FERUMOXYTOL-ENHANCED MAGNETIC RESONANCE ANGIOGRAPHY (FeMRA) FOR THE ASSESSMENT OF POTENTIAL KIDNEY TRANSPLANT RECIPIENTS

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OBJECTIVES

The traditional methods for scanning blood vessels using MRI or CT carry potential risks for patients with CKD. Ferumoxytol is a superparamagnetic iron oxide nanoparticle preparation that has potential as an MRI contrast agent in assessing the vasculature. There are reports in the literature concerning its safety and utility in both adult[1] and pediatric[2] patients with CKD.

The aim of this study was to determine the utility of ferumoxytol-enhanced magnetic resonance angiography (FeMRA) use in pre-transplant assessment of patients with CKD.

METHODS

- Patients >18yr with advanced kidney disease or on dialysis attending transplant assessment clinics in Glasgow and requiring vascular imaging prior to wait-listing for kidney transplantation were included in this series.
- All studies were performed on a 3T Prisma MRI scanner (Magnetom, Siemens Medical Solutions, Erlangan, Germany) with local phased-array imaging coils using a standardized protocol.
- A total dose of 4mg/kg of ferumoxytol (Feraheme; AMAG Pharmaceuticals, Inc., Cambridge, MA) was delivered up to a maximum of 300mg.
- Ferumoxytol infusions were delivered by an MRI compatible infusion pump for precise control over infusion rates. These were set at 1mL/sec of diluted ferumoxytol (equals to 6mg/sec of elemental iron) followed by 20mL of 0.9% sodium chloride at a rate of 2mL/sec.
- We used a proton density-weighted, in-phase (PDIP) 3D stack-of-stars gradient-echo pulse sequence (StarVIBE), to detect arterial calcifications. This was followed by first-pass and steady-state angiography using incremental doses of up to 4mg/kg body weight of ferumoxytol (diluted fourfold) as intravenous contrast agent.
- Visual assessment of the subjective image quality was performed independently by two radiologists with 5 years and >20 years of experience, respectively, in cardiovascular MR imaging.

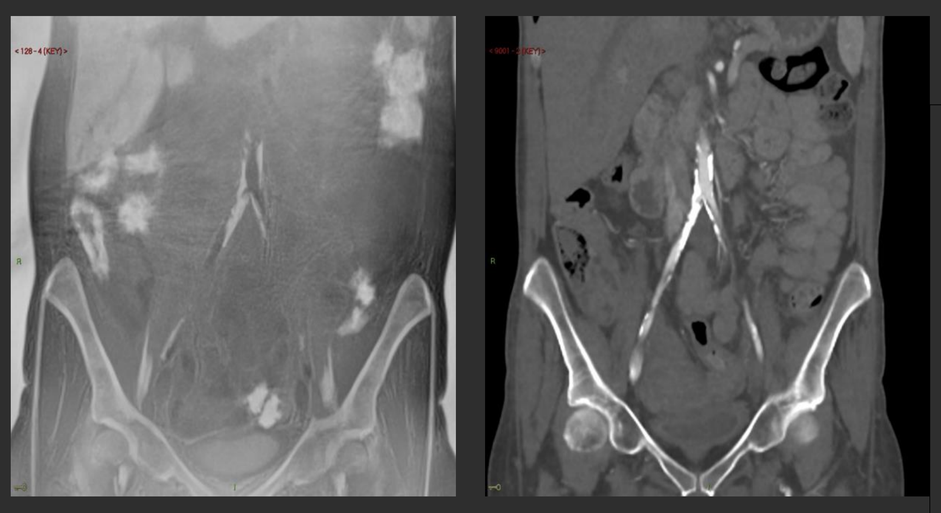

Figure 1. Coronal maximum intensity projection (MIP) views from non-contrast-enhanced MRI (StarVIBE) view after grayscale inversion (A) where the location and conformation of the vascular calcifications correspond with CTA (B).

