

WALKING POSTER PRESENTATION

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Breathing maneuvers as a metabolic coronary vasodilator for first-pass perfusion MR imaging

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Background

CMR can detect myocardial ischemia by first-pass perfusion and by oxygenation-sensitive CMR (OS-CMR) imaging. While the former can reliably determine myocardial blood flow, the latter integrates other determinants of myocardial oxygenation. Simple breathing maneuvers can trigger a coronary vascular response, which can be monitored by OS-CMR imaging.

Methods

We studied 24 healthy volunteers (37 ± 12 years; 62.5% men) in a clinical 3T MRI system. Each exam included

three sets of first pass perfusion images, (1) at rest and, after 1 minute of hyperventilation during (2) a short breath-hold (SBH) or (3) a long breath-hold (LBH), performed in random order. A reader blinded to the maneuver applied, analyzed signal intensity upslope, upslope index and time between 20 and 80% of maximal signal. For inter-observer variability, a different, blinded, reader repeated the analysis in 4 volunteers.

Results

Demographics and LV function data are presented in Table 1. All volunteers tolerated the breathing maneuvers

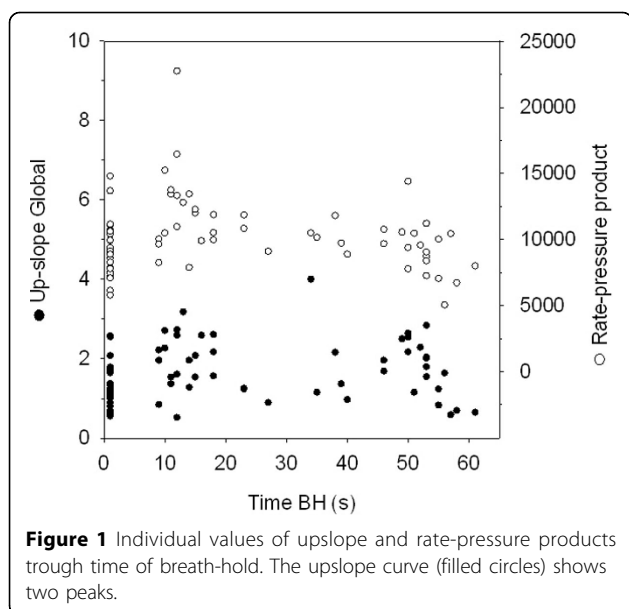
Table 1 Sample demographics and left ventricular function

Volunteer characteristics	All N=24	Men N=15(62.5%)	Women N=9(37.5%)	p-value
Age (years)	37 ± 12	41 ± 14	32 ± 7	ns
Height (cm)	171 ± 7	175 ± 6	165 ± 5	< 0.001
Weight (Kg)	69 ± 10	74 ± 7	62 ± 9	< 0.01
SBP (mmHg)	128 ± 15	134 ± 13	116 ± 9	< 0.01
DBP (mmHg)	74 ± 8	75 ± 8	73 ± 8	ns
HR (bpm)	68 ± 10	64 ± 9	75 ± 9	< 0.01
Caffeine intake [n(%)]	14 (58.3)	10 (41.7)	4 (16.7)	ns
Routine Exercise [n(%)]	17 (70.8)	10 (41.7)	7 (29.2)	ns
CMR findings				
EDV/BSA (ml/m ²)	91.1 ± 14.8	96.1 ± 16.1	82.8 ± 7.3	< 0.05
ESV/BSA (ml/m ²)	37.1 ± 7.6	39.9 ± 8.0	32.5 ± 3.9	< 0.05
MM/BSA (g/m ²)	57.0 ± 14.0	64.8 ± 11.3	44.0 ± 6.2	< 0.001
EF (%)	59.4 ± 4.0	58.6 ± 4.5	60.7 ± 2.7	ns

SBP - systolic blood pressure; DBP - diastolic blood pressure; HR - heart rate; EDV - end-diastolic volume; ESV - end-systolic volume; MM - myocardial mass; BSA - body surface area; EF - ejection fraction.

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well and completed the study protocol. The average upslope at rest was 1.34 ± 0.58 , and increased by 39% during the SBH (1.86 ± 0.70 ; $p < 0.05$), diminishing to 1.77 ± 0.82 at the LBH step. The upslope started at 13.8 ± 5.5 and 49.5 ± 7.3 seconds of breath-hold, respectively, on SBH and LBH. Figure 1 shows the relationship between time of breath-hold after hyperventilation and both the individual values of up-slopes and rate-pressure products (RPP). The upslope curve shows two peaks, a early one (15 seconds) coinciding with the peak of the RPP curve; a second one at about 50 seconds, not promoted by the RPP. The upslope index, which accounts for the arterial input, was higher at this late step (rest: 0.077 ± 0.016 ; SBH: 0.083 ± 0.015 ; LBH: 0.095 ± 0.019 ; $p < 0.01$), as was the myocardial perfusion reserve index (1.25 ± 0.22 vs. 1.09 ± 0.17). In a multiple regression model that included gender, RPP, breath-hold time, caffeine intake, BSA-indexed mass and set order, only gender, RPP and breath-hold time were independently and significantly related to the upslope ($R = 0.771$; $p < 0.001$). A different reader repeated the analysis in 4 volunteers; the intra-class correlation for the up-slope was excellent, of 0.990 (95% CI: 0.943-0.997; $p < 0.001$).

Conclusions

The blood flow response to simple breathing maneuvers can be demonstrated by first-pass perfusion CMR, with a early peak dependent on RPP increase, and a late peak due to the vasodilatory effect of long breath holds. Confounding effects of breathing may also have implications for CMR first-pass perfusion imaging performed with pharmacological vasodilators.

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