

High Resolution Wall and Lumen MRI of the Middle Cerebral Arteries at 3-Tesla

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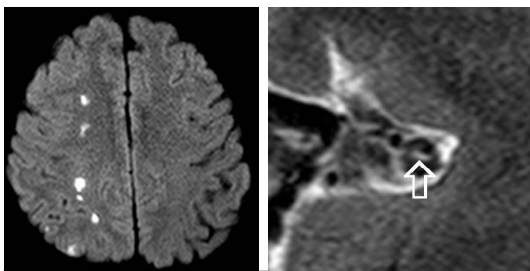
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Introduction: Important predictors of stroke risk of intracranial artery stenosis include the degree of stenosis and the underlying plaque morphology. Currently available luminal imaging cannot provide information about wall structures or atherosclerotic plaque components. Imaging modalities that are capable of assessing plaque morphology in intracranial atherosclerotic disease have prompted clinical interest for two reasons. endovascular treatment of intracranial artery and underdiagnosis of stenosis due to compensatory vascular remodeling In vivo MRI using a black blood technique has advantages to characterize atherosclerotic plaques. There have been only a few studies addressing MR imaging of the intracranial artery walls. These studies have been limited in that they have not offered comparisons between the characteristics of symptomatic and asymptomatic lesions. High-resolution imaging with a high-field MRI may be expected to visualize the walls and lumina of intracranial arteries in detail. In this study, we imaged the walls and lumina of middle cerebral arteries (MCAs) with and without stenotic segments, using high-resolution BB-MRI techniques on a 3-Tesla MR scanner. We compared the BB-MR images of MCA stenoses in symptomatic and asymptomatic lesions in order to characterize vulnerable plaques. BB-MRI was then compared with conventional angiography in order to determine if BB-MRI was able to diagnose the degree of intracranial artery stenosis.

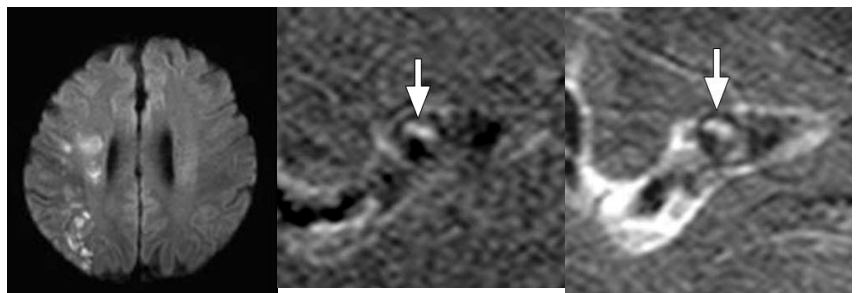
Methods and Materials: **Subjects:** BB-MR imaging of the intracranial arteries was performed in vivo in 2 volunteer subjects and in 15 consecutive patients (M:F = 8:9; mean age, 59.12 years) who presented with MCA stenosis as documented by time-of-flight MR angiography (TOF-MRA). Digital subtraction angiography (DSA) and/or three-dimensional rotational angiography (3DRA) was performed in 12 patients. **Magnetic Resonance Imaging:** MRI was performed with a 3-Tesla MRI system (Philips Achiva, Best, The Netherlands) and an eight-channel phased array coil. The MR protocol was included in four different scans: three-dimensional TOF-MRA, T1-, T2-, and proton density (PD)-weighted BB-MRI. Contralateral MCA images were acquired simultaneously in all patients with unilateral MCA stenosis, except for two. T1-weighted MRI was acquired using a two-dimensional turbo spin echo (TSE) sequence with the following imaging parameters: TR/TE = 581/20 ms, FOV = 120 × 105 mm, matrix size = 320 × 220, echo train length (ETL) = 6, and NEX = 4. For the both PD-weighted and T2-weighted BB-MRI scans, the TSE sequence used a TR/TE = 3000/80 ms for T2-weighted images and a TR/TE = 2500/30 for PD-weighted images. Both scans were run with FOV = 120 × 105 mm, matrix size = 320 × 220, ETL = 16, and NEX = 4. The black blood technique with pre-regional saturation pulses of 80 mm thickness to saturate incoming arterial flow was used for all three BB-MRI scans. The longitudinal coverage of each artery was 14–16 mm (7–8 slices) for T1-, T2-, and PD-weighted images. The best voxel size for the three BB-MR sequences was 0.38 × 0.48 × 2 mm; the reconstructed voxel size was 0.23 × 0.23 × 2 mm. **Imaging Analysis:** Subjects were classified as having symptomatic or asymptomatic stenosis based on DWI findings and clinical symptoms. The plaque signal intensity was characterized in each stenotic lesion, and character of the plaque was then compared between symptomatic and asymptomatic stenoses. Interpretation of the plaque signal intensity was made with reference to the immediately adjacent gray matter of the brain parenchyma and was evaluated. The different plaque findings in symptomatic and asymptomatic stenoses were evaluated using Fisher's exact test. In order to evaluate the plaque load, two neuroradiologists independently measured the total wall thickness at the most stenotic segment in each case. The total wall thickness was defined as the maximum distance between the lumen internal border and the outer interface of the vessel on PD-weighted images. Total wall thicknesses for asymptomatic and symptomatic stenoses were compared using the two-sample t-test.

Results: 16 MCA stenoses were identified as atherosclerotic in nature. Seven stenoses were accompanied by neurological symptoms or acute ischemic lesions in the ipsilateral brain. Nine stenoses were unrelated to the acute ischemic lesion or neurological symptoms. Four of seven symptomatic stenosis cases had a hyperintense focal area within the plaque on T1- and/or T2 sequences. Two of nine asymptomatic stenosis cases showed hyperintense foci within the plaque. High signal plaque foci were predominantly demonstrated in symptomatic lesions (57.1% versus 22%). The total wall thickness in the symptomatic group (1.96±0.29mm) was significantly higher than that in the asymptomatic group (1.45±0.39mm) (p<0.05).

Conclusions: In this study, high-resolution BB-MRI identified some cases in which focal areas with different signal intensities existed within MCA plaques. Interestingly, hyperintense focal areas within plaques on T1- and/or T2-weighted MR images were predominantly seen in symptomatic MCA stenoses. plaque load might be an important risk factor for ischemic events in the setting of MCA stenosis. Multiple contrast-weighted BB-MRI may be a useful non-invasive in vivo modality for assessing the morphological features and components of intracranial artery plaques.



A 53-year-old man with dysarthria. Diffusion-weighted image (DWI) (A) demonstrates some small acute ischemic lesions in the right centrum ovale and cortex. Focal high signal intensity (open arrow) within the atherosclerotic plaque with low signal intensity is visible on a T1- (B), and T2 -weighted BB-MR image.



A 70-year-old woman with left side weakness. DWI (A) reveals multiple diffusion restrictive lesions in the right centrum ovale and cortex. T1- (B), and T2 -weighted BB MRI (C) show juxtaluminar hyperintense areas (arrow) within plaque.