**Purpose**

Diffusion-weighted (DW) imaging can demonstrate cerebral infarctions within minutes of their onset and has rapidly become the mainstay in the diagnostic evaluation of patients with stroke. Normal random motion of water molecules in the brain results in greater diffusion and loss of signal intensity. Restriction of water movements in areas of infarcted tissue results in less diffusion and increased signal intensity relative to the surrounding normal tissues. Although it has been documented that DWI is highly sensitive for the diagnosis of acute ischemic stroke, false-negatives of standard DWI are not uncommon in small infarction, brain stem location, or imaging performed early after onset. We decreased the section thickness of DW imaging to 3mm thin-section DWI to evaluate the diagnostic value of thin-section DW imaging on acute cerebral infarction.

**Methods and Materials**

This study was approved by an institutional review board, and written informed consent was obtained from each patient or his or her next of kin. Between May 2010 and December 2011, MR imaging was performed in 247 patients with suspected stroke. Thin-section DW imaging was routinely added to our stroke protocol during this time. After an enrollment period of 19 months, we analyzed the images of all patients who were imaged at the acute stage of infarct. The median delay from onset to MR imaging was 48 hours (range, 2 hours to 3 days). The study population consisted of 161 patients (106 men and 55 women; mean age, 60.1 12.6 years; age range, 27-87 years). All infarcts were confirmed to have a decreased apparent diffusion coefficient (ADC) on the ADC maps. Stroke symptoms were as follows: aphasia (n = 31), motor weakness (n = 115), sensory disturbance (n = 21), dizziness (n = 67), other visual deficits (n = 3), and cerebellar symptoms (n = 1).

All MR examinations were performed by using a 1.5T clinical imaging system (GE Healthcare Twinspeed). The routine stroke protocol at our institute requires approximately 18 minutes and consists of the following: conventional DW imaging, T1-weighted imaging (TR/TE/TI, 1750/24/750), T2-weighted imaging (TR/TE, 4000/100), fluid-attenuated inversion recovery imaging (TR/TE/TI, 8800/120/2200), MR angiography (TR/TE, 30/2.3). Conventional DW imaging was performed with a 6-mm section thickness and 1-mm intersection gaps, with a b value of 1000 s/mm$^2$ and a TR/TE/NEX of 4500/64/2. FOV 240mm×240mm matrix 128×128 The entire brain was imaged in 19 axial sections acquisition time= 36 seconds. Thin-section DW images were obtained with a 3-mm section thickness and 0.5-mm intersection gaps. acquired using similar parameters except for the following: NEX = 4. The entire brain was imaged in 38 axial sections acquisition time 144 seconds. Both conventional and thin-section DW imaging were acquired by using three orthogonal gradients in three directions.
All MR images, including DW images, conventional MR images, and MR angiograms were viewed in retrospective fashion. Assessments of conventional and thin-section DW images were done on different days, and the order of the cases was randomized to prevent bias. Two experienced radiologist independently reviewed the images. all of the images were randomly reviewed by 2 readers blinded to the clinical data, fluid-attenuated inversion recovery images, and apparent diffusion coefficient (ADC) maps. DWI lesions were defined as hyperintense regions after exclusion of T2 shine through effects due to hyperintensities on T2-weighted echo-planar images \( b=0 \) mm\(^2\)/s. Cases of discordance between readers were resolved by consensus. For each patient with lesions seen on both DWIs, a region of interest was centered in the largest area of diffusion hyperintensity (region of interest area=26-104 mm\(^2\), mean,78.4mm\(^2\)) and mirrored on to the contralateral hemisphere to obtain a ratio of signal intensity (rSI) and ADC (rADC).

SPSS 14.0 (SPSS, Chicago, Ill) was used for statistical analysis. Interobserver agreement were assessed by using kappa test. After consensus, the number of patients with at least 1 lesion, total number of lesions, rSI, and rADC were compared between standard and then DWIs by using Fisher exact test for binary variables, paired Wilcoxon test for the total number of lesions, and Student t test for continuous variables. A value of \( P \leq .05 \) was considered significant.

**Results**

For the distinction between positive and negative DWIs, the 2 readers agreed in all of the cases on thin DWI, whereas=0.90 (95% CI, 0.74-1.06) for standard DWI. After consensus, a total of 146 patients with 167 lesions on thin-section DWI and 133 patients with 150 lesions on standard DWI was identified (\( P=.004 \)). Of 167 lesions #68 lesions were located in the anterior circulation and 99 lesions in the posterior circulation. None of the lesions seen on standard DWI were missed on thin-section DWI. Of the 28 patients with normal standard DWI, 16 patients with 17 lesions were found on thin-section DWI (Fig 1-6), thin-section DWI showed 17 additional lesions in 16 patients. These were small (mean ± SD=21±9.59mm\(^2\)), preferentially located in the in brain stem\( (n=13)\), and occasionally cortex \( (n=2)\) or deep white matter \( (n=2)\).

Lesion conspicuity was improved on thin-section DWI, The rSI of lesions was significantly(\( P= .001 \)) higher on thin-section DWI (1.62±0.31) than on standard DWI (1.46±0.26). The rADC was significantly(\( P<.001 \)) lower on thin-section DWI (0.77±0.19) than on standard DWI(0.82±0.17.)

**Images for this section:**
Fig. 1: A 54-year-old man referred for dizziness and sensorimotor weakness of the left leg that lasted 8 hours. Standard DWI demonstrated a subtle punctuate hyperintensity in the dorsolateral medullary.
Fig. 2: The same patient with figure 1. 3mm thin-section DWI confirmed a bright punctuate hyperintensity in the dorsolateral medullary(arrow).
Fig. 3: A 54-year-old man referred for the left hemianesthesia that lasted 20 hours. Standard DWI fails to show any significant abnormality.
Fig. 4: The same patient with figure 3. 3mm thin-section DWI confirmed a bright punctuate hyperintensity in matter of the left frontal lobe (arrow).
**Fig. 5:** A 63-year-old man referred for dizziness and blurred vision lasted 12 hours. Standard DWI demonstrated a subtle punctuate hyperintensity in the brain stem.
**Fig. 6:** The same patient with figure 5. 3mm thin-section DWI confirmed a bright punctuate hyperintensity in brain stem (arrow).
Conclusion

Thin-section DWI increased lesion conspicuity and directly improved the accuracy of stroke diagnosis. Because stroke influences initial management decision, thin-section DW imaging may be advantageous to guide therapy and hospital admission. thin-section DWI may be a useful adjunct when facing a doubtful signal intensity change on standard DWI.

The major drawback of this technique is the increased imaging time. At our institution, examination time is 36 seconds for conventional DW imaging and 144 seconds for thin-section DW imaging. This drawback can be overcome by scanning target location and decreasing axial sections according clinical presentations in our institution.

References

9. Bertrand A, Oppenheim C, Lamy C et al. Comparison of optimized and standard diffusion-weighted imaging at 1.5T for the detection of acute


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