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fMRI on the PMA and the SMA due to the Effects of Hyperoxemia

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I. INTRODUCTION

Functional MRI (fMRI) is widely used to obtain functional activation of brain according to various neuronal tasks in human brain. Most of physiological changes in brain depend on blood oxygenation level dependent (BOLD) effect. In general, despite of its advantage, fMRI technique has not been fully set up for detecting the performance of the clinical application. The problem of BOLD technique is that signal changes is not enough sensible to detect at 1.5T and the patients feels difficulty to perform relatively complicated activation task. To resolve these problems, we designed a single activation paradigm, which is relatively easy for the patient to follow up and evaluated the potential of oxygen as an enhancement of BOLD effect.

The purpose of this study was to compare between the apparent activation in the primary motor area (PMA) and the supplementary motor area (SMA) with and without the supplies of oxygen from same subjects. The BOLD effect due to hyperoxemia was also evaluated.

II. MATERIALS and METHODS

Twelve right-handed healthy volunteers (10 males and 2 females: age range 25-36 years) participated. All of the BOLD fMRI were acquired on 1.5T MRI (Vision-Plus, Siemens, Germany, Erlangen) with EPI pulse sequence (TR: 0.96ms, TE: 66ms, thickness: 3mm, matrix: 128x128, FOV: 210). Each volunteer was performed a simple finger-tapping task (sequential opposition of thumb to

each of the other four finger) with the right hand. Motor task was performed with a mean frequency of 2Hz as much as possible. We used ear plug to reduce noise and pads to minimize head motion.

Activation was performed by two stimulation protocols. One is rest (13s) and one cycle of activation (50s) and rest (50s) without supplies of oxygen, the other is volunteers breathed oxygen delivered through nonrebreathing face mask at 8L/min during early 30 second of activation with same protocol. After imaging acquisition, MR images were transferred into Unix workstation (SUN Spark 20, Sun Micro systems, USA) and processed with home-made analysis program based on the correlation coefficient method with threshold 0.45. BOLD effect was evaluated by signal intensity curves of activation area.

III. RESULTS

The location of PMA was successfully detected from 11 cases among 12 cases with oxygen, while 9 case without oxygen. The location of SMA was detected from 10 subjects with oxygen and 6 subject without oxygen.

The PMA with oxygen has more the pixels of activation area than without oxygen. The activation pixels of SMA with oxygen was about four times larger than without oxygen. (Table. 1)

Data from activated pixels with oxygen shows a strong positive BOLD effect. The mean of signal intensity with oxygen was 5.066±1.33 and the mean without oxygen was 3.029±0.57. The percent of mean signal with oxygen was increased 2 % more than that of without oxygen. However, the mean signal with oxygen (0.017±1.12) decreased than without oxygen (1.85±1.72) in the post-stimulus undershoot.

	With oxygen	Without oxygen
PMA	66.25±67.40	29.8±27.04
SMA	34.08±32.88	8.67±10.95

Table 1. The comparison between primary motor area (PMA) and supplementary motor area (SMA).

IV. CONCLUSIONS

The present study demonstrated that oxygen inhalation caused not only a significant positive BOLD signal but also a weak post-stimulus undershoot

signal. Increased oxyhemoglobin showed enhanced BOLD effect. However, remained high level of oxyhemoglobin may be resulted in post-stimulus undershoot because consumption of oxygen is constant in tissue. Therefore, total changes of signal could not observed between with and without oxygen. However, the PMA and the SMA using the single trial paradigm can be obtained with high success rate. The fMRI of motor area, especially for the SMA by Oxygenation may be enhanced.

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