MRI Study of ASL, MRS and BOLD in Patients with Left Symptomatic Internal Carotid Artery

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ABSTRACT Arterial Spin Labeling (ASL) is a non-invasive method to quantitatively measure perfusion without the need of contrast material. Measurement of perfusion is derived from the subtraction of two consecutively acquired scans, with or without radio frequency labeling of the magnetization in the feeding arteries[1]. ^{1}H spectroscopy (^{1}H-MRS) can identify cerebral abnormal metabolism. Patients with symptomatic occlusion of the internal carotid artery (ICA) with compromised cerebral blood flow (CBF) and decrease N-acetyl aspartate (NAA) are at risk for future ischemic infarcts in the brain. These patients can have different degree of cognitive impairment, especially working memory impairment[2]. Blood oxygenation level dependent (BOLD) is best used for studying processes that can be rapidly turned on and off like memory. In this study, we characterized CBF, MRS and BOLD changes in patients with symptomatic ICA occlusion.

MATERIALS AND METHODS MR imaging was performed by using a 3.0-T system (Trio Tim, Siemens). Magnetic resonance (MR) imaging with ASL, ^{1}H-MRS and BOLD were performed in 10 patients (age, 50.5±16.7; 5 men, 5 women) with left unilateral internal carotid artery (ICA) occlusion and in 10 control subjects (age, 51.5±10.4; 5 men, 5 women). The hospital's commission on scientific research on human subjects approved the study protocol, and all study subjects gave informed consent. Imaging parameters of ASL were TR/TE=2500/15 ms , FOV 224 mm×224mm, 6mm thick, 1.5mm gap. Cerebral blood flow (CBF) in the centrum semiovale was calculated from the occluded side and contralateral side. We performed 2 transaxial 2-dimensional proton MRS scans through the semiovale centers to assess metabolite concentrations (TR/TE=1700/135ms; spectral bandwidth, 1500 Hz; 1024 samples)[3]. Cerebral metabolism was studied by assessing ratios of N-acetyl aspartate (NAA) to choline (Cho) and to creatine (Cr) as well as Cho to Cr from centrum semiovale in both hemispheres. Imaging parameters of BOLD were TR/TE=2000/50 ms , FOV 220 mm×220mm, 6mm thick, 1.5mm gap. Digital working memory task was designed to explore cognitive models.

RESULTS AND DISCUSSION In the patients with left ICA occlusion, CBF decreased were depicted in 10 patients (Fig 1). The mean CBF values were decreased in the centrum semiovale of the ipsilateral hemisphere, as compared with values of the contralateral hemisphere ($P<0.05$) and with values the control subjects ($P<0.05$). The NAA/Cho and NAA/Cr ratios were significantly decreased in the centrum semiovale on the occlusion side (Fig 2) compared with the contralateral side ($P<0.05$) (Fig 3) and control subjects ($P<0.05$). The Cho/Cr ratio was significantly increased compared with contralateral side ($P<0.05$) and control subjects ($P<0.05$). Lactate (Lac) was observed in 3 patients. NAA concentration was positive correlation with CBF; however Cho concentration was negative correlation with CBF. Digital working memory was left hemisphere dominant. But the avtivated brain regions of the patients were more than the normal subjects and the compensatory activations were showed during retrieval phase. The left frontal and parietal cortex were the important regions for the processing of working memory (Fig4, 5). Our result suggested ASL,^{1}H-MRS and BOLD could demonstrate the abnormal cerebral perfusion, metabolic changes and mecahnisms of working memory in patients with left ICA high-grade stenosis or occlusion.
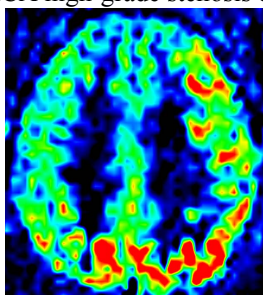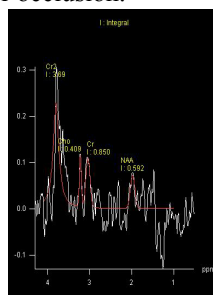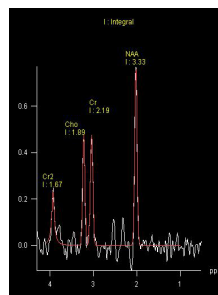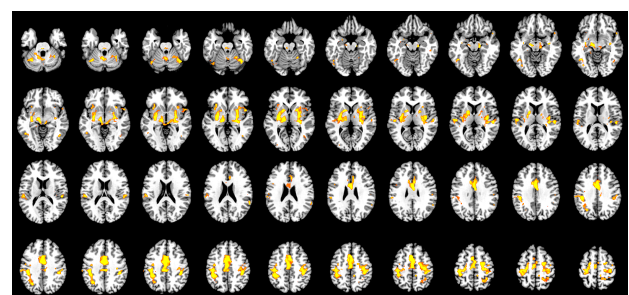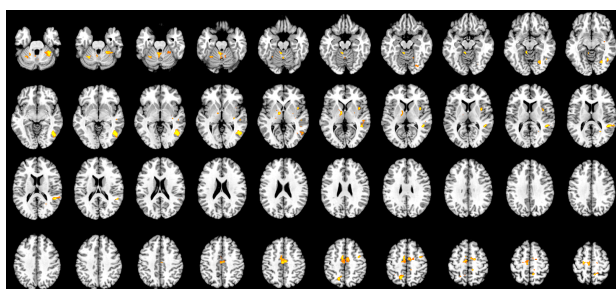

Fig 1   Fig 2   Fig 3   Fig 4

Fig 5

The patient with the left ICA stenosis. ASL image showed CBF decreased on the left hemisphere (Fig1); MRS showed NAA decreased and Cho increased on the ipsilateral hemisphere (Fig 2) than contralateral hemisphere (Fig 3). BOLD showed the avtivated brain regions of the patients (Fig 4) were more than the normal subjects (Fig 5) and the compensatory activations were showed during retrieval phase.

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