Prospective intraindividual comparison between highly accelerated breath hold non-contrast ECG-gated balanced steady state free precession MRA and ECG-gated CT angiography

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Purpose
CTA is the first line diagnostic modality for assessment of thoracic aortic pathology, and using electrocardiographic gating (eCTA), provides clear depiction of the aortic root and ascending aorta. However, it utilizes nephrotoxic contrast, of concern in patients with renal impairment, and imparts an ionizing radiation dose between 1.9 - 43mSv⁶. Recently, an ECG-gated 3D breath hold non-enhanced balanced steady state free precession (bSSFP) MRA sequence (NE MRA) has been described, that utilizes two dimensional image acceleration with acquisition of coil sensitivity and MRA data during different phases of the cardiac cycle⁴,⁵, markedly decreasing acquisition times compared with free-breathing bSSFP MRA⁷. We evaluate the performance of NE MRA in a clinical population, with eCTA as the reference standard.

Methods
16 patients (12 males, 4 females, mean 59.4, range 20-86yrs), referred for known or suspected aortic disease underwent NE MRA at 1.5T (Avanto, Siemens Healthcare) with a 6-channel body coil and posterior spine elements. NE MRA parameters were: TR/TE 3.5/1.5 ms, FA 70°, true voxel size 1.6x1.6x2.0mm³, FOV 315 x 420 mm, 6/8 slice and phase partial Fourier, 60 partitions, acquisition time 24 RR intervals, trigger pulse 1, trigger delay 500ms, acceleration factor 2 (partition) x 3 (PE).

Anonymised NE MRA and eCTA images were interpreted in random order by an experienced cardiovascular radiologist. Aortic pathology, diagnostic confidence and image quality were recorded for each patient. Aortic dimensions were evaluated in 7 defined segments (annulus, sinuses of Valsalva, sinotubular junction, ascending aorta, arch, descending aorta, diaphragmatic aorta). Diagnostic confidence and image quality were scored on a 5-point Likert scale (1=worst, 5=best). Categorical variables were compared with the Wilcoxon signed-rank test and aortic dimensions compared with the paired Student t-test, with p<0.05 considered significant.

Results
All patients successfully completed both NE MRA and eCTA, with 14 in sinus rhythm, 1 in slow atrial fibrillation, and 1 with frequent ectopics. At eCTA, aortic aneurysm (n=8), dissection (n=4), 1 Type A dissection status post ascending aortic graft repair, aortic coarctation (n=2), Sinuses of Valsalva (n=1) and 1 normal study were found, all identified with NE MRA (Figs 1 and 2). A small dissection flap post ascending aortic repair A) NE MRA and B) eCTA demonstrate recurrent narrowing (arrows) and A) NE MRA and B) images demonstrate Type B aortic dissection.

Table 1. Aortic Dimensions (mean ± SD) in mm

<table>
<thead>
<tr>
<th>Aortic Segment</th>
<th>NE MRA (mm)</th>
<th>eCTA (mm)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Annulus</td>
<td>24.6 ± 5.98</td>
<td>26.57 ± 3.88</td>
<td>0.082</td>
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<tr>
<td>Sinuses of Valsalva</td>
<td>37.6 ± 10.59</td>
<td>38.67 ± 10.38</td>
<td>0.18</td>
</tr>
<tr>
<td>Sinotubular junction</td>
<td>34.99 ± 7</td>
<td>35.49 ± 6.52</td>
<td>0.23</td>
</tr>
<tr>
<td>Ascending aorta</td>
<td>42.23 ± 12.22</td>
<td>42.62 ± 11.32</td>
<td>0.56</td>
</tr>
<tr>
<td>Aortic arch</td>
<td>29.28 ± 6.87</td>
<td>30.31 ± 6.28</td>
<td>0.03</td>
</tr>
<tr>
<td>Descending aorta</td>
<td>29.08 ± 8.07</td>
<td>30.55 ± 8.7</td>
<td>0.008</td>
</tr>
<tr>
<td>Diaphragmatic aorta</td>
<td>25.44 ± 6.23</td>
<td>26.6 ± 6.93</td>
<td>0.02</td>
</tr>
</tbody>
</table>

Diagnostic confidence and image quality were scored on a 5-point Likert scale (1=worst, 5=best). Categorical variables were compared with the Wilcoxon signed-rank test and aortic dimensions compared with the paired Student t-test, with p<0.05 considered significant.

Discussion/ Conclusion
In our initial experience, NE MRA identified all major aortic pathology with high diagnostic confidence. Although significant differences in aortic dimensions were observed in distal segments, average differences were small, and of questionable clinical impact. Diagnostic image quality was achieved, although it remained inferior to the reference standard. The breath-hold NE MRA technique evaluated offers a promising alternative to eCTA, free of both ionizing radiation and exogenous contrast, with potential clinical application in young patients, particularly where long-term surveillance is required.

References

Fig 1. 64 year-old female with prior aortic coarctation repair A) NE MRA and B) eCTA demonstrate recurrent narrowing (arrows)

Fig 2. 38 year-old male with acute chest pain A) NE MRA and B) images demonstrate Type B aortic dissection