

Evaluation of the Thoracic Aorta with Gated CE-MRA: Technical Feasibility and Comparison with Ungated Studies

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Purpose: 3D contrast-enhanced MRA (CE-MRA) is a widely used clinical tool for imaging thoracic aortic disease. Although CE-MRA has been shown to be very sensitive for detecting intimal flaps in aortic dissection [1], cardiac motion and aortic pulsation can significantly hinder vessel wall evaluation in the aortic root, proximal arch vessels, and proximal coronary arteries. These areas are critical to evaluate in cases of dissection, Marfan's syndrome, and other aortic diseases. Recently, ECG-gated CE-MRA sequences have been developed, allowing high-resolution imaging with reduced motion artifact affecting these critical areas [2]. We describe our initial experience with 2 phase and 4 phase gated CE-MRA sequences, with particular attention to the sinotubular junction, aortic arch vessels, and left main coronary artery (LCA).

Materials and Methods: 10 patients (7 M, 3F, age 27-82) were imaged on a 1.5 T system (GE Signa Excite) with an 8 element phased array cardiac coil for clinical indications including aneurysm (5), followup coarctation repair or bypass (2), rule out dissection (2), and rule out pulmonary AVM (1). Imaging was performed using a 2 phase (5 patients, TR/TE: 4.5/2.1 ms, FA: 35, 256x192-224 matrix, BW: 62.5 Hz/pixel, FOV: 350 mm) or 4 phase (5 patients, TR/TE: 3.84/1.8, FA: 20, 256x192-224 matrix, BW: 62.5 Hz/pixel, FOV: 350 mm) breath-hold acquisition. IV gadodiamide was injected at 3cc/sec to a total of 0.1-0.2 mmol/kg following a bolus tracking sequence.

In each patient, the best phase was rated for overall image quality (excellent, good, adequate, suboptimal, or poor). Each study was further evaluated for delineation of the aortic wall at the sinotubular junction (well delineated, interface blurred by motion, motion renders nondiagnostic), delineation of the proximal arch vessels (same criteria), and delineation of the proximal LCA (well delineated, patent but not clearly seen, cannot be seen). 6 of 10 patients also had ungated MRA sequences in the same or a prior examination. In these patients, the ungated series were rated according to the same criteria. Technical issues decreasing image quality were noted.

Results: In all gated studies, image quality was excellent (4), good (5), or adequate (1). The sinotubular junction was well delineated on 10/10 gated series, but blurred on 3/6 ungated series. The LCA was well delineated on 7/10 gated series, and patent but not clearly seen in the other 3/10. In contrast, the LCA could be confirmed patent in only 3/6 ungated series, and was not visualized in 3/6. In all cases, the sinotubular junction and LCA were better delineated in gated series than in their ungated comparisons. Scoring for delineation of the arch vessels was identical between gated and ungated series. All gated studies were preferred by the authors to their ungated comparisons. For the gated studies in which image quality was not excellent, problems were primarily related to long acquisition times, exceeding the patient's breath-hold capacity. Increased intravoxel dephasing was also noted on the gated sequences, partly related to respiratory motion and higher TE values.

Conclusion: ECG-gated CE-MRA offers a technically feasible method to improve image quality in thoracic aortic examination by reducing pulsation artifact and improving visualization of the aortic root and proximal coronary arteries. Limitations include incomplete breath holding during long acquisition times and increased dephasing on gated studies. 2 phase sequences, despite lower temporal resolution than 4 phase sequences, may be preferable in patients with shorter breath hold capacity, given shorter acquisition times but relatively high quality diagnostic images.

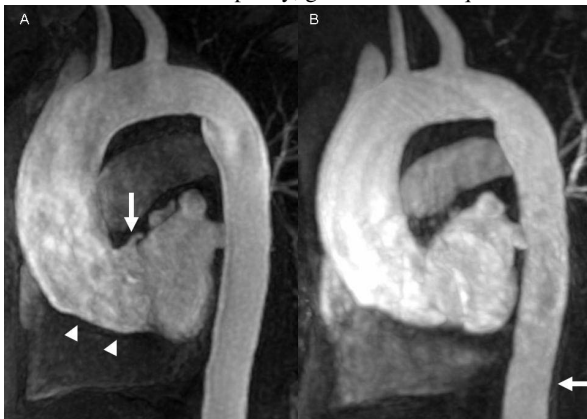


Figure 1. MIP image from gated study (A) demonstrates the LCA (arrow) and aortic wall (arrowheads) much more clearly than does MIP of the prior ungated study (B), which has more motion (arrow).



Figure 2. Prolonged acquisition time exceeds breath-hold capacity, causing motion (arrowheads). Gating and TE of 1.8 ms accentuate dephasing (*).

References: 1. Kunz RP, Oberholzer K, Kuroczynski W, et al. Assessment of chronic aortic dissection: contribution of different ECG-gated breath-hold MRI techniques. *AJR* 2004; 182:1319-1326.
2. Groves EM, Bireley W, Dill K, Carroll TJ, Carr JC. Quantitative analysis of ECG-gated high-resolution contrast-enhanced MR angiography of the thoracic aorta. *AJR* 2007; 188:522-528.