Arterial Spin Labeling with Simultaneous Multi- Slice EPI compared to EPI and 3D GRASE

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Introduction Multi-slice EPI is a commonly used readout sequence in ASL imaging. Simultaneous multi-slice (SMS) EPI having a multiband slice excitation factor (MB) could be used instead of EPI to increase slice coverage[1,2,3] or reduce acquisition time window of ASL image readout. Here we developed and evaluated SMS-EPI pulsed ASL (PASL) for perfusion imaging of brain and compared it to EPI and segmented 3D GRASE.

Methods Experiments were performed in 4 normal volunteers, using a 3T scanner with 32 channel head coil. PASL preparations use FAIR and QUIPSS II with TI_1/1000ms and TI_2/1800ms. Image parameters EPI and SMS-EPI: TR=3000ms, TE=12-18ms, 4x4 mm^2 in-plane resolution, slice thickness=5mm and 1mm or 20% slice gap; matrix = 64 × 64, full and partial Fourier = 6/8, signal averages= 40, echo spacing = 0.41~0.46ms with ramp sampling, 90° sinc excitation pulse width = 2.56ms in MB-2 up to 6.71ms in MB-5 to reduce peak RF power. Blipped-CAIPI controlled aliasing FOV/2 - FOV/4 was used to reduce g-factor penalty[3]. In 4 subjects, qualitative comparison to 3D GRASE at same slice positions required 6mm contiguous slices to match position of SMS-EPI using 5mm slices skip 1mm gaps. 3D GRASE imaging parameters: TR=3000ms, TE=19ms, matrix 64x64x20, resolution 4x4x6mm^3; partial-Fourier slice axis=6/8; 2x2=4 segmentations on Ks and Kp phase encoded axes, post IR delay (TI) = 1800ms, QUIPPS II. Background suppression was used in 3D GRASE as earlier described[4]. To achieve SNR comparison of 3D GRASE and SMS-EPI ASL at the same slice thickness and positions, in isotropic 4mm resolution, a 100% slice gap was used in SMS-EPI to match every other slice position in 3D GRASE.

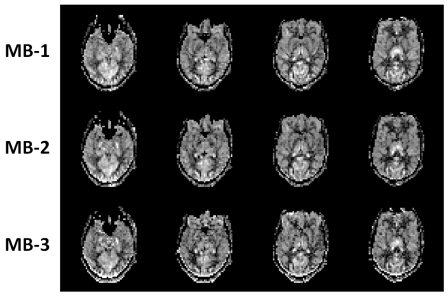
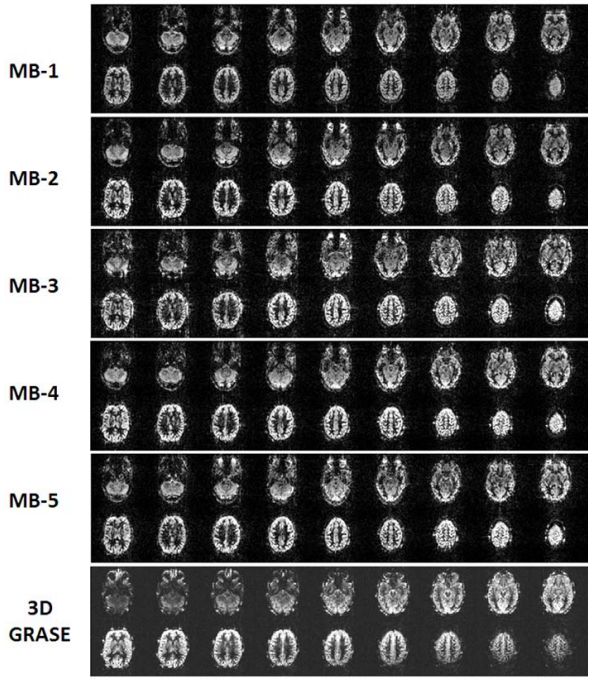


Fig 1. Quantitative CBF map comparisons.

