Advantages of High b Value Diffusion-Weighted Imaging in the Diagnosis of Acute Stroke – A Case Report

Aidos Doskaliyev^a, Fumiyuki Yamasaki^a, Taiichi Saito^a,
Eiichi Nomura^b, Kazuhiko Sugiyama^a, Toshiho Ohtsuki^b,
Masayasu Matsumoto^b, Kaoru Kurisu^a

Departments of ^aNeurosurgery and ^bClinical Neuroscience
and Therapeutics, Graduate School of Biomedical Sciences,
Hiroshima University, Hiroshima, Japan

Introduction

It may be possible to use the mismatch in perfusion- and diffusion-weighted images (PWI, DWI) on scans acquired within 6 h of symptom onset to identify salvageable tissues in patients with acute ischemic stroke [1]. Although it has been shown that DWI is sensitive for the diagnosis of acute ischemic lesions, there is increasing evidence that in some situations it may initially fail to detect acute lesions. We show that DWI obtained with a high b value may represent a useful diagnostic tool for the rapid and accurate identification of acute ischemic brain infarctions.

Case Report

A 73-year-old man with acute-onset dizziness and ataxia was admitted to Hiroshima University Hospital. MR angiography (MRA) performed within 6 h of symptom onset showed that the left superior cerebellar artery was occluded (fig. 1a), although DWI based on b value of 1,000 s/mm² (DWI_{1,000}) failed to identify any obvious changes in the cerebellum (fig. 1b). On the other hand, on DWI based on a b value of 4,000 s/mm² (DWI_{4,000}), there was an obvious high-intensity area in the upper left cerebellum supplied by the superior cerebellar artery (fig. 1c).

We administered anticoagulant therapy. A MRI study performed on the 8th day post-onset (fig. 1d) showed cerebellar lesions that were closely associated with the high-intensity lesion noted on the initial DWI_{4,000}. MRA revealed recanalization of the superior cerebellar artery.

Discussion

Early and accurate detection of acute ischemic stroke is required for treatment success and achieving improved quality of life for survivors. DWI detected infarcted tissue within 1 h of the insult in rats [2]. In clinical studies, DWI was 93–100% sensitive for the detection of stroke if the scans were acquired within 6 h of symptom onset [3, 4]. According to Lam et al. [5] up to 12.5% of hyperacute ischemic stroke was missed on the initial DWI scan. Some researchers [6, 7] have argued that a high b value at DWI does not confer a diagnostic advantage. We suspect that these

Fig. 1. All radiological examinations were performed on a 3-T MR scanner (Signa Excite HD 3.0T; GE Medical Systems, Milwaukee, Wisc., USA); the effective gradient was 40 mT/m, the slew rate was 150 mT/m/ms. The parameters of b = 1,000 and b = 4,000 DWI were: 8-channel phased array head coil, TR, 5,000 ms and TE, 66.2 ms (b = 1,000) and TR, 5,000 ms and TE, 96.4 ms (b = 4,000), NEX, 1; field of view (FOV), 220; slice thickness, 6 mm; gap, 1.0 mm; number of slices, 20; data acquisition matrix 128 × 128, and scan time, 20 and 40 s for b = 1,000 and b = 4,000, respectively. Images obtained within 6 h of symptom onset (a, b, c). MRA (a) shows occlusion of the left superior cerebellar artery (arrow). No ischemic lesions are evident on diffusion-weighted axial MR image (b value 1,000 s/mm²) (b). However, the image acquired with a b value of 4,000 s/mm² (c) clearly shows an ischemic lesion in the cerebellum as an area of high signal intensity. FLAIR axial (d) MR images obtained 8 days after symptom onset show clear ischemic lesion in the cerebellum.

findings were acquired on 1.5-T scanners and that this entails some limitations. High b-value DWI requires a hardware upgrade because most scanners cannot generate a 40-mT/m gradient field [6]. Despite the lower MR signal intensity and lower signal-to-noise ratio on high b-value images [8], 3-T DWI is at least as good as, and in some ways superior to, 1.5-T DWI for assessing hyperacute stroke [9].

