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Routine cine-CMR segmentation via a novel automated algorithm (LV-METRIC) for assessment of aortic physiology: a clinical validation study

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Background

Routine cine-CMR is widely used to assess cardiac structure and function. Partial voxel interpolation has been shown to yield improved agreement with phantom derived chamber volumes and necropsy evidenced LV mass; the utility of partial voxel interpolation for assessment of aortic physiology has never before been tested.

Methods

Cine-CMR (SSFP) was performed on 1.5 Tesla (GE) scanners; pulse sequence parameters were equivalent to those for routine CMR (typical TR 3.4 msec, TE 1.14 msec, flip angle 60°, temporal resolution 30 msec). Images were acquired in conventional cardiac (2, 3, 4 chamber) long axis or axial imaging planes. Aortic area was uniformly measured in a non-aneurysmal location within the mid-descending thoracic aorta: Cine-CMR was quantified via a novel "partial voxel" segmentation algorithm (LV-METRIC) that accounts for relative proportion of blood within each individual imaging voxel. Maximum (systolic) and minimum (diastolic) aortic areas and brachial pulse pressure were used to calculate distensibility, a measure of arterial compliance, of the mid-descending thoracic aorta.

Results

32 subjects were studied, among whom 22 had genetically-mediated aortopathies (13 bicuspid aortic valve [BAV], 9 Marfan syndrome [MFS]) and 10 were normative controls. Aortopathy subjects were similar to controls in age, gender, pulse pressure and body size (all p=NS). Aortic indices, compared between MFS, BAV and control groups are shown in Figure 1. As shown, absolute aortic size (measured in a non-aneurysmal region) was similar between groups (all p=NS). Dynamic change in aortic area (Δ Area) was lesser among MFS

Table 1: Aortic Physiologic Indices as Assessed by Routine Cine-CMR

	Controls	Bicuspid Aortic Valve	Marfan Syndrome	p-value (BAV vs. control)	p-value (Marfan vs. control)
Area (mean)	3.12 ± 0.44	3.04 ± 0.67	3.42 ± 2.13	0.47	0.67
Maximal Area (systole)	3.51 ± 0.48	3.39 ± 0.48	3.69 ± 2.08	0.68	0.81
Minimal Area (diastole)	2.77 ± 0.35	2.65 ± 0.66	3.20 ± 2.04	0.59	0.55
Δ Area	0.74 ± 0.18	0.74 ± 0.30	0.48 ± 0.15	0.99	**0.004**
Distensibility	6.96 ± 0.38	6.31 ± 2.83	4.31 ± 1.96	0.43	**0.007**

Figure 1 Aortic physiologic indices as assessd by routine cine-CMR

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vs. controls (p=0.004) as well as BAV (p=0.03), but not between BAV vs controls (p=0.99). Aortic distensibility, as measured in all aortopathy subjects and 6 normative controls, demonstrated lower values among MFS subjects as compared to normative controls (p=0.007), with a similar trend when MFS and BAV groups were compared (p=0.08). There was no significant difference in distensibility between BAV vs controls (p=0.43).

Conclusions

Routine cine-CMR can discern altered aortic physiology in non-aneurysmal regions in subjects with MFS. Larger longitudinal studies are needed to further evaluate the prognostic utility of cine-CMR segmentation, including use of central aortic blood pressure, as a potential biomarker of early aortic disease.

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