Is there a role for exercise echocardiography in the prognostic stratification of patients with low pretest probability of coronary artery disease?

A. Elhendy, D. Mahoney, K. Ostrander, C. Shub, R. McCully, P. Pellikka
Echocardiography Dept., Mayo Clinic, Rochester MN, United States of America

Rationale. The aim of this study was to determine whether exercise echocardiography provides incremental data for risk stratification of patients with suspected coronary artery disease (CAD) who are determined to have a low pretest probability.

Methods. The study included 1618 patients with pretest probability of CAD referred for symptom-limited treadmill exercise echocardiography. Mean age was 55±13 years. There were 571 men and 1047 women. Ischemia was defined as new or worsening wall motion abnormalities. Outcomes recorded during the follow-up were hard events (cardiac death and non-fatal myocardial infarction) and coronary revascularization.

Results. Cardiac events occurred in 56 patients (6 cardiac deaths, 13 non-fatal myocardial infarction, and 37 revascularization) during a median follow-up of 3 years. In the multivariate analysis of clinical, exercise and echocardiographic parameters, independent predictors of the combined endpoint of all cardiac events were the exercise wall motion score index (Chisq=20, p=0.0001) and resting systolic blood pressure >140 mmHg (Chisq=4, p=0.04). Independent predictors of hard events (Chisq=10, p=0.001) and age (Chisq=10, p=0.001). Conclusion. Exercise echocardiography is a valuable tool for the risk stratification of patients with suspected CAD who have a low pretest probability. Peak exercise heart rate and ischemic ECG change during exercise provide incremental data to the clinical variables. The extent and severity of exercise-induced wall motion abnormalities are strong predictors of cardiac events, and provide incremental value to clinical and exercise stress test data. Ischemia detected by exercise echocardiography but not by ECG was predictive of hard events in this population.

Abnormal intraventricular flow velocities in patients with angina-like symptoms and angiographically normal coronary arteries

Cardiology Dept., O.L.V. Hospital, Aalst, Belgium

The mechanism of angina-like (AL) pain in patients with normal coronary arteries is not clear. We tested the hypothesis that AL pain in pts with normal coronary angiogram is related to induction of abnormal (A) intraventricular (I) flow (F) velocities (V). Accordingly, 32 pts with AL pain (no LV hypertrophy and valvular disease) underwent dobutamine echocardiography (DE). Twelve asymptomatic pts served as controls (C). AIFV were defined as a dagger shaped Doppler spectrum > 3 m/s. Plasma noradrenaline (NOR), adrenaline (ADR) and plasma renin activity (PRA) were determined. Pts with AIFV had a higher IFV (1.1±0.15 vs 0.85±0.06 m/s, p<0.01) at rest and slightly smaller LV diastolic (d) and systolic (s) diameters (d) than C (50±4 vs 55±1.5 mm and 30.4±2.6 vs 34±1.7 mm, respectively). Female gender was more frequent in pts with AL pain vs C (60% vs 8%, p<0.01). No patient developed wall motion abnormalities during DE. However, at DE, IFV were higher in pts with AL pain vs C (2.5±1.1 vs 2.0±0.1 m/s, p<0.01). Fifty five % (18/32) of pts with AL pain developed AIFV vs only 8 % (1/12) of C pts (p<0.001). Table shows the description of AL pain pts with and without AIFV. The induction of AIFV was associated with a larger decrease in LVSD and LVEDD and a higher PRA. There were no differences in plasma NOR and ADR (0.16±0.25 vs 0.11±0.14 µg/L and 0.69±0.49 vs 0.57±0.41 µg/L, p<0.05). After 6 weeks of betablocker therapy, pts with AIFV had lower angina score than at baseline (4.1±2.3 vs 0.1±0.3, p<0.001), lower PRA (9.1±6.7 vs 0.001) and a lower AIFV during DE (2.4±1.1 m/s vs 3.7±0.6 m/s, p<0.01). Conclusions. 1. Pts with AL pain and a normal coronary angiogram are prone to develop AIFV in response to beta-agonistic stimulation. 2. This pattern can be blunted by treatment with betablockers. 3. Taken together, this suggests that a myocardial hypersensitivity to adrenergic stimulation may play a role in AL pain.
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Clinical and quantitative arteriographic determinants for development of coronary spasm during ergonovine stress echocardiography
M. Nedeljkovic, M. Ostojic, B. Beleslin, I. Nedeljkovic, S. Stojkovic, A. Arandjevic, J. Saponjic, V. Vulcovic, D. Orlic, V. Kanjuh
Cardiology Dept., Univ. Institute for CVD, Belgrade, Yugoslavia

Background: Ergonovine stress echocardiography has been used for detection of myocardial ischemia during ergonovine-induced coronary artery spasm (CS). However, the relation between clinical and arteriographic data in patients (pts) with chest pain syndrome and without significant coronary artery disease (CAD) has not been fully investigated.

Objective: The aim of this study was to obtain prognostic information on the relation of various clinical and angiographical data to the development of CS during ergonovine echocardiography.

Methods: The vasomotor response to ergonovine was studied in 100 patients (45 male, 55 female; 52±8 years) with chest pain syndrome and mild coronary stenosis (mean 20±10 diameter stenosis). The ergonovine echo test was performed in consecutive pts at the end of diagnostic catheterization disclosing non-significant CAD. Echo criteria for test positivity was appearance of new wall motion abnormalities (WMA). Doses of 0.05, 0.10 and 0.20mg of ergonovine maleate were given intravenously in succession at 3 minutes intervals. For multivariate analysis we have included data on clinical symptoms and risk factors for CAD, and quantitative coronary arteriography derived parameters obstruction diameter (OD) and % diameter stenosis (DS).

Results: CS defined as >50% reduction of diameter stenosis (75% area stenosis) up to the subtotol or total obstruction of the vessel was found in 5 patients (5%) who were accompanied with new WMA. Thus, sensitivity of ergonovine echo was 100%. Covaraffes significantly associated with the development of CS included increased number of CAD risk factors (p=0.04), high total cholesterol (OD=0.009), high HDL cholesterol (p=0.01), high triglycerides (p=0.01) and decreased basal OD (p=0.04). Stepwise multiple logistic regression identified the strongest parameter determining development of CS included total cholesterol (p=0.006) and decreased basal OD (p=0.04). We have also found significant (p<0.05) positive relation between changes in OD (basal OD - ergonovine OD) and total cholesterol.

Conclusion: Clinical and angiographical predictors for the development of CS during ergonovine echocardiography.

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Ischaemic cardiomyopathy: Interaction between viability and revascularization predicts long-term survival
M.J. Andrade 1, M. Trabulo 1, JA. Silva 1, C. Aguilar 1, AO. Oliveira 2, E. Horta 1, R. Gouveia 1, R. Seabra-Gomes 1
Cardiology Dept., Santa Cruz Hospital, Lisbon, Portugal 1, Dpt. Biomateematica, Faculadade Medicina de Lisboa, Lisbon, Portugal 2

Purpose: To assess the prognostic implications of myocardial necrosis and viability and revascularization in patients (pts) with coronary artery disease (CAD) presenting with ventricular (LV) dysfunction.

Methods: Prospective follow-up was obtained in 93 consecutive Pts with CAD and LV ejection fraction <35% who underwent low-dose dobutamine echocardiography (LDE). Wall motion score (WMS) was calculated at rest and during dobutamine infusion (5-15 mg/Kg/min), using a 16 (extent) x 3 (severity) points echocardiographic model. MCR consistent with myocardial viability was defined as a decrease >=4 points in WMS during dobutamine.

Results: MCR during LDEE was present in 60 Pts, 38 (63%) of whom underwent subsequent revascularization. Of the 33 Pts without MCR, 6 (18%) underwent revascularization. During the follow-up period, 39 events occurred (36 cardiac deaths and 3 transplants). Pts were divided in four groups according to LDEE result and type of treatment (medical vs. revascularization).

Conclusion: Clinical and angiographical predictors for the development of CS during ergonovine echocardiography.

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Detection of myocardial viability by hyperbaric oxygen treatment and echocardiography after thrombolysis for acute myocardial infarction
M. Dekleva 1, V. Obradovic 1, A. Djerdevic-Dikic 2, A. Neskovski 3, N. Dikic 1, B. Pancic 1, M. Ostojic 1
Cardiology Dept., KBC Zemun, Belgrade, Yugoslavia 1, Cardiology Dept., Institute for Cardiovascular Disease, Belgrade, Yugoslavia 2, Cardiovascular Institute, Belgrade, Yugoslavia 3

Background: It has been proposed that hyperbaric oxygen treatment (HBO) is capable of transiently reversing hypoxia in myocardium during acute phase of myocardial infarction (MI).

Objective: To evaluate whether early HBO (within 24 hours) can identify viable segments after acute MI, improvement of regional wall motion (RWM) after HBO was analyzed and compared to dobutamine stress echocardiography (DSE) performed in the third week and to follow up echocardiography (FUE) performed in 6th week after MI.

Methods: Thirty one consecutive pts with first acute MI treated with thrombolyis received 100% oxygen at 2 ATA for 60 minutes in a monoplace hyperbaric chamber within 24th after the onset of pain. All pts underwent 2D echocardiography immediately before and after HBO, DSE in third week and FUE in sixth week after MI. RWM analysis was performed using 16-segment model. Improvement in RWM of diastricentric segments for 1 grade during low DSE was considered as sign of viability. Comparison of HBO echo and follow-up studies after six weeks for the detection of viability has been made using DSE as the gold standard.

Results: There were 229 diastrientric segments before HBO (RWM 1.8±0.23). Improvement in RWM was noted in 86 segments after HBO, in 90 during DSE and in 83 after 6 weeks. Comparing HBO and DSE there were no significant differences in number of detected viable segments (p=0.385) and in RWM differences (p=0.099). The number of responding segments was time related; the shorter the time to onset of chest pain, the more segments responded (p=0.005). The sensitivity, specificity and positive and negative predictive value of HBO to detect recovery of viable segments are 87%,91%,84% and 93% respectively.

Conclusion: Our data indicate that HBO can identify viable myocardium as early as day first after MI, and has high and comparable diagnostic value to DSE.

