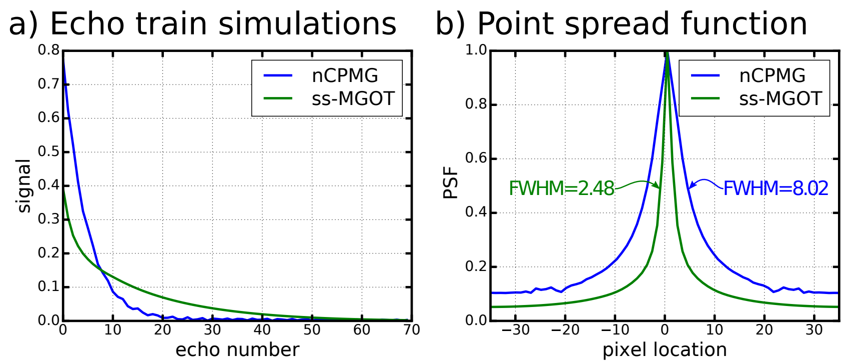
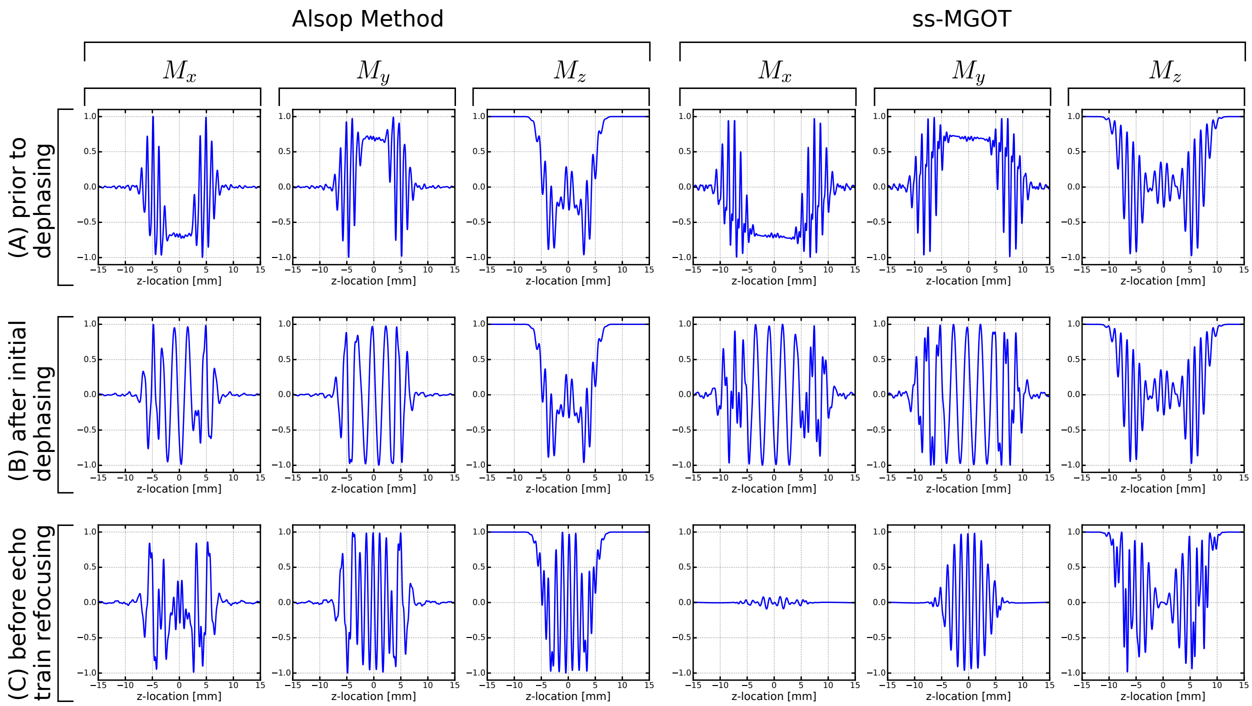
Body diffusion-weighted imaging using magnetization prepared single-shot fast spin echo and extended parallel imaging signal averaging

