

High-Resolution MR Angiography at 7T: Detection of Perforating Arteries of the Anterior Communicating and Distal Middle Cerebral Arteries

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TARGET AUDIENCE: Neuroradiologists and other researchers who are interested in MRA and intracranial perforating arteries.

PURPOSE: Three-dimensional (3D) time-of-flight magnetic resonance angiography (MRA) is a widely used non-invasive method for visualizing intracranial, including major perforating, arteries. However, some minute but clinically-important perforating arteries arising from the anterior communicating artery (ACoA) and distal middle cerebral artery (MCA), i.e., the hypothalamic branch (HTB) of the subcallosal artery (SCA) and the long insular artery (LIA), respectively, are hardly visible on conventional MRA even at 3 Tesla (T). Hence, we investigated whether these arteries can be detected using high-resolution MRA at 7T with/without a magnetization transfer contrast (MTC) technique.

METHODS: Ten healthy volunteers (5 female; age, 20–37 years), 2 patients with ACoA aneurysm (1 female; age, 71–74 years), and 2 patients with insulo-opercular glioma (1 female; age, 39–44 years) were examined using a 7T MRI scanner (MR950, GE Healthcare) with a 3D-spoiled gradient-echo sequence with/without partial MTC pulse (TR/TE/FA, 24[14]/3.3/15; matrix, 512×320; FOV, 12cm; thickness, 0.3mm; NEX, 2). Two readers blindly evaluated the depiction, origin, length, and contrast-to-noise ratio (CNR) of the SCA, HTB, and LIA.

RESULTS: The SCA arising from the ACoA was demonstrated in 13 of 14 cases and the HTB (in 11 cases) arose from the SCA and ACoA in 7 and 4 cases, respectively (Fig. 1). In the patients with ACoA aneurysms, the SCA or HTB arising from the ACoA were identified adjacent to the aneurysms. The LIA arising from the insular portion of the MCA was demonstrated in 6 of 22 MCAs (right/left, 2/4) including one of the patients with left insulo-opercular glioma (Fig.1). HTB length and LIA length were significantly longer in MRA with MTC (median, 7.3 mm and 18.8 mm, respectively) than without MTC (median, 5.0mm and 12.0 mm, respectively) ($p = 0.04$ and 0.03 , respectively, Wilcoxon test) (Fig. 2). The CNR of these vessels within the cerebral parenchyma tended to be higher on MRA with MTC than without MTC, although this was not statistically significant. No substantial complications were found in the patients during or after the surgery.

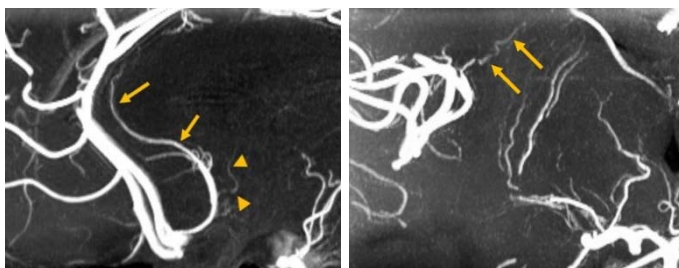


Fig.1 High-resolution MRA at 7T with an MTC pulse

The HTB (left, arrowheads) arising from the SCA (left, arrows) and the LIA (right, arrows) arising from the distal MCA are clearly visualized.

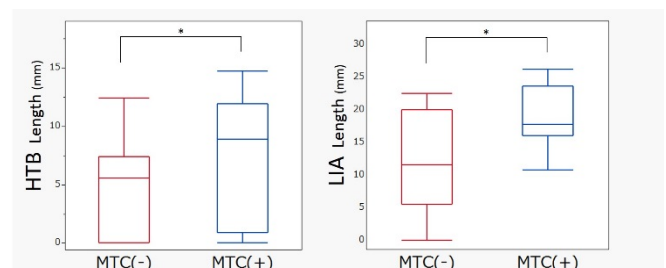


Fig.2 Length of HTB and LIA on high-resolution MRA at 7T

The lengths of HTB and LIA were significantly longer on the images with the MTC pulse than those without. * $p < 0.05$

DISCUSSION: The HTB of the SCA is a perforating artery originating from the ACoA, which supplies the septal area, column of the fornix, and anterior part of the hypothalamus; whereas LIA is a perforating artery originating from the distal MCA, which supplies the corona radiata, including the corticospinal tract. When these arteries are injured during surgery, severe complications such as dementia and hemiplegia can occur. Although MRA at or below 3T cannot detect these minute arteries, in this study, high-resolution 7T MRA could readily visualize these arteries, mainly because of its improved signal-to-noise ratio and spatial resolution, as well as suppressed brain signal and improved inflow effects due to T1 prolongation at 7T. In addition, the MTC pulse could further improve conspicuity of these arteries by attenuating the background signal, although prolongation of the acquisition time was needed to keep below the specific absorption rate limit. Nevertheless, direct visualization of HTB and LIA by 7T MRA may help to assess spatial relationships between these arteries and the parent arteries, lesions, and eloquent brain areas before surgery and can diminish the risks of undesirable surgical complications.

CONCLUSION: High-resolution MRA at 7T can readily visualize minute perforating arteries such as the HTB of the SCA and the LIA, particularly when combined with the use of an MTC, and may contribute to avoiding surgical complications of ACoA aneurysms and brain tumors.

[References] [1] Ture U, et al. J Neurosurg 2000; 92: 676-87. [2] Tanriover N, et al. J Neurosurg 2004; 100: 891-922. [3] Alexander MP, et al. Neurology, 1984; 34:752 [4] T.Kumabe, et al. J Neurosurg 2007; 106: 263-269.