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"Ischemic cascade" during dipyridamole stress echocardiography in patients with stable coronary heart disease.

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Purpose: Previous studies have shown that transmural myocardial ischaemia caused by sudden epicardial coronary artery occlusion determines a typical sequence of events characterized, in order, by left ventricular wall motion abnormalities, ST segment ischemic modifications and, only at the end, angina.

In this study, we investigate if this typical "ischemic cascade" presents with the same modalities also during subendocardial ischemia induced by dipyridamole infusion.

Patients and Methods: A total of 41 patients (63±9 years; 12 women) with chronic stable angina and angiographically documented coronary artery disease (1- vessel: 14 [34%]; 2- vessel: 8 [19%]; 3- vessel: 19 [46%]) underwent dipyridamole stress echocardiography (total dose: 0.84 mg/kg iv). Cardiac images were acquired with a 2.5 MHz probe connected to a Toshiba set, Power Vision 8000.

Results: During test, 39 patients (95%) had left ventricular wall motion abnormalities, 31 patients (75%) had ST segment depression and 32 patients (78%) had angina. The first manifestation of ischemia was left ventricular wall motion abnormalities in 7 patients (17%), ST segment depression in 16 patients (39%) and angina in 9 patients (22%). When considering only the 21 patients who developed all three manifestations of ischemia during dipyridamole stress echocardiography, left ventricular wall motion abnormalities were the first manifestation of ischemia (alone or in association with ST segment depression or angina) in 5 patients (24%), ST segment depression was the first manifestation of ischemia (alone or in association with left ventricular wall motion abnormalities or ST segment depression) in 8 patients (38%).

Conclusion: Our data indicate that dipyridamole induced subendocardial ischemia results in a very variable sequence of events, which doesn’t seem to reproduce the typical "ischemic cascade" described after sudden coronary artery occlusion. The heterogeneity of the response among patients likely depends on a variable associated with interindividual differences in the extension of ischemia, in the sensitivity of cardiac neuronal algogenic receptors and in the adenosine-mediated effects of dipyridamole on cardiac perception of pain and on electrophysiological characteristics of myocardial cells.

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Cultural evolution of digital description of coronary artery disease severity potentiating inducing myocardial ischemia during exercise stress echocardiography.


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Objective: To determine, if other characteristics including not just severity and localization of coronary stenosis but also the amount of myocardium at jeopardy, would better correlate with the potential of provoking ischemia by exercise than classical numeric description of diseased coronary vessels.

Background: Although simply and easy, coronary artery disease severity described by the number of diseased vessels, may underestimate the potential importance of coronary anatomy, as well as the importance of myocardium at risk to develop myocardial ischemia during exercise stress echocardiography test.

Methods: We evaluated 211 consecutive pts (171 male, 40 female; mean age 73±9 years; 12 women) with chronic stable angina and angiographically documented coronary artery disease (1-vessel: 14 [34%]; 2-vessel: 8 [19%]; 3-vessel: 19 [46%]) underwent dipyridamole stress echocardiography according to Bruce treadmill protocol and coronary arteriography (one-vessel CAD, 114 pts; multi-vessel CAD, 45 pts). Myocardial jeopardy score is calculated for each vessel as a sum of all significant lesions represented as a product of: (1) myocardial kinetic status (0 for akinetic, 0.5 for hypokinetic, 1 for normokinetic), (2) diameter stenosis of significant coronary artery (0.5 for heptonic, 1 and 1 for each normokinetic myocardial segment subserved by the vessel with equal or more than 50% diameter stenosis), (2) diameter stenosis of significantly stenosed coronary artery vessel (scored from 3-5), and (3) weighting flow factor for particular localization.

Results: Univariate logistic regression analysis showed significant correlation between number of diseased vessels, % diameter stenosis, weighting flow factor, myocardial jeopardy score, with the results exercise stress echocardiography (p<0.0001 for all). However, in multivariable analysis significant predictor of stress test results was only myocardial jeopardy score (p<0.0001). Cut-off value of myocardial jeopardy score best predictive for stress test outcome was 9.5.