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Is the aortic root part of territory afflicted by acute coronary occlusion?
Cardiology Dept., Athens Univ., Athens, Greece

The human aortic (Ao) root is nourished by pure venous (v) originating from the coronary arteries (CA). Experimental v fluorescence disruption has been shown to cause prompt deterioration of Ao root elastic. By contrast, the effects of spontaneous v flow disruption are unknown. To investigate this issue, the following approach was undertaken: Transesophageal echo and CA angiogram were performed in 60 pts (age 56±10.9 years, 52 male) with AMI as their first CAD event. Two indices of regional Ao mechanics were calculated: Ao distensibility (AD)=2 x (pulsatile change in ao diameter) / (x); Ao strain=pulsatile change in diameter / diamatio ao diameter. Diastemers were considered to reflect Ao strain. Ao pulse pressure (PP): Blood pressure (BP) was measured by brachial artery sphygmomanometry. Cefradam/loop pulse wave velocity (PWV) was determined as an index of overall ao stiffness. Considering available anatomic data on the origin of human ao v (origin in proximal parts of the CA; predominant contribution of the left CA), pts were grouped according to culprit lesion location in group A: lesion in proximal LAD, middle LAD or proximal Lcx (n=32 pts), and group B: lesion in distal LAD, distal Lcx or entire RCA (n=28 pts). Regional and overall ao function indices were compared between the 2 groups.

Pts in group A were older (59.2±10.7 vs 53.4±7.0 years; p<0.04) and had lower LVEF (0.39±0.1 vs 0.45±0.08; p<0.02). Results: Groups did not differ regarding ao dimensions, BP, heart rate, prevalence of risk factors, risk factor sum per pt, CAD extent, culprit CA patency status, and drug treatment on the day of the echo. Both indices of regional ao elasticity were significantly lower in group A vs B (AD: 1.17±0.68 vs 1.70±0.70; p<0.005; 5.25±1.78 vs 4.45±1.50; p=0.001). PWV did not differ between groups (10.0±2.9 vs 10.6±2.4 m/s, p=NS). Multiple regression analysis identified lesion location (A vs B) (r=0.46, p=0.001) and pulse pressure (r=0.39, p=0.004) as significant independent predictors of AD. Location was the only significant predictor of aortic strain (r=0.54, p<0.001).

Age was the only significant predictor of PWV (r=0.54, p=0.003). Indices of regional ao root strain elasticity correlated poorly with PWV.

Our data suggest that the ao root is influenced by CA occlusion, particularly when the latter regards the central parts of the left CA. Clinical implications of these findings concern post-MI undermining of ao wall integrity.
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Cardiac arterial wall velocities assessed by tissue Doppler imaging reveals significant reduction of velocities in patients with atherosclerosis
O. Papademetriou, G. Pelle, S. Adnot, P. Gueret, J.L. Dubois-Rande, L. Belhassen
U286-INSERM, CHU Henri Mondor, Paris, France
Background: Vascular ultrasound is used to detect early stages of atherosclerosis, to evaluate plaque structure and motion, and determine functional parameters of the arterial wall. Arterial wall velocities (AVV) determination could be useful in evaluating atherothrombotic early damage to the vascular wall. In this study, we analyzed cardiac AWV using a new implementation of Tissue Doppler Imaging (TDI) techniques.

Methods:High resolution color B mode DTI acquisitions were performed on common carotid arteries (CCA) using a 7-12 MHz broadband transducer (ATL HDI 5000) in 12 healthy volunteers (39.7±7.1 years) and 12 patients (57.6±18.9 years) with patient atherosclerosis. Mean transmural AVV were calculated over time for anterior and posterior walls. Values were corrected for global translation motion of the artery. Mean peak systolic velocities (Vmax) and accelerations (Amax) of the anterior and posterior walls were analyzed.

Results: High quality AVV acquisitions could be obtained from all subjects with a very good reproducibility. Controls had higher Vmax than patients, both on anterior (8.7±4.3 mm/s vs. 3.3±1.2 mm/s, p<0.001) and posterior wall (8.8±5.1 mm/s vs. 3.6±1.3 mm/s, p<0.001). Controls had also higher Amax than patients (216.3±87.7 mm/s-2 vs. 108.6±33.8 mm/s-2 for anterior wall, p<0.001, and 182.3±78.5 mm/s-2 vs. 111.7±34.6 mm/s-2 for posterior wall, p<0.01).

Conclusions: Velocities and accelerations of common carotid arterial walls are significantly reduced in patients with patent atherothrombotic arteries. Vascular DTI is sensitive and reproducible in analyzing vascular wall velocities and could have important implications in patients clinical management.

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Endothelium-independent vasodilation is impaired at peripheral microcirculation. Vessel in hypertensive patients with left ventricular hypertrophy
F. Vitonne 1, C. Morizzo 2, M. Ciardetti 1, M. Kozakova 2, C. Palombo 1
Cardiology Dept., Inst. of Clinical Physiology, Pisa, Italy 1, Dept of Internal Medicine, Pisa University, Pisa, Italy 2
In patients with essential hypertension (HBP), left ventricular hypertrophy (LVH) is an independent risk factor for cardiovascular events, and it is recorded to be associated with structural and functional alterations, both at coronary and peripheral level, which may contribute to the LVH related-risk. The so-called "concentric remodeling" (i.e., increased relative wall thickness with normal LV mass) has been associated to a risk profile similar to that of LVH.

The aim of this study was to assess microcirculatory function at peripheral level in HBP patients according to the presence or absence of an "hypertrrophic geometry", including LVH and concentric remodeling.

Methods: 29 untreated patients with mild to moderate HBP (mean age 53.7±5.8 yrs), SBP/DBP 155±69/66±10 mmHg and in 17 normotensive control subjects (NC, mean age 50±9 yrs), SBP/DBP 118±72/59±6 mmHg vasodilatory capacity of peripheral microcirculation was investigated at forearm level by means of laser Doppler flowmetry at baseline and during five stepwise doses of iontophoretically applied Acetylcholine (ACh) and Sodium Nitroprusside (SNP). At basal M-mode echocardiography, 17 HBP patients showed either LVH or concentric LV remodeling (mean LV mass index 94.2±17 g/m²). Mean arterial blood pressure was not different in the two hypertensive subgroups (94±27 and 101±11 mmHg, respectively).

Results: Baseline skin blood flow was comparable in all groups. HBP patients showed a lower response to both vasodilators, although it did not reach statistical significance. By contrast, HBP patients with an "hypertrrophic profile" showed significantly reduced response to SNP as compared to both nonhypertrrophic HBP and NC. Peak vasodilation response at SNP was 28±5.8 vs 18.5±4.6 vs 44.6±27.5 vs 48±23 percentage units, respectively.

Conclusion: Compared to controls, hypertensive patients show a reduced vasodilatory response of skin blood flow to ACh and SNP. Such a dysfunction is more evident in response to SNP and in presence of LVH or concentric LV remodeling. These findings further support the hypothesis of structural peripheral vascular abnormalities (vascular rarefactions) parallel- ing LVH and possibly contributing to the overall ischemic burden in these patients.

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Myocardial viability by low-dose adenosine stress echocardiography: detection and prognostic value
D. Djojodjikic-Dikic, M. Ostoic, BB. Belelivan, IN. Nedeljkovic, JS. Stojkovic, MN. Nedeljkovic, SS. Stojkovic, ZP. Petrasinovic, DO. Orlic
Cardiology Dept., Inst. for Cardiovascular Disease, Belgrade, Yugoslavia
Objective: The aim of this study was to identify myocardial viability by low-dose adenosine (Ado) echo-echocardiography (echo) and to assess its prognostic value during follow up.

Methods: Forty three pts with resting dyskysnergy, due to previous myocardial infarction, underwent low-dose ado (80, 100, 110 mcg/kg/min in 3 minutes intervals) echo test. Criteria for myocardial viability was improvement in systolic wall motion of dysenergetic segments of ≥2 grade. Coronary angiography performed in 41 pts revealed one vessel coronary artery disease in 30, 2 vessel in 9 and 3 vessel in 2 pts (diameter stenosis ≥50% of at least one major coronary artery). Twenty six pts were revascularized and 17 were medically treated. Follow up data (13±11 months) were available in 37 pts. Echo follow up was obtained after 3±3 months in 29 pts.

Results: Systolic blood pressure (rest: 133±15 mmHg) decreased significantly after low-dose Ado (127±18 mmHg, p<0.001 vs rest), as well as diastolic blood pressure (81±9 mmHg to 78±12 mmHg, p<0.001). Heart rate at rest 75±12 bpm increased significantly to 83±20 bpm (p<0.001) during low-dose Ado. One patient had biphasic response during low-dose Ado. Wall motion score index (WMSI) improved from rest 1.52±0.29 to 1.33±0.26 at low-dose Ado, p<0.001. Of the 102 segments with baseline dysenergency, 83 were responders, and 79 were non-responders. Echo identified 91 segments as viable, and in 71 no signs of viability was observed. Follow up WMSI was 1.31±0.30 (p<0.001 vs. rest). The sensitivity of Ado for detection of viable segments was 86 %, while specificity was 94 %. Positive and negative predictive values were 95% and 94%, respectively. During follow up, the only event was occurrence of angina, more frequent in revascularized pts with no signs of viability at Ado test (p=0.003), and was associated with worse WMSI at follow up (p<0.04).

Conclusion: Low-dose adenosine echo test has high diagnostic value for predicting functional recovery in revascularized and medically treated pts. In revascularized pts absence of viability is related with more frequent occurrence of angina during one year follow up. Ado echo test is adequate alternative to low-dose dobutamine test for evaluation of myocardial viability.

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The impact of beta-blockers on the detection of myocardial viability by dobutamine stress echocardiography
T. Zaglavara 1, R. Haaverstad 2, B. Camberger1, T. Irvine 1, H. Karvounis 2, G. Parhatidis 2, A. Kenny 1
Cardiology Dept, Freeman Hospital, Newcastle Upon Tyne, United Kingdom 1, Cardiology Dept, Aristotle University, AHEPA Hospital, Thessaloniki, Greece 2
Beta-blocker withdrawal for 3-4 days before DSE is a common practice before Dobutamine Stress Echocardiography (DSE) studies, however it is potentially dangerous in patients with LV dysfunction and significant CAD. We hypothesized that beta-blockers by preventing the early occurrence of ischaemia, in addition to safety would improve the sensitivity of DSE to predict functional recovery in revascularized and medically treated pts.

