Effect of Single Ischemic Lesion on Cortical Networks

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Introduction

Ischemic stroke (IS) may lead to abnormalities in brain areas remote to the IS lesion[1]. Functional networks containing ischemic stroke lesions were reported to experience more changes during recovery[2], while the network involvement beyond the anatomical location of the IS lesion are yet to be defined. This study aimed to explore the effect of single IS lesion on the cerebral functional networks defined using probabilistic independent component analysis.

Materials and experiments

A group of fourteen subjects (male/female=9/5, average age 60±14.95years) with first-ever single ischemic lesion were enrolled. Magnetic Resonance study was performed on a 1.5T scanner (Siemens, Erlangen, Germany) with a standard head coil at day 2 (n=1), day 7 (n=12) and day 15 (n=1) post stroke. T1-weighted images were acquired using MPRAGE with TR/TE 1900ms/3.37ms, matrix size 256×256，slice thickness 1mm, FOV 250mm, flip angle 90°. Diffusion weighted image was acquired for the detection of acute stroke using single-shot spin echo echo-planar imaging with TR/TE 4100ms/100ms, 28 slices, FOV 250mm, slice thickness 3mm, flip angle 90°, matrix size 128×128. DWI images were spatially normalized to MNI coordinates using SPM8 (http://www.fil.ion.ucl.ac.uk/spm/). Lesions were manually drawn on the DWI data using the drawing tools available in MRICro software (http://www.mccauslandcenter.sc.edu/mricro/mricro/mricro.html) and binarized as a mask for each subject. The templates of eight networks (Figure 1) retrieved from the FMRIB database[3] (http://www.fmrib.ox.ac.uk/analysis/royalsoc8/) are functionally defined as: (a) medial visual cortical areas; (b) lateral visual cortical areas; (c) auditory system; (d) sensorimotor system; (e) visuospatial system[4]; (f) executive control; (g and h) right and left dorsal visual stream, respectively. In order to categorize the eight networks into affected and unaffected, an overlap between each of the binarized eight network templates and the individual lesion masks was computed through multiplication using REST software (http://www.restfmri.net). An overlap > one voxel was defined as involved network, no overlap as uninvolved.

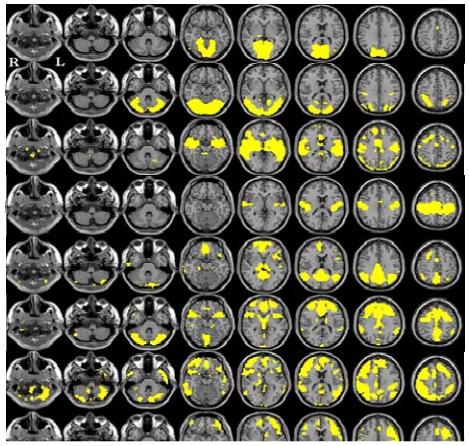

Figure 1. The eight network templates. Axial slices of the eight independent components based on probabilistic independent component analysis.

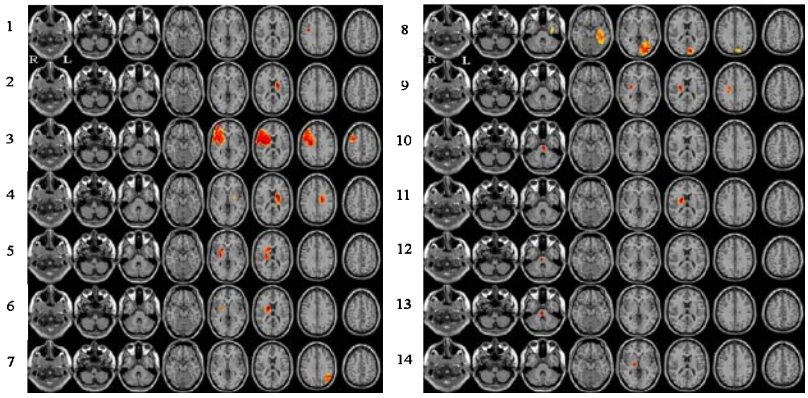

Figure 2. Individualized lesion masks for the subjects. Axial slices of the individual lesions based on DWI images. Red color represents the lesioned areas.

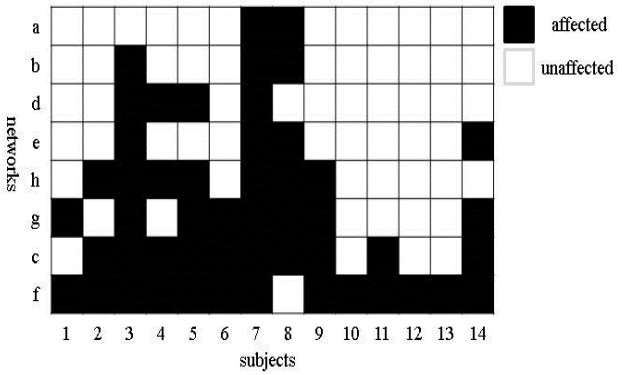

Figure 3. Affected and unaffected networks. The x-axis depicts the 14 subjects and the y-axis depicts individual networks arranged in ascending order of affected quantity.

Results

The individualized lesion masks for each patient was shown in Figure 2 and the overlap of the eight network templates was summarized in Figure 3. Executive control, auditory system and dorsal visual system were the mostly involved networks in the acute IS with a heterogeneous context of lesion distribution.

Conclusion

Extensive involvement of brain functional networks as a result of single IS lesion was observed in this study. The clinical relevance of the network involvement needs further investigation. This preliminary study may provide valuable reference into the cerebral functional network research during the rehabilitation of ischemic stroke.

Reference

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