Altered Resting Cerebral Blood Flow in adults following low-frequency Electronic Acupuncture as Revealed by Perfusion Functional MRI

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Introduction

Acupuncture has been widely accepted in pain-relief treatment [1], and there is a growing interest in its neurological mechanism. A number of previous studies have utilized blood oxygenation level dependent (BOLD) fMRI to map brain activity related to relatively short periods (< 8min) of acupuncture stimulation [2-4]. However, in previous clinical studies, 30min of continuous acupuncture was required to induce pain relief in younger adults [5]. Given the well-known concern regarding the reproducibility of BOLD fMRI in detecting the brain response to low-frequency tasks [6], the present work explored the effects of 30min of low-frequency electroacupuncture stimulation (EAS) on resting state cerebral blood flow (CBF) using the arterial spin labeling (ASL) technique [7,8].

Materials and Methods

Ten right-handed adults (5 women, 22-28 years old) were recruited for this study and provided informed consent as approved by the hospital ethical committee. All participants were free of brain disease and other psychological symptoms based on extensive clinical examinations conducted by both neurologists and psychologists. During the scanning time, subjects were instructed to keep their eyes closed, think of nothing and stay awake. Acquisition of CBF was performed for 8 minutes, both before and after 30min of 2Hz EAS applied to the left LI4 acupoint. EAS was delivered at maximal intensity without pain (14±4.6mA) using an MRI-compatible Hans 200 electric acupoint stimulation device (Nanjing Jensun Medical Technology Co., Ltd., Nanjing, China). There was no time delay between the EAS and the post scan.

All MRI experiments were performed on a GE 3T Signa system with a standard head coil. Functional data were acquired using a double readout spiral-out pulsed ASL sequence with simultaneous CBF and BOLD acquisition [7]. CBF/BOLD readouts were acquired at TE of 3.1/30 ms covering 10-12 axial slices of the cerebrum and most of the cerebellum. SPM2 and MATLAB were used for data processing. For each subject, functional images were first realigned to correct for head motion and coregistered with the anatomic image. Perfusion-weighted image series were then generated by pairwise subtraction of the label and control images, followed by conversion to absolute CBF image series based on a single-compartment continuous arterial spin-labeling perfusion model. One mean CBF image was generated for each individual subject, normalized to a MNI 3*3*3mm template and smoothed in space with a three-dimensional, 8mm full-width-at-half-maximum Gaussian kernel. Global CBF was calculated and compared by paired t-test. The mean CBF images for each group were averaged. Finally, the results of the pre- and post-EAS absolute mean CBF images were compared using paired t-test to identify regions with statistically significant differences (uncorrected voxel level p<0.001, cluster corrected p<0.05 contiguous voxels > 10).

Results

Thirty minutes of low-frequency EAS did not significantly change the global CBF of these 10 subjects (pre = 64.70 ± 4.45 ml/100g/min, post = 64.68 ± 4.13 ml/100g/min). The acupuncture reduced regional CBF within several regions, including the ipsilateral (left) inferior parietal lobe (IPL), the contralateral (right) inferior prefrontal cortex (IPFC), the ipsilateral dorsal anterior cingulate cortex (dACC), and the contralateral postcentral gyrus(Fig.2). On the other hand, CBF did not increase within any brain region.

Discussion & Conclusion

In conclusion, this study determined the effect of a relatively long period (30min) of low-frequency EAS on resting-state CBF. We observed that blood flow significantly decreased within the ipsilateral IPL and dACC, as well as the contralateral IPFC and postcentral gyrus. The observation that the acupuncture did not significantly increase CBF within any brain region is contrary to previous reports using block-designed acupuncture assessed by functional MRI[9]. These differences may have resulted from longer duration of acupuncture stimulation and/or different observation time of the acupuncture effect. Future research should therefore explore potential mechanisms through which low-frequency acupuncture may modulate the central nervous system.

References