Patients and Methods: Ten patients with 3 vessel CAD, impaired LV function (mean EF 45±7%), underwent low-dose Ado (80, 100, 110 mcg/kg/min) stress testing with the standard protocol. Resting LV function was assessed by echocardiography for predicting functional recovery in revascularized and medically treated pts.

Results: Systolic blood pressure (rest: 133±15 mmHg) decreased significantly after low-dose Ado (127±18 mmHg, p<0.001 vs rest), as well as diastolic blood pressure (81±9 mmHg to 78±12 mmHg, p<0.001). Heart rate at rest 75±12 bpm increased significantly to 83±20 bpm (p<0.001) during low-dose Ado. One patient had biphasic response during low-dose Ado. Wall motion score index (WMSI) improved from rest 1.52±0.29 to 1.33±0.26 at low-dose Ado, p<0.001. Of the 102 segments with baseline dysenergency, 83 were responders, and 79 were non-responders. Echo identified 91 segments as viable, and in 71 no signs of viability was observed. Follow up WMSI was 1.31±0.30 (p<0.001 vs. rest). The sensitivity of Ado for detection of viable segments was 86 %, while specificity was 94 %. Positive and negative predictive values were 95% and 94%, respectively. During follow up, the only event was occurrence of angina, more frequent in revascularized pts with no signs of viability at Ado test (p=0.003), and was associated with worse WMSI at follow up (p<0.04).

Conclusion: Low-dose adenosine echo test has high diagnostic value for predicting functional recovery in revascularized and medically treated pts. In revascularized pts absence of viability is related with more frequent occurrence of angina during one year follow up. Ado echo test is adequate alternative to low-dose dobutamine test for evaluation of myocardial viability.
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The assessment of left ventricular function by dynamic and pharmacological stress echocardiography in survivors for childhood cancer
L. Elbi 1, H. Hrdlová 2, V. Chaloupka 1, J. Novotný 3
Cardiopulmonary Testing Dept, University Hospital, Brno, Czech Republic 1, Dept. of Pediatrics, Faculty Hospital, Brno, Czech Republic 2, Dept. of Physical Education, Masaryk University, Brno, Czech Republic 3
Background: Late cardiotoxicity, which may present years after successful treatment, has been described in children. Echocardiographic abnormalities are common, ranging from 23 to 65%. Aim of study: To assess rest and stress variables of LV function and to compare their response to dynamic (bicycle, DYSE) and pharmacological (dobutamine, DSE) stress echocardiography. Methods and patients: We have examined 49 patients (25 boys, 24 girls, age of diagnosis 7.4 + 4.8 yrs) four years after the completion of the chemotherapy. We have used symptoms limited dynamic stress echo (25W/min) and pharmacological stress test with small doses of dobutamine (5-10 ug/kg/min in duration of 4 minutes). The increase of EF >5% was considered as a normal response to the stress. Results: All children revealed normal rest values of EF and parameters of diastolic function. The exercise capacity was excellent (2.35W/kg) and did not differ to healthy adolescents. EF increased from 6 + 3% to 7 + 5% during DYSE and from 6 - 3% to 7 - 5% during DSE (n.s.). Isovolumic relaxation time (IRP) shortened after both stress modalities but more markedly after DYSE (30% versus 17%, p<0.0001). Dobutamine has improved relaxation of LV as follows: IRP decreased of 17%, E/A increased of 17% and deceleration time remained unchanged. Conclusion: 1. We have not found changes in LV systolic and diastolic function in children four years after chemotherapy. 2. Both stress modalities revealed unimpaired relaxation of LV and contractile reserve. 3. Small doses of dobutamine can be used in LVEF identical to that after maximal physical endurance; in addition, DSE enables to study the diastolic function more accurately.

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Tissue Doppler echocardiographic examination of ischaemic myocardium before and after coronary revascularisation
F. Szabó1, K. Heotai1, E. Bodor2, T. Vecsey2
Cardiology Dept., Hungarian Railways Hospital, Budapest, Hungary 1, Cardiologic Surgery, Semmelweis Medical University, Budapest, Hungary 2
Our goal was to detect the myocardial systolic function after coronary revascularisation with tissue Doppler echocardiography (TDE) in those infants myocardium among segments which had indicated myocardial viability during the stress TDE in the acute phase of myocardial infarction. Methods: TDE was performed in 29 patients between 9-14 days of myocardial infarction. Inflow of 0.28 mg/kg dybridol/dobutamine was stopped for 4 minutes, than 6 mg/kg/min dobutamin (DBA) for 3 minutes and 10 mg/mg/min DSE was given. By TDE the peak systolic wall velocity (PSWV) was measured before and after the stress test in all ischelimic segments. The segment was respected as visible if PSWV increased more than 10% during the low dose DPD-DBA stress test. Out of the patients 13 undertaken coronary bypass surgery and at the others PTCA were done. After more than 6 month of the coronary revascularisation the previously infarcted segments with wall motion abnormalities at rest, were examined again by TDE to detect whether the examined segment was alive or not at resting condition. Furthermore the left ventricular fractional shortening (FS) and the wall motion index (WMI) using the 16 segments echocardiographic score were examined before and after revascularisation . Results: Before the coronary revascularisation 404 segments were observed and out of them 130 indicated ischelimic wall motion disturbances on the resting echo. Out of them 34 segments predicted myocardial viability during the stress test during small doses of dobutamine. After coronary revascularisation 87 segments were alive determined by TDE. After revascularisation both EF and PSWV increased significantly: EF: 44.6 + 9.2% vs. 51.6 + 2.9% (p<0.001), PSWV: 5.6 ± 1.8 cm/s vs. 7.1 ± 2.1 cm/s (p<0.001); while WMI decreased: 1.47 ± 0.28 vs. 1.12 ± 0.12 (p<0.001). The statistic analyses indicated that the stress TDE had the following result to predict the living myocardium after coronary revascularisation. Sensitivity: 81%, specificity: 69%, positive predictive value 87%, negative predictive value: 59%, accuracy: 78%. Conclusion:TDE is a reliable quantitative method to predict the expected results of the coronary revascularisation. Its positive predictive value is highly significantly predicts whether which segments will be alive after coronary revascularisation.

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Left atrial mechanical dysfunction in patients developing atrial fibrillation during dobutamine stress echocardiography
D. Tsapras, A. Macela, G. Koutroulis, R. Slight, P. Nihoyannopoulos
Echocardiography & Cardiology Dept, Hammersmith Hospital, London, United Kingdom
The development of atrial fibrillation (AF) during pharmacological stress echocardiography can be a significant complicating factor. In the majority of cases, AF is associated with a benign complication of dobutamine stress echocardiography (DSE), often self terminated. There is little information about atrial fibrillation predisposing to AF. We hypothesised that a subclinical mechanical dysfunction of the left atrium (LA) may be a predisposing factor leading to AF during intracavitary stimulation with dobutamine. Methods: All patients (pts) with onset of AF during DSE were reviewed for the study (Group1). Apical 4 and 2 chamber views were used to calculate Left Atrial Volumes using area-length formula at end systole(A1/A0), end diastole (LA1/LA0) and the P Echo wave (LWP). The Total(TEV), LA(max-LAmin), Passive (PEV: LA(max-LA0)) and Active(AEV: LA0-LAmin)Emptying Volumes were calculated. In addition, Total(TEV), Passive(PEP) and Active(AEP) Ejection Fractions were calculated as follow : TEF=TEV/LAmax, PEF=PEV/LA(max-AEV) and AEV/PEV. The percentage of PEF and AEP to the TEP (PERTEF & AEPE/TEF) and the PEP/PEV ratio were also estimated. These patients were compared with a group of patients (Group2) matched for age, LV function, LV hypertrophy, MR severity and DSE result. Comparison of measurements between the groups was performed using non-parametric tests. Results: From 1/1994 to 12/1999, among 1506 DSE studies, 15 pts (0.99%) with new onset of AF were found. Of those, 12 with satisfactory echo-images were reviewed. LA was more dilated in Group1 (LAVmax: 74.6 ± 28 vs 48.6 ± 24, p=0.03, LAmin 40.6 ± 25.9 vs 26.9 ± 20.7, p<0.001) and longer (p<0.001) , PSWV: 5.6 ± 1.6 cm/s vs 7.1 ± 2.1 cm/s (p<0.001), while WMI decreased / 1.47 ± 0.28 vs 1.12 ± 0.12 (p<0.001), PEF/TTEF: 0.71 ± 0.13 vs 0.48 ± 0.22, p<0.008, AEP/TTEF: 0.28 ± 0.13 vs 0.51 ± 0.22, p<0.008, PEF/AEP:3.2 ± 2.0 vs 1.9 ± 0.5, p<0.008. Follow up data were available in 13/15 group pts. During a period of 37 ± 16 months, 4/13 pts (30%) of group 1 and 0/12 pts of group 2 had recurrence or were in chronic AF (p=0.03) Conclusion: New onset of AF during DSE appears to unmask a subclinical mechanical dysfunction of the LA, which increases the possibility of recurrent and chronic AF in the future.

