

Real-Time Imaging of 'Initial Cerebral Metabolism' Using Human Functional Near-Infraredgraphy (fNIR)

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Introduction

In vivo animal optical imaging studies (1) have provided evidence of an initial increase in Deoxy-Hb following the onset of activation. We developed the principal method of human functional spectroscopy was using the scattering light of the near-infrared (NIR) (2). This method can provide the real-time changes of the regional cerebral blood volume (rCBV), the regional Oxy-Hb and the regional Deoxy-Hb from skull at the bedside. Recently, we named this regional cerebral functional examination as functional near-infraredgraphy (fNIR). The previous photic experiment of Kato T, et al (2, 3) prove the increase of Oxy-Hb and the slight increase of Deoxy-Hb using sustained visual stimulation In this study, we focused on the temporal behavior of the cerebral metabolism due to short visual stimulation using fNIR

Methods

fNIR experiments: The rCBV = Oxy-Hb + Deoxy-Hb, HbO₂, and Deoxy-Hb were estimated using a fNIR system with 24-channel (Hitachi Medical Corporation) (4). Light for the fNIR from two laser diodes was directed into the head through a fiberoptic bundle (1 mm in diameter). Near-infrared light with wavelengths of 780 and 840 nm was used. The distance between the photon probes was 3cm. The sampling time for each photon count was 0.5 sec. The changes in the Oxy-Hb and Deoxy-Hb concentration were calculated using the differences in the absorption indexes for the two wavelengths. The center of 24 channels (90 x 90 min/ square) was located in skull surface on the occiput. A total of 13 imaging sessions with 9 normal volunteers were performed. The paradigm consisted of two control periods that embedded the short visual stimulation task period. 8Hz flashing light using LED visual stimulator (SMP-4100, NIHON KOHDEN) produced photic stimulation The stimulus duration of 2sec, 4sec or 6 sec were studied during 7-10 ON/OFF epochs, each a 60-80s OFF period. Maps and time courses of functional activation were generated by the Hitachi Medical Corporation made software package (5). The time courses were averaged with 7-10 epochs. The data with the serious motion artifact were removed.

Results

An initial increase in Deoxy-Hb and the delayed increase in Oxy-Hb following the onset of the short visual stimulation were observed using non-invasive fNIR. The appearance of the early and delayed response was consistent with the animal studies (1). However, the initial decrease in rCBV following the onset of the short visual stimulation was observed in the first time. The real-time functional mapping of the Deoxy-Hb in the occipital cortex shows Fig. 1 using fNIR. After the initial increase of the Deoxy-Hb in the primary visual cortex (A), the increase of the Deoxy-Hb was observed in the bilateral visual association cortex (B) (the 2-3cm distance between A and B). Also the individual differences of photosensitivity was observed.

Conclusion

This evidence may indicate the increase of the after the oxygen consumption rate, the contraction of the vascular bed in the initial cerebral metabolism and fNIR is a very promised tool for temporal human brain mapping and physiology.

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