ABERRANT REGIONAL HOMOGENEITY RELATED TO COGNITIVE IMPAIRMENT IN SUBCORTICAL STROKE PATIENTS: A RESTING-STATE FMRI STUDY

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TARGET AUDIENCE

This study is expected to provide information about aberrant regional homogeneity (ReHo) related to cognitive impairment in subcortical stroke patients to radiologists as well as neurologists.

PURPOSE

This study utilised resting-state functional magnetic resonance imaging (rs-fMRI) to investigate ReHo changes in subcortical stroke patients and whether these changes were correlated with cognitive performance.

METHODS

The current study included 24 subcortical stroke patients and 23 healthy controls. Scores from neuropsychological tests and ReHo values were obtained and compared between the two groups. The preprocessing of the rs-fMRI and the ReHo analysis were conducted using the following two software tools: Data Processing Assistant for Resting-State fMRI (DPARSF; http://www.restfmri.net/forum/DPARSF) and Resting-State fMRI Data Analysis Toolkit (REST; http://www.restfmri.net); both tools are based on statistical parametric mapping (SPM8; http://www.fil.ion.ucl.ac.uk/spm). The potential relationships between ReHo values and cognitive performance were evaluated via partial correlation analysis.

RESULTS

The subcortical stroke patients and the healthy controls did not significantly differ in age, sex, education, BMI, vascular risk factors or brain parenchyma volume (all $P > 0.05$). The patients exhibited significant deficiencies in cognitive performance, including general cognitive performance (MMSE and MOCA, $P < 0.001$) and episodic verbal and visual memory (AVLT and CFT delayed recall tests, $P < 0.05$). The patients also demonstrated significantly decreased ReHo values in the right inferior temporal gyrus(ITG)/fusiform and the right medial frontal gyrus (MFG) as well as increased ReHo values in the left inferior parietal lobule and the bilateral superior temporal gyrus (STG)/middle temporal gyrus (MTG) compared with the controls (Fig. 1). The partial correlation results indicated that the ReHo values of the right MFG were positively correlated with the MMSE scores ($r = 0.514$; $P = 0.020$) in the subcortical stroke patients (Fig. 2A). Moreover, the ReHo values of the right STG/MTG were negatively correlated with the MMSE scores ($r = -0.533$; $P = 0.015$) as well as the MOCA, AVLT delayed recall and CFT delayed recall test scores ($r = -0.514, -0.615,$ and -0.636, respectively; $P = 0.021, 0.004,$ and 0.003, respectively) in the stroke group (Fig. 2B, C).

DISCUSSION

Several previous studies have demonstrated that the most significant expression of vascular cognitive impairment after a stroke is the dysfunction of episodic verbal and visual memory[1, 2]. The primary function of the ITG is to process visual stimuli of objects in one's field of vision; it is also involved in object recognition memory and semantic memory [3]. Thus, the reduction in ReHo values observed in the right ITG/fusiform is consistent with previous results. Moreover, it is known that stroke patients can suffer from executive dysfunction, and the prefrontal cortex is a critical neural substrate for execution control [4]. Thus, this evidence of executive deficiencies after strokes supports our observations of reduced ReHo in the MFG, which is part of the prefrontal cortex. The significant ReHo/cognition correlation in the MFG further reinforces the significance of the role of this brain region in the executive performance of stroke patients. The STG is one part of the parallel organisation of the cortico-striato-thalamic circuits, which support both actual and potential movements (motor preparation and motor planning). The increased ReHo observed in the STG in our research may be indicative of compensation that arises after a subcortical stroke that affects the corpus striatum or thalamus because of the resulting deficiencies in prefrontal function, thereby requiring additional effort or cognitive effort. The MTG has been proven to be involved in various processes, such as accessing word meaning while reading, recognising known faces and contemplating distance[5]. In our study, increased neuronal activity in the right STG/MTG may hint at more severe cognitive impairment.

CONCLUSION

ReHo could represent a promising tool for the observation of neurobiological consequences such as cognitive impairment in post-stroke patients.
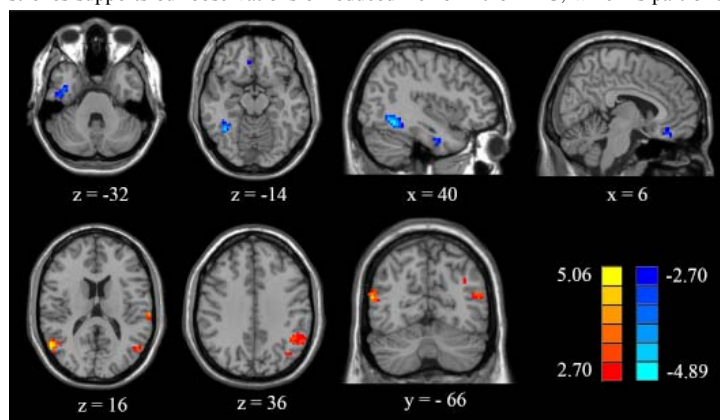

Figure 1. ReHo differences between the healthy controls and the stroke patients. The specific brain regions with abnormal ReHo values are displayed in transverse, coronal and sagittal views. Thresholds were set to P < 0.01, AlphaSim corrected. The colour scale represents the t values. R, right; L, left.

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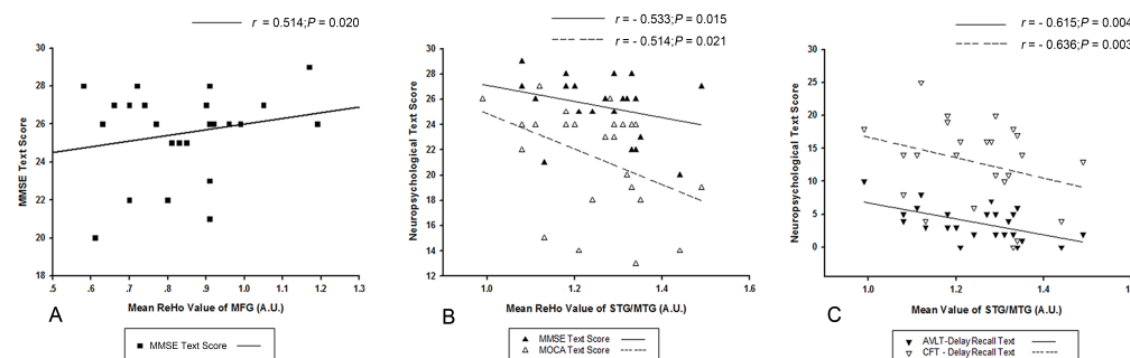
Figure 2. Correlations between cognitive performance and the ReHo values extracted from significantly different regions (partial correlation). (A) The ReHo values of the right MFG exhibited a significant positive correlation with the MMSE scores ($r = 0.514$; $P = 0.020$). (B and C) The ReHo values of the right STG/MTG exhibited a significant negative correlation with the MMSE ($r = -0.533$; $P = 0.015$), MOCA ($r = -0.514$; $P = 0.021$), AVLT delayed recall ($r = -0.615$; $P = 0.004$) and CFT delayed recall test scores ($r = -0.636$; $P = 0.003$). A.U., arbitrary units.