Ultrafast *in vivo* Diffusion Imaging of Stroke at 21.1 T by Spatiotemporal Encoding

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Introduction

Two of the most pressing concerns in MRI have been the enhancement of image signal-to-noise and speed of image acquisition. The former has motivated a push to higher magnetic fields while the later issue has inspired echo-planar imaging (EPI), parallel imaging and compressed sensing. These solutions also can degrade image quality by introducing susceptibility gradients and other artifacts that distort not only anatomical information but also quantification. Fortunately, a new suite of super-resolved ultrafast single-shot spatiotemporally encoded (SPEN) imaging sequences [1] are robust in the presence of high-field artifacts and offer high temporal resolution.

Experimental

Using an EPI readout, SPEN employs a 90° excitation achieved with a chirped pulse in the presence of a gradient [1]. For slice selection, a standard three-lobed 180° sinc pulse is used, with diffusion encoding gradients surrounding the pulse. Fully refocused SPEN signals were acquired with a 30-40 ms EPI readout covering a FOV of 32×32×2 mm using a matrix size of 100×100. SPEN-DWI was obtained at six b-values. Standard DW-EPI and DW-SE experiments were conducted using SE excitation and diffusion parameters similar to the SPEN-DWI experiments. For *in vivo* experiments, stroke was induced by middle cerebral artery occlusion (MCAO) using a 2-3-mm rubber coated filament according to methods previously described [2]. The two-hour occlusion created a stroke in the right striatum and cortex; 3 MCAO stroked rats and 2 control rats were scanned one day after stroke.

Results and Discussion

Figures 1 and 2 show representative magnitude images and ADC maps (μm^2/ms) for each of the acquisition techniques. At 21.1-T, the SPEN-DWI sequence is immune to susceptibility artifacts that are particularly strong in non-segmented DWI-EPI using similar acquisition parameters. SPEN-DWI reveals a large hyperintense stroke region characteristic of toxic edema and swelling associated with the MCAO. Though the DW-SE provides the best quality images, the required acquisition time (>19 min) severely restricts diffusion measurements to a reduced number of b-values. For all acquisitions, decreased ADCs were evident in the stroke lesion compared to contralateral and control measurements, but SPEN-DWI ADC values and lesion extent differ from DW-EPI.

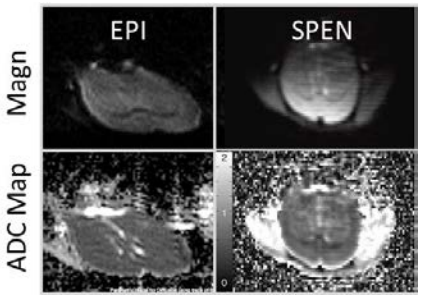

Figure 1. Control rat magnitude MRI & ADC maps acquired at 21.1 T.

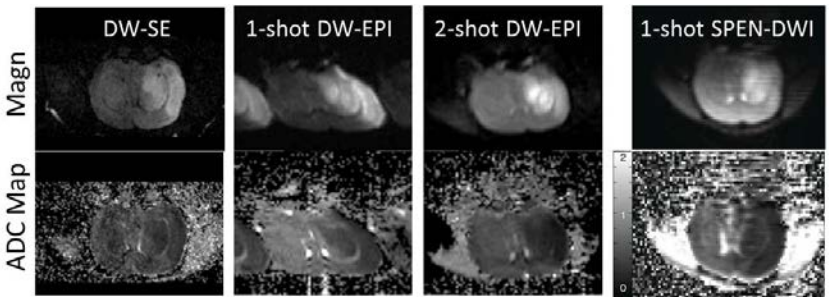

Figure 2. Stroked rat magnitude DW-MRI (b = 1000) & ADC maps for different acquisition schemes.

Conclusions

Overall, the quality of the SPEN-DWI and resulting ADC maps make this form of single-shot acquisition a clear choice for comprehensive, high-throughput in vivo stroke studies at ultra-high fields and/or heterogeneous signal regions.

Acknowledgement

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References

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[3] Solomon, E., *et al.,* (submitted).