The feasibility of a spin-echo EPI based perfusion MRI in moyamoya disease on a 3.0T MR system

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Background and Purpose

Perfusion MRI has been known to be useful as a noninvasive tool for the evaluation of the hemodynamic information in moyamoya disease (MMD) together with a SPECT method. Most MR perfusion techniques used a gradient echo (GRE) EPI sequence due to a high sensitivity and broader coverage. GRE EPI, however, has a disadvantage of the sensitivity to large vessels, which resulted in the wrong estimation of capillary microcirculation. Spin-echo (SE) EPI, known to be sensitive to capillary vessels, would be more useful in MMD with small size collateral vessels (1-3). In addition, GRE EPI may show spatial distortion artifacts in some areas due to its large sensitivity to susceptibility, especially in higher field MR system. Pre- and post-operation evaluation of hemodynamic information in MMD was very important for their treatment planning and follow-up monitoring. Thus, a gradient echo EPI caused the evaluation of hemodynamic information after post-operation to be problematic especially near surgical sites. Thus a SE-EPI technique may be more suitable for a perfusion imaging in MMD. Also, higher magnetic field system of 3.0T may cover low SNR in SE-EPI compared to a gradient echo EPI. Therefore, we evaluated the feasibility of a spin echo EPI technique for MR perfusion imaging of moyamoya disease on 3.0T MR system.

Materials and Methods

Eight patients with MMD (mean age: 11 yrs) were examined in our study. Conventional angiography was performed for the diagnosis of MMD and confirmed the occlusion and/or high grade stenosis of the internal carotid artery (ICA)(Table 1). The perfusion MR imaging was performed by using an interleaved single shot spin echo EPI sequence (TR/TE=2000 ms/90 ms, FOV=240 mm, matrix size=128x128, slice thickness/gap=5 mm/1.5 mm) on a 3.0 T MR unit (GE, VH/i) with an 8 channel head coil. A total of 750 consecutive images in 15 axial slices (50 images/one slice) were acquired in 1 minute 40 sec. A bolus of 0.1 mmol/kg body weight of Gd DTPA was administrated at a rate of 1 cc/sec via intravenous injection by auto-injector (MedRad, USA). Conventional rCBV, TTP and MTT perfusion image was obtained from the log-scaled concentration-time curve. rCBF was measured as rCBV divided by MTT. We evaluated the image qualities and the dynamic signal change pattern at various regions such as white and gray matters in the frontal lobe, and the region near large veins.

Results

The signal-time curve in all regions of white and gray matters, and large veins showed the characteristic dynamic patterns with high SNR shown in perfusion study (Fig. 1). In most patients, reduced image distortion in frontal sinus was shown, but not perfect in temporal lobe (Fig.2). All patients using a SE-EPI based technique showed successful perfusion map images (Fig. 3). Delayed TTP and MTT map images due to the development of collaterals and dilated leptomeningeal vessels corresponded to the finding of conventional angiography (Table 1).

Conclusion

Our preliminary results suggest a spin echo EPI sequence on 3.0 T MR system provide high SNRs enough for the good quality perfusion map images and the hemodynamic information on patients with MMD in accordance with the results of angiography. Although better image quality of reduced distortion was obtained at frontal sinus and temporal lobe compared to a GRE-EPI method, distortion problem remains not to be solved completely. Thus, the usage of parallel imaging technique that can reduce a long echo train, but have a constant effective TE will be helpful. Also, because image quality is dependent on a TE in perfusion using a SE-EPI method, further study on the optimization of TE value in perfusion using a SE-EPI will be needed.

References

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Table 1. Angiographic findings and their perfusion results in MMD.

Patient	Angiography	Perfusion
1	bilateral ICA stenosis	delayed TTP and MTT at lt hemisphere, symmetrical rCBV and rCBF at both sides
2	rt ICA mild narrowing, lt ICA severe stenosis	delayed TTP and MTT at lt hemisphere , symetrical rCBV and rCBF at both sides
3	bilateral ICA occlusion	delayed TTP and MTT at rt frontal lobe
4	lt ICA occlusion	decreased rCBV at rt MCA, delayed TTP and MTT at lt MCA
5	bilateral ICA occlusion	delayed TTPat rt frontotemporal lobe
6	rt ICA narrowing, lt MCA narrowing	delayed TTP and MTT at lt temporal lobe and bilateral frontal lobe(lt>rt)
7	lt MCA stenosis	delayed TTP and MTT at lt hemisphere, symmetrical rCBV and rCBF
8	rt ICA occlusion, lt MCA narrowing	delayed TTP and MTT at rt frontal and parietal lobes

* rt:right, lt:left

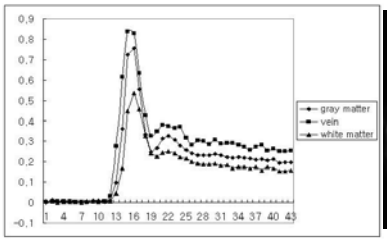

Fig.1. Log-scaled signal-time curve of white and gray matters, and vein in frontal lobe

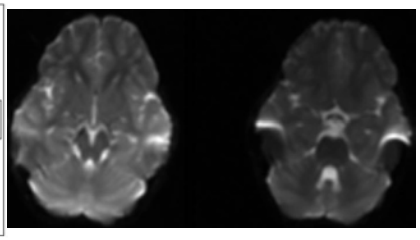

Fig.2. Image quality of frontal sinus and temporal lobe using a SE-EPI sequence

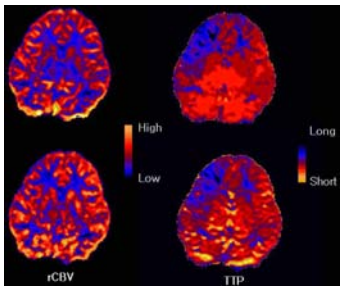

Fig.3. Perfusion map in a MMD patient with right ICA occlusion. Delay TTP and MTT were found in right frontal lobe, but rCBV and rCBF were symmetrical at both sides.