Middle cerebral artery plaques in recent small subcortical infarction on 3D High-resolution black blood MRI at 3.0T

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INTRODUCTION: Small subcortical infarction (SSI) is a different entity with distinct pathogenesis.[1] Traditionally, SSI is thought to be caused by intrinsic disease of the perforating arterioles.[2] As large artery disease may also lead to SSIs.[3] It would be useful to distinguish between the two vasculopathies as they would require different treatment methods. Diagnosis of intracranial atherosclerosis based on conventional angiography is not easy as arterial expansive remodeling can keep the vessel lumen unchanged in angiographic images.[4] We sought to investigate the presence of MCA plaques in patients with SSI using 3D high-resolution contrast-enhanced black blood MRI imaging.

Methods: Patients: This study was approved by the institutional review board. 23 patients (21 male, 40~71 years old) with SSI (maximal lesion diameter ≤ 2cm) but do not have ipsilateral MCA stenosis on MRA were recruited within four weeks after symptom onset. Informed consents were obtained from all participants. The patients were scanned with a 3.0T MR system (Magnetom Verio, Siemens, Erlangen, Germany) using a 32-channel head coil for signal reception. Protocol: A localization scan was first performed, followed by high resolution MRA (isotropic voxel size ~0.6mm) and DWI. A parameter optimized 3D high-resolution black blood MRI sequence (aka T1w-SPACE)[5] was used for intracranial artery wall imaging with the following parameters: TR/TE = 938ms/24ms; turbo factor = 29 ~ 35; echo spacing = 4.54ms; iPAT = 2; average = 2. Depending on patient condition, images were acquired with uninterpolated isotropic voxel resolution between 0.5mm and 0.7mm (average ~ 0.58mm), and takes between 6min ~ 10min (earlier images found to have motion artifacts would use a lower resolution protocol). Gadopentetate dimeglumine was administered manually (BeiLu Pharmaceutical Co., Ltd, Beijing, China). T1w-SPACE was repeated 1~2 minutes after the contrast administration. Image analysis: Pre- and post-contrast images from T1w-SPACE were first co-registered using commercial software on a workstation (Syngo Fusion, Siemens). MPR was used to visualize the cross-sectional and longitudinal views of the MCA. The presence of MCA plaques was assessed using the co-registered images based on wall thickness change and/or signal enhancement. The cross-sectional locations of plaques were classified as superior or inferior side (Figure 1). All images were analyzed by two experienced readers independently blinded to clinical information. The discrepancies between 2 readers were solved by consensus.

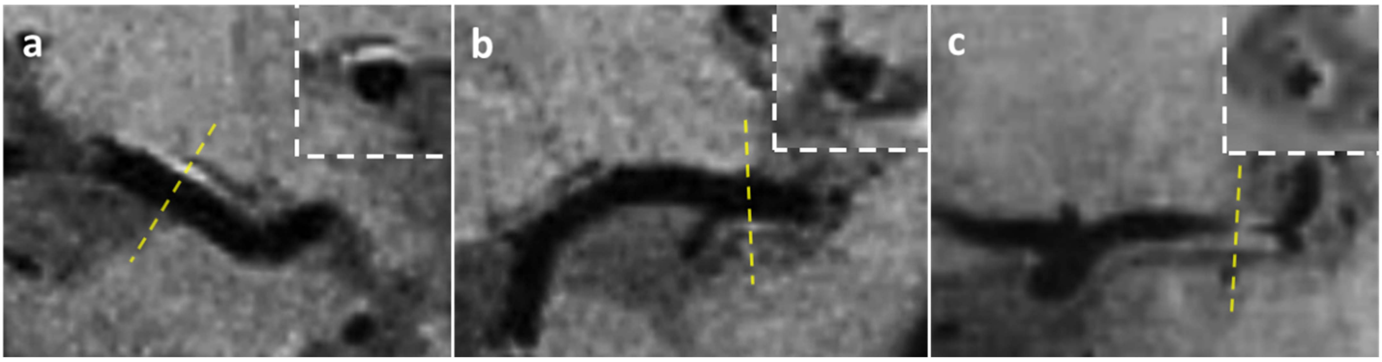

Figure 1. Categorize plaque distribution on contrast enhanced dark blood MRI imaging. (a) Superior plaque; (b) Inferior plaque; (c) Plaque involving both superior and superior wall

Results: Of the 23 patients enrolled in the study, 5 were excluded (due to image quality etc). A total of 36 MCA without stenosis were examined. Atherosclerotic plaques at the MCA were found in 19 vessels: 13 of 18 ipsilateral MCA and 6 of 18 contralateral MCA harbored plaques. Among ipsilateral MCAs, eight vessels had superior plaques, one had an inferior plaque and four had plaques involving both superior and inferior wall. Among contralateral MCAs, two vessels had superior plaques, one had an inferior plaque and three had plaques involving both superior and inferior wall. The frequency of MCA plaque was significantly higher in ipsilateral than in contralateral MCA (72.2% vs 33.3%; p=0.044). In the vessels with plaques, there was no statistical difference in the frequencies of superior wall plaques between the ipsilateral and contralateral MCA (92.3% vs 83.3%; P = 1.000) (Table 1).

Table 1. ipsilateral and contralateral MCA wall findings

Wall findings	Ipsilateral (n = 18)	Contralateral (n = 18)	P Value
Presence of plaque	13 (72.2%)	6 (33.3%)	0.044
Superior wall	12 (92.3%)	5 (83.3%)	1.000
Inferior wall	5 (38.5%)	4 (66.7%)	0.350

Discussion and Conclusions: This study is the first to evaluate the MCA atherosclerotic plaques in patients with SSI using 3D dark blood MRI. Three-dimensional acquisitions are advantageous for intracranial artierial wall imaging because the corresponding datasets can be retrospectively reformatted in any orientations. The analysis found 19 plaques in 36 MCAs that did not cause stenosis on MRA, suggesting that the 3D MRI technique was more sensitive than MRA in detecting plaques. Atherosclerotic plaques were observed frequently in MCA ipsilateral to the infarct lesions, and most of which were superiorly located. Hence, Application of 3D contrast-enhanced black blood MRI technique will contribute to subclassify the stroke more accurately and unravel the pathogenic mechanism of SSI, which can have significant impact on treatment strategy.

Reference: **1.** Boiten J, et al. Stroke. 1993;24(5):652. **2.** Fisher CM, et al. Neurology. 1965;15:774. **3.** Adachi T, et al. Journal of neurology. 2000;247(4):280. **4.** Glagov S, et al. The New England journal of medicine. 1987;316 (22):1371. **5.** Zhang L, et al. 21th ISMRM, Salt Lake City, Utah, USA, 2013, p.4537.