

New Horizons in Diffusion Weighted Imaging: A Comprehensive Evaluation of a Fast Spin Echo DWI Sequence with Radial k-space Sampling at 3T using a 32-Channel Head Coil in Acute Brain Ischemia.

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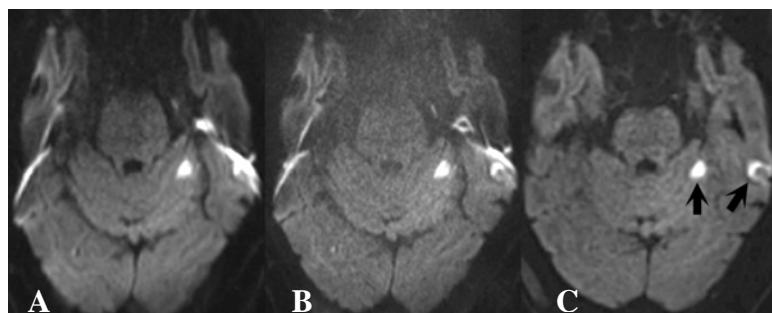
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Background: The time window for successful thrombolytic therapy is small, with a reliable diagnostic method needed to detect acute ischemic brain areas early after stroke onset. Diffusion weighted MR imaging (DWI) fulfills this role, and is widely accepted for the diagnosis of acute brain ischemia. Its sensitivity and specificity for the detection acute brain ischemia is reported to be 88-100% and 86-100% [1-3]. Single-shot spin echo echoplanar imaging (EPI) is the most commonly used approach, clinically, for acquisition of diffusion weighted scans. However, the relatively low resolution of such scans, low SNR and bulk susceptibility artifacts decrease their diagnostic value. A promising new scan technique ('BLADE' DWI) is now available for diffusion imaging using a fast spin echo sequence with radial k-space sampling that could help overcome susceptibility artifacts. The aim of this study was to evaluate the diagnostic quality and the SNR of diffusion weighted imaging using a fast spin echo (FSE) sequence with BLADE k-space trajectory at 3 T in combination with a 32-channel head coil, with comparison to a standard spin echo EPI DWI sequence and a high resolution spin echo EPI DWI sequence with an increased matrix size of 256x256.

Material and Methods: 14 patients with acute brain ischemia were enrolled in this study and evaluated with three different sequences on a 3 T MR-system using a 32-channel head coil: a) a standard spin echo (SE) EPI DWI (TR/TE 4100/91 ms, matrix size 192x192, parallel imaging factor 2), b) a high resolution SE EPI DWI with a matrix size of 256x256 and a parallel imaging factor (IPAT) of 4 (TR/TE 4100/92 ms) and c) a FSE DWI BLADE (TR/TE 4100/124 ms, matrix size 192x192, parallel imaging factor 2). For SNR comparisons, an additional group of 10 healthy volunteers was enrolled. For quantitative evaluation in this healthy volunteer subset each of the three scans were performed twice, due to the use of a multichannel coil and parallel imaging. For the SNR comparison a paired student t-test was performed, with a p value < 0.05 considered statistically significant. A blinded read of the patient exams was performed to assess image quality.

Results: In the blinded read, 56 judgments (14 x 4) assessing image quality were performed. In 47 out of all 56 judgments FSE BLADE DWI scans were preferred, whereas the high resolution SE EPI DWI sequences were not rated superior to the standard EPI DWI data sets or BLADE data sets in any instance. Ranking these three scans in terms of bulk susceptibility artifacts, BLADE showed the least artifacts followed by the 256x256 EPI DWI and then the standard EPI DWI. In 13 out of 14 cases (93%) BLADE was the preferred scan for the diagnosis of any diffusion abnormality. The standard EPI DWI was preferred only once. In no instance was the high resolution EPI DWI sequence preferred. The BLADE DWI was also the scan sequence preferred most for visualization of the diffusion abnormality present (43%); in 50% the reader had no preference. SNR_{mean} values (21.8±5.3) of the standard EPI DWI sequences were significantly higher than SNR_{mean} values of the BLADE DWI (11.3±3.8, p<0.0001) and the high resolution EPI DWI (11.9±2.6, p=0.0009). There was no statistically significant difference between the high resolution EPI DWI and the BLADE DWI (p = 0.6) for SNR.

A small acute left superior cerebellar infarct, together with a small left middle cerebral artery infarct (lateral temporal lobe) are difficult to diagnose with certainty on (A) standard and B) high resolution EPI DWI scans, due to the presence of bulk susceptibility artifacts. (C) The BLADE FSE DWI scan well depicts each infarct (black arrows). Comparing the two EPI scans, the bulk susceptibility artifacts are slightly reduced in (B) the high resolution, IPAT 4, scan. Note also the geometric distortion on the EPI scans, in the anterior-posterior direction, which is particularly evident on (A) the scan acquired with lower in plane spatial resolution and a lower parallel imaging factor. The high resolution EPI DWI scan (B) is limited by low SNR



Conclusion: The diagnostic feasibility of a FSE DWI scan with radial k-space sampling in comparison to standard and high resolution SE EPI DWI sequences using a 32-channel coil at 3 T in acute brain ischemia is shown in this study. The image quality of the BLADE DWI scan was not degraded by bulk susceptibility artifacts, and it was the preferred scan, as assessed in a blinded read, for the detection of acute diffusion abnormalities.

References: [1] Srinivasan A, et al; Radiographics 2006; 26 Suppl 1: S75-95. [2] Hacke W, et al; Stroke 2005;36:66-73. [3] Provenzale J, et al; Radiology 2003;229:347-359.