We postulate that one reason for missed acute ischemic stroke might be the conspicuity of acute ischemic lesions on diffusion-weighted images, which is related to the b-value. In some cases (as in this one) higher b-values might offer an opportunity for earlier lesion detection. We found that DWI_{4,000} performed on the 3-T scanner was superior for the identification of ischemic lesions. Our findings suggest that the PWI-DWI mismatch time window is shorter than was previously thought. Studies are underway in our laboratory to determine the optimal b value for the assessment of acute stroke. Based on our findings, we suggest that high b-value DWI is useful for the selection of thrombolytic therapy in patients with acute stroke.

References

- 1 Kane I, Sandercock P, Wardlaw J: Magnetic resonance perfusion diffusion mismatch and thrombolysis in acute ischemic stroke: a systematic review of the evidence to date. *J Neurol Neurosurg Psychiatry* 2007;78: 485–491.
- 2 Mintorovitch J, Moseley M, Chileuitt L, et al: Comparison of diffusion and T₂-weighted MRI for the early detection of cerebral ischemia and reperfusion in rats. *Magn Reson Med* 1991;18:39–50.
- 3 Gonzalez R, Schaefer P, Buonanno F, et al: Diffusion-weighted MR imaging: diagnostic accuracy in patients imaged within 6 hours of stroke symptom onset. *Radiology* 1999;210:155–162.
- 4 Saur D, Kuchinski T, Grzyska U, et al: Sensitivity and interrater agreement of CT and diffusion-weighted MR imaging in hyperacute stroke. *AJNR Am J Neuroradiol* 2003;24:878–885.
- 5 Lam WW, Wong KS, Rainer TH, et al: Assessment of hyperacute stroke like symptoms by diffusion-weighted images. *Clin Imaging* 2005;29: 6–9.
- 6 Meyer J, Gutierrez A, Mock B, et al: High b-value diffusion-weighted MR imaging of suspected brain infarction. *AJNR Am J Neuroradiol* 2000;21:1821–1829.
- 7 Burdette J, Elster A: Diffusion-weighted imaging of cerebral infarctions: are higher b-values better? *J Comput Assist Tomogr* 2002;26: 622–627.
- 8 Cihangiroglu M, Uluğ AM, Firat Z, et al: High b-value diffusion-weighted MR imaging of normal brain at 3 T. *Eur J Radiol* 2007.
- 9 Kosior RK, Wright CJ, Kosior JC: 3-Tesla versus 1.5-Tesla magnetic resonance diffusion and perfusion imaging in hyperacute ischemic stroke. *Cerebrovasc Dis* 2007;24:361–368.

Kaoru Kurisu, MD, PhD
Department of Neurosurgery
Graduate School of Biomedical Sciences
Hiroshima University
1-2-3 Kasumi, Minami-ku, Hiroshima, 734-8551 (Japan)
Tel. +81 82 257 5225, Fax +81 82 257 5229
E-Mail kuka422@hiroshima-u.ac.jp

Cerebrovasc Dis 2009;27:617–618

DOI: [10.1159/000218074](https://doi.org/10.1159/000218074)

Large Carotid Thrombus

M.G. Delgado^a, P. Vega^b, V. Mateos^a, J. Bogousslavsky^c

Departments of ^aNeurology and ^bRadiology, Hospital Central de Asturias, Oviedo, Spain; ^cDepartment of Neurology, Genolier Swiss Medical Network, Valmont-Genolier, Glion-sur-Montreux, Switzerland

A 76-year-old female with high blood pressure and atrial fibrillation as cerebrovascular risk factors was admitted because of sudden left hemiparesis and disarthria with a right periorbital headache. Transcranial Doppler ultrasound showed increased velocity in the right carotid siphon. Her cranial CT was normal. She was anticoagulated because of carotid siphon stenosis with low-molecular-weight heparin (0.6 ml subcutaneous nadroparin calcium every 12 h). An angio-CT showed calcified plaque in the right carotid siphon with a large thrombus (fig. 1A, B), resulting in a high-grade stenosis. We suggested the thrombus formation was due to a cardiac embolus stopped in the right

Fig. 1. Intra- and extracranial angio-CT. Coronal and lateral projections showed a large thrombus in the right internal carotid artery (arrows, red in the online version).

Color version available online