Rapid 3D PC-MRA using Spiral Projection Imaging

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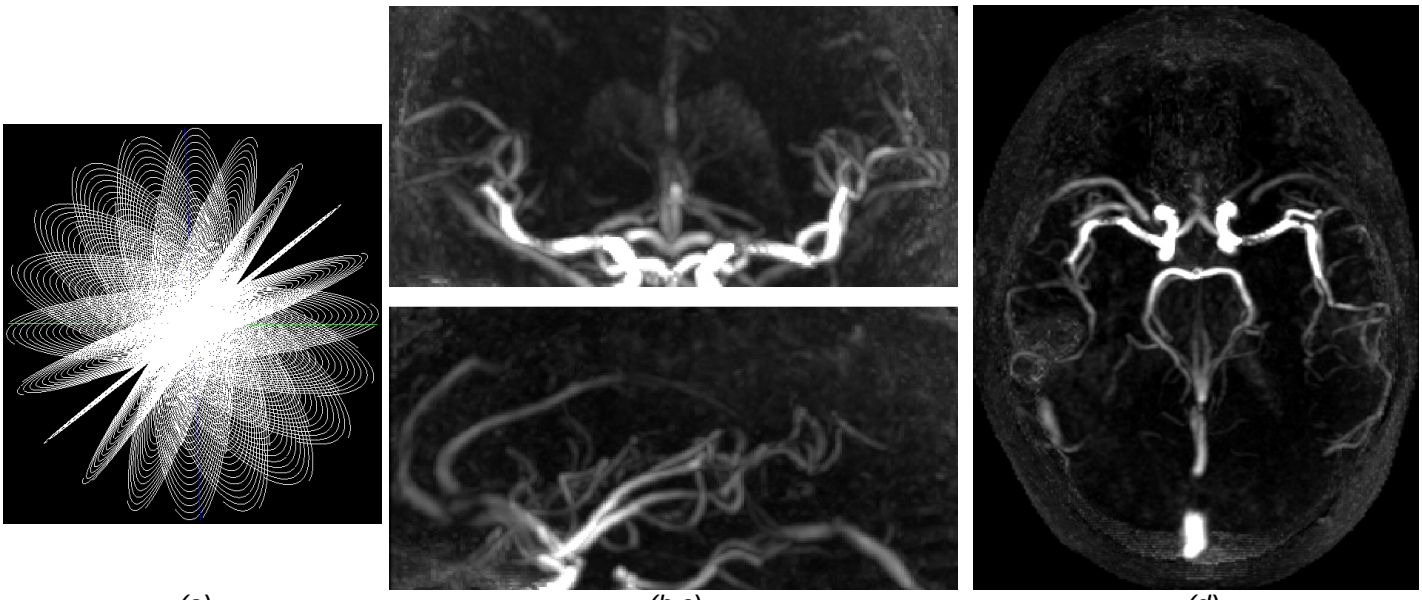
INTRODUCTION: Phase Contrast MRA (PC-MRA) has a unique potential among all imaging modalities to give reproducible, quantitative information about blood flow velocities and patterns(1), definition of intra-luminal space and vessel wall morphology(2), flow shear at vessel wall(3) and plaque localization and characterization. The ability to reliably collect this information in a practical setting will enhance our ability to understand, diagnose, and treat vascular disease. Despite its promise PC-MRA is currently under-utilized clinically, due in part to long imaging times. This work takes a newly developed fast three-dimensional scanning method and investigates its use in PC-MRA.

METHODS and RESULTS: A novel three-dimensional trajectory, called Spiral Projection Imaging, has been developed by rotating a base 2D variable density spiral trajectory(4) in such a way that it collects data in a sphere in k-space, as illustrated in Fig. 1a(5). This pulse sequence was adapted for PC-MRA by adding bipolar lobes and modifying data collection such that the velocity encoding direction is interleaved each TR to minimize motion related artifacts.

The method was developed on a GE 1.5T EXCITE scanner with Echo-Speed gradients. Typical parameters for application this sequence in the head are a $(24\ cm)^3$ FOV, $(1\ mm)^3$ resolution, scan time 30 seconds or less (depending upon the # of interleaves and degree of undersampling). The images shown in Fig. 1 (b,c,d) are the rms velocities calculated from V_x, V_y, and V_z using 6 sets of velocity encodings (Venc 25cm/s), with a total scan time of three minutes.



(a) *(b,c)* *(d)*

Fig.1. Illustration of the Spiral Projection Imaging 3D trajectory, and coronal, sagittal, and axial MIP's (b,c,d) acquired using the PC-MRA version of this sequence in a normal volunteer.

DISCUSSION: This sequence shows very early promise for PC-MRA. The use of spiral encoding from the center of k-space every TR, with no slice select gradient employed, ensures low contributions from the imaging gradients to the motion-encoding moments. Its rapid scan times should enable the use of multiple-venc scans which can use high-venc data to unalias very high SNR low-Venc scans.(6) Expansion of earlier 3D deblurring methods(7) should allow longer ADC values to be used, increasing the SNR and efficiency of this method. Additionally, better refinement of the filter to reduce background noise is needed to enhance vessel conspicuity.

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