3D Radial Parallel imaging for bandwidth limited acquisitions.

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Introduction. Sweep imaging with Fourier transformation SWIFT (1) is a fast 3D-radial short-T2 sensitive sequence, in which the data are acquired in gaps during the RF-excitation. SWIFT can not currently be used with slice-selection, which implies that the FOV has to be larger than the object being imaged. Additionally, with SWIFT the gradients are always on, and smoothly varying from projection to projection,. Typically the maximum gradient-strength is not utilized, since the FOV has to be big, and thus slew-rates are not of concern.For high resolution imaging, this implies that the SWIFT pulse has to be lengthened, which both increases acquisition time and reduces the sensitivity due to T2* and T2 SNR loss during the lengthened readout. To achieve higher spatial resolution while maintaining short scan time and high sensitivity the use of parallel imaging is explored. For a radial sequence, multi-channel reconstruction with either CG-SENSE(2) or GRAPPA(3) can be used to effectively fill in k-space for missing projections. This will reduce radial streaking in the image PSF or conversely extend the Nyquist sampled radius, which does not significantly increase the resolution (4). To increase the spatial resolution, in this work the FOV is selected to be aliased, while maintaining broadband excitation of the object, and each projection is unaliased with a GRAPPA interpolation kernel. In the gapped pulse, due to presence of sidebands (5), the excitation bandwidth is much larger than the FOV, and for reduction factors of to 3, for example, the 1st RF sidebands are used for excitation. **Methods**. A breast phantom composed of water and fat, with an embedded spherical glass-vial was imaged in a quad transmit 2 channel receive breast coil. A fat-suppressed SWIFT sequence was used with 256 gaps per projection, a total of 24576 projections, with a CHESS fat-suppression pulse and spoiling once every 16 views. Two acquisitions with an FOV of 25cm and 12.5 cm respectively were obtained, with otherwise identical parameters. An azimuthally independent 1x4 GRAPPA interpolation kernel was calibrated from the 25cm acquisition and applied to the 12.5 cm FOV acquisition. After interpolation with the GRAPPA kernel, each channel was constructed with gridding, and a root-sum-of-squares (RSOS) combination was performed. **Results and Discussion**. The full FOV SWIFT image (un-accelerated, 2-fold zero-filled, RSOS reconstruction) is shown in figure 1A, with a zoomed region displayed in figure 1B. Figure 1C shows the higher resolution image achievable with an identical acquisition but acquired with ½ the FOV and reconstructed with GRAPPA (R=2). The effective volume element is 1/8 the size of that in the full FOV image, and a higher noise level is seen. Truncating the reconstructed FID's to the same extent as in the full FOV acquisition is shown in figure 1D. Comparable noise-level and resolution with the un-accelerated acquisition is noticed. The effective acquisition time would be 50% less than the full acquisition, and with acceptable performance for the ROI shown. **Conclusion**. Readout parallel imaging reconstruction has been applied to 3D radial imaging with the SWIFT sequence. The achievable benefits are significant for the SWIFT sequence, since the FOV previously had to be bigger than the object. The method has been demonstrated for a 2 channel reconstruction, with an acceleration factor of 2.

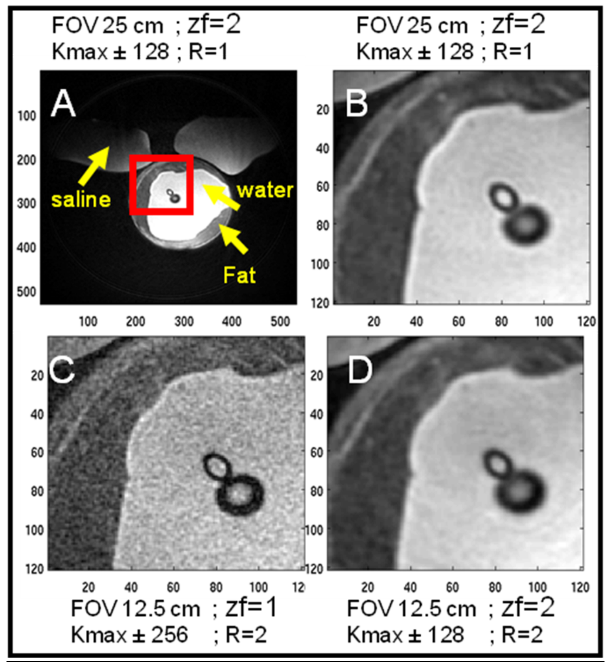

Figure 1. A selected slice of 3d SWIFT images with a resolution of 0.5x0.5x0.5 mm^3. A) Full FOV with 2X zero filling. B) Zoom of red box in A. C) R=2 reconstruction of aliased FID's with 128 points. D) R=2 reconstruction of aliased FID's with 64 points and with 2X zero filling after reconstruction.

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