

Optimizing non-contrast 3D aortic morphology MRI with compressed sensing

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Aims: Accurate evaluation of aortic size and growth is crucial in aortic disease. We aimed to compare different MRI acquisition strategies without contrast agent injection, and define the optimal balance between scan time and reliable quantification of 3D aortic morphology.

Methods: 48 healthy volunteers (39±14years, 29women) underwent non-contrast respiratory- and ECG-gated MRI (1.5T, Siemens) of the aorta in sagittal view during diastole. A gradient-echo sequence with spectral fat saturation (fs), spatial resolution (SR)=1.28x1.42x2mm³, and acquisition time=7:42±2:27min was used as reference. Then, 3 strategies based on compressed sensing (CS, research prototype) with isotropic SR=1.3mm³ were tested while using either fs (CS_{fs}, acceleration factor R=5), inversion-recovery (CS_{SPAIR}, R=5) or Dixon (CS_{Dixon}, R=7). A last acquisition was performed using CS, R=5, fs and SR=1.28x1.42x2mm³ (CS_{resoREF}). Aortic cross-sectional diameter at 7 anatomical landmarks from sino-tubular junction to celiac trunk, length and volume of ESC reference segments #1-4 were measured from each dataset, after semi-automated 3D aortic segmentation using custom software (Mimosa), blinded to acquisition strategy.

Results: As expected, CS strategies were significantly faster than fs reference (CS_{fs}: 2:56±0:51min; CS_{SPAIR}: 3:03±0:59min, CS_{Dixon}: 3:12±0:55min, CS_{resoREF}: 1:38±0:32min; all p<0.0001). Image quality and aortic segmentation were visually higher for reference (0 exclusion) than for CS acquisitions (diameter/length and volume measurements were excluded in 3/4% cases for CS_{fs}, 5/6% for CS_{SPAIR}, 4/5% for CS_{Dixon} and CS_{resoREF}). CS strategies provided reliable aortic morphology measurements, as revealed by high correlation coefficients with reference (CS_{fs}: r≥0.93; CS_{SPAIR}: r≥0.93, CS_{Dixon}: r≥0.88, CS_{resoREF}: r≥0.92) and low Bland-Altman biases, which further ranged within inter-operator variability (diameter≤0.55[-3.2;4.3]mm, length≤0.62[-14;15]mm, volume≤0.51[-9.1;10]ml). Overall, the best performance was obtained using CS_{fs} strategy, with absolute differences below 15±12% compared to the reference.

Conclusion: A non-contrast 3D aortic morphology MRI sequence combining CS, fat saturation and standard resolution achieved high agreement with conventional reference, while dividing average scan time by 3.