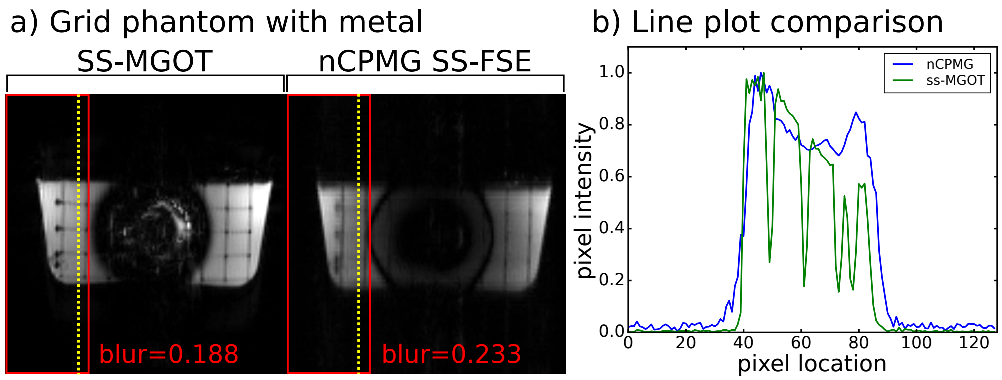
Supporting Information



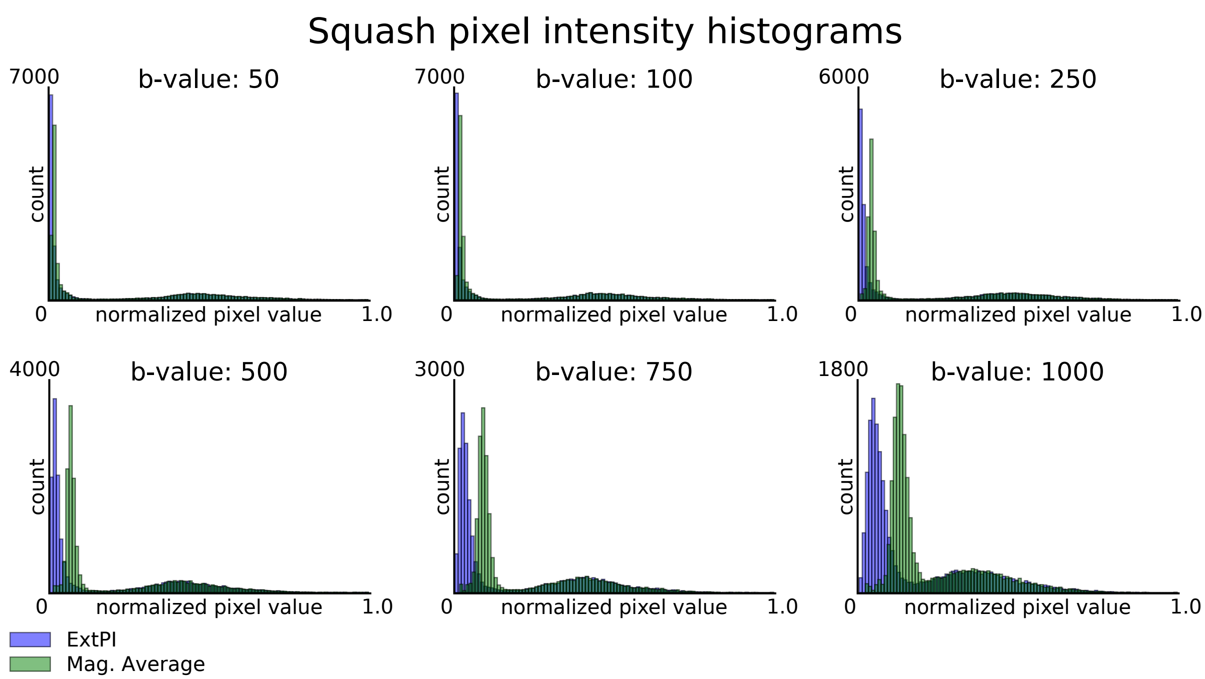
Supporting Figure S1: Comparison of nCPMG SS-FSE and ss-MGOT echo train signal and point spread functions (PSF). a) An echo train signal is simulated through Bloch simulation. Relaxation time constants are chosen to represent muscle at 3T, similar to other Bloch simulations in this work. Because of the variable flip angle scheme and the shorter effective echo spacing (as double phase encoding is nonessential for ss-MGOT), the ss-MGOT signal remains flatter throughout the echo train and sees less decay than the nCPMG SS-FSE sequence. b) The calculated point spread functions based on the echo train modulation are plotted for both nCPMG SS-FSE and ss-MGOT. The nCPMG SS-FSE PSF is considerably broader than the ss-MGOT PSF. The calculated full width at half maximum (FWHM) is 3.23 times larger for nCPMG SS-FSE compared to ss-MGOT. Consequently, the nCPMG SS-FSE sequence should produce much more phase encode direction blurring compared to the ss-MGOT sequence.



Supporting Figure S2: Bloch simulations of the magnetization signal throughout various points in the Alsop and ss-MGOT pulse sequences. For reference as to where these time points occur in the sequence, please see Figure 1. *Top Row, Point A*: the signal after the $180°$ spin echo pulse in the diffusion preparation module. Both sequences give similar signals, though the ss-MGOT method uses a slab selective preparation to ensure uniform preparation across the thinner excited slice used in imaging. *Middle Row, Point B*: the signal immediately after the first dephasing gradient which introduces 2 cycles of phase modulation across the excited slice. Both sequences give similar signals, but the wider slab used in ss-MGOT gives a more uniform dephasing across the slice to be imaged than the Alsop approach. *Bottom Row, Point C*: the magnetization after the spoiling portion (for the Alsop method this occurs after the $90°$ tip up pulse whereas for the ss-MGOT approach this occurs after the $90°$ re-excitation immediately prior to the echo train portion of the sequence). In the Alsop approach, significant net magnetization is left on M_x, which is problematic as it will be recalled during the echo train leading to signal instabilities. Conversely, the M_x signal is nearly non-existent due to the spoiler pulse while the MG portion of the signal was "hidden" on the longitudinal axis prior to re-excitation.



Supporting Figure S3: a) Grid phantom images of the grid phantom with the metal should implant are compared for nCPMG SS-FSE and ss-MGOT. These images show that the the nCPMG SS-FSE images show more blur in the phase encode direction when compared to the ss-MGOT sequence. Over an ROI (indicated by a red box), the blur factor for both images are calculated. The blur factor is described in [35] and applied to MRI in [36]. The blur factor can range from 0 to 1.0, with higher values indicating more blurring. In these images, the nCPMG SS-FSE image has a higher blur factor than the ss-MGOT image. b) The blurring can also be seen in the line profiles (sampled from the figure as indicated by the yellow line). In this image the ss-MGOT image clearly shows the grid lines, where the nCPMG SS-FSE image does not show the grid lines as clearly.



Supporting Figure S4: Histogram comparison of the ExtPI averaging and magnitude averaging of squash phantom images. These histograms from each image demonstrate a rapidly increasing noise floor in the magnitude averaging case compared to the ExtPI reconstruction.