Aortic elasticity measured by MRI is decreased during exercise in young adults.

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Purpose

Although the evaluation of the risk of aortic rupture is based on the vessel diameter, biomechanical properties have additional prognostic values. Indeed, in vivo evaluation of aortic elasticity might be of interest to discriminate between normal and altered aortic tissue. Aortic elasticity can be evaluated with different parameters, such as the aortic compliance (AC), the aortic distensibility (AD) and the pulse wave velocity (PWV) (1). However, using MRI, these parameters are calculated at rest, and their values are not well-establish during exercise. The purpose of the present study was to investigate the change of aortic elasticity in young individuals during rest and exercise using 1.5 T MRI and supine bicycle system.

Methods

MRI was performed at rest and during supine exercise using an amagnetic ergometer (Lode, the Netherlands) with a 1.5 T imager (Siemens, Avanto) on 15 young adults (8 men, median 29 (23-41) years) with no risk factor for atherosclerosis. The data were acquired at the level of the pulmonary trunk (allowing the study of the ascending (AA) and descending aorta (PDA)), of the distal descending aorta (DDA) and of the aorta above the renal artery (RA) using a cine-FISP sequence (TR/TE=30ms/1.8ms, thickness=6mm, α=65°, matrix=148x256, temporal resolution=30ms, retrospective gating) and gradient pulse sequence with a velocity encoding in through plane direction (TR/TE=25ms/2ms, thickness=6mm, matrix=256x256, flow encoding=200cm/s, α=25°, temporal resolution=25ms, retrospective gating). For exercise the volunteers pedaled during 2 minutes at 25 W, and work load was increased every 2 minutes for a minimum of 10 minutes, to obtain twice the resting heart rate. Breath held stress dataset of 2 acquisitions were acquired immediately after stop cycling. The volunteer was instructed to pedal again at least 2 minutes at the last exercise level, and the images acquisition was repeated. Then, AC (defined as the change in aortic surface area caused by a given change in arterial blood pressure), AD (defined as the AC divided by the minimum cross-sectional area) and PWV (defined as the ratio of the distance between two aortic levels and the time difference between the arrival of the pulse wave at these levels) were calculated at the different levels of the aorta using semi-automatic methods (2).

Results

The tables 1 and 2 summarize the elastic parameters calculated at rest and during exercise. Stress induced a significant decrease in AC and AD at all sites ($p<10^{-3}$), associated with an increase of PWV (only significant at the PDA and DDA levels (with p=0.02 and p=0.008, respectively)). Moreover, at rest and during stress, AC was statistically higher in AA compared to the whole descending aorta (p<0.0007).

	AA	PDA	DDA	RA
AC at rest	2.71 ± 0.7	1.35 ± 0.27	1.35 ± 0.37	1.39 ± 0.51
AC during exercise	1.99 ± 0.61	0.85 ± 0.27	1.08 ± 0.44	0.86 ± 0.24
AD at rest	6.19 ± 1.55	5.81 ± 1.59	7.53 ± 2.14	8.22 ± 2.58
AD during exercise	4.84 ± 1.31	3.79 ± 1.32	5.18 ± 1.26	5.19 ± 1.32

Table 1: AC (in mm²/mmHg) and AD (in $mmHg^{-1} \times 1000$) calculated at the different levels

Discussion

This study demonstrates the feasibility to evaluate regional aortic function during an exercise-induced stress MRI. Our preliminary results show a decrease of the aortic elasticity during stress in young adults.

	AA-PDA	AA-DDA	AA-RA
PWV at rest	4.69±1.38	3.91±0.46	3.87±0.64
PWV during stress	5.57±1.26	4.85±1.19	4.23±1.24

Table 2: PWV (in cm/s) calculated between AA and PDA, DDA, RA

References

(1) O'Rourke et al. Am J Hypertens. 2002; 15(5): 426-444.

(2) Lalande et al. J Magn Reson Imaging. 2008; 28(5): 1180-1187.