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Second harmonic imaging improves sensitivity of dobutamine stress echocardiography for the diagnosis of coronary artery disease
FB. Sozzi1, D. Poldermans1, J.J. Bax1, WB. Vletter1, E. Boersma1, A. Borghetti2, E. Youvouni2, JRTC. Roelandt1
ThoraxCenter, Erasmus Medical Center, Rotterdam, Netherlands 1, Internal Medicine & Nephrology Dept, Pavia, Italy
Background. Second harmonic imaging (SHI) was shown to improve left ventricular (LV) endocardial border visualization at rest. The aim of this study was to assess the value of SHI, compared to fundamental imaging (FI), for the diagnosis of coronary artery disease (CAD) during dobutamine stress echocardiography (DSE). Methods. Sixty-four pts underwent DSE (up to 40 μg of dobutamin/kg/min). Both FI and SHI were performed at rest and during DSE. Endocardial border visualization was assessed by using a 16-segment/3-point score model. Coronary angiography was performed within 3 months of DSE. Significant CAD was defined as more or equal than 70% luminal diameter stenosis in 1 or more epicardial coronary arteries. Results. Heart rate increased from rest (70±13 beats/min) to peak dose (129±16, p<0.001). There was a higher prevalence of segments with new onset LV endocardial border with FI compared to SHI at rest (11% vs. 8%, p<0.05) and at peak stress (17% vs. 10%, p<0.0001). There was an increase of the number of segments with invisible border from rest to peak stress by FI (11% vs. 17%, p<0.01) whereas the difference was less significant for SHI (8% vs. 10%, p=0.05). The overall sensitivity, specificity and accuracy of DSE for the diagnosis of CAD by FI and SHI were respectively 78% vs. 94% (p<0.05), 73% vs. 77% and 73% vs. 89% (p=ns). The increase of sensitivity using SHI compared to FI, was more marked in pts with single vessel coronary disease (p<0.05). Conclusion. The advantage of using SHI in the detection of LV endocardial border was more marked at higher heart rates than at rest. SHI increased the sensitivity of DSE for the diagnosis of CAD compared with FI, particularly for one-vessel coronary disease, while specificity remained unchanged.
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Quantification of dynamic mitral regurgitation by exercise echocardiography in patients with LV dysfunction: What is the best Doppler method?
F. Lebrun, R. Ancion, L. Périn
University Hospital of Liége, Belgium.
To quantify dynamic mitral regurgitation (MR) during exercise in patients with LV dysfunction, we studied 26 pts with chronic coronary artery disease and < 35% ejection fraction during semi-supine exercise echocardiographic test (SEE). Regurgitant volume by the PISA method (RV PISA) increased from 21 ± 12 (range: 5-55) to 38 ± 23 (range: 6-85) ml (p = 0.0001). Optimal flow convergence could be obtained in 92% (24 of 26) during exercises. Interobserver variability was low for rest (3.2 ± 2.4 ml) and exercise measurements (5.0 ± 3.1 ml). Correlations between the measurements obtained by two observers were r = 0.96 at rest and r = 0.98 at peak stress. Regurgitant volume by the quantitative Doppler method (RV Doppler) increased from 29 ± 13 to 48 ± 24 ml (p = 0.0001). RV PISA was highly correlated with RV Doppler at peak-stress (r = 0.91). Vena contracta width (VCW) increased from 4.2 ± 1.0 to 6.7 ± 1.5 mm (p = 0.0001), regurgitant jet area/left atrium area ratio (RJ/A/LAA) from 23 ± 10 to 37 ± 15% (p = 0.0001) and pulsed-wave mitral VTI/Aortic VTI ratio (VTI/mitAo) did not change significantly (p = NS). Correlations between exercise-induced changes (Δ = peak-rest) in RV PISA and MR changes by the other methods are presented in figure 1.

We conclude that 1) RJA is useless, 2) the PISA method can be applied during SEE in a high proportion of pts with heart failure and 3) it is probably the most reproducible method for quantifying MR exercise.

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Prognostic value of ECG changes elicited by dipyridamole stress echocardiography in hypertensive patients is gender related?
J. Milosavljevic 1, M. Ostojic 2, J. Marinkovic 2, N. Milic 2
Institute for Cardiovascular Diseases, Belgrade, Yugoslavia 2
Cardiology Dept., Medical center, Jagodina, Yugoslavia 1

Background: ST segment depression elicited by dipyridamole stress echocardiography after acute myocardial infarction is a sign of ischemia or impaired left ventricular function. The aim of our study was to assess whether paradoxical response during dobutamine stress echocardiography after acute myocardial infarction is a sign of ischemia or impaired left ventricular function.

Methods: All pts with established diagnosis of mild-moderate HT under therapy (60, 66.6%). All of them had uncomplicated infarction. 56 (62.2%) patients had anterior myocardial infarction and 34 (37.8%) patients had inferoposterior localisation of myocardial infarction. The most of them were treated with thrombolytic therapy (60, 66.6%). All of them had uncomplicated infarction. 56 (62.2%) patients had anterior myocardial infarction and 34 (37.8%) patients had inferoposterior localisation of myocardial infarction. On the 10th day all of them underwent dobutamine stress echocardiography examination. During the follow up period of 3 months, patients underwent coronary angiography.

Results: A decrease in the heart rate occurred at increasing doses from 15-40mcg/kg/min in 10 patients (11.11%), in 2 patients with anterior localisation and 8 with inferoposterior localisation. The decrease was sudden in 4 (40%), and gradual In 6 (60%) patients. In 3 (30%) junction rhythm developed and in 5 (25%) AV block II-III. Only in two of them there was a worsening of regional function during high dose-dobutamin infusion, but 7 of them showed improvement during low dose. In one case there was no change in regional wall motion. In 8 (80%) patients there was a simultaneous decrease in blood pressure. Coronary angiographic examination showed that in 5 (50%) patients there was significant coronary artery disease and they underwent PTCA and aorto-coronaryypass, but in 5 (50%) patients there was significant artery stenosis (because of successful thrombolysis) and they were only treated with medications (antiplaet, beta-blockers and with/without nitrates). Also there was not any significant arrhythmic disorder in that group of patients or repeated hospitalisation because of postinfarction angina or heart failure.

Conclusion: We can conclude that paradoxical sinus deceleration does not mean only significant coronary artery disease and "bad left ventricle" and may be due to a vasodepressor's reflex (Bezoar-Jarisch) even after acute myocardial infarction.
220 Myocardial stunning – changes in regional systolic function during a dobutamine challenge: an experimental atrial rate imaging study
F. Jamali 1, J. Strohm 2, F. Windrem 3, T. Kukalek 1, J. D’hooge 1, B. Bljns 1, L. Hafte 1, I. De Scheinder 2, GR. Sutherland 1
Cardiology Dept., Univ. Hospital Gasthuisberg, Leuven, Belgium 1, Cardiology Dept., Univ. Hospital of Wurtzburg, Wurtzburg, Germany 2
It is widely accepted that stunned myocardium responds to low dose dobutamine by a visual increase in regional function. To investigate whether ultrasonic Strain Rate Imaging (SRI) can quantify the changes in the contraction of stunned myocardium during incremental intravenous dobutamine infusion (2.5-10 and 20 µg/kg/min), 12 closed chest pigs had either 30 minutes of severe subtotal ischaemia induced by a perfusion catheter positioned in the circumflex coronary artery (n=6) or served as normal controls (n=6). For each stage, the segmental function of the posterior wall was monitored from a parasternal short axis view using SRI to derive the maximal systolic radial strain rate (SR) and systolic radial strain (eR). The absence of myocardial necrosis was verified with postmortem staining. Results: With dobutamine, SR increased linearly in controls while eR decreased markedly by 26 and 57% respectively vs. baseline, and dobutamine administration resulted in no significant change in SR and eR at the lowest doses (<10 µg/kg/min) increasing only with the highest infusion rates (Figure). Conclusion: In closed-chest pigs, a significant increase in maximal rate and magnitude of systolic deformation in stunned myocardium was only seen at the highest doses of dobutamine infusion. This contrasted markedly with the response of normal myocardium to incremental isoproterenol stimulation.

221 Pac ing-dobutamine stress echocardiography is a method of choice for non-invasive diagnosis of coronary artery disease in selected patients
JL. Darvar, EB. Roberts, JG. Coghlan, DP. Lipkin, TR. Evans Cardiology Dept., Royal Free Hospital, London, United Kingdom
Accuracy of dobutamine (D) stress echo (DSE) very much depends on achievement of target heart rate (THR) or to 85% of max.pedicated HR. Patients (pts) on large doses or combinations of negatively chronotropic anti-anginal medications often fail to achieve THR even when aggressive D–atropine protocols are used. Atropine pacing is a useful means of achieving target HR but lacks the indocine, oxygen-wasting effects of dobutamine. Methods: Pacing-Dobutamine Stress Echocardiography (PDSE) was performed in 41 pts receiving high doses of B-Blockers and/or negatively chronotropic Ca channel blockers. HR increase was achieved using transthoracic photodiode (TO) pacing with a bipolar pill electrode in 96 patients and by in situ DSE pacing in 5 pts. For the PDSE protocol D was used in incremental doses of 5-10-20 mcg/kg/min. Atropine was added in doses 300-600 mcg if the Wenckebach point was reached before 85% of THR was achieved. 21 pts. underwent cardiac catheterisation (CC), 11 pts with CAD underwent both conventional DSE (D 5-10-20-30-40 mcg/kg/min, atropine up to 2000 mcg) and PDSE. Results: 40 pts (88%) attained > or = to 85% of maximum predicted HR. One pt did not tolerate TO pacing. Sensitivity of PDSE for CAD in 21 pts who had PDSE and CC was 95% with Specificity 100%. In 3 out of 11 pts (27%) who underwent both stress tests reversible ischaemia was demonstrated only with PDSE. These pts failed to achieve THR during conventional DSE despite significantly higher maximal dose of D being used (40 vs 20 mcg/kg/min) as well as maximal dose of atropine. Conclusion: PDSE is a well-tolerated test with high diagnostic accuracy. It allows comprehensive assessment of myocardial ischemia in pts who are difficult to stress adequately by conventional DSE.