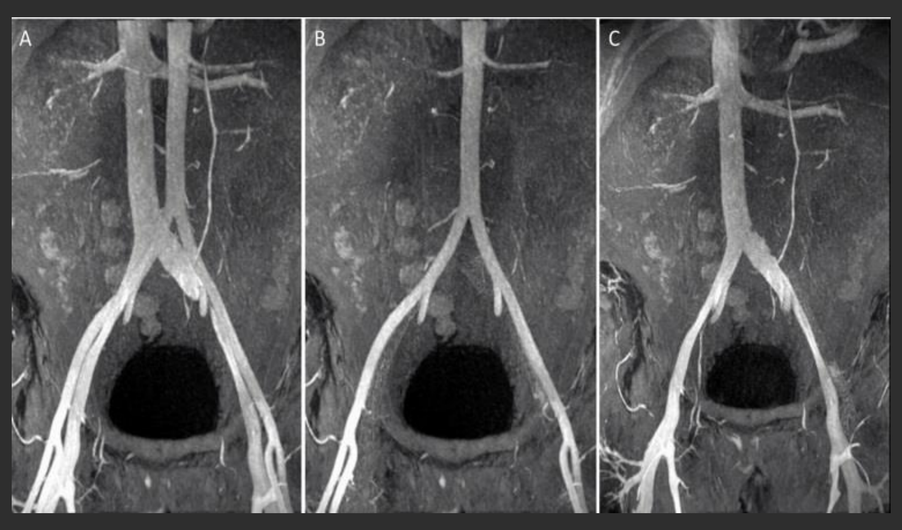

Figure 2. FeMRA of abdominal and aorto-iliac vasculature. (A) Steady-state acquisition showing enhancement of both arterial and venous vasculature. (B) First-pass imaging showing selective arterial enhancement (arteriography). (C) Steady-state acquisition showing selective venous enhancement after subtraction of the arterial compartment (venography).

RESULTS

- A total of 20 patients had FeMRA as part of their pre-operative kidney transplant assessment.
- All subjects completed first-pass and steady-state MRA acquisitions with ferumoxytol enhancement without any adverse events associated with ferumoxytol administration.
- Image quality on steady-state acquisitions was scored as grade 4 in 245 of 320 (76.6%, 90% confidence interval 72-79%) and grade 3 in 75 of 320 (23.4%) vascular sections (at least diagnostic quality) when assessing the arterial and venous vasculature by both readers.
- There was very good agreement on all individual assessments of image quality (kappa=0.85 on assessment of the arteries; kappa=0.76 on assessment of the veins).
- We successfully demonstrated calcifications in the abdominopelvic region, which appeared dark on source images with signal-to-noise ratio (SNR) near background noise levels (Figure 1). Good arterial and venous enhancements were achieved, and FeMRA was not limited by calcification in assessing the arterial lumen (Figure 2). Following each dose increment, signal intensity and image quality were improved in both arterial and venous compartments (Figure 3).

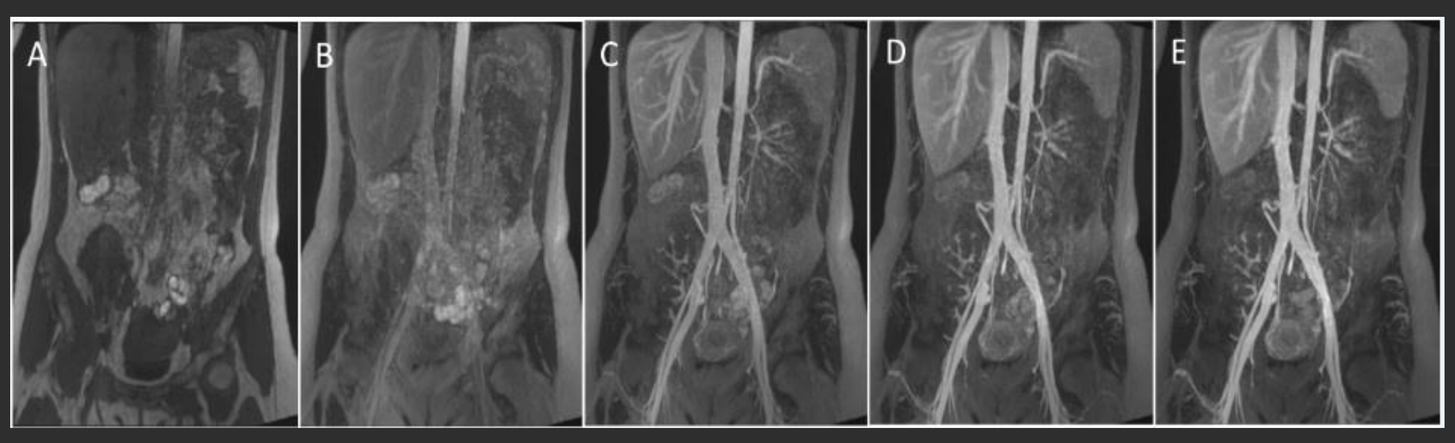

Figure 3. Arterial phase MIP images of abdominal and aorto-iliac vasculature after each increment of ferumoxytol. (A) Pre-contrast and after administration of (B) 1mg/kg, (C) 2mg/kg, (D) 3mg/kg and (E) 4mg/kg of ferumoxytol. Both arterial and venous compartments enhance due to contrast pooled intravascularly from previous infusions.

CONCLUSIONS

- We administered a total of 4mg/kg of diluted Ferumoxytol in divided infusions and achieved good signal intensity and image quality with absence of any adverse events.
- The information gained from synchronous depiction of arterial and venous compartments using a single investigation is essential when planning kidney transplantation.
- Using a consistent dosing regimen for contrast administration, we have shown that ferumoxytol-based vascular imaging has the potential to offer a clinically useful and reliable alternative in renal patients in whom standard imaging methods cannot be used.

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