BOLD response of the auditory cortex in patients with unilateral internal carotid artery occlusion

D. Bilecen¹, E. Seifritz², M. Rausch¹, S. wetzel¹, E.W. Radü¹, K. Scheffler³

Department of Radiology¹ and Psychiatry², University of Basel, Section of Medical Physics³, Department of Radiology, University of Freiburg, Germany

INTRODUCTION

The internal carotid arteries (ICA) and their arterial end branches are responsible for perfusion of the cortical structure of the primary and secondary fields of the auditory system. We hypothesize that the BOLD signal changes are dependent on the integrity of the microvasculature and that dysfunctions due to unilateral ICA occlusions disturb the BOLD signal response to acoustic stimulation.

MATERIAL AND METHODS

Three patients (1 f, 2 m) with unilateral asymptomatic ICA occlusion underwent fMRI of the acoustic system. Functional integrity of the auditory perception was excluded by audiometry. ICA occlusion was diagnosed by MR digital subtraction angiography [1] (Fig. 1). Ischemic lesions were excluded by diffusion-weighted MRI.

Fig. 1: MR-projection angiography displays left sided ICA occlusion.

FMRI protocol: A 1000-Hz sine tone (pulsed at 6 Hz, 95 dB sound pressure level) delivered through a pneumatic system was used for acoustic stimulation. The fMRI sequence was based on a 64 x 64 GE-EPI sequence with an echo time of 52 ms. Imaging of 9 slices was repeated every 11s to reduce scanner noise [2]. The acoustic stimulation paradigm consisted of three OFF-ON cycles with five scans each resulting in a total of 30 EPI acquisitions (see Fig. 3). Total examination time including MR projection angiography was 20 minutes.

RESULTS

After binaural acoustic stimulation, all patients showed a unilateral BOLD response (~5%-signal change) in the auditory cortex on the healthy side. No BOLD signal change was detected on the side of ICA occlusion. Fig. 2 shows patient 1 and 2 (p1, p2) with left sided ICA occlusion resulting in an ipsilateral loss of BOLD signal change. Patient 3 (p3) with right sided ICA occlusion revealed a BOLD response only on its left hemisphere.

Fig. 2: Linear correlation maps of BOLD signal changes in response to binaural stimulation in three patients. Activation was detected only on the healthy side without occlusion ( p1 and p2 = ICA occlusion left, p3 = ICA occlusion right).

The BOLD signal time course upon acoustic stimulation is shown in Fig. 3. The time course was averaged within the activated region of the healthy side for all three patients.

Fig. 3: Mean BOLD signal change on the healthy side of the three patients.

DISCUSSION AND CONCLUSIONS

Although T₂ and diffusion weighted images revealed no acute ischemic lesions, no BOLD response was detected within the auditory field on the side of ICA occlusion. In contrast, normal BOLD response was found on the healthy, regularly perfused hemisphere. Because bilateral auditory stimulation produces a bilateral response in healthy subjects [2], and unilateral response is found only in patients with acutely acquired unilateral deafness [3], we conclude that these effects are related to vasomotoric dysfunctions on the side of ICA occlusion.

The reason for BOLD signal loss is unclear. Reactive vasodilatation of arterioles including decreasing flow resistance may lead to an exhaustion of perfusion reserves. Therefore, the reserve capacity of blood flow increase within the stimulated area is drastically reduced.

REFERENCES