

Non-enhanced vs. contrast-enhanced MRA at 7Tesla: A feasibility and comparison trial.

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Introduction

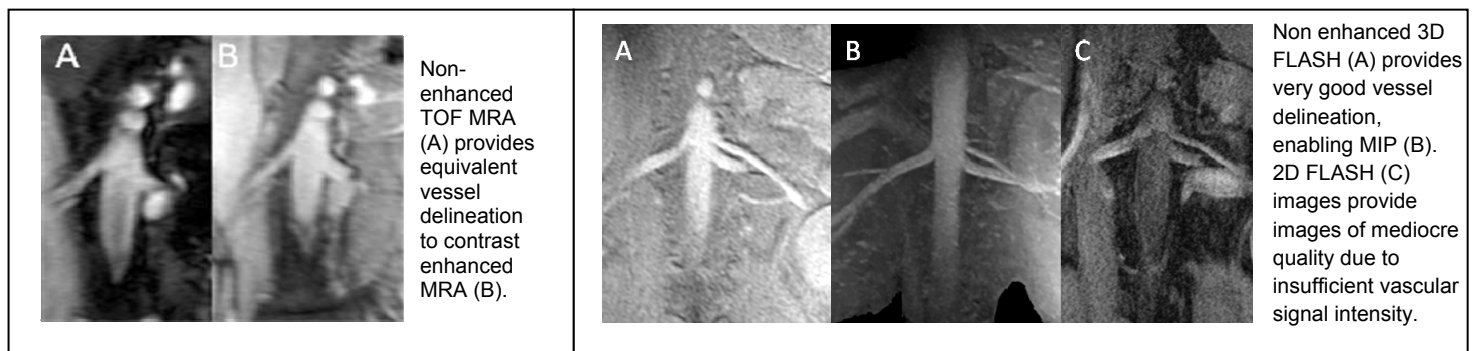
First approaches in non-contrast-enhanced intracranial 7T MR angiography (MRA) have demonstrated the potential of highfield MRA, especially due to the inherently hyperintense signal intensity of arterial vasculature in T1w imaging (1). With further developments in multi-channel transmit/receive radiofrequency (RF) body coil technology and B1-shimming (2, 3), the initial interest has expanded from neuro imaging and musculoskeletal imaging towards whole body investigations (4). The aim of this study was to investigate the feasibility of 7T non-enhanced and contrast-enhanced highfield MRA of the renal vasculature and to evaluate the diagnostic potential of non-enhanced MRA sequences (2D FLASH, 3D FLASH, TOF-MRA) in correlation to a contrast-enhanced 3D FLASH sequence.

Methods

Eight healthy volunteers (average age: 30.3 years, range 26-33 years) were enrolled in this trial. Examinations were performed in head first, supine position on a 7T whole-body MR system (Magnetom 7T, Siemens Healthcare Sector, Erlangen, Germany). For image acquisition, a custom-built 8-channel RF transmit/receive body coil was used, constructed of two arrays with 4 elements each placed ventrally and dorsally on the upper half of the abdomen. After RF shimming and sequence modification, the following sequences were obtained each within a breath-hold interval of max. 30 seconds: The examination protocol included 1) fatsaturated 2D FLASH sequence (TR/TE = 130/3.57ms, FOV 400 x 400 mm, flip 70°, BW 410 Hz/pixel, 13 slices, matrix 512 x 512 interpolated to 1024 x 1024, resulting in an uninterpolated in-plane resolution of 0.8 x 0.8 mm², a slice thickness of 2 mm, and an acquisition time (AT) of 31 sec), 2) fatsaturated 3D FLASH sequence (TR/TE = 2.9/1.02 ms, FOV 400 x 400mm, flip 10°, BW 920Hz/pixel, 27 slices, matrix 320 x 320 interpolated to 640 x 640, resulting in an uninterpolated in-plane resolution 1.3x1.3mm², a slice thickness of 1.6 mm, and an AT of 27 sec) 3) 2D TOF-MRA (TR/TE= 17/4.70 ms, FOV 250x188 mm, flip 60°, BW 230 Hz/pixel, 20slices, matrix 256x96 interpolated to 512x192, resulting in an uninterpolated in-plane resolution 1.0x2.0 mm² a slice thickness of 2.5mm, and an AT 33sec). For contrast-enhanced imaging 0.1mmol/kg BW Gadobutrol (Gadovist, Bayer Schering Pharma) was administered by an automated injector (EMPOWER MR, EZEM, Lake Success, USA) and 3 contrast phases of the 3D VIBE sequences (TR/TE = 2.98/0.97ms, FOV 400 x 400mm, flip 25°, BW 450Hz/pixel, 112slices, matrix 269 x 384 interpolated to 538x768, resulting in an uninterpolated in-plane resolution 1.5x1.0mm², a slice thickness of 1.0 mm, and an AT of 20 sec) were acquired. SNR and CNR were measured in the abdominal aorta as well as in both proximal renal arteries in correlation to adjacent psoas major muscle. Visual qualitative image analysis was performed by two senior radiologist to compare the aforementioned sequences with regards to vessel delineation using a 5-point scale (5= excellent vessel delineation, 1= non-diagnostic).

Results

The inherently high signal intensity of the renal arterial vasculature in T1w imaging enabled a mediocre to excellent vessel delineation in all non-enhanced sequences. Visual analysis demonstrated the diagnostic superiority of the TOF MRA among the non-enhanced MRA sequences (overall vessel delineation 4.8) and its diagnostic equivalence to contrast-enhanced MRA (overall mean value 4.9). TOF MRA showed highest SNR values (mean 63.3) and due to its good background suppression also the highest CNR values of 39.9. 2D FLASH imaging only provided poor vascular signal intensity and delineation of the aorta and proximal renal arteries (SNR 19.7), mostly due to reduced in-flow effects associated with residual inhomogeneities of B1-shimming.



Discussion

This pilot study of non-enhanced versus contrast-enhanced MRA of the renal vasculature at 7 Tesla demonstrates the feasibility of in vivo highfield MRA. Non-enhanced T1w imaging in general and especially in TOF MRA appears to be promising techniques for good quality non-enhanced vasculature evaluation. This may be of high diagnostic interest in patients with renal insufficiency, considering the issue of Nephrogenic Systemic Fibrosis. Further optimization of imaging sequences, B1-shimming techniques, and dedicated RF coil concepts are expected to better cope with the physical effects associated with high magnetic field strength and to enable the acquisition of even higher image quality with further improved clinical diagnostic value.

References:

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