Acupuncture-stimulated Auditory-cortical Activation observed by fMRI – A case of Acupoint SJ5 Stimulation

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Introduction
Recently, functional Magnetic Resonance Imaging (fMRI) has been used to visualize many classes of behavior of the human brain by visualizing changes in blood oxygenation and the related regional Cerebral Blood Flow (rCBF) with high temporal resolution from a few seconds to minutes. In the brain, blood deoxygenation and oxygenation as well as rCBF are presumably related to neural activity measurable by fMRI and PET which can measure brain activity when subjects perform specific tasks or are exposed to specific stimuli.

Recent studies we performed with fMRI revealed that there is a strong correlation between acupoint stimulation and activation of its corresponding cortical area. As they have been reported, a vision-related acupoint (BL67) is located in the lateral aspect of the ear and deafness. [1-2]

Methods
Experiments were carried out using multi-slice gradient-echo EPI on a standard clinical GE 1.5 T Signa MRI system. Sixteen healthy human volunteers were studied for both acupuncture and auditory stimulations. For each fMRI experiment, spin-echo T2-weighted images were obtained as the reference anatomical image set of the whole brain. For the experimental study, a repetition time of 3 sec., an echo time of 50 msec., a field of view (FOV) of 260 mm, a slice thickness of 10 mm, and a matrix size of 128x128 were used. Eight slices were acquired within one repetition time and 60 sequential time-series images were obtained.

For direct auditory stimulation, light music was played, which was turned “on” and “off” for 60 seconds each for the auditory stimulation paradigm. For the acupuncture stimulation paradigm, we used electro-acupuncture and inserted the electric acupuncture needle into the SJ5 point on the Triple Energizer Meridian Channel located in the left arm (see Fig. 1(a)). The acupoint (SJ5) is known as a treatment point for ear-disorders. The stimulation paradigm of acupuncture was made the same as the auditory stimulation, i.e., the electric acupuncture (wide range of frequencies from the low of 2-3 Hz to as high as 1kHz by sweeping from low to high frequency) was turned “on” and “off” for a period of 60 seconds for each stimulation paradigm. The results of the acupuncture stimulation were then compared with the auditory stimulation experiment.

Signal processing of data was carried out by using the standard correlation coefficient method for each pixel with a box-car waveform as a reference [3].

Experimental Results
The first three representative slices (the 11th, 14th, and 15th slices) among the eight slices were selected for demonstration of the correlation of cortical activation between conventional auditory stimulation and acupuncture stimulation of acupoint SJ5. Results of selected representative activation are shown in Fig. 1(b) and (c) for simple auditory stimulation and acupuncture stimulation of acupoint SJ5. Among the 16 volunteers, only 8 volunteers showed cortical activation during acupuncture stimulation. In Fig.2, eight averaged or overlayed cortical activation images of four selected slices for the conventional auditory stimulation and acupuncture stimulation of acupoint SJ5, respectively, are shown for demonstration. In the lower part of Fig.2, a set of corresponding image templates with related cortical areas, including auditory cortex, are shown for reference. Quite remarkable correspondence is seen between direct auditory stimulation and acupuncture stimulation of SJ5, respectively. (c) Display of a set of templates corresponding to the activation areas of interest are shown for reference.

Conclusions
The present study is a step toward understanding Oriental acupuncture in relationship to brain function of the CNS, which has largely been ignored in classical Oriental medicine. It also represents an important step toward understanding the pathways of brain activations by the peripheral nervous system of our body.

References