

Comparison of High Spatial Resolution Time-Resolved 3D Contrast-Enhanced MR Angiography

P. M. Young¹, J. F. Glockner¹, C. R. Haider¹, P. M. Mostardi¹, T. J. Vrtiska¹, T. A. Macedo¹, and S. J. Riederer¹

¹Diagnostic Radiology, Mayo Clinic, Rochester, MN, United States

Introduction: Recently, computed tomographic angiography (CTA) has become widely used for lower extremity arterial runoff imaging, in part because of high spatial resolution and extended coverage obtained with continuous table movement during the exam. However, even with optimized technique, 2-3% of studies are nondiagnostic because of calcification, poor contrast opacification, or venous contamination [1]. Recently, our group described high-spatial-resolution (1-mm isotropic) time-resolved 3D contrast material-enhanced magnetic resonance angiography (MRA) of the peripheral vasculature with Cartesian acquisition with projection-reconstruction-like sampling (CAPR) and 8x two-dimensional (2D) sensitivity encoding (SENSE) [2]. We sought to compare image quality and characteristics in patients who had undergone both CTA and CAPR runoff studies of the lower extremities.

Methods and Materials: The study was performed in compliance with IRB review at our institution. 10 patients were imaged with CTA according to our clinical standard protocol on a 64-detector row CT scanner with injection of 145 mL Omnipaque 350, 25 mL at 5 ml/sec and 120 ml at 4 ml/sec with 30 ml of saline at 4 ml/sec. The examination covered from 4 cm above the iliac crest to the bottom of the feet. Technical parameters included 0.5 sec rotation time, pitch 0.8, 15 mm/rotation, 120 kVp, 250 mAs. Automated triggering and exposure control were employed. CT spatial resolution was $0.6 \times 0.6 \times 2.0 \text{ mm}^3$. Subsequently, the patients were imaged using CAPR according to a technique previously described [2]: 0.2 mmol/kg gadobenate dimeglumine injected at 2ml/sec, followed by 20 ml saline at 2ml/sec, 3T MRI scanner, 8 channel receive array coil, GRE sequence, TR/TE = 5.85/2.7 ms, FA 30°, BW = $\pm 62.5 \text{ KHz}$, 40 (S/I) \times 32 (L/R) \times 13.2 (A/P) cm^3 , 8x 2D SENSE acceleration, spatial resolution 1 mm^3 , frame time 4.9 sec and temporal footprint 17.6 sec. It should be noted that some patients were referred for CAPR MRA because of nondiagnostic imaging with CTA. Subsequently, two board-certified radiologists experienced in vascular imaging assessed five vessels in each leg according to standard criteria, noted the degree of diagnostic confidence, recorded limiting factors (such as calcification or SENSE artifact), and assigned an overall image quality ranking.

Results: On CTA, calcification limited vessel evaluation for both readers in 5/10 patients, and for one reader in an additional (?) 3/10 patients. Contrast opacification was rated poor by both readers in 2/10 patients, and by one reader additionally in 1/10 patients. Venous contamination limited CTA interpretation for both readers in 2/10 patients. These limitations were not apparent in any of the CAPR MRA studies. Contrast opacification of vessels was rated “excellent” by both readers in 9/10 patients, and “excellent” by one reader and “adequate” by the other in the other 1/10 patients. Venous signal did not limit CAPR MRA interpretation of arteries in any case. SENSE reconstruction artifact was apparent on source images in all patients, but did not impair interpretation in any patient. In several cases, the time-resolved dataset provided information about vascular flow or tissue perfusion that was not apparent on the static CTA dataset. Figures 1-2 illustrate these findings.

Conclusion: CAPR MRA is a promising technique for evaluation of below-the-knee vascular runoff. Although our study population was skewed toward those with poor quality CTA exams, CAPR MRA demonstrated fewer artifacts and a trend toward higher confidence in making a diagnosis. CAPR MRA may be useful for further evaluation of below-the-knee runoff in the setting of nondiagnostic CTA.

References: [1] Meyer, Eur Radiol, 2008; 18:1546-1555. [2] Haider, Radiology, epub ahead of print.

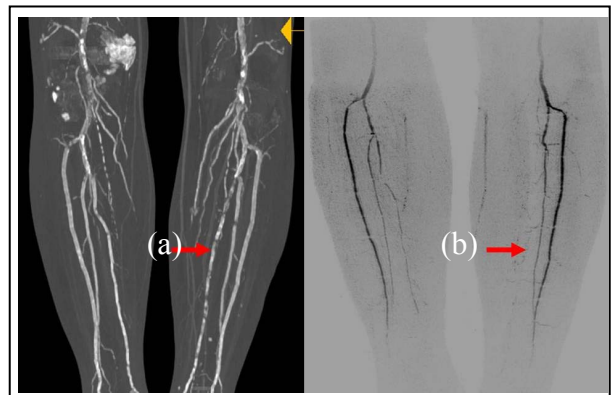


Fig 1. (a) CTA MIP with bones removed demonstrates calcification throughout the course of the posterior tibial artery (arrow), precluding evaluation. (b) CAPR MRA demonstrates non-filling of the posterior tibial artery (arrow), confirming occlusion.

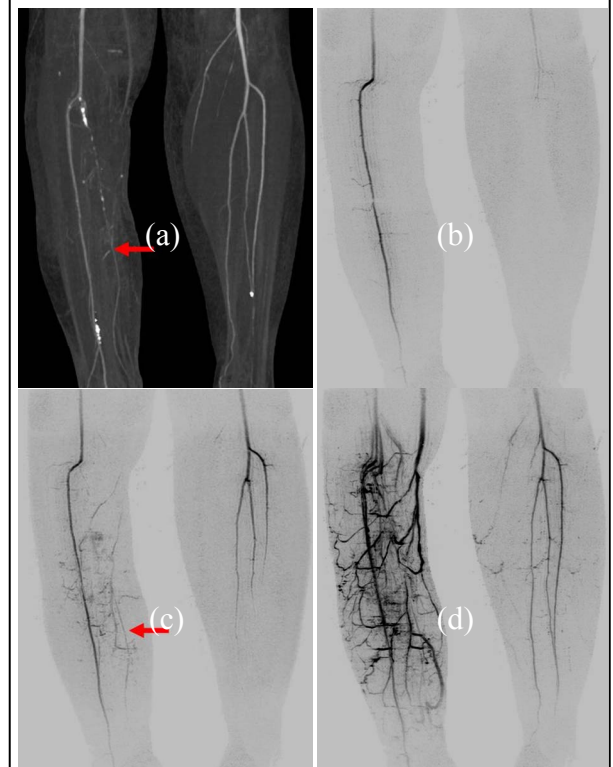


Fig 2. (a) CTA MIP with bones removed demonstrates indeterminate density with calcifications along the course of the posterior tibial artery (arrow). (b) Early filling of the right anterior tibial artery on MRA, with no posterior tibial filling and minimal arterial contrast in the left leg. (c,d) Subsequent temporal phases demonstrate extensive arteriovenous shunting in the right leg, explaining the early filling not apparent on CTA.