Optimal Partial Fourier Reconstructions in Electron Paramagnetic Resonance Imaging

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Purpose: Electron paramagnetic resonance imaging (EPRI) employed using single-point (SP) imaging techniques offers the capability to dynamically image *in vivo* tumor oxygenation. While highly specific, current capabilities for high spatial resolution dynamic imaging are limited. Recently, we have investigated partial *k*-space acceleration techniques for SP-EPRI [1]. In this work, we extend these findings to determine the optimal technique for the inherently low resolutions used in SP-EPRI acquisitions. We show that the SP-EPRI imaging technique is highly suited to PF techniques due to its tractable phase characteristics, and that performance of each method is dependent upon image matrix size.

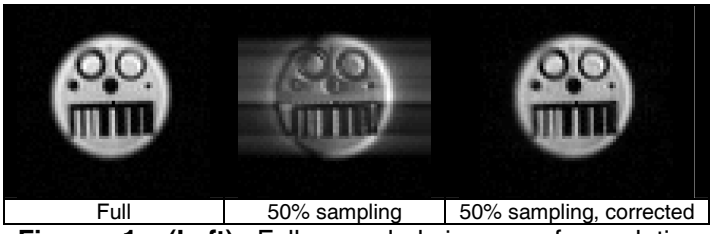

Figure 1. (Left) Fully-sampled image of resolution phantom. **(Middle)** PF reconstruction using 50% sampling. **(Right)** Phase-corrected PF reconstruction.

Methods: Image data was acquired on a EPRI spectrometer operating at 300 MHz. A resolution phantom was imaged in 2D with 61x61 phase encoding points. As presented in Figure 1, PF reconstruction using conjugate symmetry (with phase correction using the zero gradient magnitude k-space FID) performed better than all other well-known partial *k*-space sampling reconstructions [2]. To identify the characteristics of reduced sampling, the data was subsampled to resolutions of 11x11, 21x21, 31x31, 41x41, 51x51, and 61x61 and reconstructed using elliptical sampling, phase-corrected conjugate symmetry (using 55%, 65%, and 75% sampling), and a combination of the two (using net 45% sampling). Images were generated from the respective phase encoded FIDs corresponding to time delay 810 ns. *In vivo* images were acquired on a mouse with SCC tumor cells implanted in the right femoral muscle. The acquisition was performed in 3D using 19x19x19 phase encoding points.

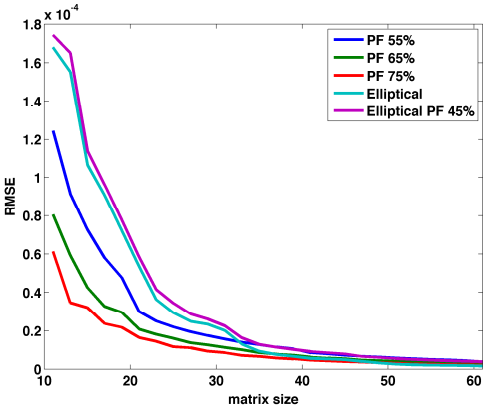

Figure 2. Reconstruction error (RMSE) versus image matrix size for the evaluated partial k-space sampling schemes.

Results: The reconstruction error (RMSE) was calculated for each sampling strategy and is shown in Figure 2. Elliptical scans have higher error at lower matrix sizes, but all techniques have comparable error at larger matrix size. Figure 3 shows that images have highly comparable quality, even with just 45% of the original data points sampled (2.2x acceleration). Figure 4 shows similar results for *in vivo* data; however, elliptical methods performed poorly, while good quality results were achieved with 63% sampling (1.6x acceleration)

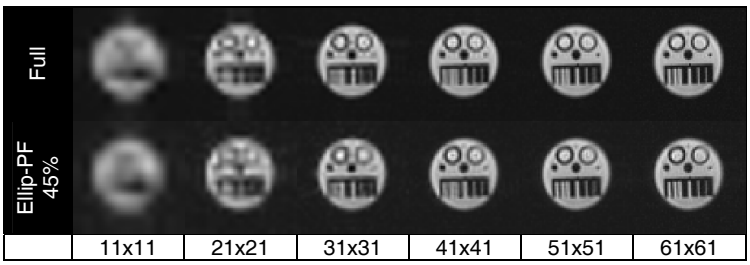

Figure 3. Combined elliptical-partial *k*-space images exhibit good overall quality compared to fully-sampled data with 45% data sampling.

Discussion and Conclusion: As expected, smaller matrix size increases the density of *k*-space measurements and reduces the performance of all partial sampling strategies. Images can be reconstructed with little error using large PF factors due to the low image phase resultant from the low B_0 fields employed in the modality, as well as the SP acquisition which results in data reconstructed only from k-space points with an identical time delay. EPRI will benefit from the use of partial *k*-space sampling to improve temporal resolution, which can be used to improve spatial resolution for comparable scan times. Remaining work includes evaluation of the effect of partial *k*-space sampling on quantitative measurements of pO_2.

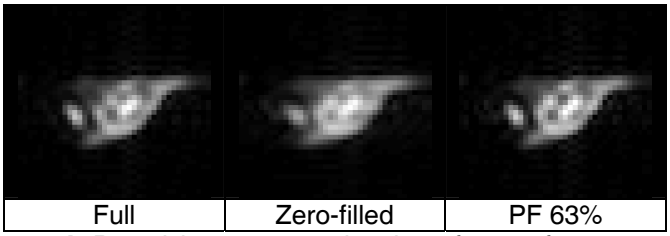

Figure 4. Partial *k*-space sampling by a factor of 63% results in an acceleration factor of 1.6x for *in vivo* EPR oximetry.

References

[1] Subramanian et al. (2012). MRM. [Epub, In press].
[2] McGibney et al. (1993). MRM. 30:51-59.