Flow-independent, Non-contrast-enhanced, Free Breathing Renal MR Angiography

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Introduction Non-contrast-enhanced MR angiography (MRA) techniques are particularly relevant for patients with compromised renal function, as is often the case in suspected renovascular hypertension. Many non-contrast-enhanced MRA techniques rely on in-flow of blood for artery-to-background contrast. This flow-dependence can cause post-stenotic signal voids secondary to decreased and/or turbulent flow distal to a stenosis.[1] To improve depiction of renal artery morphology, a flow-independent non-contrast-enhanced renal MRA sequence was implemented and evaluated in 3 healthy volunteers.[2]

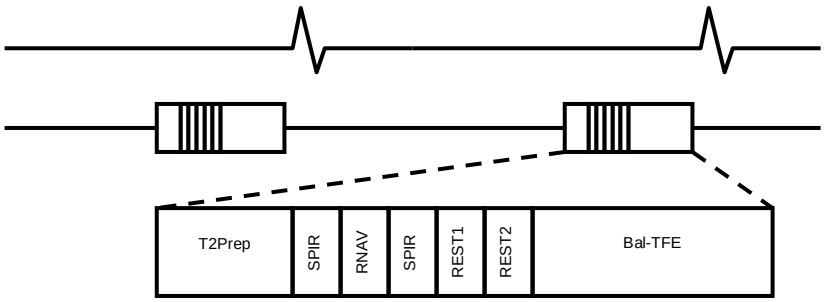

Fig 1. Pulse sequence schematic. ECG-triggered acquisition occurs during diastole. T2-Prep, fat-saturation (SPIR), pencil-beam respiratory navigator (RNAV), SPIR, and regional saturation pulses (REST) precede the radial low-high Bal-TFE readout.

Method All imaging was performed on a 1.5T GyroscanNT with release 12.1 software (Philips Healthcare, Best, the Netherlands) using a 4 channel SENSE Body Coil. The sequence (Fig 1) uses VCG-triggering for diastolic acquisition, pencil-beam respiratory navigator gating with 7 mm acceptance window to eliminate respiratory motion artifacts, spectrally-selective fat saturation (SPIR), T2-Prep [3], and variable number of freely positioned regional saturation slabs (REST). The balanced turbo gradient echo (Bal-TFE) readout used an $\alpha/2$ startup pulse and radial low-high profile order. Acquisitions were evaluated with and without T2-Prep and with variable T2-Prep echo times (50, 80, 110 msec), and all T2-Prep sequences used 4 refocusing pulses. Axial volume was 256x166x60 mm^3. TR/TE/α = 4.2ms/2.1ms/90 deg. Acquired resolution was 1.68x1.72x2.40 mm^3 (reconstructed to 0.73x0.73x1.20 mm^3). The Bal-TFE readout required 104 ms. Scantime was 4:26 with 70% navigator efficiency, a heart rate of 64 bpm, and 2 averages. Coronal scans were also acquired in each volunteer to assess flow dependence.

Results The acquisition was successful in all 3 subjects with excellent depiction of the renal arteries. SPIR effectively nulled fat, while the T2-Prep reduced background signal and provided greater blood-to-background contrast (Fig 2a,b). T2-Prep TE of 80ms provided the best blood-to-background contrast. Renal veins (vs. arteries) did not appear to be preferentially suppressed by T2-Prep. REST slabs placed over the kidneys and IVC provided only minimal suppression of venous signal. Coronal and axial curved reformats of the renal arteries are shown in Fig 2c,d. Coronal acquisition (Fig 2e) showed no reduction in lumen signal along the aorta or in the renal arteries.

Discussion Cardiac-triggering and respiratory navigator gating minimize cardiac and respiratory motion artifacts and related blurring in the free-breathing exam. In addition, acquisition during slower flow diastole reduces flow artifacts during the readout. This sequence does not rely on flow-labeling pulses or in-flow into the imaging volume for blood-to-background contrast, as appreciated on coronal acquisitions where no signal loss is seen (Fig 2e), and by the fact saturation bands had little effect on signal intensity. Thus the technique is less flow-dependent than previous non-contrast-enhanced renal MRA techniques. This decreased flow dependence will likely provide improved depiction of diseased renal arteries, particularly distal to stenoses. Further studies are underway to evaluate the sequence in patients suspected of renal artery stenosis, and will be presented. The lack of venous suppression makes projections less aesthetically pleasing, however does not hinder evaluation of proximal renal arteries, the site of most atherosclerotic renal artery disease. Improvements to venous suppression may be necessary to evaluate distal disease such as fibromuscular dysplasia. While cardiac-triggering complicates the clinical renal MRA exam, the reduction of flow voids in diseased vessels and improved sharpness may justify its use.

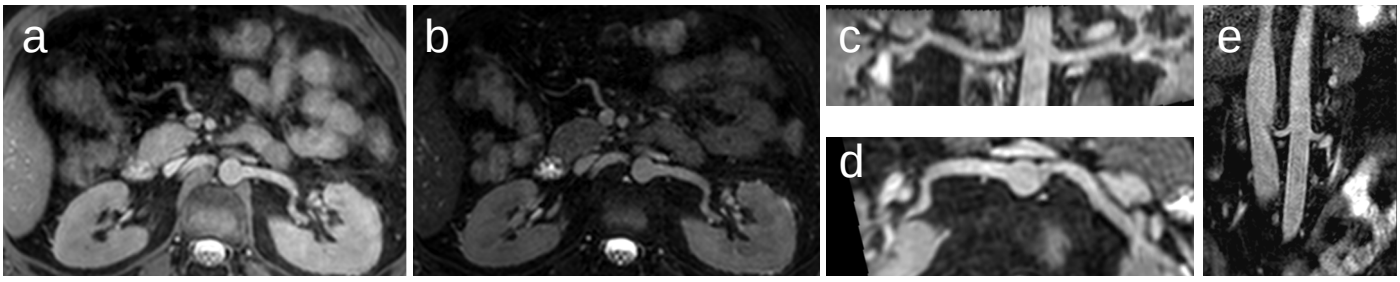

Fig 2. a,b) Axial source images: a) without T2-Prep; b) with T2-Prep (TE = 80 ms). c,d) curved reformats depicting renal arteries. e) source image from coronal acquisition in different volunteer. Coronal acquisition shows no signal variation due to in-flow effects.

References

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2. Weber OM, Martin AJ, Higgins CB, Magn Reson Med 50:1223, 2003.
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