Clinical evaluation of IR prepared 3D TrueFISP for non-contrast abdominal angiography - a comparison to ce-MRA

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Introduction: Contrast enhanced Magnetic Resonance Angiography (CEMRA) is a valuable technique for imaging the renal vasculature and detecting various pathologies. Contrast imaging is not a viable option for some patients for a variety of reasons. Conditions such as renal impairment or pregnancy may be considered contraindications to performing a contrast study. Alternative imaging techniques should be explored so that MR technology may still be used in patients with these conditions. The aim of our study was to investigate a novel noncontrast MRA (NCMRA) technique using a 3D TrueFISP sequence and compare it to CEMRA for evaluation of the renal vasculature.

Methods: 10 patients scheduled for CEMRA studies were scanned using the 3D TrueFISP protocol in addition to clinical contrast-enhanced protocols. Subjects had been referred for CEMRA studies to evaluate various abdominal vascular pathologies. The experimental protocol was performed prior to contrast imaging in all cases. All MR studies were performed on a 1.5 T MRI scanner (Avanto, Siemens Medical Solutions, Erlangen, Germany). NCMRA was performed using a navigator-gated, ECG-triggered 3D TrueFISP sequence. A slice-selective inversion slab was graphically planned to suppress signal from static tissues within the imaging volume [1,2]. TI was adjusted so that only inflowing blood during the inversion recovery time showed high signal intensity. Imaging parameters include: TR/TE/FA = 3.8/1.9/90°. Acquired voxel size was 1.3×1.3×2.0 mm^3 and reconstructed to 72 slices with 0.65×0.65×1.0 mm^3 voxel size. TI ranged from 700 msec to 1200 msec.

CEMRA images were acquired with a 3D fast gradient-recalled echo sequence and intravenous injection of 0.2 mmol/kg of Gd-DPTA within a breath-hold. Imaging parameters included: TR/TE/FA = 3.4/1.2/25°. 40 slightly tilted coronal slices were acquired and reconstructed into 80 slices with 1.0×0.74×1.5 mm^3 voxel size. Both non-contrast and contrast-enhanced acquisitions were accelerated with parallel imaging (GRAPPA) factor of 2 in the phase-encoding direction. A 12 element body matrix coil was used.

Results of the NCMRA and CEMRA were reviewed by an experienced radiologist and quantitative evaluation was performed to determine renal artery length and number of branch vessels visualized. CNR and SNR measurements were calculated for the aorta and a region of interest in the proximal renal artery for both NCMRA and non CEMRA. Results were also evaluated for image quality on a qualitative scale. The renal artery was divided into four segments and each segment was graded on a four point scale for image quality.

Results: In quantitative analysis, the average length of renal artery visualized was 7.8 cm with the noncontrast protocol and 6.9 cm with the contrast-enhanced protocol. The average number of branch vessels visualized were 2.9 and 2.5 with NCMRA and CEMRA respectively. Average SNR values were 76.0 and 32.6 for NCMRA and CEMRA respectively (Two-tailed t-test, p = 0.009) Average CNR values were 48.5 and 16.4 for NCMRA and CEMRA respectively (Two-tailed t-test, p = 0.009).In qualitative analysis, the noncontrast protocol had average scores that were equal or better than that of the contrast-enhanced protocol for all four segments (Fig 1). Statistically significant differences were demonstrated for segments 2 and 4 only (Two-tailed t-test, p = 0.013 and p = 0.003 respectively). Two cases of renal artery stenosis (moderate and severe) were detected on both NCMRA and CEMRA images.

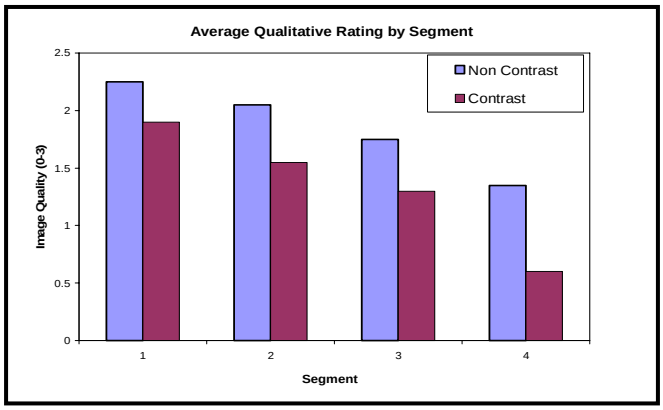

Figure 1: Comparison of qualitative scoring for the segmental analysis of the renal arteries

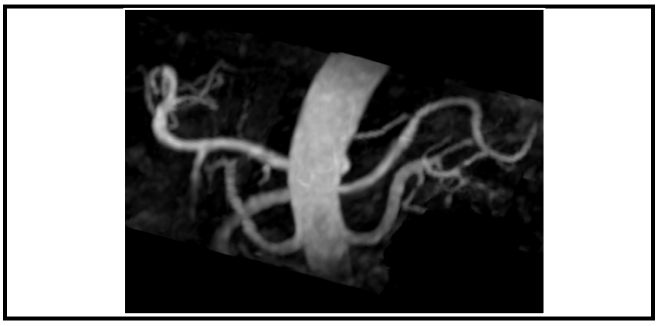

Figure 2: IR prepared TrueFISP in an arteriopathy where the upper abdominal vasculature is well demonstrated.

Conclusion: The NCMRA technique examined has comparable or better quality compared to CEMRA on all parameters examined. 3D TrueFISP is a useful technique to evaluate the renal arteries and may be clinically advantageous for patients who are contraindicated for contrast administration. This is particularly significant due to recent concerns over gadolinium contrast agents and their role in Nephrogenic Systemic Fibrosis (NSF) [3].

As the method is reliant on replacement of blood in the vessels of interest during the inversion time, the technique is likely to be less robust in situations where this condition is compromised. In cases of severe renal artery stenosis the technique may fail to demonstrate the arterial tree distal to the stenosis, this observation in itself may be a useful indicator of the hemodynamic alterations but reduces the ability of the method to accurately depict the morphological degree of stenosis. Additionally, in some patients where cardiac output is compromised (heart failure) the replacement of blood during the TI requirement is not fulfilled and may make this particular technique non-viable in those patients.

Figure 3: AP **(a)** and Transverse **(b)** maximum intensity projections of noncontrast MRA images in a patient with Takayasu's arteritis. The right proximal renal artery is severely stenosed (yellow arrows) and illustrates loss of signal distally which recovers in the distal intra-renal branches (red arrows). This illustrates a feature of this approach to angiography which may be of benefit in assessment of the hemodynamic significance of the lesion but conversely reduces its role as a lunimographic technique. The corresponding contrast enhanced angiogram **(c)** demonstrates the lumen of the main renal artery well but contributes less physiological information.

References:

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