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Quantitative assessment of left ventricular function by 2D-speckle tracking during exercise: a feasibility study

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Objectives: To study the feasibility of quantifying left ventricular (LV) function by 2D-speckle tracking of myocardial deformation during exercise echocardiography in normal subjects.

Background: Accurate assessment of LV functional reserve during stress testing is challenging. For this purpose, the value of LV ejection fraction is limited. 2D-speckle tracking allows accurate quantification of LV regional function at rest. However, no study has evaluated the exercise-induced changes in myocardial deformation in normal subjects.

Methods: Fifty-three consecutive normal subjects underwent quantitative assessment of LV function using 2D-speckle tracking at rest and during a semi-supine graded exercise echocardiography. All strain and LV rotation parameters were measured at rest and at exercise to assess longitudinal strains in apical views and radial strains in parasternal short-axis view.

Results: During test, LV ejection fraction increased significantly from rest to peak exercise (64.3±5.6% vs 74.6±6.4%; p<0.0001) whereas LV end-systolic volume decreased (p<0.001). All strains parameters of myocardial deformation (longitudinal 20.1±2.8% to 24.6±3.6%, p<0.0001, radial 48.4±12.8% to 60.3±10.2%, p<0.001) increased during exercise. Changes in LV ejection fraction during exercise were well correlated with changes in longitudinal function (R^2=0.379, p=0.018). LV apex rotation and rotation rate also increased during test (11.5±3.8 to 21.8±2.5 deg, p<0.0001 and 122.2±47.7 to 209.5±41.9 deg s^{-1}; p=0.0001 respectively for rotation and rotation rate). Intra- and inter-observer agreements for strain measurements were good. The variability between observers ranged from 0.5 to 6.4%.

Conclusion: Evaluation of LV function by 2D-speckle tracking during exercise is feasible. This method can thus be used to accurately assess LV functional reserve during stress.

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Assessment of left ventricular function by real-time three-dimensional speckle tracking echocardiography compared to magnetic resonance imaging

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Aims: Real-time three-dimensional speckle tracking (3DST) echocardiography has recently been proposed to improve left ventricular myocardial function assessment. To evaluate its accuracy, we investigated the correlation between 3DST data and left ventricular ejection fraction (LVEF) obtained by magnetic resonance imaging (MRI).

Methods: 37 patients (56±15 years old, 26 men) referred for LVEF assessment by MRI, underwent on the same day real-time 3D-echocardiography. LV volumes, LVEF and 3D strain components (longitudinal, radial, and circumferential strains) were computed by a 3D-speckle tracking software using multi-beat 3D datasets.

Results: A close correlation between MRI and 3DST was observed for end diastolic (r^2=0.7, mean=130±62mL), end-systolic (88±72ml, r^2=0.8) volumes and LVEF (r^2=0.7, mean=52±16%). No significant bias was observed between MRI and 3D-speckle tracking for LVEF measurement (52±16% vs. 51±14%, p=0.6). In addition, all strain data obtained by 3DST correlated with LVEF by MRI [r=0.5 for longitudinal strain, r=0.6 for radial strain, and r=0.7 for circumferential strain].

Conclusion: Real time 3D-speckle tracking provides a reliable assessment of LV volumes and ejection fraction compared to MRI data, with a comprehensive measurement of myocardial deformation indexes.

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Relative importance of the afterload and of myocardial disarray on left ventricular longitudinal function. A rest and standardized exercise study

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Background: Hypertrophic cardiomyopathy (HCM) and aortic stenosis (AS) may impact left ventricular (LV) systolic functions despite preservation of the LV ejection fraction (EF). Studies have especially demonstrated in these two populations a decrease in LV longitudinal function.

AIMS: We sought to determine the relative importance of the afterload and of myocardial hypertrophy (& disarray) on LV longitudinal potential dysfunction at rest and during a standardized exercise.

Methods: Consecutive patients with a severe (<1.5cm²) asymptomatic AS and patients with a HCM were explored according to the same protocol by a rest and exercise echocardiography. A complete echocardiography including tissue Doppler was performed at rest and during the exercise on a dedicated table. Furthermore, long-axis function was assessed at rest and at exercise by using deformation imaging (2D-strain). Exclusion criteria were: altered LVEF (<50%), coronaropathy, intra-L obstruction >30mmHg at rest, arrhythmia, diastolic LV thickness ≥30mm, NYHA > II.

From these two populations, we selected 25 patients apparied in age, sexe, rest and exercise blood pressure, degree of LV hypertrophy and LVEF.

Results: The mean age was, the mean blood pressure was and the workload reached during the exercise stress echocardiography was. The inter ventricular septum diastolic thickness was 1.45±0.2mm in AS vs. 1.55±0.2mm in HCM (p=0.053). Global longitudinal strain (GLS) was at rest –14.9±4.7% in AS vs. –16.1±3.9% in HCM (p=0.30). At 110±10 beat/min, the SGL was –14.1± 4.2% in AS vs. –18.1±5.4% in HCM (p=0.005), during exercise GLS decreased in AS but increased in HCM (ΔGLS 0.77 ±3.1% in AS vs –1.94 ±3.37% in HCM).

Conclusion: Longitudinal LV deformations, during the exercise, were very significantly lower in AS-patients as compare to HCM-ones despite very close characteristics at rest. The greater afterload in AS patient might explain this different LV-myocardial response to exercise in these 2 groups of patients having very closed LV-myocardial function at rest.

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A novel method for automatic quantification of late gadolinium enhancement in acute myocarditis

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Purpose: Late gadolinium enhancement sequence is a robust technique for detection of fibrosis in acute myocarditis. However, there is no consensus regarding the quantification of LGE in myocarditis. Some centers use visual assessment; some others use signal intensity thresholds of 2 or more standard deviations (SD). This method is semi-automatic needing to trace manually a remote myocardium. The Otsu-Auto-Threshold (OAT) method is based on the so-called Otsu algorithm, which automatically divides the histogram into two "classes", normal and enhanced, and automatically calculates a threshold which best separates the two classes, minimizing intra-class variance. No specific region within the myocardium has to be defined as normal or abnormal. The purpose of this study was to compare these and standard-deviation based thresholds for automatic quantification methods of LGE in acute myocarditis.

Methods: CMR was performed in 30 patients with acute myocarditis. LGE was quantified by visual assessment (as a reference method) and compared to OAT, full-width-half-max (FWHM) and thresholds using 2SD, 3SD and 5SD above mean SI of remote myocardium. The total enhanced mass was measured by all approaches for each patient.

Results: The mean mass of LGE with visual analysis was 16.5±10.4g. All methods were significantly correlated with visual assessment with a very strong correlation with the OAT method (r=0.976,

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