

## Value of improved motion sensitized driven equilibrium(iMSDE) sequence in preoperative evaluation for carotid endarterectomy and carotid artery stenting in cases of atherosclerosis: compared with digital subtraction angiography

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**Introduction:** Currently, the MR imaging protocols for carotid artery vessel wall are commonly using 2D black-blood sequences. However, these sequences are often limited to clinical use due to their longer scan times, thus lead to fewer number of slices that can be collected and/or the slice spatial resolution of the resulting images. An improved motion-sensitization driven equilibrium (iMSDE) sequence based upon an MLEV-4 sequence was proposed for black-blood vessel wall imaging<sup>[1]</sup>. This new pulse sequence provides excellent blood suppression with high temporal efficiency<sup>[2,3]</sup>. This is especially important for quantitative characterization of vascular wall morphology. In addition, the high special resolution and isotropic acquisition of 3D MERGE yield to reconstruction at any orientations that allows visualizing the details of atherosclerotic lesions and adjacent stenotic or normal vasculature. There has been, however, no studies compared iMSDE and digital subtraction angiography (DSA) for blood vessel morphology assessments.

**Purpose:** To evaluate the value of the iMSDE black-blood magnetic resonance (MR) imaging in atherosclerotic carotid artery assessment by comparing with DSA.

**Methods:** Twenty-nine patients (mean age 64.5 years, 23 males) with at least 50% carotid stenosis identified by duplex ultrasound, including 17 cases scheduled for carotid artery stenting (CAS) and 12 cases scheduled for carotid endarterectomy (CEA), were recruited for iMSDE MR imaging and DSA within 1 week prior to the therapy. All images were acquired using a whole body clinical scanner (Philips Achieva, R3.2, the Netherlands) and a dedicated phased-array carotid coil. A 3D iMSDE protocol (TR/TE 9.2/4.3ms) with longitudinal coverage of no less than 150 mm was used for image acquisition. Two radiologists independently assessed the rate of visualization, location of maximal lumen stenosis, minimum lumen diameter and plaque involvement on DSA and iMSDE images. The differences between DSA and the iMSDE in measurement of carotid vessel morphology were assessed by using the statistical software package (SPSS 13.0, Inc., Chicago, IL).

**Results:** Compared to the DSA, the iMSDE sequence showed a good consistency in defining the location of the maximal lumen stenosis ( $\kappa=0.92$ ), no significant difference was found in measurement of minimum lumen diameter (3.4±1.0mm vs. 3.2±0.8mm,  $P=0.112$ ). The iMSDE showed a high sensitivity in detecting plaque ulcer as compared with DSA (7 of 8, 87.5%) (Fig.1). The plaque extent measured on iMSDE was significantly larger than that on DSA (22.1±5.1mm vs. 15.8±2.4mm,  $P=0.018$ ). In addition, 7 plaques with >3mm wall thickness (atherosclerosis) were identified in 5 arterial beds on iMSDE images, but completely missed by DSA (Fig.2).

**Discussion and conclusions:** The preoperative value of iMSDE were demonstrated for the first time by comparing with DSA, the gold standard for carotid vessel morphology measurements. Compared to DSA, the iMSDE sequence allows noninvasive and sensitive detection of the location of the maximal lumen stenosis, minimum lumen diameter, plaque extent and plaque rupture. Histology after CEA should be gold standard for plaque ulcer identification, we would further compare this two modalities with histology validation in future studies. Due to the frequent existence of arterial outer wall remodeling of carotid atherosclerosis<sup>[4]</sup>, the iMSDE sequence could provide a more accurate depiction of early wall thickening. The iMSDE sequence was found to be a reliable and efficient means for preoperative evaluation of the carotid artery plaques before CEA and CAS. The iMSDE technique allows additional parallel views of the plaque and vessel wall, which can be beneficial for clinical assessment.

### References:

- [1] Wang J et al. J Magn Reson Imaging. 2010; 31: 1256–1263.
- [2] Dong L et al. J Magn Reson Imaging. 2010;32:452-458.
- [3] Wang J et al. PLoS One. 2011;6:e26567..
- [4] Glagov S, et al. N Engl J Med, 1987, 316: 1371-1375

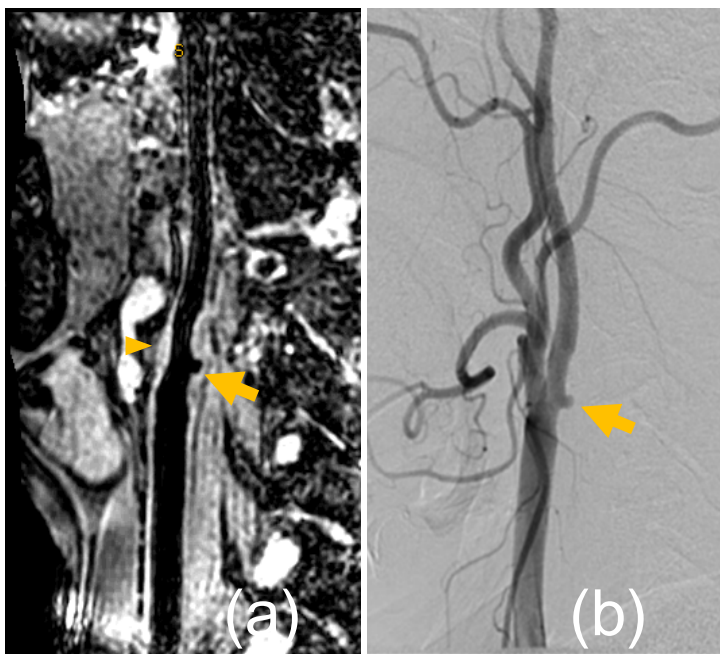


Fig. 1 The ulcer (the arrow) of carotid plaque surface detected on the iMSDE image(a) and DSA(b). The carotid plaque morphology (the arrowhead) was visualized on the iMSDE image (a).

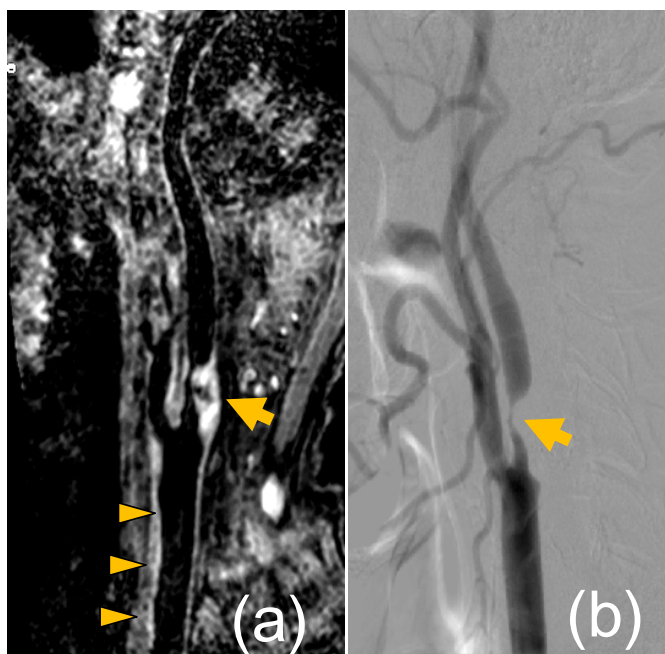


Fig. 2 The advanced plaque (the arrow) caused severe internal carotid stenosis were detected on both the iMSDE image (a) and DSA (b). The common carotid wall thickening (arrowheads) was visualized on the iMSDE image (a) but presented normal on DSA (b).