Low Level Laser Stimulation of K1 Acupoint Induced Precuneus Activations

Chang-Wei Hsieh[1], Chao-Hsien Hsieh[2], Jih-Huah Wu[3], Qwa-Fun Wang[4], Jyh-Horng Chen[2]

[1]Department of Information and Communication Engineering, Asia University, Taiwan
[2]Interdisciplinary MRI/MRS Lab, Department of Electrical Engineering, National Taiwan University, Taiwan
[3]Department of Biomedical Engineering, Ming Chuan University, Taiwan
[4]School of Post-Baccalaureate Chinese Medicine, China Medical University, Taiwan

Abstract— **This study aims to explore the acupuncture elict activity in specific brain area using low level laser. We investigated the cerebral effects of laser acupuncture at acupoint K1 with functional magnetic resonance imaging (fMRI). After group analysis, we find the significant activation area is on the Precuneus which concern with a wide spectrum of high intergrated tasks.**

Keywords— **low level laser therapy, fMRI, Acupuncture.**

Introduction

Acupuncture is an ancient Chinese method to treat disease and reduce pain. In recent decades, the international community related programs and researches growing, so that the traditional techniques from the past metaphysical explained that gradually accepted by the people of the world. The researches about acupuncture, nowadays, can be classification into three kinds, one is to revalidate the effect of specific acupuncture points; another is to understand pain processing, and modulation of pain with Acupuncture. [1]

Functional magnetic resonance imaging (fMRI) to observe the brain function of the human brain response to the adventage of its non-invasive and radiation, has become an important brain function method. In particular, for those animals can not be carried out by the senior human cognitive neuropsychological researches. Hemoglobin is diamagnetic when oxygenated but paramagnetic when deoxygenated. The magnetic resonance (MR) signal of blood is therefore slightly different depending on the level of oxygenation. Therefore, fMRI research uses Blood-oxygen-level dependent (BOLD) as the method for determining where activity occurs in the brain as the result of various experiences. Functional MRI is an effective tool to observe the human brain's response of acupuncture stimulation.

There are three kinds of acupuncture stimlation sources for research, needle, electrical and laser acupunncture. Among multiplicity stimulation methods, low level laser is the easiest way to design pure placebo acupuncture experiment that subjects were not to distinguish placebo acupuncture from verum acupuncture.[2][3] In the aspect of tradition Chinese medicien(TCM), K1 (Yongquan) is an important acupoint for human, but less attention in recent reseaches. Therefore, we use low level laser acupuncture (LLLA) to stimulate K1 (Yongquan) acupoint and observe the human cerebral cortical activations.

Materials & Methods

Experiments were performed on a Bruker MEDSPEC 3T system (Bruker, Ettlingen, Germany) with a birdcage head coil. 6 right-handed healthy subjects were enrolled, and ages are between 22~38 years old. Subjects had no history of mental or neurological diseases, and recent experiments had no pain and physical and psychological symptoms of depression.

We use low level laser diod that operates with continued wave laser beam (30mW output, and 830nm wavelength). The configuration of this experiment setup in figure 1, we used the GRASS™ S44 Stimulator outside the MR scan room as the signal generator to control the laser module on/off.

The acupoint that stimulates in this experiment is K1 (Yongquan) on sole of left foot. This point is located at the bottom of the foot. It is located on the beginning of the kidney channel (meridian). The paradigm is block design with two conditions (on: A/ off: R) with each block lasting 1 minute. A time series RARARA was acquried.

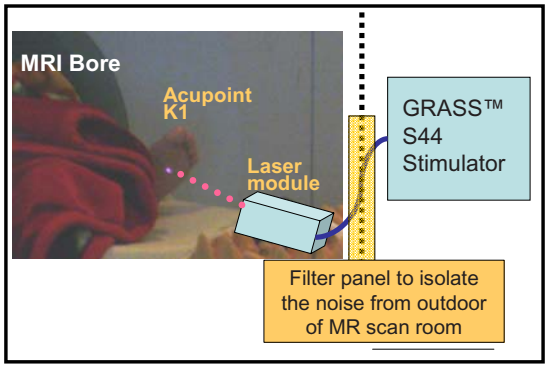

Figure 1 the configuration of fMRI laser acupuncture experiment.

O. Dössel and W.C. Schlegel (Eds.): WC 2009, IFMBE Proceedings 25/VII, pp. 477–479, 2009.
www.springerlink.com

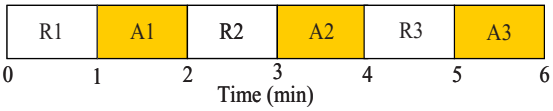

Figure 2. Stimulation paradigm desigm. R1, R2, R3 represent the resting phases without Laser radiation, and A1, A2, A3 the infared ray laser stimulation phases.

Total scan time is 6 minutes. Images were acquired using gradient-echo echo planar image (EPI) with matrix size of 64 x 64, TE of 30 ms, and TR of 4 sec. The experiment had 25 continuous slices with slice thickness of 5 mm, field of view of 24 x 24 cm^2. A plastic belt was tied on the subject's head to prevent the head motion.