Results and Discussion Quantitative CBF maps, Fig.1, were calculated and compared between MB-1, MB-2 and MB-3, in a 12 slices data set. For the first 4 slices, which have the same TI for each slice across sequences, the mean intraclass Correlation Coefficient (ICC) values were .73 for MB-1_MB-1, .62 for MB-1_MB-2 and .61 for MB-1_MB-3. Spatial SNR for the perfusion weighted images averaged across subjects was 3.28 and 3.44 for initial two MB-1 acquisition, 3.25 for MB-2 and 2.98 for MB-3. The relative temporal SNR was 1.0 for MB-1, 0.87 for MB-2 and 0.78 for MB-3. Fig. 2 comparisons of 20 slice scan with SMS-EPI and EPI ASL used 40 averages (avg) in 4.5 min scan time and segmented 3D GRASE ASL used 2 avg in 48 sec scan time. With SMS-EPI the time window of image acquisition was reduced from 874ms for EPI (MB-1) to 436ms, 312ms, 237ms, and 196ms in MB-2 through MB-5, respectively. The susceptibility artifacts and distortions were the same in SMS-EPI and EPI while greatly reduced in 3D GRASE due to rf refocusing in the spin echo CPMG sequence. Fig. 3 shows the comparison of 3D GRASE to SMS-EPI with 100% gap at same 4 mm isotropic resolution as GRASE but with a longer acquisition time or reduced SNR in SMS-EPI. This difference was greatly effected by background suppression, not possible to implement in SMS-EPI as it did not have identical slice excitation time as does 3D GRASE. In conclusion, PASL performed with SMS-EPI has major advantage over EPI based ASL with greater slice coverage and little penalty in SNR, however both have marked SNR disadvantage compared to 3D GRASE ASL.



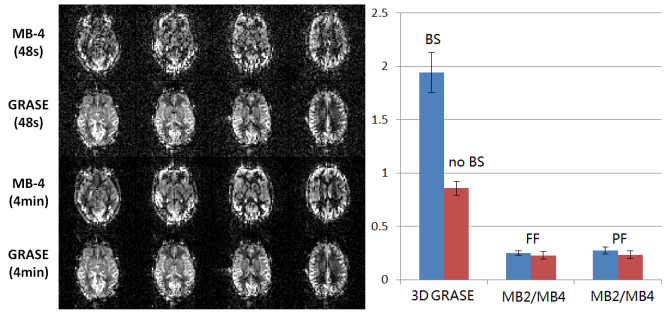


Fig 3. Comparison (left) image quality in 48 sec and 4 min scans. (right) temporal SNR: 3D GRASE w/ and w/o background suppression (BS), SMS-EPI Full Fourier (FF) TE=18ms and 6/8 partial (PF) TE=13ms.

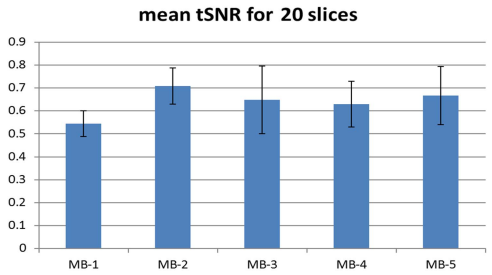


Fig 2. Comparison of perfusion weighted images (above) and temporal SNR for 20 slice acquisitions. (tSNR in 4 subjects).

References [1] Moeller S et al. *Magn. Reson. Med.* 63:1144–53, 2010 [2] Feinberg DA et al. PLoS ONE, 5(12):e15710, 2010 [3] Setsompop K et al. *Magn. Reson. Med*. 2012 [4] Garcia DM et al. *Magn. Reson. Med*. 54:366-72, 2005 **Acknowledgements** Funded in part by NIH grants 1R44 NS073417, 1R44 NS084788.