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Metabolic Changes in Human Brain with fMRI and ^1H MRS

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INTRODUCTION

Functional magnetic imaging (fMRI) is sensible to detect the signal changes during ment al activity within brian tissues and capillary.

Glucose and oxygen are known as the primary substrates of brain energy metabolism an d consumed by that organ at the matched rates that maintain stable lactate concentration. Usually the elevation of brain lactate indicates the pathologic evidence. However, the seve ral recent reported the brain lactate elevation during visual stimulation .

Physiological activation of brain cortex causes proportionate increases of cerebral blood f low (CBF) and cerebral metabolic rate for glucose (CMRglu), but disproportionately small increases in crebral metabolic rate for oxygen ($CMRo_2$). As the result, hyperoxygenation was occuered in capillary and vein. On the other hand, paramagentic deoxyhemoglobin de creased. For glucose metabolism to rise the excess of O_2 consumption, lactate production is increased.

The purpose of this study was to evaluate the blood oxygen level dependent (BOLD) co ntrast fMRI in the occipital lobe and to compare with metabolic changes based on ^1H M R spectroscopy (MRS) and MR spectroscopic imaging (MRSI) before and after visual sti mulation.

METHOD

Healthy human volunteers (eight males and two females with 24-30 years) partcipated in this study.

All of the BOLD fMRI were acquired on a 1.5T MR system (Vision-Plus, Simens, Ger many, Erlangen) with EPI sequence (TR: 0.96ms, TE: 66ms, thickness: 3mm, matirix: 12 8×128, FOV: 210mm) and used with a standard head coil during supervised visual stimul ation in occipital lobe. The red flicker with 8Hz was used for visual stimulation. Visual actiavtion was subsequent 2 cycles of 20s rest (20 series) and 20s stimualtion (20 series).

After imaging acquisition, the MR images were transferred into unix workstaion(SUN S park 20, SUN micro systems, USA) and processed with home made analysis program bas ed on the correlation coefficient method.

^1H MRS data sets were acquired from the same location based on the actication map w ith STEAM sequence (TR: 2000ms, TE: 20ms, voxel size: 2×2×2, No of acquisition: 128, acquisition time: 4m 23s) in three volunteers. To evaluate lactate peak elevation, PRESS pulse sequence (TR; 2000ms, TE: 135) was used to seven volunteers. Peak of integratio n area of NAA, Cho, Cr and lactate were measured before and after stimualtion. And the n, magnetic resonance spectroscopic imaging (MRSI) (TR: 1500ms, TE: 135, No of acqui sition: 1, matrix: 16×16, acqusition time: 6m 31s) was acquired to analyze the lactate cha nges before and after stimulation.

RESULT

The acivation maps were successfully produced by BOLD effect due to visual stimulation on occipital lobe in all of volunteers. NAA/Cr ratio varied only from 1.79 ± 0.28 to 1. 88 ± 0.20 before and after stimulation in activation area guided by BOLD fMRI images.

However, the integration area of lactate was elevated 9.48 ± 4.38 times higher than befo re stimulation. Lactate elevation was confirmed that shows inversion on PRESS pulse seq

uence with TE of 135 after visual stimulation. Lactate metabolite images were acquired d uring the visual stimulation. This metabolite images consistent with BOLD effect fMRI.

DISCUSSION

Several studies have addressed the metabolic responses to functioanl activation in human brain using the positron emission tomography. The BOLD contrast fMRI is not enough se nsitive to detect the acivated area in human brain during visual stimulation.

CONCLUSION

Lactate metabolite map presents the evidence of lactate elevation on the same area of B OLD fMRI. Two results of this study compared together with different physiological effec t increased the confidence. But, low spatial resolution of metabolite image and low tempo ral resolution of spectroscopy due to recouping will be improved in future.