Abstract: P2603

Impaired right ventricular force-frequency relationship in patients with heart failure is associated with diastolic dysfunction and worse functional capacity

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Topic(s):
Chronic Heart Failure - Pathophysiology

Citation:

Background: The force-frequency relationship (FFR) is an important intrinsic regulatory mechanism of cardiac contractility, related to changes in Ca²⁺ availability within the myocardial cell. In normal hearts this relationship is positive, so that an increase in contractile force is induced by elevation of the stimulation frequency. In heart failure (HF), the force-frequency relationship can be markedly depressed, but most studies focused their attention on left ventricular function and little is known about the right ventricle (RV).

Purpose: We aimed at performing a comprehensive analysis of HF phenotypes based on the right ventricular force-frequency relationship. To this purpose we stratified a large cohort of HF patients using the relationship between RV function (assessed by tricuspid annular plane systolic excursion, TAPSE) and heart rate (HR) during a symptom-limited cardiopulmonary exercise test (CPET).

Material & Methods: We prospectively enrolled 184 HF patients, irrespective of their LV ejection fraction. We performed a stress echocardiographic evaluation using a tiltable cycle ergometer, recording standard images to assess LV systolic, diastolic, and valvular function.

We divided patients in 2 groups using the slope of the linear relationship between TAPSE and HR at rest and at peak exercise, as follows: slope =0.01 for "positive" FFR, slope <0.01 for "flat or negative" FFR.

Differences between groups were tested using unpaired t-tests for continuous variables (or Mann-Whitney U tests, when appropriate) and chi-square tests for categorical variables.

Results: 55 patients had a "flat or negative" FFR: they were slightly older (age 70 ± 10 vs. 66 ± 12; p=0.036), but the 2 groups had similar clinical characteristics such as hypertension, diabetes or COPD rate.

Patients with a "flat or negative" FFR had a worse diastolic function, with higher left ventricular filling pressures (E/e’ ratio 24 ± 10 vs. 19 ± 11 p=0.022) and left atrial volume (LAVi 55 ± 29 ml/m² vs. 44 ± 20 ml/m²; p=0.009). No differences in LV ejection fraction, mitral regurgitation and pulmonary artery systolic pressure were observed between the groups.

TAPSE at rest was similar between the groups (18 ± 5 mm vs. 18 ± 4 mm; p=0.553) but significantly different at peak exercise (16 ± 4 mm vs. 22 ± 5 mm; p<0.001). Average peak heart rate was similar in the 2 groups.

Patients with a "flat or negative" FFR exhibited a significantly lower peak VO₂ (11.6 ± 3.0 ml/min/kg vs. 13.5 ± 4.4 ml/min/kg; p=0.003), whereas they had a higher VE/VCO₂ slope (35.1 ± 9.6 vs. 32.3 ± 8.2 p=0.05).

Conclusion: The "flat or negative" right ventricular force-frequency relationship identifies a peculiar phenotype, with a higher grade of diastolic dysfunction and an impaired exercise capacity. The inability to adapt right ventricular contractility with increasing heart rate seems not related to RV afterload (similar PASP increase) but rather to an intrinsic failure of the right heart.

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Right Ventricular Force-Frequency relationship

mean slope: 0.11
mean slope: -0.05

"flat or negative" FFR
"positive" FFR

Rest
Peak