2D Projection MRA of Aortic Arch with Single dose Gadolinium

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Purpose

To evaluate dynamic 2D MR digital subtraction angiography technique using single dose contrast enhancement, fast data acquisition and complex subtraction in conjunction with a head/neck coil. It is essentially a "free" sequence in patients receiving a Gd injection for the brain imaging part of a brain MRI/carotid MRA study.

Introduction

Accurate imaging of carotid arteries has become essential as the indications for carotid endarterectomy have been clarified by the Asymptomatic Carotid Atherosclerosis Study (ACAS) and North American Symptomatic Carotid Endadarterectomy Trial (NASCET) trials. Time-of-flight 2D phase contrast, and MOTSA techniques are effective for imaging the carotid artery bifurcations but are limited in imaging the great vessel origins/aortic arch. Assessment of the great vessel origins and intrathoracic carotid anatomy are important for surgical planning. Dynamic MR digital subtraction angiography using contrast enhancement, fast 2D data acquisition, and complex subtraction has previously been described as an effective technique for dynamic depiction of circulation with a short acquisition time. (1) It is limited to producing just one projection, however, this is all that is required for the aortic arch. This technique produces images similar to those obtained with x-ray DSA. Combined head and neck coils are now available that extend over the chest to allow imaging of the aortic arch.

Methods

Ten patients undergoing routine head and neck MRI and MRA were imaged using a neurovascular phased array coil (MRI Devices) in a 1.5-T MR imaging system (GE). All patients had a 20 or 22g intravenous catheter placed which was connected to a SmartSet apparatus for dynamic injection of Gd. Breath-hold dynamic MR digital subtraction angiograms using contrast enhancement, fast data acquisition, and complex subtraction were obtained in one LAO imaging plane during the duration of the breath-hold. All patients received the standard single Gd dose they would have received for their brain imaging which was .1 mmole per kilogram. Eight patients had intravenous lines placed in the right arm and two patients lines in the left arm. The contrast was injected using a hand injection simultaneously with initiation of scanning and immediately followed by 40cc of NS flush. The entire injection time, including flush, was approximately 15 sec.

Axial fast spoiled gradient echo images from the base of the skull to the aortic arch were obtained for graphic prescription. The 2D image volume was oriented LAO at 300-345 degrees to the coronal plane in line with the aortic arch or the right carotid arterial system. Graphic placement varied from the aortic arch to the mid cervical area. Imaging was performed with the following parameters: TR = 7-9.7, TE = 1.8-2.2, bandwidth 15.6-31.3, FOV 24-44cm, slab thickness 80-140cm, graphic angle 300-345degrees, , phase encoding steps= 192, and NEX-1. The acquisition was repeated 15-20 times in rapid succession. These images were reviewed to identify when contrast first arrived in the aortic arch. The image just preceding this was used as a mask for performing complex subtraction on the first four cases. On the subsequent cases this image in addition to later images was used for the mask.

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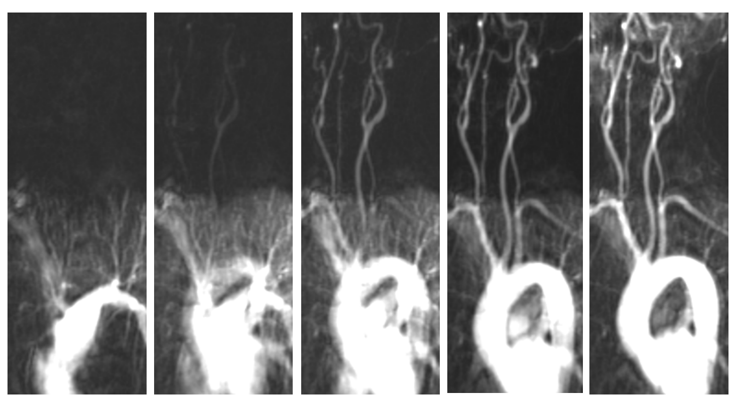
Results/Discussion

An angle of 325 degrees, LAO for the aortic arch, allowed visualization of the aortic arch AND opened up the carotid bifurcations. A slab thickness of 140cm provided imaging of the subclavian arteries in addition to the aortic arch and carotids with only minimal increased motion artifact. Fifteen acquisition phases, each 2 secs., were adequate to image pulmonary and arterial phases in all 10 patients. The carotid arteries were first visualized between 10 and 18 seconds after the start of the injection, phases 5-9. Duration of the arterial phase was approximately 10 seconds, 5 phases. Contrast injection through a right arm intravenous site provided less interference from the subclavian vein as compared to the left. Subclavian vein contamination on the right side could be more easily eliminated with judicious choice of mask images.

This technique provides rapid single view evaluation of the aortic arch, the great vessel origins, vertebral origins, proximal subclavian arteries, and proximal CCAs . It is easy and fast; no bolus timing is required because the 2 second acquisition time adequately resolves bolus transit through the arch and carotid arteries. It provides an individualized anatomic roadmap similar to a standard angiogram for surgical planning. At a minimum it can be used as a screening tool for those patients who need additional imaging prior to surgery. The dynamic complex subtraction short acquisition technique decreases the likelihood of motion artifact and allows for images without venous contamination giving superior arterial image quality. It provided additional contrast enhanced view of areas with equivocal findings on the 2D-TOF/pc/MOTSA imaging.

Conclusion:

The "free" dynamic 2D-MRA projection images obtained in the head-neck coil provided additional useful clinical information from that obtained with the TOF/pc/MOTSA images alone.



15 sec **17 sec** **19 sec** **21 sec** **25 sec**

Figure 1. Selected images from 2D MRA with complex subtraction obtained at 2 second intervals in LAO projection. Note initial pulmonary and eventual arch and carotid phase of bolus.

References

1. Yi Wang, et al. MRM. 36: 551-556(1996).
2. Remonda et al. Radiology. 1998: 209: 95-102.
3. Rofsky et al. Radiology. 1998: 209: 31-34.
4. Solsman et al. AJR. 1998: 170: 489-495.
5. Willig et al. Radiology. 1998; 208:447-51
6. Marcus et al. Radiology 1998; 208:353-357.
7. Huston et al AJNR 1998; 19:309-315.