Resting State fMRI for Presurgical Motor Cortex Mapping is Not Enough

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Introduction

The localization of motor cortex in tumor patient plays an important role in presurgical planning and risk assessment. Most previous studies have indicated that tumors may cause the displacement of brain tissue and the reorganization of brain functional network in patients [1-3]. Therefore, over the past few years, resting state fMRI (RS-fMRI) and task-based fMRI have been used together to localize the motor cortex. Most recently, some researchers suggested that the RS-fMRI have the potential to map the motor cortex by itself in presurgical patients [4-7]. However, it is worth noting that whether the RS-fMRI can serve as a promising alternative to the task-based fMRI in the mapping of motor cortex still remains pending due to the insufficient dataset of tumor patients. In our work, we compared the rs-fMRI and task-based fMRI in mapping of motor cortex with data collected from 12 patients with brain tumors. The aim of this study is to evaluate whether rs-fMRI is appropiate and robust for mapping motor cortex in presurgical planning.

Subjects and Methods

Twelve patients with brain tumors were selected (age range: 29 ~ 61 years, mean: 47±0.5 , female: n=5) . The types of the tumors included: astrocytoma (n=7), meningeoma (n=3), angiocavernoma (n=1), and one metastatic tumor. We employed a 3.0-T GE scanner equipped with an eight-channel head coil. Both structural images (3D FSPGR 1x1x1 mm^3, 140 slices) and BOLD EPI data (TR/TE = 2500/40 ms, flip angle=90°, 3.75x3.75x3 mm^3) were obtained. In our experiment, first all the patients did a resting state block (150 images, 6.15 minutes, eyes closed). Then they were asked to perform a hand-movement task, which consisted of five 30s blocks of movement task and six 30s fixations; the total time was 5.5 minutes. To allow for the initial stabilization of fMRI signal, the first four volumes were excluded from the data analysis. The fMRI dataset was analyzed by using FSL MELODIC ICA software (www.fmrib.ox.ac.uk/fsl), and then the motion correction was processed by using FLIRT (MCFLIRT). The spatial smoothing was performed at 6-mm FWHM Gaussian kernel to reduce noise. The fMRI images were filtered with high pass filter. The functional images were normalized to the MNI152 standard brain space through their structure images. The ICA analysis was carried out using probabilistic independent component analysis (PICA). The number of component was automatically estimated from the fMRI data by means of a Laplace approximation to the Bayesian evidence of the model order. The resulting maps were thresholded using an alternative hypothesis test based on fitting a Gaussian/Gamma mixture model to the distribution of voxel intensities within spatial maps and a posterior probability threshold of $p > 0.5$.

Results

In Fig. 1, the top row of images show the independent components of the resting state motor network for each patient (IC-rest, green color); the second row of images show the task-based motor activation mapping (yellow color); and the third row of images show the overlapped activations between the resting and task-based states. It is seen that the motor activation mappings from the RS-fMRI are quite similar to those from the task-based fMRI in the patients with tumors far from motor cortex (patients 1, 3, 7, 8, 11). However, in each the patients with tumors around motor cortex (patients 2, 4, 5, 6, 9, 12), the spatial distribution of motor cortex activation from the RS-fMRI does not match the distribution from the task-based fMRI well as shown in Fig. 1. These results indicate that the task-based fMRI is more reliable in the motor activation mappings of patients with tumors nearby motor cortex. It is also evident that tumor positions have a big impact on the accuracy of RS-fMRI motor activation mappings.

Discussion and Conclusions

In this work, we evaluated the possibility and robustness of mapping the motor cortex by means of RS-fMRI and task-based fMRI for the presurgical planning of tumor patients. Our results show that obvious differences presented between RS-fMRI and task-based fMRI for mapping motor cortex. Much attention should be paid when using RS-fMRI to map motor cortex. According to our preliminary results, we suggest that RS-fMRI cannot be used alone in motor activation mapping, which should be employed as a complementary method. However, due to the dataset limitation, the influence of tumor locations was not taken into account. Further studies are undergoing to evaluate the RS-fMRI for mapping motor cortex in patients without task performance ability.

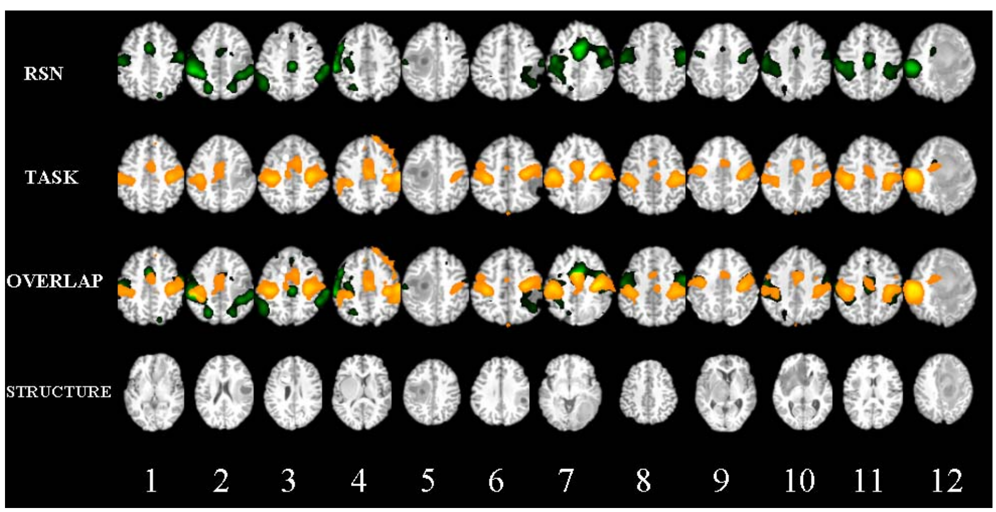

Fig.1 RSN, TASK, and RSN and TASK mapping overlap with structure images, as well as structure images for 12 tumor patients.

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