Free-breathing steady-state free-precession (SSFP) MR Angiography of the renal arteries without contrast agent: a prospective intraindividual comparison with high-spatial-resolution contrast-enhanced MR Angiography

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Purpose:
To assess diagnostic accuracy of non-contrast renal magnetic resonance angiography (MRA) using a navigator-gated free-breathing 3D SSFP sequence, compared to contrast-enhanced (CE) MRA.

Methods:
Thirty hypertensive patients (mean age 57 years) with suspected renal artery stenosis underwent navigator-gated 3D SSFP MRA during free-breathing (acquired voxel size: 0.9x1.2x2.0 mm), followed by a high-resolution (acquired voxel size: 1.1x1.3x2.5 mm), breath-hold (CE) MRA (0.15 mmol/kg Gd-BOPTA) using the SENSE parallel imaging technique. Imaging was performed with a 1.5T Philips Intera scanner (Philips Medical Systems, the Netherlands) with Software Release 11. The cardiac-triggered navigator-gated SSFP MR sequence with a slab-selective inversion pulse to suppress static tissue and veins allows selective visualization of the renal arteries. This is without the use of contrast media during free breathing in a scan time of 2-3 minutes depending on the patients' heart rate. Trigger delay time was adjusted to apply the inversion prepulse before, and then acquire data after the aortic pulsatory wave using a quantitative flow measurement on the aorta. Such timing will maximize the inflow effect in the renal arteries and eliminates motion and diameter changing which occurs in untriggered sequences due to the aortic pulse wave. All examinations were performed with a 4-channel phased-array body coil. Renal artery stenosis was graded on a 5 point scale. Renal artery length was measured for both techniques. Consensus reading of CE-MRA and DSA (n=8) were used as a standard of reference. Two blinded observers evaluated non-contrast SSFP versus CE-MRA.

Results:
Eleven cases of renal artery stenosis > 50% were diagnosed on the contrast enhanced CE-MRA and/or DSA. Sensitivity of non-contrast SSFP MRA for detection of significant renal artery stenosis (>50%) was 100% for both observers (CI 0.82-1.15 and 0.82-1.18). Specificity was 90% (CI 0.85-0.95) for reader 1 and 95 % (CI 0.91-1.0) for reader 2, and accuracy was 92% (CI 0.88-0.97) and 96% (CI 0.92-1.01), respectively. Visualised renal artery length was significantly greater in CE-MRA (66.7±24.5 mm) compared to SSFP MRA (51.6±51.6 mm) (p<0.001).

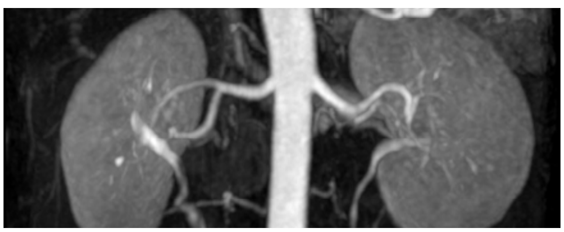

Fig. 1
Maximum Intensity Projection (MIP) of a contrast-enhanced (CE) MRA of normal renal arteries.

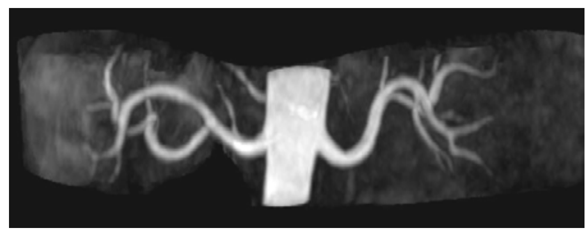

Fig. 2
MIP from a navigator-gated free breathing 3D SSFP sequence of the same patient as in Fig.1

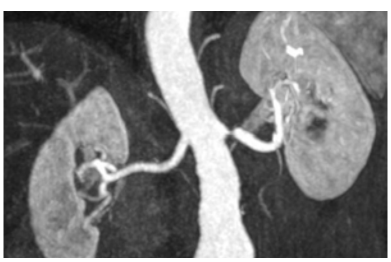

Fig. 3
Maximum Intensity Projection of a CE-MRA showing significant proximal left renal artery stenosis.

Fig. 4
Digital Subtraction angiography confirms the presence of a >50% stenosis of the proximal left renal artery.

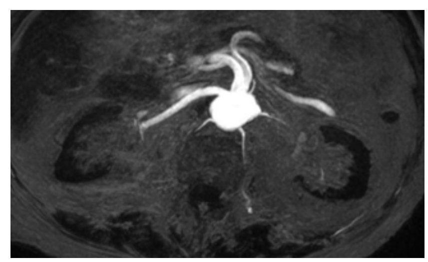

Fig. 5
MIP from 3D SSFP MRA shows a signal loss distal to the stenotic lesion in the left renal artery.

Conclusion:
Compared to CE-MRA, free-breathing navigator-gated SSFP MR angiography has a high diagnostic accuracy for assessment of renal artery stenosis without the need for contrast media, therefore reducing the cost of MRI for screening of renovascular disease. However, severity of renal artery stenosis may be overestimated by SSFP MR angiography due to signal loss distal to the stenotic lesion. SSFP MRA may be more advantageous compared with CE-MRA as patients are able to breathe freely rather than having to hold their breath.

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