Flow-sensitive Susceptibility-weighted Imaging of the Brain: Initial Experience in Ischemic Lesions

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Purpose

Susceptibility-weighted MR imaging (SWI) of the brain is effective for the detection of blood degradation products and intracerebral iron (1, 2). It can also depict small veins as it is sensitive for hemoglobin-induced signal loss (3). In an attempt to obtain more information of blood vessels on SWI, we developed a flow-sensitive SWI sequence that uses a dephasing sequence and detects phase dispersion and shift of intravoxel spins by incorporating black-blood MR angiography (4-6). In this preliminary study, we evaluated the feasibility of this technique in the diagnosis of steno-occlusive diseases of intracranial major arteries.

Materials and Methods

Our technique employed a combination of 3D gradient field-echo (FE) sequence and a dephasing gradient pulse of a *b*-factor of 4 sec/mm^2 at 1.5-T. Scanning parameters of the 3D-FE sequence included TR/TE/FA=50 msec/40 msec/20°, FOV=22x22 cm, imaging matrix=320x320, slab thickness =1.5x1.5x30 mm interpolated to 0.75x0.75x60 mm, and scanning time of 4 min 16 sec. We additionally utilized a parallel imaging method with a reduction factor of 2 using a 5-channel receiver coil. Our subjects comprised two groups. In a group of three healthy volunteers (three males, 26-41 years), we compared our sequence with another test sequence using a rephasing pulse to minimize the flow effect. Another group of patients consisted of nine patients (four males and five females, 5-84 years) with steno-occlusive disease of the internal carotid artery (two patients) or the middle cerebral artery (MCA, seven patients). There were four patients examined in the acute phase (< 1 day) and five patients examined in the chronic phase (> 1 month). In the patient group, we assessed information added by the SWI comparing with conventional MR images and MR angiograms.

Results

In the volunteer group, signal voids of distal arteries and possibly of cortical veins were more apparent in our sequence than in the test sequence that used rephasing. This was also noted in the patient group. In four of the five patients with chronic disease in the patient group, cortical vessels were well demonstrated probably due to collateral flow and/or recanalization in the affected territory. Among four patients with acute disease, a thrombus was visualized in three patients and the degree of demonstration of cortical vessels was inversely correlated with extent of ischemia detected on diffusion-weighted images in all patients **(Fig. 1)**.

Discussion

SWI is a valuable tool in the acute cerebral ischemia as it sensitively depicts a thrombus as well as signals representing hemorrhagic transformation. Meanwhile, status of the collateral flow is incompletely visualized on conventional 3D time-of-flight MR angiography mainly due to reduction in flow speed. In the original SWI, signals from vessels are rather suppressed. Our flow-sensitive SWI sequence seems to work not only as SWI but also black-blood MR angiography allowing visualization of cortical arterial branches that are not well shown on conventional MR angiography. We consider that the initial experience in this study suggested the utility of our technique to predict the prognosis an ischemic lesion.

Conclusion

Our technique is promising as it can work not only as an original SWI sequence but also as a method to evaluate collateral formation in the diagnosis of steno-occlusive diseases of intracranial major arteries.

References

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Fig. 1: Acute right MCA occlusion in an 83-year-old male.

A thrombus (large arrow) is depicted. Well developed collaterals are also shown (small arrows).