TARGET AUDIENCE: Vascular imaging professionals.

PURPOSE: To present a time-resolved variation of nonenhanced QISS MRA using a golden angle radial trajectory and highly constrained back projection (HYPR) reconstruction that displays peripheral arterial anatomy and flow with high spatial and temporal resolution.

METHODS: This study was IRB approved. Imaging of the lower or upper limbs of 6 healthy subjects and 2 patients was performed on a 32-channel 1.5T MRI system (MAGNETOM Avanto, Siemens Healthcare) using a cardiac-gated saturation-recovery radial 2D trueFISP sequence acquiring golden angle (111.25°) incremented views over the majority of the cardiac cycle (Figure 1). Sliding window reconstruction was used to create a series of 20 time-resolved MR angiograms; all acquired views were reconstructed to create a static MR angiogram. Typical imaging parameters were: TR/TE/flip of 4.1-4.5 ms/2.0-2.2 ms/90°, slice thickness 2.3-3.0 mm, in-plane spatial resolution 1.0-1.2 mm, 160 (upper limbs) to 432 (lower limbs) slices, 1 heartbeat/slice (i.e., single-shot mode), 20 temporal frames/heartbeat, phase-based fat suppression, tracking venous saturation. A multi-shot implementation (2-4 heartbeats/slice) was tested to improve SNR and/or temporal resolution.

Using the static angiogram and the undersampled time-resolved reconstructions, local HYPR reconstruction was performed as shown in Figure 1. Comparisons of undersampled and HYPR-enhanced time-resolved reconstructions were made. Static angiograms were compared to Cartesian QISS MR angiograms and/or contrast-enhanced MRA (CE-MRA).

RESULTS: The described nonenhanced MRA method depicted the onset and propagation of arterial flow in the peripheral arteries and created static and HYPR-enhanced time-resolved angiograms that provided excellent arterial conspicuity (Figures 2 and 3). Multi-shot imaging enabled the use of undersampled constraining images with narrower temporal footprints, and increased the signal-to-noise of the static MR angiogram. HYPR reconstruction enhanced the quality of the time-resolved MR angiograms.

DISCUSSION: High quality time-resolved and static nonenhanced MRA of the peripheral arteries is feasible using saturation-recovery 2D radial golden angle trueFISP and HYPR reconstruction. The technique produces 3D angiograms displaying the propagation of blood flow in the peripheral arteries and a static 3D high spatial resolution angiogram that is comparable to CE-MRA in initial studies. A single-shot implementation enables rapid static and time-resolved nonenhanced MRA of a large vascular territory, while a multi-shot configuration affords the user the freedom to improve temporal resolution and/or signal-to-noise. Initial patient studies show the method can depict the impact of arterial stenosis on the pulse wave. Future studies will rigorously test the method for diagnosing and characterizing vascular disease.

CONCLUSION: Time-resolved and static nonenhanced MRA of the peripheral arteries is feasible with a variation of QISS using a 2D golden angle radial trajectory, an extended data acquisition window, and HYPR reconstruction.


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