222 Dobutamine stress echocardiography and contrast-enhanced electron beam tomography for the detection of significant coronary artery disease
D. Ropers, UX. Nilsson, C. Kullen, T. Menne, FA. Flachskam, W. Moshage, W. Daniel, S. Achenbach Cardiology Dept., University of Erlangen-Nuernberg, Erlangen, Germany
Dobutamine stress echocardiography (DSE) and contrast-enhanced electron beam tomography (EBT) both have the potential to noninvasively detect coronary artery disease (CAD). We compared the accuracy of both methods to detect significant CAD (angiographic presence of coronary artery stenoses exceeding 70% diameter reduction) in a direct comparison.
Methods: 62 patients (24 women, 38 men, mean age 63 years) were admitted for coronary angiography due to suspected CAD (primary diagnostic procedure) were studied. DSE was performed using a standard protocol (5 to 40 µg/kg/min dobutamine plus 0.25 mg to 1.0 mg atropine if necessary). Analysis was performed from the parasternal short axis view using SRI to derive the maximal systolic radial strain rate (SR) and systolic radial strain (eR). The absence of myocardial necrosis was verified with postmortem staining. Results: With dobutamine, SR increased linearly in controls while eR decreased markedly by 26 and 57% respectively vs. baseline, and dobutamine administration resulted in no significant change in SR and eR at the lowest doses (<10 µg/kg/min) increasing only with the highest infusion rates (Figure). Conclusion: In closed-chest pigs, a significant increase in maximal rate and magnitude of systolic deformation in stunned myocardium was only seen at the highest doses of dobutamine infusion. This contrasted markedly with the response of normal myocardium to incremental isoproterenol stimulation.

Evaluation possible Sensitivity Specificity PPV NPV
DSE 95% (59/62) 73% (15/21) 89% (30/34) 8% (1/12) 25% (2/12)
EBT 95% (59/62) 92% (22/24) 89% (30/34) 75% (22/29) 93% (28/30)
DSE=dobutamine stress echocardiography EBT=electron beam tomography PPV=positive predictive value NPV=negative predictive value

223 Harmonic vs fundamental dobutamine stress echocardiography in diagnosing coronary artery disease
S. S selo 1, J. Kohnowski 2, S. Stwolczik 2, K. Filipiak 2, K. Putlewicz 2, D. Kosior 1, G. Opolski 2
Department of Cardiology, The Warsaw Medical University, Warsaw, Poland 1, Cardiology Dept., The Warsaw Medical, Univ., Warsaw, Poland 2
The aim of the study was to compare harmonic versus fundamental imaging during dobutamine stress echocardiography (DSE). We analyzed 94 patients (pts) 52 women aged 59.6±12.9 yrs, 62 men aged 62±11.8 yrs) with CAD diagnosed by medical history and ECG stress test. Patients were divided into 2 groups: hdDSE – 46 pts diagnosed by harmonic DSE, fDSE – 48 pts by fundamental DSE. Harmonic DSE were made using Agilent Sonos 5500 with stress echo module. Dobutamine was infused in 3 minutes stages from 10 to 40 mcg/kg/min. Atropine was added when required to achieve 85% maximum heart rate. Each test were recorded on magneto-optic disc and/or S-VHS tape for later assessment for 2 independent experienced cardiologists. All patients had coronary angiography. Each test were recorded on 16 mm film and S-VHS video tape and were assessed by 2 independent cardiologists.
Conclusion: Harmonic dobutamine echocardiography has better sensitivity and specificity than fundamental dobutamine echocardiography.

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<td>84%</td>
<td>77%</td>
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<tr>
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<td>84%</td>
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Prognostic value of exercise echocardiography in patients with left ventricular hypertrophy
A. Eihendy, D. Mahoney, B. Khandheria, K. Otander, J. Sewrul, F. Pelliccio
Echocardiography Dept., Mayo Clinic, Rochester MN, United States of America

Background: Left ventricular hypertrophy (LVH) is associated with increased incidence of cardiovascular mortality and mortality. Exercise ECG has a limited accuracy in the evaluation of coronary artery disease in patients with LVH. This study evaluates the prognostic value of exercise echocardiography in patients with LVH.

Methods: Exercise echocardiography was performed for evaluation of known or suspected coronary artery disease in 608 patients (age 66±11 years, 356 men) with LVH by echocardiographic criteria. Five hundred sixteen (85%) patients had hypertension and 80 (13%) had a previous myocardial infarction. Echocardiographic imaging was performed before and immediately after each test. Results: During a median follow-up of 3 years, 35 hard cardiac events occurred (11 cardiac death and 24 non-fatal myocardial infarction). The incidence of cardiac events was 3.6% (12/333) in patients with normal wall motion abnormalities by exercise echocardiography (p<0.01). The incidence of cardiac events was 7% (19/281) in patients with a negative exercise ECG, 1% (1/115) in patients with ST depression, and 7% (15/212) in patients with non-diagnostic ECG. Clinical and exercise variables associated with an increased risk of cardiac events in the multivariate analysis were an increased risk of cardiac events in the multivariate analysis were an increased risk of cardiac events in the multivariate analysis were a history of coronary artery disease (Chi2=24.6, p<0.01) and a lower rate pressure product (Chi2=13.1, p<0.0005). In an incremental model of exercise echocardiographic variables, exercise ejection fraction was the most powerful variable associated with an increased risk of cardiac events. cinnamon to clinical and hemodynamic variables (Chi2=18.1, p<0.0001).

Conclusion: Exercise echocardiography provides important data for identification of patients with LVH who are at a higher risk of cardiac death and non-fatal myocardial infarction.

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"Hidden" value of dobutamine and diprydramole stress electrocardiography findings: relation to coronary stenosis morphology
Cardiology Dept, Institute for Cardiovascular Diseases, Belgrade, Yugoslavia

Background: It has been previously shown that the results of pharmacological stress echocardiography (echo) tests are associated with quantitative and qualitative coronary stenosis features. Objectives: To evaluate the relationship between multiple angiographic variables and dobutamine (Dob) and diprydramole (Dip) electrocardiography (ECG) results during stress echo testing.

Methods: The study population consisted of 155 patients (127 male, 28 female, mean age 51±8 years) with one-vessel coronary stenosis ranging from minor stenosis to complete obstruction of the vessel. In all patients we have performed Dob (up to 40mcg/kg/min) and Dip (0.94 mg/kg over 10 min) stress echo test. ECG was considered positive when >0.1mV ST depression was observed 0.08 sec after J point. Observed angiographic variables included particular coronary vessel, site of stenosis, presence of collaterals, plaque morphology according to Ambrose classification (simple, groups I and II; complex, groups III and IV), and percent diameter stenosis (%DS) and obstruction diameter (OD) as assessed by quantitative coronary arteriography.

Results: Positive pharmacological ECG was associated with smaller OD (Dob, p=0.01; Dip, p=0.03), higher %DS (Dob, p=0.01; Dip, p=0.01) and complex lesions morphology (Dob, p=0.002; Dip, p=0.003), but not particular coronary vessel, presence of collaterals and the site of the stenosis (p=ns). By multivariated regression analysis positive Dip and Dob ECG were only associated with complex lesion morphology (Dob, p=0.002; Dip, p=0.003). In addition, sensitivity of Dip and Dob ECG were significantly higher in the patients with complex (44% and 48%, respectively) than simple lesions (23% for both tests; p<0.05 for Dip and Dob).

Conclusion: Although of limited sensitivity in detecting coronary stenosis, Dip and Dob ECG positivity is associated with complex lesion morphology of coronary stenosis. Thus, the relation between quantitative and qualitative features and stress echo results may be extrapolated to stress pharmacological ECG results, highlighting most jeopardized patients for adverse cardiac events.

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Fully automated border detection for stress echo by Active Appearance Models
JG. Bosch 1, SC. Mitchell 2, BPF. Lelieveldt 1, M. Sonka 3, C. F. Niland 2, O. Kamp 3, JHC. Reiber 2
Radiology, Image Processing Dept., Leiden University Medical Center, Leiden, Netherlands 2
Electrical Engineering Dept., University of Iowa, Iowa City IA, United States of America 3
Cardiology Dept., Free University Hospital AZVU, Amsterdam, Netherlands 2

Objective: to evaluate a new fully automated border detection technique based on Active Appearance Models (AAM) for application in stress echo (SE). Existing automated border detection techniques are unreliable, or necessary user interactions hampers their application in SE, where many sequences need to be analyzed in a consistent manner.

Methods: in 129 infracted patients, left ventricular end-diastolic (LVED) endocardial contours were drawn manually (MAN) in four chamber (4CH) views by an expert. Patients were randomly divided into a training set (TRN, n=117) and test set (TST, n=12). Contours and images of TRN were used to train an AAM, which represents the statistical variation in shape and grey level appearance over the TRN set and can regenerate any example in this training set. AAMs allow fully automated ap- proximate border detection in 4CH LVED SE images and may open the road to automated SE analysis.
Biphasic response to dobutamine stress echocardiography is associated to more severe coronary artery disease in patients with acute myocardial infarction

R. Bigi 1, A. Desideri 2, P. Colombo 3, C. Sponzilli 3, D. Castini 3, L. Cortigiani 2, C. Fiorentini 4
Cardiology Dept., Cardiovascular Research Foundation, Castelfranco Veneto, Italy 1, Cardiology Dept., Cardiovascular Research Foundation, Castelfranco Veneto, Italy 2, Cardiology Dept., "S. Paolo" Hospital, Milan, Italy 3, Biomedical Sciences Institute, University of Milan, Milan, Italy 4

Background: we previously found the biphasic response (BR) to myocardial infarction frequent and severe obstructive lesion of the infarct-related artery was found in 16/17 pts. with BR and 27/43 pts. with direct worsening (p<0.001, RR 2.3, 95%CI 1.5-3.5), so that their specificity was 94% and 63%, respectively. Moreover, Gensini score (GS, main left stream) in epicardial coronary arteries or their major branches indicated an obstructive lesion. Gensini score (GS, reflecting the severity of lesions) and jeopardy score (JS, reflecting the extension of area at risk) were derived.

Methods: 105 pts (55±9 yrs, 5 females) underwent pre-discharge DSE (up to 40 mcg/kg/min plus additional atropine to achieve 85% of age-predicted maximal heart rate) off therapy and selective coronary angiography. A diameter narrowing >70% (50% for the main left stream) in epicardial coronary arteries or their major branches indicated an obstructive lesion. Gensini score (GS, reflecting the severity of lesions) and jeopardy score (JS, reflecting the extension of area at risk) were derived.

