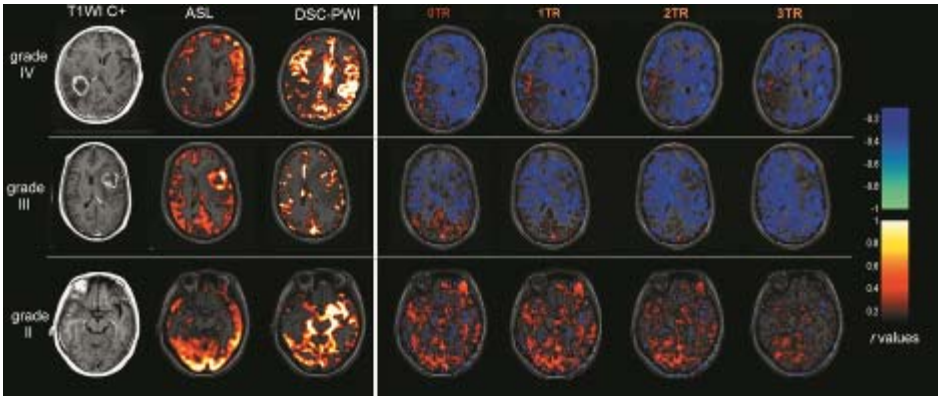

Figure1. Resting-state fMRI based time-shift functional connectivity of supratentorial glioma, and the comparing results of ASL- and DSC-based PWI. Visual inspection revealed that higher grade glioma shows more significant result in time-shift functional connectivity map (grade IV > III > II). Results of the 3TR-shift connectivity mapping was more significant. Spatial pattern of time-shift functional connectivity maps was more similar with DCE perfusion map than

Discussion:

Using BOLD fMRI based time-shift functional connectivity analysis, this preliminary study assessed the features of hemodynamic alterations in Supratentorial glioma. Traditionally, BOLD fMRI measures brain activity by detecting hemodynamic alterations underpinned by neurovascular action. Recently, by employing detection of hemodynamic property of brain tissue, resting-state fMRI has been applied for cerebro-vascular diseases [1,2]. Selection of referential time signal is a key step for time-shift functional connectivity. ROI signal of sagittal sinus is more specific than averaged global brain signal for setting referential signals, and may be more appropriate for investigation of focal lesion in brain, such as brain tumor. The glioma with different pathological grades showed different time-delayed positive-correlation with referential signals in resting-state fMRI fluctuations, may underpinned by different perfusion feature, e.g., the hemodynamic property of microvascular in tumor.

Conclusion: These preliminary results suggested that resting-state fMRI based time-shift functional connectivity, had capability for detecting perfusion property of supratentorial glioma. This novel neuroimaging approach may have potential for assessment of grading of glioma.

References

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