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Meeting abstract

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2088 Effect of spatial resolution on measurement of aortic compliance using MRI

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Background

The human aorta is a compliant artery which normally increases in cross-sectional area by 10–20% during each cardiac cycle, but is known to stiffen with age and disease. Magnetic resonance imaging (MRI) has been used in numerous research studies to measure arterial distension, but the effect of image spatial resolution on errors in distension measurements has not been evaluated.

Purpose

To examine the effect of spatial resolution on the measured distension of an *in vitro* model of the human aorta using MRI.

Materials and methods

A computer-controlled pulsatile flow pump was used to produce physiologically realistic flow profiles with water as the working fluid. Two flow conditions were generated, corresponding to two levels of tube distension. The flow loop consisted of the pump, tubing, check valves to ensure one-directional flow, and the compliant test section. The test section was made of latex tubing (1" inner diameter) and was mounted inside a polycarbonate container filled with water to ensure adequate signal for imaging. Compliant tubing was added to the flow loop to assist in the reproduction of a bi-phasic flow wave. The flow loop was inserted inside a 1.5 Tesla MRI scanner (Avanto, Siemens Medical Solutions, Germany) with the test section placed at the isocenter. Cross-sectional (axial) imaging slices were placed at different locations in the test section and cine steady state free precession (SSFP) images were acquired at five different spatial resolutions, as follows (Table 1):

For all images, slice thickness was 8 mm, bandwidth 650 Hz/pixel, and imaging was synchronized to the generated flow wave using an external trigger from the piston pump amplifier. Image analysis was performed using Argus software (Siemens Medical Solutions, Germany). The inner diameter of the latex tube was manually delineated in each image of the cine acquisitions. For each spatial resolution case, the maximal distension was computed as $(AREA_{MAX} - AREA_{MIN})/AREA_{MIN}$.

Results

At each flow condition, both the absolute change in area [mm^2] and the relative change in area [%] were generally consistent across all spatial resolution cases (see Table 2); the only exception was found at the higher flow condition using a spatial resolution of 2 mm. Similarly, the change

Table 1:

Spatial Resolution/pixel size (mm)	TR (ms)	TE (ms)	FOV (mm)	Matrix
0.7	4.3	2.2	224	320
1.0	3.8	1.9	320	320
1.3	3.5	1.8	256	320
1.6	3.3	1.7	192	300
2.0	3.2	1.6	128	256

Table 2:

Spatial Res (mm)	High Flow Condition				Low Flow Condition			
	ΔArea				ΔArea			
	mm^2	%	Pixels	Δdiam (mm)	mm^2	%	Pixels	Δdiam (mm)
0.7	65	14%	132	1.7	30	7%	61	0.8
1.0	63	13%	63	1.6	34	8%	34	0.9
1.3	67	14%	40	1.7	35	8%	21	0.9
1.6	66	14%	26	1.7	34	8%	13	0.9
2.0	78	16%	20	1.9	31	7%	8	0.8
Avg	68 ± 6	14 ± 1%	-	1.7 ± 0.1	33 ± 2	8 ± 1%	-	0.9 ± 0.1

in diameter was consistent for all spatial resolutions. At the high flow condition, the change in tube area averaged 14%, similar to the expected distension in a healthy aorta. At the low flow condition, the change in tube area averaged 8%, analogous to that which might be expected in a stiffened aorta. The overall consistency in the results was maintained even in the low flow case using the lowest spatial resolution settings, in which the area changed by only 8 pixels.

Discussion

Previous studies have computed aortic compliance and distensibility using MR images with spatial resolutions ranging from 1.2–2.0 mm (with most in the middle of this range), but no standard has been established. These results indicate that aortic distension can be determined by MRI with equal accuracy over the range of spatial resolutions studied.