Results: DSE was positive in 60 pts. (BR in 17, direct wall motion worsening in 43), and negative in 45 (sustained improvement in 8, no change in 37). Positivity was found in 27/45 pts. with area at risk in 60/60 and also in a different vascular territory in 12/60 pts. Among pts with positive DSE, an obstructive lesion of the infarct-related artery was found in 16/17 pts. with BR and 27/43 pts. with direct worsening (p<0.001, RR 2.3, 95%CI 1.5-3.5), so that their specificity was 94% and 63%, respectively. Moreover, Gensini and jeopardy scores of pts. with BR were significantly higher than those with direct worsening (92±7 vs. 48±4 and, respectively, 5.7±0.9 vs 4.0±0.4, p<0.05).

Conclusions: the biphasic response to DSE is associated to more frequent and severe obstructive lesion of the infarct-related artery as compared to the direct worsening pattern in pts. with acute myocardial infarction.

Dynamic stress echocardiography in adults after cardiac surgery: improvement of patients' functional status and contractile reserve of the left ventricle

L. Elišť 1, V. Chaloupka 1, I. Vosařova 2, M. Navrátil 1
Cardiopulmonary Testing Dept, University Hospital, Brno, Czech Republic 1, Internal Medicine Dept, University Hospital, Brno, Czech Republic 2

Background: Cardiotoxicity of doxorubicin (DOX) is well recognized. We have used dynamic stress echocardiography (DYSE) one year after the completion of chemotherapy to assess: 1. physiological status of patients, 2. functional status and contractile reserve of the left ventricle.

Methods and patients: We have investigated 40 pts (25 male/15 female of age 53±8 yrs) who have undergone subclinical cardiotoxicity between zero and one year after chemotherapy (progressive drop in EF > 10% of enter value or maximal or symptoms limited stress test on bicycle - with an increment in EF >3% and the maximum of stress test on bicycle - with an increment of workload of 25W/min). Echocardiographic examination was performed before and immediately after cessation of the test.

Results: Exercise capacity was comparable in both subgroups (1.7±0.46W/kg in controls and 1.5±0.4W/kg in pts. n.s.). Patients responded to the DYSE with an increment in EF +3% and the control group +1±4% (n.s.). The group with cardiotoxicity had lower rest and stress EF in the comparison to the group without cardiotoxicity (rest EF: 5±6%, 6±4%, p<0.007; stress EF: 6+6%, 7±4%, p<0.04). Parameters of LV function and exercise capacity correlated negatively with the age of patients. We have not found any difference in hemodynamic parameters among the groups.

Conclusions: 1. Exercise performance is not impaired one year after chemotherapy and reflects a good quality of life of cancer patients. 2. We have not found any pathological response of EF to DYSE. 3. One year after the treatment patients with subacute cardiotoxicity showed impaired rest EF and decreased stress EF in the comparison to the controls, but the increment in EF was comparable. Thus, the contractile reserve of LV was not impaired.
A negative dobutamine stress echocardiogram (DSE) in diabetic renal transplant candidates predicts favorable perioperative and long-term prognosis

T. Wilkin 1, M. Radu 1, C. Ynare 1, I. Singh 1, K. Johnson 2, B. Byrd III 2
Cardiovascular Medicine Dept, Vanderbilt University Medical Center, Nashville TN, United States of America

Nephrology Dept, Vanderbilt University Medical Center, Nashville TN, United States of America

Routine coronary angiography with prophylactic recanalization is considered optimal pretransplantation in diabetic candidates for renal transplantation. However, the invasive approach of coronary angiography and intervention in this population carries significant risks. A non-invasive technique may obviate the need for coronary angiography in these patients. Previous studies using DSE and nuclear perfusion imaging in screening for significant coronary artery disease have been inconclusive. However, the prognostic value of a negative DSE in this patient population has not been adequately studied. We performed DSE and coronary angiography in 18 diabetic renal transplant candidates (9 M, 9 F, mean age 46 +/- 12.3 years) in a blinded fashion. A positive DSE was identified by an existing regional wall motion abnormality (RWM) on resting echocardiogram or an inducible RWM during dobutamine infusion. Positive coronary artery stenosis was identified by the presence of >70% visual stenosis in any major epicardial coronary artery (lumen diameter at least 2 mm). Patients were followed for a mean of 3 +/- 10 months after their DSE for cardiac events (death, myocardial infarction, congestive heart failure, and vascular and ventricular arrhythmias). Results: Fourteen patients had a negative DSE (group A) and 4 patients had positive DSE (group B). Positive coronary angiogram was identified in one of the group A patients (single vessel disease) and 3 of the group B patients. A positive DSE correlated well with positive coronary angiography (sensitivity 93%, specificity 100%). Sixteen patients in group A and 3 patients in group B had a renal transplant during follow-up. Coronary revascularization was performed in 3 of the group B patients and 1 of the group A patients. There were 2 deaths in group B; one patient with a negative coronary angiogram had sudden death 6 months after the DSE while awaiting transplant and the other underwent a complicated renal transplant procedure and 20 months later died during the transplant operation. In group A, there was one isolated episode of perioperative ventricular tachycardia but no deaths or other cardiac events during the follow-up period. The negative predictive accuracy for peroperative (1 month) and long-term (3 +/- 10 months) cardiac events was 92% and 100%, respectively. In diabetic patients with end-stage renal disease undergoing renal transplant, a negative DSE is associated with a favorable perioperative and long-term prognosis. Therefore, a negative DSE may obviate the need for screening coronary angiography in those patients.

Value of Doppler index combining systolic and diastolic myocardial performance on cardopulmonary exercise capacity in patients with heart failure. Effects of Dobutamine

Fl. Partenakis, M. Kanakaraki, EM. Kanoukakis, AP. Panatiankos, OK. Philippou, GF. Diakakis, PE. Vardas
Cardiology Dept., Heraklion Univ. Hospital, Heraklion, Crete, Greece

We evaluated the effects of Dobutamine (D) on a new index of combined systolic and diastolic myocardial performance (MPI) in patients with ischemic (16) and idiopathic (20) dilated cardiomyopathy and the correlation of its changes with cardopulmonary exercise performance. Methods: We studied 36 patients, 24 men, 5 +/- 13 years old, on sinus rhythm with ischemic (16) or idiopathic (20) dilated cardiomyopathy. MPI was defined as the sum of the LV isovolumetric contraction (IC) and relaxation (IR) times divided by the LV ejection time, and was estimated at rest and during low dose (D), MPI formula (a+b) was calculated by measuring two intervals: the interval a from cessation and onset of mitral inflow velocity and the interval b from the duration of LV outflow velocity, using transmimral and aortic pulsed Doppler echocardiography. All patients underwent a modified Naughton protocol with gas exchange analysis and oxygen consumption was measured at peak exercise (peak VO2) and at the anaerobic threshold (VO2AT). Results: The mean rest value of MPI tended to be higher in pts with advanced NYHA functional class and in pts with restrictive, as opposed to non restrictive filling pattern (1.1 +/- 0.26 vs 0.7 +/- 0.15, p<0.001). A strong correlation was found between MPI and rest cardiac output, LV stroke volume, filling pattern and late filling velocity, as well as between MPI and oxygen consumption at peak exercise (r=0.550, p<0.001) and at the anaerobic threshold (r=0.490, p=0.002). At (D) infusion, there was an improvement in MPI from 0.9 +/- 0.25 to 0.7 +/- 0.26 (p<0.001), and a decrease of the time from starting of therapy (11.27 +/- 9.27 vs 8.24 +/- 7.97 msec, p<0.001) and IC intervals (8 +/- 4 vs 8 +/- 24 msec, p<0.001). There was also a significant negative correlation between MPI changes during D and the changes in cardiac output and stroke volume. No correlation was found between MPI changes and max HR in cardopulmonary exercise. Conclusions: MPI changes during Dobutamine infusion predict cardopulmonary exercise capacity in patients with ischemic or dilated cardiomyopathy. This non-invasive index is useful in assessing global myocardial performance in those patients.
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Prognostic value of dobutamine stress echo in the elderly
JL Davar, EB. Roberts, JG. Coghlan, DP. Lipkin, TR. Evans
Cardiology Dept., Royal Free Hospital, London, United Kingdom

Aim: To investigate the prognostic value of Dobutamine Stress Echo (DSE) in patients over 70 years old. Methods: 120 patients (pts) of mean age 75±3.8 y.o. underwent DSE and were followed up for mean 25.1±10.9 months. Events looked fore were cardiac deaths, MI, unstable angsina, and revascularisation.

Statistics: To assess the risk stratification provided by DSE, Kaplan-Meier survival curves were generated. The Cox proportional-hazard model using univariate and stepwise procedures was used to evaluate the ability of variables to predict an event.

Results: 51 pts (42.5%) had positive DSE. There were 21 events during the follow up. 19 events (37.3%) were in positive DSE group and 2 events (2.9%) in negative DSE group. Positive DSE (p=0.0001), typical (p=0.0007) and atypical (p=0.0041) angina were identified as univariate predictors of cardiac events. With Cox step-wise analysis only typical angsina (relative risk 3.6; 95% C.I=1.2-11.6, p=0.02) and positive DSE (relative risk 6.9; 95% C.I=1.8-30.6, p=0.01) were found to be independent predictors of future cardiac events. The cumulative event free survival rate to 43 months post DSE was 95.6% for patients with a negative test and 67.3% for patients with a positive test.

Conclusion: 1. Negative DSE allows identification of a substantial group of elderly pts with low (average annual rate = 1.2%) future cardiac event rate.

2. Positive DSE in the elderly identifies pts with high probability of a cardiac event. There is a strong relationship between the number of ischaemic coronary artery territories on DSE and likelihood of cardiac events.

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Prognostic value of myocardial jeopardy score and coronary artery score during exercise echocardiography: Correlation with stress echocardiography
Cardiology Dept., Univ. Institute for CVD, Belgrade, Yugoslavia

Background: Myocardial jeopardy score (JS) and coronary artery score (CS) are proposed as new methods for estimating the functional significance of coronary lesions including coronary anatomy and myocardial status.