Statistical analysis

Processing of fMRI data was done using Statistical Parametric Map 2 (SPM2, The Welcome Department of Cognitive Neurology, University College London, UK), and the preprocessing were realignment, coregistration, normalization of Talairach space, smoothness with FWHM of 8 mm.

In this experiment, we are concerned with making statistical inferences from functional magnetic resonance imaging studies involving multi-subject. The majority of early studies in neuroimaging combined data from multiple subjects using a “Fixed-Effects” (FFX) approach. This methodology only takes into account the within-subject variability. It is used to report results as case studies and shows the “average effect in the group”. If we want to make formal inferences about the population from which the subjects are drawn, we have to use the Random-Effect (RFX) analysis. In neuroimaging, RFX is implemented using the computationally efficient summary-statistic approach. In the first level, fix the model for each subject using different General Linear Models (GLMs) for each subject. Then, define the effect of interest for each subject with a contrast vector. Finally, feed the contrast images into each second level GLM that implements a one-sample t-test.

The analysis of multi-subjects in this experiment was applied RFX analysis (uncorrected, $p<0.006$).

Result

After group analysis of laser radiating the left acupoint K1, we find the significant activation area is on the Right Cerebrum, Parietal Lobe, Precuneus of Talairach coordinates. And the second significant activation was on the area of Left Cerebrum, Parietal Lobe, Sub-Gyral, White Matter.

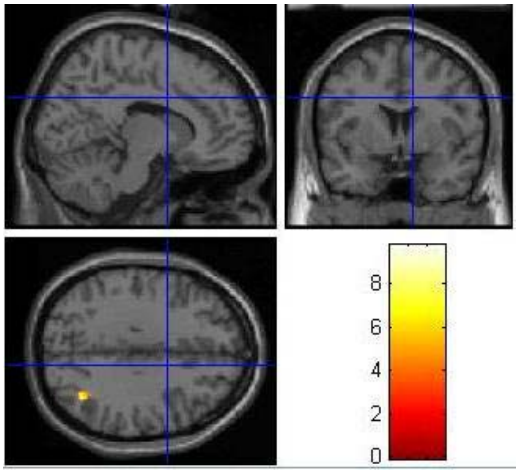

Figure 3. Activation map of Laser stimulation K1 acupoint. Group results are processed by RFX, and the activation area was on the Right Cerebrum, Parietal Lobe, Precuneus of Talairach coordinates.

MNI-coordinates			Location
X	Y	Z	
38	-66	34	Right Cerebrum, Parietal Lobe, Precuneus, White Matter
34	-60	28	Right Cerebrum, Temporal Lobe, Middle Temporal Gyrus, White Matter
-32	-36	40	Left Cerebrum, Parietal Lobe, Sub-Gyral, White Matter
-24	-42	44	Left Cerebrum, Parietal Lobe, Sub-Gyral, White Matter

Table 1. Activation clusters detected for the constracts of images acquired during laser on and off condition. (uncorrected, $p<0.006$)

Discussion

The results indicate that continue wave laser acupuncture of acupoint K1 leads to significant activations in precuneus. This cortical area has tranditionally recevied little attention. Recent functional imaging findings in healthy subjects suggest a central role for the precuneus in a wide spectrum of high intergrated tasks, including visuo-spatilal imagery, episodic memory retrieval and self-processing operations. Furthermore, precuneus and sourndng posteromedial area are displaying the highest resting metabolic rates and are characterized by transient decreases in the tonic activity during engagement in non-self-referential goal-directed actions (default-mode of brain function). Therefore, it has recently been proposed that precuneus is involved in the interwoven network of the neural correlates of self-consciousness, engaged in self-related mental representations during rest. This hypothesis is consistent with the selective hypometabolism in the posteromedial cortex reported in a wide range of altered conscious states, such as sleep, drug-induced anaesthesia and vegetative states [4].

According to the TCM, stimulation K1 has the effects of curing insomnia, poor memory, and loss of consciousness, our finding from fMRI seems to support these effects.

REFERENCES

[1]Lewith GT, White PJ, Pariente J "Investigating acupuncture using brain imaging techniques: the current state of play" eCAM (2005) 2(3), pp.315–9.

[2]C.M. Siedentopf, F. Koppelstaetter, I.A. Haala, V. Haid, P. Rhomberg, A. Ischebeck,W. Buchberger, S. Felber,A. Schlager, S.M. Golaszewski, Laser acupuncture induced specific cerebral cortical and subcortical activations in humans, Lasers Med. Sci. (2005) 20 (2) 68-73.

[3]C.M. Siedentopf, S.M. Golaszewski, F.M. Mottaghy, C.C. Ruff, S. Felber, A. Schlager, Functional magnetic resonance imaging detects activation of the visual association cortex during laser acupuncture of the foot in humans, Neurosci. Lett. (2002) 327 (1) 53-56.

[4]Andrea E. Cavanna, Michael R. Trimble "The precuneus: a review of its functional anatomy and behavioural correlates" Brain (2006) 129(3):564-583,;