

High Temporal and Spatial Resolution Imaging of Body AVMs

P. M. Young¹, P. M. Mostardi¹, M. A. McKusick¹, and S. J. Riederer¹

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

Introduction Magnetic resonance evaluation of arterio-venous malformations (AVMs) requires high spatial resolution to define small feeding vessels and the structure of the malformation as well as high temporal resolution to distinguish high-flow versus low-flow filling patterns. Ideally, such techniques allow imaging of the arteries supplying the lesion, a sense of the geographic filling of the lesion, and depiction of venous outflow to identify any outflow obstruction such as venous thrombi which may affect potential for sclerotherapy. A number of recently developed highly accelerated CE-MRA techniques have made acquisition of time-resolved datasets with high spatial and temporal resolution possible. One such technique, CAPR [1], has been shown to provide high quality time-resolved imaging in the head [1], calves [2], and hands and feet [3]. The purpose of this work is to describe the further application of CAPR to imaging AVMs of the upper and lower extremities.

Methods Six patient studies have been performed and are summarized in Table 1. The patients were referred for CAPR CE-MRA for assessment of the AVM and potential planning of sclerotherapy. The CAPR sampling pattern, as previously described [2] was implemented with modification of the matrix size as appropriate for the anatomy being imaged. Studies were performed at 3T (GE, v20.0). For all studies R=8 2D SENSE acceleration was done using an eight-element (8CH) modular coil designed for circumferential placement about the region under study. For the contrast-enhanced CAPR acquisition 20 ml Gd contrast agent was injected at 3 ml/sec followed by 20 ml saline at 3 ml/sec. The scan was started prior to contrast injection to acquire one full contrast-free image to be used for subtraction, and the scan was continued for 3-4 minutes to acquire 36 frames post-injection.

Results All patients were successfully imaged and diagnostic image time series were obtained. Representative results are shown in Figures 1 and 2. Figure 1(A-D) show consecutive full FOV coronal MIPs and (E-H) corresponding zoomed MIPs about the AVM in the right leg of Patient #6. The slow-filling AVM is shown in sharp detail. Figure 2(A-C) show consecutive coronal MIPs from Patient #3, demonstrating high spatial resolution depiction of an AVM of the right hand with rapid arterio-venous transit of contrast. The time post-injection is noted on the images. Figure 1(D) shows a later time frame, demonstrating the comparatively delayed filling of the left hand. The bilateral study allows for comparison of the flow pattern of the affected side with that of the opposite side. Figure 1E shows a time-of-arrival (TOA) map of the right hand, which maps the time of contrast arrival to the color scale shown at the bottom of the image. The TOA map shows the rapid enhancement and venous return of the AVM.

Conclusion CAPR CE-MRA has been shown to provide diagnostic quality time-resolved imaging of AVMs of the upper and lower extremities. The time resolved series and TOA maps may be useful for assessment of AVMs as well as planning of sclerotherapy.

References [1] Haider CR, MRM 60:749(2008); [2] Haider CR, Radiol 253:831(2009); [3] Haider CR, JMIR submitted (2010)

Table 1: Summary of CAPR AVM Studies

Pt #	Anatomy	Coil	Matrix	FOV (cm)	Spatial Resolution (mm ³)	Frame Time (sec)
1	Forearm	8CH calf	400 x 360 x 108	40.0 x 36.0 x 10.8	1.0 x 1.0 x 1.0	4.61
2	Thigh	8CH calf	400 x 320 x 132	40.0 x 32.0 x 13.2	1.0 x 1.0 x 1.0	4.88
3	Hand	8CH calf	320 x 256 x 108	32.0 x 25.6 x 10.8	1.0 x 1.0 x 1.0	3.48
4	Foot	8CH calf	400 x 320 x 220	30.0 x 24.0 x 24.2	0.8 x 0.8 x 1.1	7.01
5	Thigh	8CH abd	400 x 400 x 132	45.0 x 45.0 x 18.5	1.1 x 1.1 x 1.4	5.59
6	Thigh	10CH abd	400 x 400 x 132	45.0 x 45.0 x 19.8	1.1 x 1.1 x 1.5	5.59

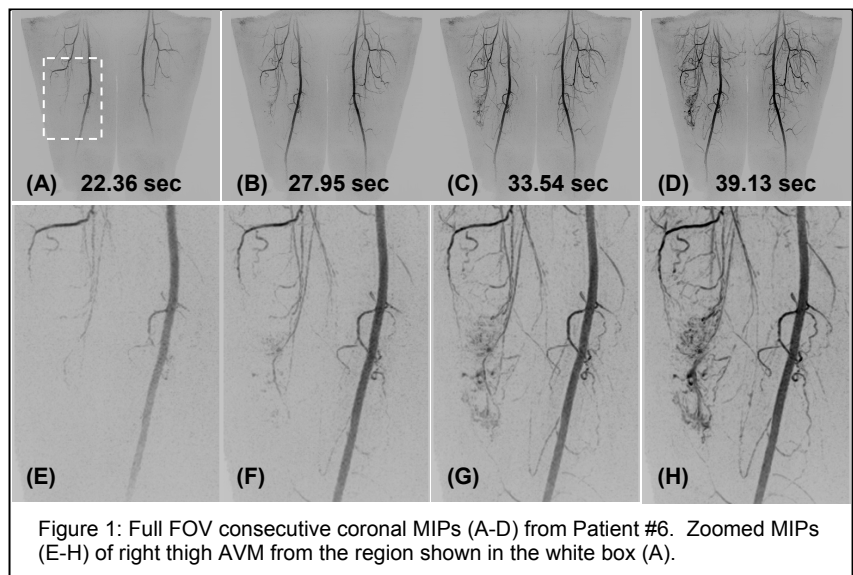


Figure 1: Full FOV consecutive coronal MIPs (A-D) from Patient #6. Zoomed MIPs (E-H) of right thigh AVM from the region shown in the white box (A).

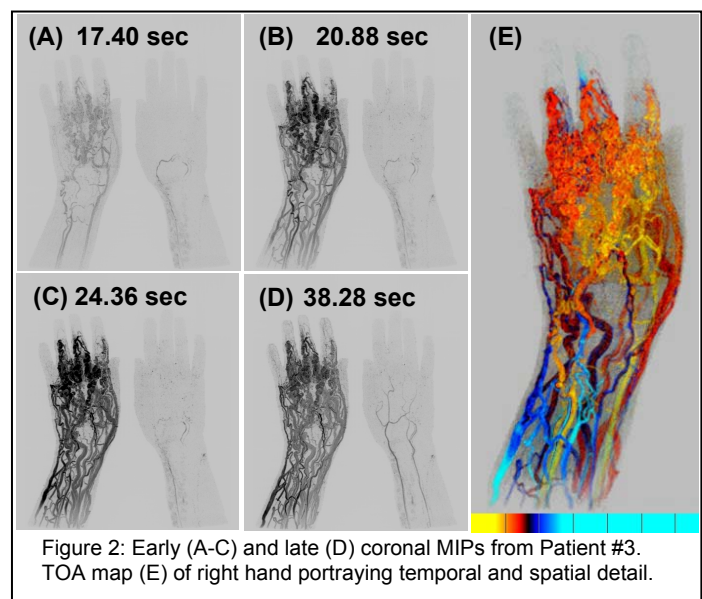


Figure 2: Early (A-C) and late (D) coronal MIPs from Patient #3. TOA map (E) of right hand portraying temporal and spatial detail.