Objectives: To determine, in the same group of patients, the predictive value of JS and CS in assessment of functional significance of coronary artery stenosis as judged from dobutamine-atropine (DobAtro), dipyridamole-atropine (DipAtro) and exercise (Ex) stress echo results. Methods: DobAtro: (up to 40 mcg/kg/min i.v. Dob with addition of 1 mg of atropine), DipAtro (up to 0.84 mg/kg Dip with addition of 1 mg of atropline), Ex (Bruce) and coronary arteriography (analysed by quantitative angiography: Off-line quantitative assessment of myocardial viability early after myocardial infarction, E. Petropou/ou, P. Lance//otti, F. Lebrun, L.A. Pi~n9ard, University Hospital of Liege, Belgium.

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Exercise versus dobutamine-induced ST elevation in the infarct-related electrocardiographic leads: clinical significance and relation with functional recovery
P. Lancellotti, E. Petropoulov, L.A. Pliéard, University Hospital of Liége, Belgium.

The clinical significance of stress-induced ST-segment elevation (ST) early after myocardial infarction (MI) and its relation with functional recovery remain controversial. To determine the relative accuracy of stress induced-ST for predicting functional recovery, we investigated 52 patients (pts) during the first week of MI. All pts underwent semi-supine exercise and dobutamine stress electrocardiography on a tilting table. ST was defined as new or worsening > 1 mm, 80 ms after J point. Quantitative angiography was available in all pts and 37 were treated by coronary angioplasty (PTCA). T ST developed during 30 dobutamine and 24 exercise tests. The mean sum T ST was higher during dobutamine (7.7 ± 3.8 mm) than during exercise (5.5 ± 2.5 mm) (p = 0.03).

A low peak CK level was the single independent predictor of cardiac events. CS = 1.9 (95% C.I., 0.8-3.8, p < 0.01) and positive DSE during the follow up. 19 events (37.3%) were in positive DSE group. Positive DSE (relative risk 6.9; 95% C.I=1.8-30.6, p=0.01) were found to be independent predictors of future cardiac events. The cumulative event free survival rate to 43 months post DSE was 95.6% for patients with a negative test and 67.3% for patients with a positive test.

Conclusions: 1. Negative DSE allows identification of a substantial group of elderly pts with low (average annual rate = 1.2%) future cardiac event rate.

2. Positive DSE in the elderly identifies pts with high probability of a cardiac event. There is a strong relationship between the number of ischaemic coronary artery territories on DSE and likelihood of cardiac events.

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Myocardial Doppler velocities during low level exercise echocardiography: Off-line quantitative assessment of myocardial viability early after myocardial infarction.
E. Petropoulov, P. Lancellotti, F. Lebrun, L.A. Pliéard, University Hospital of Liége, Belgium.

Assessment of myocardial velocities by Doppler tissue imaging (DTI) is gaining importance and may offer a quantitative approach of stress echocardiography. However, its feasibility during exercise echocardiography to detect myocardial viability early after myocardial infarction is unknown. Twenty-one consecutive patients (pts) underwent exercise echocardiography 3 days after primary coronary angioplasty of the infarct-related artery. Semi-supine exercise test was performed at 25 W for 6 minutes. Peak systolic velocity (PSV) was measured off-line at rest and at low charge. Functional recovery was assessed by follow-up echocardiogram 1 month after the acute event. Sixty-eight out of 320 segments analyzed were dysynnergic at rest. Contractile reserve was visually detected in 43 segments (63%). A significant increase in PSV was observed at low charge in segments with contractile reserve. In contrast, PSV did not change in segments without contractile reserve.

PSV (cm.s\(^{-1}\)) Rest Low charge Follow-up P value

<table>
<thead>
<tr>
<th>Viability</th>
<th>3.14 ± 1.79</th>
<th>6.12 ± 1.65</th>
<th>5.21 ± 1.83</th>
<th>0.004</th>
</tr>
</thead>
<tbody>
<tr>
<td>No viability</td>
<td>2.14 ± 0.96</td>
<td>1.82 ± 0.53</td>
<td>1.63 ± 0.51</td>
<td>NS</td>
</tr>
<tr>
<td>P value</td>
<td>&lt;0.0001</td>
<td>&lt;0.001</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Functional recovery occurred in 40 segments (59%), PSV at rest increased significantly from early to follow-up echocardiogram in segments that recovered. No significant change was observed in segments without functional recovery.

Conclusion: Measurement of PSV during low-level exercise echocardiography is feasible and accurate for the identification of viable myocardium that can recover early after myocardial infarction.
240 Quantitative approach of semi-supine exercise echocardiographic interpretation: Off-line analysis of myocardial Doppler velocity imaging

E. Paloupolou, P. Lancellotti, F. Lebrun, C. Rinken, L.A. Piérard
University Hospital of Liège, Belgium

Digital tissue Doppler imaging (DTI) may offer a quantitative approach of stress echocardiography. Previous studies have analysed the systolic changes during graded exercise. This ongoing study, presently, includes 66 healthy subjects (mean age 47, range 25–75 years) during semi-supine exercise echocardiography by pulsed DTI to characterize the systolic velocity profiles of the left ventricular segments. Exercise test was performed at 25 W for 6 minutes for low charge evaluation and thereafter workload was increased by 25 W every 2 minutes. Peak systolic velocities (PSV) were measured at each stage. Resting velocity gradient from basal to mid segments persisted with exercise. Increase in workload was accompanied by a proportional increase in velocities. At low charge, we observed a rapid augmentation of PSV in all segments. This rising in PSV remained stable during the whole low charge stage. New increment in PSV was observed at further stages. Results for the PSV of basal and medium segments of the LV are shown in the table:

<table>
<thead>
<tr>
<th>PSV (cm/s)</th>
<th>Rest</th>
<th>25W</th>
<th>50W</th>
<th>100W</th>
<th>Peak</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basal septum</td>
<td>5.78±0.63</td>
<td>7.12±0.68</td>
<td>7.02±0.62</td>
<td>8.38±0.85</td>
<td>10.34±1.52</td>
</tr>
<tr>
<td>Mid septum</td>
<td>6.25±1.91</td>
<td>6.75±1.28</td>
<td>5.52±1.38</td>
<td>6.5±1.87</td>
<td>9.5±2.91</td>
</tr>
</tbody>
</table>

Conclusions: 1) Tissue Doppler velocity off-line measurements are feasible during exercise, 2) PSV already increases at low charge, 3) Proportional increment in PSV occurred at further stages, 4) This study may be helpful to provide normal values of myocardial velocities profile according to different age subgroups.

242 Potential benefit of adding routinely contrast during stress echocardiography

J. Zamorano 1, V. Sanchez 2, C. Almería 1, J.L. Rodrigo 1, V. Serra 1, A. Aubele 1, M. Roca 1, A. Aubele 1, J.A. Bacchetta-Harguindeguy 1, 2
Cardiology Dept., Hospital Clínico, Madrid, Spain 1, 2

The aim of this study was to assess if adding contrast agents routinely during pharmacological stress echocardiography (SE) will imply a better agreement between 2 experienced observers in stress echo. For this purpose a total of 121 consecutive SE were analyzed. Of this 121 studies, 69 were dobutamine (DOB) SE and 52 were dipyridamol (DYP). Contrast agents (Levovist®) were used in 47/121 consecutive non selected patients (25 DYP; 22 DOB). All studies were performed with harmonic imaging and stress echo digitalization (HP Sonos 5500). The agreement between both experts, at the basal examination, in the analysis of the regional contractility was good in those cases without or with contrast (Kappa 0.83 and 0.86 respectively). Results in the agreement for DYP and DOB are shown in the table:

<table>
<thead>
<tr>
<th>Contrast</th>
<th>Kappa 0.79</th>
<th>Kappa 0.74</th>
</tr>
</thead>
<tbody>
<tr>
<td>DOB</td>
<td>0.85</td>
<td>0.83</td>
</tr>
</tbody>
</table>

In conclusion, the routine use of contrast agents really provides a better agreement between experienced observers during dobutamine stress echo. This benefit is less for dipyridamol stress echo, where the agreement without contrast is also higher than in DOB. Selected groups of patients, mainly those with poor acoustic windows may also get a higher benefit of adding contrast during stress echo.

243 Left ventricular diastolic filling patterns in patients with coronary artery disease during dobutamine-stress Doppler echocardiography

R. Napetvaridze, N. Emukhvari, I. Khintibidze
Cardiology Dept., Tbilisi St. Medical University Clinic, Tbiliss, Georgia

Abnormalities of left ventricular (LV) filling have been demonstrated in patients during ischemia induced by dobutamine (DOB) stress test and have been proposed as more sensitive indicators of myocardial ischemia than wall motion abnormalities. The aim of the study was to assess the changes of Doppler indexes of LV diastolic function induced by DOB stress in patients with CAD and their importance in diagnosis.

Methods: The study population comprised two groups. Group I consisted of 9 normal subjects (mean age 46.1±12 years) and group II consisted of 19 patients (mean age 59.2±9 years) with stable angina. 6 patients had a history of old myocardial infarction. These patients underwent DOB stress echocardiography (10–40 mcg/kg/min) and Doppler echocardiography. Early and atrial peak velocities (E and A) and the ratio between early and atrial peak velocities (E/A) were studied at baseline and peak DOB.

Results: No patient in group I developed angina, ST segment changes and wall motion abnormalities. DOB infusion in this group induced hyperkinetic wall motion with enhanced systolic thickening. In group II wall motion abnormalities at rest were detected in 5 patients. During peak stress 6 patients had new wall motion abnormalities, 10 had angina and 6 had ST changes. At baseline there were not significant differences between the groups in any Doppler indexes of LV filling. In patients with CAD at peak DOB E and E/A ratio were significantly lower, than in normal subjects (53.5±10.2 vs 87.2±14.3; P<0.001; 0.58±0.15 vs 1.15±0.3; P<0.001). There were pronounced differences between these groups in the effect of DOB on Doppler indexes of LV filling. In normal subjects DOB induced significant increases in E (from 7.7±10.4 to 97.2±14.3; P<0.001) and A (from 56.5±11.4 to 75.5±16.7; P<0.001) and in patients with CAD significant reduction in E (from 70.9±14.1 to 53.5±10.2; P<0.001) and E/A ratio (from 1.06±0.3 to 0.53±0.15; P<0.001) with a significant increase in E/A (from 8.4±1.34 to 66.5±13.5; P<0.001). These abnormal changes of LV filling indexes were identified in all patients. These findings suggest that myocardial ischemia is a possible mechanism of LV diastolic dysfunction.

