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Therapeutic Iron Infusion Causing Delayed Venous Contamination in Magnetic Resonance Angiography

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Abstract

The diagnostic quality of magnetic resonance angiography (MRA) depends on the reliable suppression of venous signal, which otherwise overlaps arterial signal. In the case presented here, the quality of non-enhanced MRA was severely contaminated by venous signal due to a therapeutic iron infusion (ferumoxytol, intravascular half-life ~15 hours) two days prior to the MRA exam. The cause of the venous contamination was that intravenously injected ferumoxytol substantially shortened the longitudinal relaxation time (T1) of the blood, so that venous presaturation no longer was effective. This case highlights the importance of considering prior iron infusion as a cause of MRA artifacts and including it in the pre-exam questionnaire.

Keywords: Enhanced MRA; Venous contamination; Feraheme; Ferumoxytol; Iron

Introduction

Diagnostic quality of peripheral magnetic resonance angiography (MRA) depends on the reliable suppression of venous signal, which otherwise overlaps arterial signal. The efficacy of venous suppression relies on the presumption of a long T1 relaxation time for blood, typically on the order of 1.2 – 1.4 sec at 1.5 T [1]. With contrast-enhanced MRA, venous suppression is obtained through the rapid repetition of moderate flip angle radiofrequency pulses. With unenhanced MRA using quiescent-interval single-shot (QISS) or two-dimensional (2D) time-of-flight approaches, venous suppression is obtained through the application of tracking presaturation radio frequency (RF) pulses [2-4]. However, we recently encountered a case in which extensive venous enhancement was encountered due to an iron infusion well prior to the unenhanced MRA exam. The institutional review board of our institution has waived written informed consent from the patient for publication of the case report.

Case Presentation

A 73-year-old female patient with claudication was scheduled for nonenhanced MRA of her lower extremities because of impaired renal function (estimated glomerular filtration rate (eGFR) < 30 mL/min/1.73 m^2). QISS MRA was performed on a 1.5-T MR scanner (MAGNETOM Avanto; Siemens Healthcare, Erlangen, Germany) using multiple phased array coils to cover the area from the level of renal arteries to the feet. Nine-station QISS imaging (48 axial slices per station; 432 total slices) was prescribed. The major parameters of the QISS sequence included electrocardiographic (ECG) gating, repetition time (TR) = 3.0 ms echo time (TE) = 1.4 ms, flip angle = 90°, quiescent interval = 350 ms, trigger delay relative to the R-wave of 100 ms, slice thickness = 3.0 mm, field of view = 400 ms. Details regarding the imaging protocol can be found in reference [2].

While performing the exam, we observed severe venous contamination (Figure 1A and B). By comparison, a QISS MRA performed one day earlier on a healthy volunteer showed clear depiction of the arteries and excellent suppression of veins and background tissues (Figure 2A and B). To rule out the possibility of scanner dysfunction, we interrupted the study, restarted the MR scanner, and then repeated the exam which showed no change. Subsequently, on a coronal abdominal scout image, we observed anomalously low signal from the liver and spleen (Figure 1C). Upon further questioning of the patient, it was discovered that the patient had received an intravenous injection of 510 mg (30 mg/mL) of Feraheme™ (ferumoxytol, Advanced Magnetics, Cambridge, MA) two days prior to the MR exam as treatment for iron deficiency anemia.

Discussion

Both QISS and 2D time-of-flight MRA use RF presaturation to suppress the appearance of

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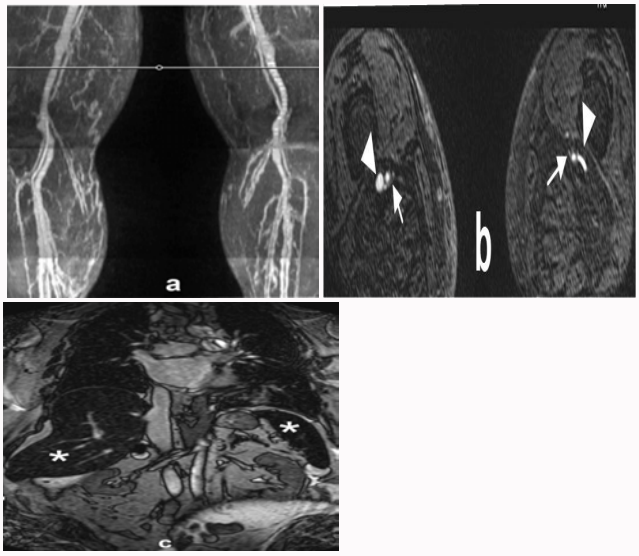

Figure 1: A 73-year-old female with claudication, poor renal function, and history of iron infusion two days earlier for treatment of iron deficiency anemia: a) Coronal maximum intensity projection image from QISS MRA shows both arteries and veins. b) Transverse source image at the level of the white horizontal line in (a); both arteries (arrows) and veins (arrowheads) can be seen. c) Coronal scout image of the abdomen (obtained with a balanced steady-state free precession sequence) shows low signal from the liver and spleen (*), indicating iron deposition.

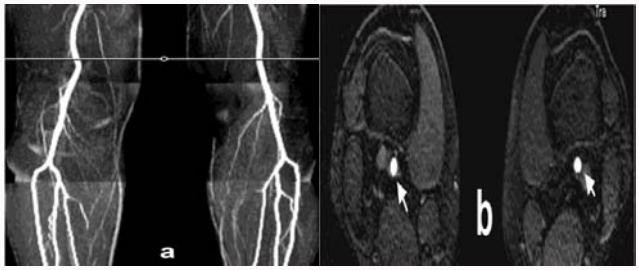

Figure 2: QISS MRA of a 48-year-old male healthy volunteer acquired using identical imaging parameters to the patient study shown in Figure 1: a) Coronal QISS maximum intensity projection image at the level of the popliteal trifurcation. Note the excellent depiction of arteries with near complete suppression of venous signal. b) Transverse QISS source image at the level of the white horizontal line in (a); the arteries (arrow) are shown without substantial venous signal.

venous signal. Ferumoxytol infusion is a recently approved therapy for iron deficiency anemia. It is an iron-based therapy that consists of ultra-small superparamagnetic particles. Given its safety in patients with severe renal functional impairment, long intravascular half-life, and ability to shorten the T1 relaxation time of blood, it has also been tested as an intravascular MRA contrast agent [5-6]. Unlike most gadolinium-based extracellular chelates, which have an intravascular half-life on the order of minutes, ferumoxytol has a much longer intravascular half-life (~15 hours) and shortens the T1 relaxation time for many hours following administration. Alteration of liver signal with conventional MR imaging may persist for several months.

Given the frequency of renal functional impairment in patients with peripheral vascular disease [7] and the associated common complication of iron deficiency anemia with chronic kidney disease, information about iron supplements should be included in the MRI pre-exam questionnaire. If possible, the MRA study should be conducted prior to the iron agent administration or at least several days afterwards to avoid the confounding effects of intravascular T1 shortening.

Conclusion

Therapeutic iron infusion should be considered as a potential cause of venous contamination when performing MRA.

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