

## Advantages of fast spin-echo diffusion weighted imaging in detecting small stroke lesions

J. P. Debbins<sup>1</sup>, J. Karis<sup>2</sup>, J. G. Pipe<sup>1</sup>

<sup>1</sup>MRI Research, St. Joseph's Hospital, Phoenix, AZ, United States, <sup>2</sup>Neuroradiology, St. Joseph's Hospital, Phoenix, AZ, United States

**INTRODUCTION:** Spin Echo diffusion methods have been proposed for Diffusion Weighted Imaging (DWI) using various methodologies [1-2]. The introduction of a multishot FSE DWI variant [3] on commercial MR systems has lead to the direct clinical comparisons between standard clinical EPI DWI sequences. There is now growing evidence [4] that PropDWI performs better, particularly when depicting very small stroke lesions, on the order of 1-2 voxels. The goal in this work is to systematically confirm these findings and formulate hypotheses to help understand the mechanisms behind this apparent improvement.

**METHODS and RESULTS:** All suspected/follow up stroke patients at our institution receive a high resolution PropDWI [5] as their primary diagnostic test. For this study, a standard single-shot EPI dual spin echo DWI sequence and an equivalent lower resolution PropDWI sequence were also added. All scans used the identical slice geometry. Processed isotropic images in 50 patients were compared for differences in lesion count and size. Examples of two patients with small stroke lesions are shown in Fig 1.

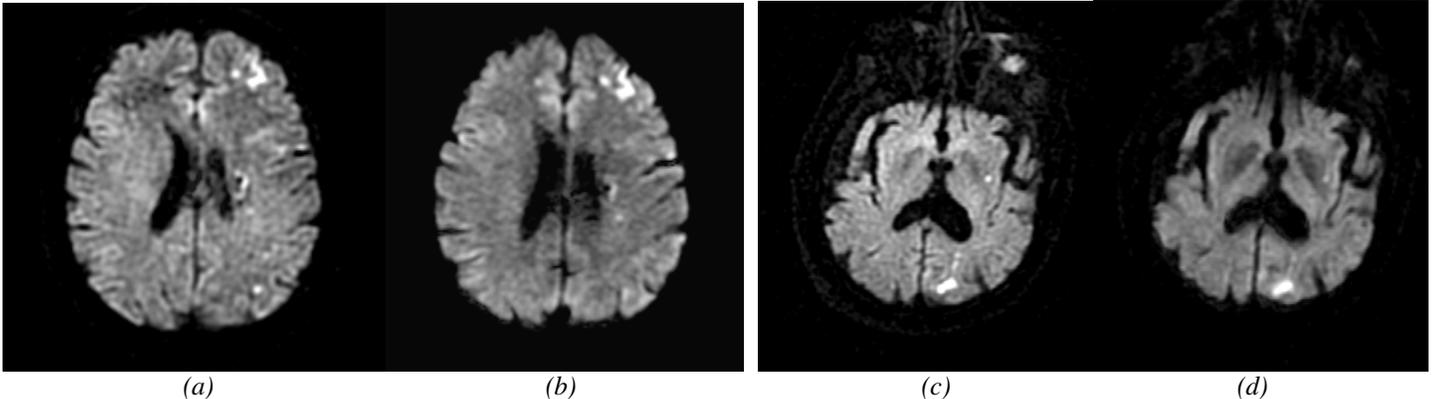


Fig.1. Two example patients. Low resolution PropDWI (a,c) and low resolution EPI DWI (b,d). Note reduced conspicuity of small lesions on EPI (b,d) compared to PropDWI (a,c). Voxel sizes of all images are equivalent.

Findings in ALL patients with small lesions (2-4mm) demonstrate that the low resolution PropDWI yields more lesions than a similar resolution EPI DWI and with better conspicuity. We hypothesize the following primary mechanism for this observation; acute stroke lesions contain higher regional concentrations of deoxyhemoglobin [6] relative to normal brain tissue. For very small lesions this will create strong local T2\* effects and thus signal loss with long echo-train single shot EPI DWI methods, particularly at high spatial frequencies. We developed a susceptibility-weighted sequence using an EPI readout comparable to the low resolution PropDWI. Resulting T2\* characteristics could be indirectly measured by changes in signal intensity in the area of the small lesions. Several patients were scanned and small lesions analyzed, which were shown to have increasing signal loss for increasing echo offsets on the order of 5-15msecs, suggesting local T2\* reduction of stroke signal. In the single-shot EPI DWI clinical sequence, the high k-space echoes are positioned at the extremes of the single shot echo train (>>10msec), which would significantly contribute to the signal degradation of small (high resolution) lesions due to observed local T2\* effects of these small lesions.

**DISCUSSION:** The standard single-shot EPI DWI method, used globally on most commercial scanners, is a very fast (sub-minute) stroke screening tool. However it may underestimate the total scope of stroke, particularly small lesion count. PropDWI consistently yields better overall lesion conspicuity and total stroke estimation. A clinical study of this effect is currently in progress, additionally including 1) comparisons to single-shot EPI using shorter readouts (parallel imaging), 2) investigating how small lesions near regions of high susceptibility become distorted, blurred or folded making the lesion perceptible, and 3) understanding the contrast to noise contributions of PropDWI.

**REFERENCES:** 1. Gudbjartsson H, Maier SE, et al. *Magn Reson Med.* 36: 509– 519, 1996. 2. Bastin M, Le Roux P., *Magn Reson Med* 48 (1): 6 – 14, 2002 3. Pipe JG, Farthing VG and Forbes KP, *Mag Reson Med.* 47(1): 42-52, 2002. 4. Forbes KP, Pipe JG, et al., *Radiology.* 225(2): 551-555, 2002. 5. Pipe JG, *ISMRM 10th Annual Scientific Meeting and Exhibition*, p435 Honolulu, Hawaii; 2002. 6. Hermier M, Nighoghossian N. *Stroke.* 2004 Aug;35(8):1989-94. 2004