Published in final edited form as:

JACC Cardiovasc Imaging. 2018 March ; 11(3): 505–508. doi:10.1016/j.jcmg.2017.10.017.

Intraluminal Assessment of Coronary Arteries with Ferumoxylol-Enhanced Magnetic Resonance Angiography

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Diagnostic left heart catheterization is often foregone in patients with an estimated glomerular filtration rate (eGFR) <30ml/min/1.73m² not yet on dialysis to avoid precipitating renal failure. Such patients are not able to receive iodine-based or gadolinium-based contrast agents due to the risk of acute kidney injury or nephrogenic systemic fibrosis, respectively.¹ Currently, there are no alternatives to diagnostic coronary angiography for such patients that are, for example, being evaluated for kidney transplantation. Ferumoxylol-enhanced cardiac magnetic resonance angiography (cMRA) can offer additional data to assess the potential effect of a coronary artery intervention.

Although there has been recent concern for anaphylaxis with the use of ferumoxylol², Patients 1–5 tolerated the full procedure without adverse event (Video 1–10). Patient 1 and 2 had a cardiac catheterization performed 154 and 185 days prior to MRA, respectively (Video 11,12 and 13,14, respectively). Estimated glomerular filtration rate was <20ml/min/1.73m² in all patients (Supplemental Table 1).

In summary we build on previous work that has depicted the resolution of ferumoxylol-enhanced cMRA in visualizing the right coronary artery. We demonstrate that the left coronary artery tree in adults can also be visualized and corresponds with findings of conventional coronary angiogram, including segmental stenosis.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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CLINICAL TRIAL: <https://clinicaltrials.gov> NCT02954510

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Acknowledgments

Grant Funding: K08DK089002, NIH/NIDDK (Bethesda, MD)(A.M.S.); AMAG Pharmaceuticals, Inc (Waltham, MA), Investigator-sponsored research grant # 2016D004506 (A.M.S.). Dr. Matthew S. Chin, Dr. Michael Steigner, Dr. Wenqing Yin and Dr. Raymond Y. Kwong and have no relationships with industry associated with this study.

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Figure 1. Three dimensional reconstruction of the heart after intravenous ferumoxytol injection and image acquisition using cardiac magnetic resonance angiography and cardiac/respiratory gating and ventricular wall subtraction

(A) four chamber view, clockwise: main pulmonary artery, descending thoracic aorta, left ventricular chamber, right ventricular chamber, ascending thoracic aorta, (B) sagittal reconstruction with visualization of left coronary artery (arrow) and overlying main pulmonary artery, (C) multi-planar reconstruction of the coronary tree viewed superior to inferior showing distribution of [left to right, green lines], right coronary, left main continuous with left anterior descending artery, and left circumflex beginning at the level of the ascending aorta.

Figure 2. Cardiac MRA directly following intravenous ferumoxytol injection (fcMRA) and correlated to left coronary artery cardiac catheterization in Patient #1 performed 154 days prior (A) [i] Left heart cardiac catheterization with demarcated section of left coronary artery [blue=proximal, red=distal] corresponds to MRA demarcation and Video 11, [ii] three dimensional reconstruction (with ventricular wall subtraction) showing path of vessel descent and axial cross section showing left lateral direction of vessel, *=aortic root. (B) [i] multi-planar straight-line and [ii] curvilinear reconstruction shows ferumoxytol-containing left main origin and LAD [green line], [iii] luminal cross section at the proximal (left) and distal (right) segment, respectively.

Figure 3. Cardiac MRA directly following intravenous ferumoxytol injection (fcMRA) and correlation with right coronary artery cardiac catheterization in Patient #1

(A) [i] Right heart cardiac catheterization with demarcated section of right coronary artery [blue=proximal, red=distal] corresponds to MRA demarcation and Video 12, [ii] three dimensional reconstruction (with ventricular wall subtraction) showing path of vessel descent and axial cross section showing right lateral direction of vessel, *=aortic root. (B) [i] Multi-planar straight-line and [ii] curvilinear reconstruction shows patent, continuous, ferumoxytol-containing proximal-to-mid RCA [green line], [iii] luminal cross section at the proximal (left) and distal (right) segment, respectively, scale bar=5mm.

Figure 4. fcMRA performed 185 days after Patient #2 received a 3.75×23mm Xience drug-eluting stent to the mid-left anterior descending artery

(A) [i] Post-deployment coronary angiography with iodinated contrast identifies the stent (yellow arrow) in the left anterior descending artery proximal to the second diagonal branch and corresponds to MRA demarcation and Video 13 [ii] three dimensional reconstruction (with ventricular wall subtraction) and axial cross section showing left lateral direction of vessel, *=aortic root. (B)[i] Multi-planar straight-line and [ii] curvilinear reconstruction shows ferumoxytol-containing LAD, yellow bar = stent, [iii] luminal cross section at the proximal (left) and distal (right) segment, respectively.

Figure 5. fcMRA performed 185 days after Patient #2 received a 3.75×23mm Xience drug-eluting stent to the mid-left anterior descending artery and correlation with right coronary artery cardiac catheterization showing stenosis

(A) [i] 70% mid-right coronary artery lesion (red arrow) is visualized by right coronary artery catheterization and corresponds to MRA demarcation and Video 14, [ii] three dimensional reconstruction (with ventricular wall subtraction) and axial cross section showing left lateral direction of vessel, *=aortic root. (B) [i] Multi-planar straight-line and [ii] curvilinear reconstruction shows RCA luminal stenosis [red arrow], [iii] luminal cross section at the proximal (left) and distal(right) segment, respectively, scale bar=5mm.

Figure 6. Origins of right and left coronary arteries, left anterior descending artery and left circumflex artery in Patients 1–5

Axial cross section of right coronary origin (first column), and sagittal cross sections of left main artery origin (second column), and representative segments of left anterior descending (LAD)(third column) and left circumflex (fourth column) (red arrows), traced to their most distal points in corresponding Videos 1–10 in the axial and sagittal planes, respectively (Patient 1 = video 1,2; Patient 2 = video 3,4; Patient 3 = video 5,6; Patient 4 = video 7,8; Patient 5 = video 9,10). Patients 1–4 were in sinus rhythm throughout the study while Patient 5 was in atrial fibrillation. Patient 4 was 122.5 kg and weighed at least 34.3% more than Patients 1–3. Mean continuous length of left and right coronary circulation measured

was 6.53 ± 1.26 cm and 6.08 ± 2.8 cm (n=5) from respective origins also summarized in Supplemental Table 1.

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