Variable Appearance of Normal Central Venous Anatomy and Thoracic Inlet Veins with Dynamic Contrast-Enhanced MRA

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Background and Purpose

Dynamic contrast-enhanced Magnetic Resonance Angiography (MRA) has become the method of choice for imaging of arterial structures in the thorax(1). Such MR angiographic acquisitions can be extended in time to acquire both arterial and venous phases, thus providing a MR Venogram of the upper chest. This could then be used to assess the central venous anatomy and the thoracic inlet veins (subclavian and jugular veins). Today the evaluation of thoracic inlet veins is done by ultrasound (2) or X-ray Venography. Ultrasound requires special skills and X-ray Venography is invasive. It is now yet known if dynamic contrast-enhanced MR venography can replace Doppler ultrasound and/or X-ray venography for the detection of venous thrombus, venous compression or tumor invasion in the central venous anatomy and thoracic inlet veins. The purpose of this initial study was to document the variable appearance of the central venous anatomy and thoracic inlet veins on contrast-enhanced Upper Chest MR Venograms.

Methods

Twenty-five (25) patients (age: 47 to 82 years; average 63 years; all male) were referred for a contrast-enhanced MR angiogram of the upper chest because of a variety of vascular problems: aortic arch vessel pathology (5/25); pulmonary embolism (5/25); possible complications from PICC line placement (3/25); dissection (4/25) and other vascular problems (8/25). Twelve of the 25 patients had a comparison Doppler ultrasound or X-ray Venogram to evaluate relevant portions of the central venous system, jugular veins and subclavian veins.

All MR studies were performed on a 1.5 Tesla commercial scanner (Vision; Siemens Medical Systems, Inc, NJ), using a 3-D FLASH sequence with the following parameters: TR = 4.5, TE = 1.7, flip = 30, matrix 512 x 512, FOV = 460 mm. A 108-mm thick coronal slab with 78 slices (1.5 mm each) was acquired in 25 seconds. Test bolus injection for timing followed by 20mL Magnevist® contrast bolus injections were used. Breathhold acquisitions during the arterial and venous phase were acquired in all patients, with a 10-second rest period in between. A phased-array thoracic surface coil was used, positioned over the upper chest and neck area.

The MR Venogram portions of the MRA studies from the 25 patients were retrospectively (double blind) evaluated by three experienced radiologists. The upper chest venous anatomy and inlet veins were subdivided as follows: SVC, right inominate and subclavian vein (distal and proximal half), left inominate and subclavian vein (proximal and distal half), and right and left jugular veins. The image quality (graded from 0 to 5), confidence level (graded from 1 to 5) and presence of “blind spots” were evaluated for each portion of the venous anatomy. Blind spots are portions of the anatomy which are difficult to evaluate due to overlapping or adjacent vascular structures. The side of venous injection (right or left arm) was also noted.

Results

Four (4) of the 25 patients had evidence of venous thrombosis confirmed by Doppler ultrasound and/or X-ray venography. Of the 4 positives, one patient had bilateral subclavian vein thrombosis with multiple collateral. Two patients had left subclavian vein thrombosis and one had right subclavian vein thrombosis. One patient with partial thrombosis of the left subclavian vein by Doppler ultrasound had a normal MR Venogram study. All other patients had either documented patency of the central venous system and thoracic inlet veins or were studied for an arterial problem (carotids and or pulmonary arteries) without clinical suspicion of venous thrombosis.

The confidence level for interpretation of the MR Venograms studies was uniformly graded as “relatively confident that MR Venogram interpretation is correct” by all three observers.

The ability to visualize portions of the venous system was dependent upon the location within the chest and thoracic inlet (see Figure 1). For the inominate and subclavian veins, the image quality was most often rated as a 3 = “gross artifacts inside vessel” or as a 2 = “poorly visualized, but present”. This made it difficult to distinguish between thrombosed and poorly visualized veins. Only the SVC and jugular veins were rated as 4= “well seen, with minor signal inhomogeneity”.

Two significant “blind spot” on the MR Venograms were the left inominate vein, which runs anterior to the aortic root (not seen in 38% of cases), and the proximal left subclavian vein (not seen in 39% of cases).

Conclusions

The ability to detect thrombus using contrast-enhanced MR Venography is seriously compromised given the high prevalence of poorly visualized portions of the central venous system and thoracic inlet veins. Interpretation of these images should be made with great cautions as one can easily overcall the presence of partial or total venous thrombosis.

References: