Initial evaluation of ferumoxytol as a renal-safe MR contrast agent for abdominal vascular assessment

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Target Audience

Clinical radiologists; abdominal MR radiologists; vascular MR radiologists

Purpose

Ferumoxytol (Feraheme, AMAG pharmaceuticals), a superparamagnetic iron oxide agent, has been recently described in clinical practice as an off-label blood pool MR contrast agent in patients with end-stage renal disease (ESRD) who cannot receive gadolinium-based contrast agents. Although studies have evaluated the utility of ferumoxytol in peripheral vascular, cardiothoracic, and cerebral vascular imaging, there have been very few descriptions of the use of this agent for abdominal applications (1-4). The purpose of this study was to review our preliminary experience using ferumoxytol in evaluating the abdominal vasculature in patients with ESRD.

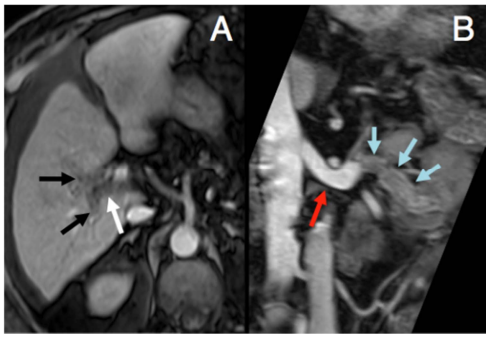

Figure 1, A: Thrombosis of the right portal vein (white arrow) extending into the divisional branches (black arrows), proven at conventional angiography. B: Proximal left renal vein tumor thrombosis (blue arrows) in a patient with renal cell carcinoma, with patency of the distal left renal vein (red arrow) in a different patient.

Methods

The local institutional review board approved this retrospective study. Abdominal MRI examinations from 26 consecutive patients with ESRD were analyzed, which had been performed on 1.5T and 3T MR systems. Imaging protocols included precontrast T1w and T2w images. Contrast injection protocol was: intravenous injection of 3 mg/kg ferumoxytol diluted with normal saline to a total volume of 30 mL (based on previously published work using this agent); a 20 mL saline chaser; all injected at 2 mL/sec. Post-contrast imaging included three fat-suppressed T1w hepatic arterial phase acquisitions in a single breath-hold beginning at 15-20 sec post-infusion (PI); portal venous phase at 45-60 sec PI; and equilibrium phase at 5 min PI.

Three radiologists evaluated for vascular findings in consensus. Criteria for the presence of vascular thrombosis included: lack of enhancement on all phases of imaging, absence of flow void on T2w images, and confirmation using other modalities. Criteria for vessel patency included enhancement in the equilibrium phase as well as the presence of a flow-void on T2w images. Based on our experience with this agent, we also assessed for the presence of an artifact mimicking vascular thrombosis on post-contrast images. Criteria for the artifact included apparent vascular segment non-enhancement despite contrast enhancement visualized proximal and distal to the involved segment on at least one image set; and patency confirmed in the equilibrium phase from the same study or from imaging with a different modality, if available. Patient demographics and injection protocol characteristics were compared using an unpaired T-test to elucidate factors predictive of the presence of the artifact.

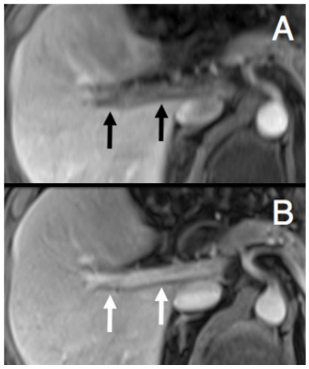

Figure 2, A: Apparent thrombosis of the portal vein on early dynamic imaging. Note that contrast material is present in the hepatic artery and hepatic veins. B: Complete enhancement of the portal vein in the equilibrium phase, confirming that the apparent thrombosis in image A is artifactual.

Results

Of the 26 patients, there were six confirmed vascular findings: three portal vein thromboses, one tumor thrombosis of a renal vein in a patient with renal cell carcinoma, one iliac artery dissection, and one abdominal aortic aneurysm. Figure 1 shows thrombosis of a right portal vein and tumor thrombosis of a left renal vein in two different patients. The artifact mimicking thrombosis was identified in 15 patients and in 23 out of 130 total post-contrast sequences; 21 out of 23 of these artifacts were present on arterial phase image sets. Figure 2 shows the artifact mimicking portal vein thrombosis. There were statistically significant differences between patient populations demonstrating the artifact and those without the artifact were weight and body mass index (both higher in patients with the artifact, $p < 0.05$), and administered concentration of ferumoxytol ($p < 0.02$; average concentration of 0.31 mg/mL in cases where the artifact was observed, compared with 0.26 mg/mL in cases without the artifact).

Discussion

Abdominal vascular MRA with ferumoxytol was useful for demonstrating benign and malignant vascular thromboses and other vascular findings. Notably, we observed an artifact mimicking vascular thrombosis on early dynamic images in a large number of cases (15/26 patients). Given that this artifact was observed in the early/central portion of the contrast boluses, was associated with relatively higher administered concentrations of ferumoxytol, and given the known potential for susceptibility effects with this iron-based agent, we suggest that the artifact represents susceptibility artifact related to high concentrations of the agent at certain time points. Since this artifact was associated with higher administered concentrations of ferumoxtyol, optimization of the injection protocol/lower administered concentration may reduce the presence of the artifact.

Conclusion

Our preliminary experience suggests that ferumoxytol may help detect important abdominal vascular abnormalities in patients with ESRD, who are not suitable candidates for conventional gadolinium-based agents. Radiologists should be aware of possible pitfalls during dynamic vascular imaging studies using ferumoxytol, which may be related to T2*-shortening effects from concentrated ferumoxytol. Our preliminary data suggests that the likelihood of this artifact is influenced by the concentration of contrast material administered.

References

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