A Network Analysis of Acupuncture Effects by Functional Connectivity MRI

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Objects To test these hypotheses that there is a default network about pain and analgesia in the resting brain, and acupuncture can modulate this network, then gaining the analgesia effect in the clinic., using the functional connectivity MRI , the most optimal technique to investigate the related network of acupuncture.

methods In this study, we used functional MRI (fMRI) to examine brain activity in a group of 18 subjects. We used two runs ,in run 1, subject underwent a real acupuncture stimulation at ST.36. In run 2, subject was performed a sham acupuncture stimulation, in which all are identical except that it was at a nonacupoint. Subjects were scanned in a GE 3T Signa scanner. Functional images were collected with sagittal sections parallel to the AC-PC plane in 5mm thickness without gap. The first 5 time points of the total 500 time points were discarded in order to obtain a stable state and equalize with the resting state dataset. All data were motion-corrected using the INRIAlign toolbox, a histogram process was performed to create a mask (this removed those pixels outside the brain). The data were further processed (spatially normalization to MNI space and re-sampled at 3mm3) by SPM2. We select the precise left ventral anterior cingulate cortex(vACC) as seed point,then the peak voxel and its nearest 8 neighbors in the left vACC were defined as a group ROI. This group ROI was used to further define subject-specific ROI. The time courses of voxels within the ROI were averaged to generate a single low-frequency reference time series, named 'seed' time course.For each subject, the seed time course was cross-correlation with all other low-pass filtered voxels across the brain to form functional connectivity maps using the datasets of run 1and 2 individually.We have got two groups of functional connectivity t-maps. One is the resting state after acupuncture; the other is for the resting state after sham.In order to compare the functional connectivity difference of post-acupuncture resting state with post-sham resting state, a paired t-test were performed across subjects(post-acupuncture resting state vs. post-sham resting state). The final t-maps were cluster-filtered to remove activations involving < 5 contiguous pixels and superimposed on high-resolution anatomical images using a $P < 0.05$ cutoff (FDR corrected) individually.The above procedures were coded in MATLAB7 (The MathWorks, Inc.), SPM2 package and FMRIstat package.

Results (see Figure 1 *and* 2)

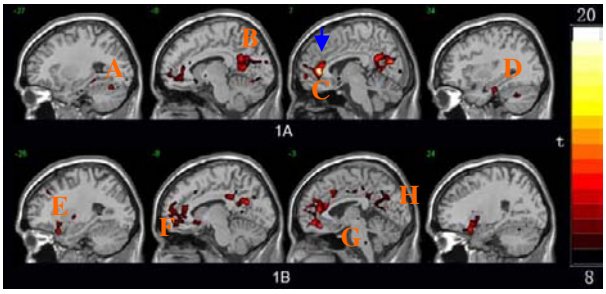

Fig.1 Maps of the functional connectivity: 1a is for the post-effect of sham acupuncture resting state ($t > 2.68$, $df = 21$, $p < 0.02$ FDR corrected); 1b is for the post-effect of acupuncture resting state ($t > 4.2$, $df = 21$, $p < 0.001$ FDR corrected). The blue arrow indicates the approximate location of the vACC peak. A, cerebellum. B, PCC.C, MPFC. D, parahippocampal gyrus.E,DLPFC. F, OFC. G, mesencephalon.H, IPC.

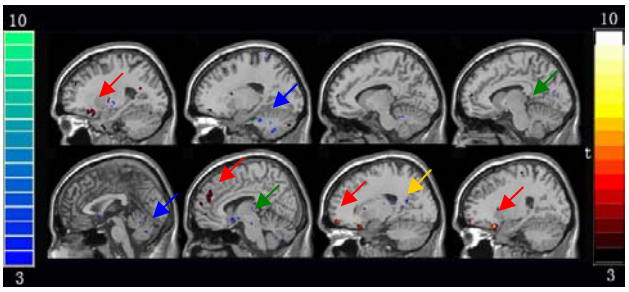

Fig. 2: The difference between acupuncture and sham stimulation on the maps of the functional connectivity : red is acupuncture have but sham havn't; blue is sham have but acupuncture havn't ($t > 3.0$, $df = 13$, $p < 0.005$ uncorrected).red arrows: the approximate locations of medial and prefrontal lobe. Blue arrows: the cerebellar vermis and anterior lobe. Green arrows: the mesencephalon and thalamus. Yellow arrow: rostral insula(IC).

Conclude This is the first study, to our knowledge, to demonstrate resting state functional connectivity between brain regions implicated in the acupuncture effects network. Greicuis had proposed that there have been a default mode in resting state of brain function, constituting a network including PCC and ACC. We selected vACC as seed point to map the acupuncture-related network. This study demonstrated vACC is significantly correlated with PCC, DLPFC, MPFC, IPC, OFC, hypothalamus, nucleus accumbens, hippocampus, and midbrain after acupuncture. It was same to the results of Greicius. This default network is associated with affective and autonomic processing including nucleus accumbens, hypothalamus, midbrain, ACC and PCC.We found the compelling similarity existed in the network of resting state between acupuncture and sham manipulation. The main difference was found in the prefrontal lobe, rostral insula(IC) and cerebellum. We conclude that the default pain functional network exists in human brain, and the network of the resting state after sham stimulation is similar to that after acupuncture.This kind of similarity between two stimulations maybe due to the select of seed point.