

BOLD responses according to stimulation orders and manipulation methods

G-H. Jahng¹, S-I. Bae², and S. Lim²

¹Department of Radiology, Kyung Hee University Hospital-Gangdong, Kyung Hee University, Seoul, Seoul, Korea, Republic of, ²Department of Meridian and Acupuncture, Graduate School of Applied Eastern Medicine, Seoul, Seoul, Korea, Republic of

Introduction: The previous neuroimaging studies have the experimental paradigm of acupuncture stimulations being used in a block design at the left [1,2,3] or right acupoint [4,5,6] only and/or both the left and right ones [7,8]. However, there has not been imaging studies of acupuncture stimulations at the left and right acupoint alternately. Needling orders of those may affect results of acupuncture activations. Needling patterns of those may also affect results of acupuncture activations. To the best of our knowledge, no study has been performed yet to investigate 1) how a stimulation order of acupuncture can be affected in the brain activations or 2) how a manipulation method of acupuncture can be affected in the brain activations. In order to investigate neuronal effects of acupuncture stimulations by varying stimulation orders and manipulation method, this study was planned to investigate the blood oxygen level-dependent (BOLD) response with acupuncture stimulations at the left and/or right acupoint of ST36.

Materials and Methods : Fourteen healthy subjects were participated in this study. The experimental design of this study consists of four different sessions. In the first session, the placebo needle stimulation was performed during only the activation periods. The order of the placebo stimulation was carried out at the right ST36 and then at the left ST36. The placebo needle stimulation was performed using a blunt, non-penetrating needle. We call this first session is "continuous session with the placebo stimulation, CP." In the second session, the same placebo stimulation was also performed during only the activation periods, but the order of the placebo stimulation was carried out at the right ST36 and left ST36, alternately. We call this second session is "interleaved session with the placebo stimulation, IP." In the third session, the acupuncture stimulation was carried out at the right ST36 and then at the left ST36. We call this third session is "continuous session with the acupuncture stimulation, CA." In the fourth session, the order of the acupuncture stimulation was carried out at the right ST36 and left ST36, alternately. We call the fourth sessions are "interleaved session with the acupuncture stimulation, IA." The experiment was performed with a 3.0T MRI system (Philips Achieva). Pre-processing and statistical analysis were performed using SPM8 software. The data were analyzed by using the within-subject ANOVA test with a statistical threshold of $p < 0.005$ uncorrected combined with spatial extent threshold.

Results :

Effects of the stimulation orders(Fig 1): Higher BOLD response with the acupuncture stimulation at the left acupoint in the continuous session (session 3) compared with that in the interleaved session (session 4) yielded mainly in bilateral primary somatosensory cortex (SI, BA 2 and 3), supplementary motor areas (SMA, BA 6), inferior frontal gyrus (BA 44 and 47), middle temporal gyrus (BA 22, 37 and 39), postcentral gyrus (BA 43), precuneus (BA7), lingual gyrus (BA 18 and 19), anterior cingulate gyrus (ACC, BA 24, 25 and 31). Lower BOLD response with the placebo stimulation at the right acupoint in the continuous session (session 1) compared with that in the interleaved session (session 2) yielded in ipsilateral amygdala, anterior cingulate gyrus (BA 32) contralateral parahippocampal gyrus (BA 28).

Effects of the manipulation methods(Fig 2): Higher BOLD response with the acupuncture stimulation in the CA (session 3) using both left and right compared with that in the IA (session 4) yielded in left primary somatosensory cortex (BA 2 and 3). In addition, lower BOLD response with acupuncture stimulation in the CA using both left and right compared with that in the IA yielded in both superior temporal gyrus (BA 38), left middle frontal gyrus (BA 10) and left ACC (BA 32), shown in Fig. 2B.

Discussion: The first major finding of this study was that BOLD signals could be altered by changing the stimulation orders of both acupuncture and placebo, especially in limbic and limbic-related areas. Higher BOLD response with the acupuncture stimulation at the left ST36 in the CA compared with that in IA provides additional evidence in support of previous reports that acupuncture modulates the limbic system and limbic-related structures.

The second major finding of this study was that BOLD signals could be altered by changing the manipulation methods for both acupuncture and placebo, especially in the cerebral cortex. Higher BOLD response with the acupuncture stimulation in the CA using both left and right compared with that in the IA are not consistent with the former result of bilateral activation and/or deactivation in the brain [1,5]. It may be due to acupuncture stimulations at the different acupoint.

Conclusion: To our knowledge, this is the first reported fMRI study to investigate neuronal effects of acupuncture according to three acupuncture parameters; stimulation order and manipulation method as well as needling at the right or left side. In conclusion, We studied the effect of stimulation parameters of acupuncture extensively. These results would be fundamental evidences of emphasizing the importance of stimulation parameters and of explaining the variability of acupuncture effect.

Acknowledges: This research was supported by Basic Science Research Program through the National Research Foundation of Korea (NRF) funded by the Ministry of Education, Science and Technology (2009-0089314) and by a grant of the Korean Health Technology R&D Project, Ministry for Health, Welfare & Family Affairs, Republic of Korea (A092125).

Fig 1. Comparisons of two different types of stimulation order: CA>IA(A), CA<IA(B), and CP<IP(C).

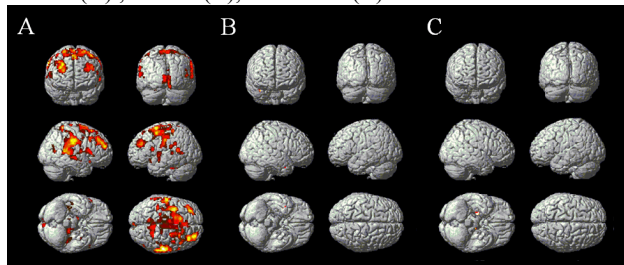
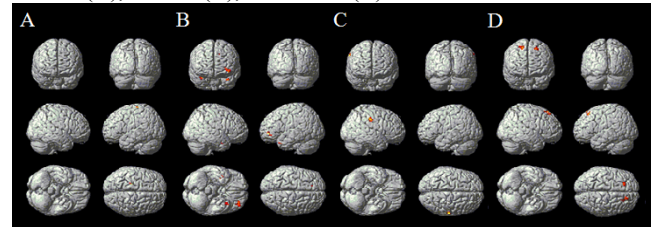


Fig 2. Comparison of two different types of manipulation method: CA>IA(A), CA<IA(B), and CP>IP(C).



References: 1. Y. Chae, et al, Neurosci Lett 450 (2009) 80-84. 2. S.S. Jeun, et al, Am J Chin Med 33 (2005) 573-578. 3. J. Kong, L. et al, J Altern Complement Med 8 (2002) 411-419. 4. K.K. Hui, et al, Neuroimage 27 (2005) 479-496. 5. K. Li, et al, J Altern Complement Med 12 (2006) 615-623. 6. V. Napadow, et al, Hum Brain Mapp 24 (2005) 193-205. 7. I.K. Gareus, et al, J Magn Reson Imaging 15 (2002) 227-232. 8. K.K. et al, Hum Brain Mapp 9 (2000) 13-25.