Oscillating and Pulsed Gradient Diffusion Magnetic Resonance Microscopy Over an Extended b-Value Range: Implications for the Characterization of Tissue Microstructure

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Introduction

Oscillating gradient spin echo (OGSE) employs oscillating gradient waveforms in lieu of those with equal amplitude and duration as seen in pulsed-gradient spin echo (PGSE) sequences. Compared to PGSE methods, OGSE offers the ability to achieve shorter effective diffusion times (TD_{eff}). This characteristic has been proposed as a means of investigating shorter diffusion length scales and thus represents a novel MR method for probing subcellular structure [1]. In the current study, we collect OGSE data at previously unrealized length scales as well as compare the results of OGSE and PGSE experiments conducted at equivalent TD_{eff}.

Experimental

Fixed rat hippocampal slices (300μm) were imaged MRI using a 100μm diameter surface coil. Planar gradients (6600 G/cm) were employed to generate high frequencies (ω=67-1000 Hz) using OGSE and short diffusion times (*TDeff*=1.2-15.0 ms) using PGSE over a wide range of diffusion values (*b*=0-3.2 ms/μm^2). Image analysis was performed in adjacent layers of the hippocampal CA1 region and included the strata oriens, pyramidale and radiatum.

Results and Discussion

Our analysis indicated that ADC values estimated from data collected using OGSE and PGSE techniques were in close agreement [2] (data not shown); however, the estimates generated for apparent kurtosis (K_{app}) differ in magnitude (PGSE > OGSE) and trend in opposite directions with respect to TD_{eff} (**Figure 1**). In addition, equivalence in diffusion signal was only observed between OGSE and PGSE data collected at low b-values (b ≤ 1.0 ms/μm^2) (data not shown).

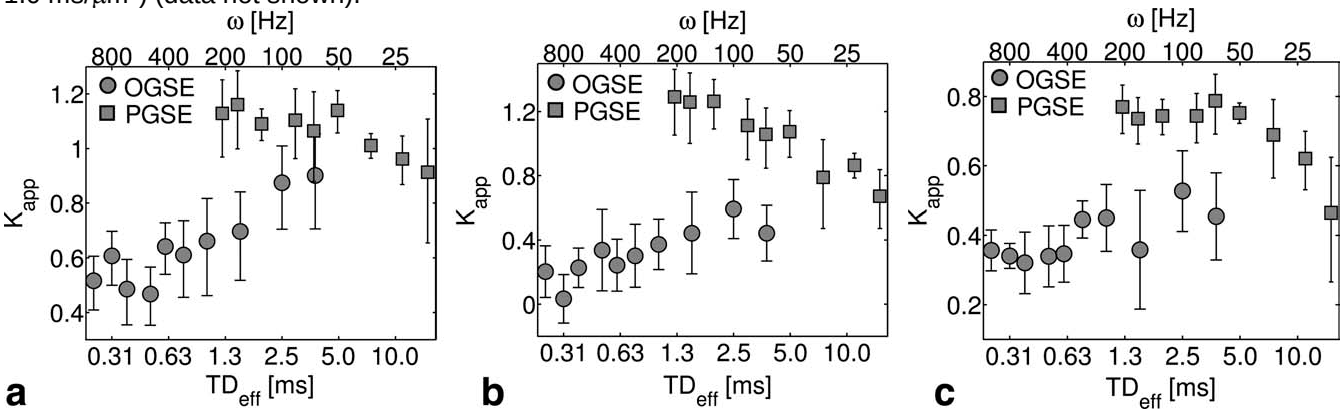

Figure 1. Estimates for values of apparent kurtosis (K_{app}) in strata radiatum (a) oriens (b) and pyramidale (c) generated using OGSE (circle) and PGSE (square) diffusion imaging protocols. Error bars correspond to the 68% confidence interval.

Conclusions

Differences in apparent kurtosis observed using OGSE and PGSE methods are likely due to PGSE's increased sensitivity to non-Gaussian diffusion. Alternatively, this discrepancy could be attributed to compartmental exchange occurring during OGSE diffusion weighting periods. Study currently in press.

Acknowledgements

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References

[1] Parsons, E., *et al*., Magnetic Resonance in Medicine, **55(1)**, 75-84 (2006).
[2] Portnoy, S., *et al*., Magnetic Resonance in Medicine, doi: 10.1002/mrm.24325 [in press] (2012).