Conclusion: Global myocardial jeopardy score was the only multivariate predictor of stress echocardiography test results containing the information of functional stenosis significance (severity and localization) and amount of myocardium at risk. Thus, this is the best digital description of coronary artery disease potential for provoking ischemia by exercise.

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Automated classification of wall motion abnormalities by analysis of left ventricular endocardial contour motion patterns.

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Objective: fully automated border detection (ABD) and classification of wall motion abnormalities (WMA) is highly desired for objective analysis of stress echo.

Methods: We developed a fully automated ABD technique based on Active Appearance Motion Models (AAMM), which learns typical shape-motion patterns from a set of example image sequences. AAMM uses Principal Component Analysis to find eigenvarianes of shape/motion, including typical normal and pathological endocardial contraction patterns, and expresses each shape as a linear combination of these. We hypothesized these AAM modal shape coefficients (MSCs) would allow WMA classification.

Experiments: Low-dose dobutamine (LDD) stress echo was performed on 120 patients with coronary artery disease and training (TRN, n=45) and test set (TST, n=64). Expert-verified endocardial contours (MAN) were available in 4-chamber (4c) and 2-chamber sequences for baseline and LDD. AAMMs were generated from TRN and ABD was tested on TST sets. Resulting borders (AUTO) were compared to MAN borders (AUTO vs. MAN).

Results: on 4c baseline TST, AAMM ABD succeeded (APD >4mm) in 97% of cases (APD Mean±SD: 3.6±3.2mm, LVA regression: AUTO=0.91±1.7cm2, n=48). Multivariate linear regression showed good correlations between AAM MSCs and global and segmental (average R²=0.6) WMS. Discriminant analysis showed good prediction of both segmental (85±6% correctness) and global WMA (90% correctness).

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Conclusion: AAMM allows fully automated endocardial border detection and its MSCs show promising accuracy for automated classification of WMA.

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Positive pre-ejection velocity changes during dobutamine stress test in identifying hibernating myocardium and predicting functional recovery.

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Introduction: The value of pre-ejection velocity changes recorded by tissue Doppler imaging (TDI) during dobutamine stress echocardiography to predict functional recovery has not been studied.

Purpose: The aim of this study was to evaluate the accuracy of TDI velocity changes during low-dose dobutamine stress echocardiography to predict functional recovery. 2-5 days before revascularization. TDI ejection (E) and PE as well as early (Ea) and late (Aa) diastolic velocities were recorded during rest and dobutamine stress echocardiography.

Results: Rest echocardiography was repeated 3 months after revascularization.

Conclusion: Left ventricular ejection fraction increased from 24±4 to 35±5 at follow-up (p<0.001). Of the 408 revascularized segments with severe dysfunction, 188 (45%) improved at follow-up. E, PE and Ea velocities (cm/sec) changed significantly dobutamine stress echocardiography vs. rest (4.8±1.2 vs. 5.9±1.6, 4.9±1.13 vs. 6.5±1.95, 4.8±0.9 vs. 5.6±1.4, respectively, p<0.001), whereas Aa velocities (cm/sec) did not change (6.3±1.4 vs. 6.4±1.3). The use of receiver operating curves identified a stress-induced increase of 0.5 cm/sec in E velocity as the optimal cut-off value for viability, which predicted recovery of myocardial function with a sensitivity of 80% and a specificity of 86%. Interestingly, a stress-induced increase of PE velocity by 0.6 cm/sec was identified as having superior sensitivity of 91% and a specificity 90% in predicting functional recovery. A cut-off point of 0.44 cm/sec change in Ea velocity during Dobutamine stress echocardiography had a high also sensitivity (80%) and specificity (81%) to predict myocardial recovery function.

In conclusion, pre-ejection velocity increase is the most accurate index, for the identification of hibernating myocardium during dobutamine stress echocardiography, concerning prediction of functional recovery. This is maybe due to lower tethering effect during pre-ejection period.