ECG-gated high resolution Contrast-Enhanced MR angiography of thoracic aorta

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Introduction:

Diseases of the thoracic aorta, such as aneurysms and dissections, are a significant cause of morbidity and mortality worldwide. Contrast-enhanced magnetic resonance angiography (CE-MRA) is now routinely used as a first-line tool for assessing the thoracic aorta [1]. While this technique is useful for imaging the majority of the thoracic aorta, the ascending portion and sinuses of Valsalva are not infrequently obscured by motion artifact due to cardiac pulsation. A number of acceleration techniques, such as parallel imaging, have recently been developed and, when these are used in conjunction with conventional CE-MRA, it is possible to shorten the acquisition time significantly. With imaging times this short, it may be possible to implement CE-MRA with ECG-gating, potentially resulting in a significant improvement in image quality [2].

Purpose:

To compare ECG-gated high-resolution CE-MRA to conventional CE-MRA for the assessment of the thoracic aorta.

Materials and Methods:

50 consecutive patients (22 male; 28 female; age range: 19-80 years), who had undergone CE-MRA for suspected disease of the thoracic aorta, were evaluated retrospectively. The study was carried out in accordance with institutional review board guidelines. The basic technique involved a 3D gradient echo FLASH pulse sequence with the following scanning parameters: TR/TE: 2.8/1.4 msec, flip angle: 25^0, 512 readout, voxel size: 1.4x0.8x1.3 mm^3. 0.2 mmol/kg of Gadolinium was injected through a peripheral intravenous cannula during image acquisition and the contrast transit time was calculated using a standard timing bolus acquisition. Digital subtraction of 3D data sets was used and there was automatic maximum intensity projection (MIP) post-processing.

The first 25 patients in the study group underwent conventional CE-MRA. The second group of 25 patients underwent ECG-gated CE-MRA. For the ECG-gated MRA, parallel imaging, with acceleration factor of 2, was utilized to shorten the acquisition time. Each partition was then gated such that the acquisition took place at end diastole (fig.1).

The MRA images from both groups underwent a quantitative analysis for vessel sharpness. Vessel sharpness was measured by generating a signal intensity profile perpendicular to the major axis of the aorta in 3 different anatomic locations (aortic root, aortic arch, descending aorta). The slope of the upstroke and downstroke were calculated and the distance (d) between 20% minimum and 20% maximum calculated. Sharpness was represented as 1/d.

The data obtained from both groups of patients were compared using a student's T-test and a p-value of <0.05 indicated statistical significance.

Results:

Quantitative measurements of vessel sharpness were superior at the aortic root with the ECG-gated CE-MRA technique compared to the conventional technique ($p<0.001$) (table 1). Sharpness was superior in the other 2 locations, but this was not statistically significant ($p>0.05$). A subset of 6 patients underwent both techniques. Sharpness was again higher with the ECG-gated technique compared to the ungated technique (fig.2).

Discussion:

With current acceleration techniques, it is possible to implement CE-MRA of the thoracic aorta with ECG-gating. This results in a significant improvement in image quality in the ascending aorta and sinuses of Valsalva, potentially producing more accurate measurements of aortic diameter and better depiction of pathology in this location.

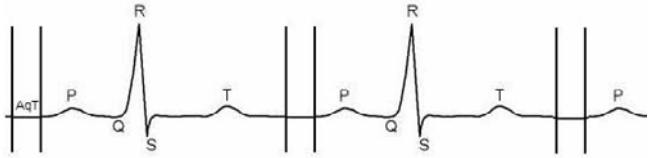

Figure 1. Diagram of ECG-gated acquisition (AqT) during diastolic period of cardiac cycle.

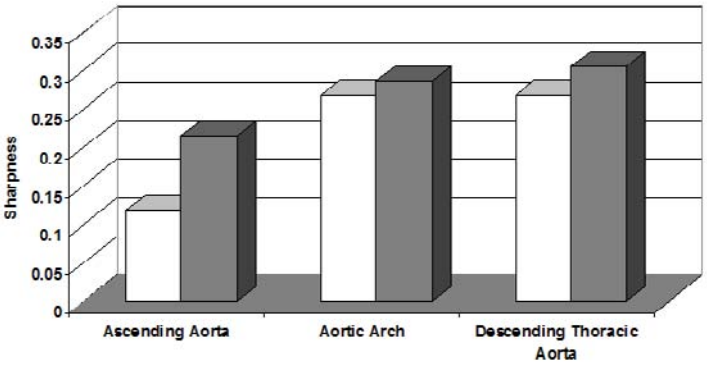

Table 1: Shaded bars are the ECG-gated data and un-shaded bars are the data without ECG-gating. Sharpness was higher for the ECG-gated technique

[1] Prince M., et al. Radiology 1992

[2] Carr J, et al. ISMRM 2005

Figure 2: Comparison of un-gated (a,c) and ECG-gated (b,d) images from 2 different patients. Fig 2a and b = patient 1. Fig 2c and d = patient 2.