

Optimization of Time-Resolved 3D TRICKS Abdominal MR Angiography with a Real-Time System

O Wieben¹, W Block^{2,3}, T Grist³, C. Mistretta^{2,3}, Depts. of (1) Electrical & Computer Engineering, (2) Medical Physics, and (3) Radiology, University of Wisconsin-Madison, Madison, Wisconsin

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Time-resolved, contrast-enhanced 3D MRA has performed successfully in the carotid arteries and lower extremities. Improved frame rates are obtained using a variable rate k-space sampling technique called *TRICKS* while multiple time frames eliminate coordinating image acquisition with contrast arrival. Time-resolved imaging of abdominal vessels also provides beneficial flow pattern information but limited scan time requires efficient oversampling of the lower spatial frequencies, managing artifacts from varying contrast concentration, and detecting contrast arrival to initiate breathholds.

We have modified our real-time system to acquire low spatial resolution images at an adequate frame rate to monitor the contrast arrival and then coordinate the patient breathhold. When the breathhold begins, we divide k-space into elliptical annuli of increasing radii. The center annulus defines most of the image contrast and thus is sampled at a higher temporal rate. Elliptical segmentation of k-space along with proper sizing of the central annulus increases the efficiency of the time-resolved technique. We also use the real-time system to monitor arterial contrast concentration and then vary the flip angle accordingly during acquisition. Other investigators and previous simulations show this modification provides significant signal gain for data acquired after the first contrast passage. During image reconstruction, the remaining k-space modulation from varying contrast concentration is compensated by reweighting k-space. Reweighting reduces blurring but can cause increased noise from k-space annuli acquired during decreased vessel enhancement. Using a matched filter to combine regions that have been sampled multiple times and reweighting k-space based on a Wiener filter can minimize this degradation.