Conclusions: Our study demonstrates that in normal subjects DOB stress enhances LV diastolic performance. DOB stress induces abnormal changes of LV filling in patients with CAD. Abnormal changes of Doppler indexes of LV filling during DOB stress is a more sensitive marker of CAD, than wall motion abnormalities.
244 Restrictive left ventricular diastolic filling pattern identifies patients without viable myocardium after first acute myocardial infarction

A. Sebbi 1, C. Coletta 2, N. Aspromonte 2, A. Galati 2, V. Ceci 2
Rome, Italy 1, Cardiology Dept., Santo Spirito Hospital, Rome, Italy 2

Determination of the presence and extent of dysfunctional but viable myocardium (VM) has become an important component of the diagnostic assessment of patients with coronary artery disease. The objective of this study was to examine the hypothesis that there is a relation between the presence of VM in patients (pts.) after first acute myocardial infarction (AMI) and the filling pattern of the left ventricle (LV).

Methods: 158 consecutive pts with first AMI (mean age: 58±9, M=136, F=22) underwent echo-Doppler examination 5-10 days after hospital admission. The following parameters were considered: 1) E and A waves peak velocities, 2) E/A ratio, 3) E deceleration time (Edt), 4) LV systolic function, using Simpson’s rule, 5) Wall motion score index (WMSI), using standard 16-segment model of the left ventricle and a 1-4 scoring system. In the same day, an echo-dobutamine stress test to identify viable myocardium was performed at incremental doses (5 to 20 μg/kg/min) in 3 min-steps. VM was defined as any contractile improvement in > 2 LV dysfunctioning segments during dobutamine stimulation. Finally pts were divided in two groups based on LV filling pattern: Group 1 (restrictive: 21 pts, E/A < 2 or E/A > 3 + Edt < 140 msec); Group 2 (non-restrictive: 137 pts, E/A > 2 or E/A > 3 + Edt > 140 msec).

Results: Comparison between the two groups revealed that Group 1 pts. (restrictive), had larger infarct size (peak of creatine kinase: 11466±2417 vs. 1993±1596 U/l, p<0.001), higher WMSI (1.8±0.21 vs. 1.62±0.23, p<0.001), LV regional and global function decreased by 23.8% and 17.6%, A increased by 8.4% and 7.7% compared with baseline values. After ExE the rate of E wave and E/A ratio reduction in ischemic segments was significantly higher in pts with restrictive LV diastolic filling pattern than in pts without restrictive LV filling pattern.

246 Can strain rate imaging characterize the spectrum of changes in regional systolic function induced by either dobutamine infusion, atrial pacing, or placebo? A color Doppler myocardial imaging study

F. Weidemann, F. Jamal, T. Kukulski, J. D’Hooge, B. Bijnens, I. De Scheerder, L. Hatte, G. Sutherland
Cardiology Dept., Univ. Hospital Gasthuisberg, Leuven, Belgium

Ultrasound derived Strain Rate and Strain have the potential to quantify local myocardial deformation independently from overall heart motion and adjacent segments contraction.

Methods: To determine whether Strain Rate (rate of deformation) and Strain (% deformation) can characterize regional myocardial function at different inotropic states, maximal radial Strain and maximal radial systolic Strain Rate were obtained from 9 closed chest pigs during: a) atrial pacing (100-180/min), b) constant esmolol infusion+atrial pacing (100-180/min), c) graded dobutamine infusion. For each increase in heart rate (HR), radial Strain Rate and Strain values were calculated for the posterior wall in a short axis view.

Results: Radial Strain Rate during dobutamine but not control conditions decreased by 29.4% and 24.3% and Strain decreased by 11.2% and 9.9% compared with baseline values. During atrial pacing, radial Strain values decreased with increasing HR. For esmolol infusion+atrial pacing, radial Strain values were abnormally low at baseline and decreased linearly with increasing HR.

Conclusion: For normal myocardium, in-plane ultrasound Strain Rate and Strain measurement can quantify regional myocardial deformation over a wide range of heart rates and inotropic states. Strain Rate is in contrast to Strain relatively independent on HR in normal myocardium. This means that Strain Rate is very useful for studying changes in myocardial deformation during inotropic stimulation.

245 Difference between symptomatic and asymptomatic myocardial ischemia assessed by Doppler tissue imaging variables during stress echocardiography

M. Deljanin Ilic 1, S. Ilic 1, B. Lovic 2, Lj. Jovovic 2
Echo Lab Dept, Institute of Cardiology, Niska Banja, Yugoslavia 1, Echo Lab Dept, Cardiovascular Institute Dedinje, Belgrade, Yugoslavia 2

The aim of the study was to compare regional systolic and diastolic myocardial velocities (m.v.) changes induced by symptomatic and asymptomatic myocardial ischemia (m.i.) during stress echocardiography using pulsed wave Doppler tissue imaging (PDW DTI).

Methods: In the study group of 78 pts with known or suspected CAD exercise stress echocardiography (ExE) was performed. ExE identified ischemic episodes by the occurrence of wall motion abnormalities (WMA) with stress. Apical views were used to assess m.v. (Acuson-Sequoia, PW DTI) on baseline and at the peak stress. The sample volume was placed in each of 11 segments in which the left ventricle was divided, and we calculated peak m.v. of systolic (S), early (E) and late (A) diastolic waves and their ratio E/A.

Results: During ExE 155 ischemic myocardial segments in 54 pts were detected (102 segments in 31 pts with symptomatic and 53 segments in 23 pts with asymptomatic m.i.), while in 24 pts WMA during stress echo were not observed. After ExE value of wall motion score and number of ischemic segments per patient was significantly bigger in pts with symptomatic than in pts with asymptomatic m.i. (P<0.02 and P<0.01). In segments with ExE provoked symptomatic and asymptomatic WMA, DTI variables showed similar dynamics: E decreased by 23.8% and 17.6%, A increased by 8.4% and 7.7%, ratio E/A decreased by 29.4% and 24.3% and S decreased by 11.2% and 9.9% compared with baseline values. After ExE the rate of E and E/A ratio reduction in ischemic segments was significantly higher in pts with symptomatic than in pts with asymptomatic m.i. (P<0.01 and P<0.02).

Conclusion: Our data showed that both types of m.i. have similar effects on wall motion variables, but changes in symptomatic m.i. are more pronounced in symptomatic m.i. Reduction of E wave and E/A ratio in ischemic segments are significantly higher in symptomatic than in asymptomatic m.i.

247 Can colour Doppler myocardial imaging identify chronically ischaemic myocardium during a dobutamine stress? An experimental study

M. Szilard 1, F. Weidemann 2, F. Jamal 2, X. Liu 2, Y. Huang 2, T. Kukulski 2, B. Bijnens 2, E. Verbeke 3, G. Sutherland 2, I. De Scheerder 2
Cardiology Dept., Univ. Hospital Louvain, Leuven, Belgium 1, Cardiology Dept., Univ. Hospital Gasthuisberg, Leuven, Belgium 2, Department of Pathology, University Hospital, Leuven, Belgium 3

The aim of the present study was to investigate whether Color Doppler Myocardial Imaging (CDMI) deformation indices (i.e. strain rate and strain) can characterize the changes in regional systolic function during a dobutamine (DSE) challenge in a closed-chest porcine model of chronic ischemia.

Methods: Progressive coronary stenosis was induced by implantation of a polymer coated stent in the circumflex and left anterior descending coronary artery, resulting in chronic myocardial ischemia (n=19). After 4 weeks, a CDMI study was performed at rest and during DSE. This study was focused on the evaluation of the posterior wall in a parasternal short axis view. Maximal systolic strain rate (SR) and maximal strain (S) were calculated off-line. Animals were divided in 2 groups: group I (n=7) with a circumflex stenosis less than 75%, and group II (n=12) with a circumflex stenosis bigger than 75%. Additional 6 animals served as normal controls.

Results: In both groups, after 4 weeks of follow-up, SR and S values were significantly lower than control values at rest. During incremental DSE, SR increased in controls and in Gr 1 but not in Gr 2. Conversely, S increased only in the normal animals (Fig). Histology showed the circumflex area at-risk to be viable in all animals.

Conclusions: The changes in CDMI-derived radial systolic strain rate and strain during an inotropic challenge can potentially differentiate chronically ischemic from normal myocardium. In addition, the combined analysis of these two parameters might distinguish between mild and severe chronic ischemia.

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248 Examination of the left ventricular contractile reserve by Doppler myocardial imaging
TF. Filip, H. Hegedus, A. Kertesz, E. Edes
Cardiology Dept., Univ. of Debrecen, Debrecen, Hungary
Detection of the left ventricular contractile reserve (L V C R) by means of Dobutamine stress echocardiography is a well-known technique. The aim of the present study was to detect the velocity changes during the administration of dobutamine, and to establish, whether Doppler myocardial imaging (DMI) is a suitable method for determination of the LV C R and whether DMI furnishes more information than traditional stress echocardiography. 25 patients were examined. Doses of 5-10 and 20-30 mg/kg/min dobutamine were administered, the dose being elevated at 4- min intervals. The ejection fraction (EF) was calculated via the Simpson rule. The peak systolic velocity (S), and the early (E) and late (A) diastolic velocities were measured in the middle segment of the septum and in the inferior wall. Results: 1.) S was increased significantly (in the septum: 0.11±0.03 vs. 0.2±0.05 m/sec, p=0.001; in the inferior wall: 0.1±0.05 vs. 0.17±0.06 m/sec, p=0.003). 2.) E was not changed significantly in the septum or in the Inferior wall (in the septum: 0.13±0.07 vs. 0.13±0.06 m/sec p=0.9, in the inferior wall: 0.12±0.5 vs 0.09±0.5 m/sec; p=0.29). 3.) A was increased significantly (in the septum: 0.17±0.05 vs 0.22±0.07 m/sec p=0.01, in the inferior wall: 0.18±0.08 vs 0.21±0.02 m/sec p=0.01). 4.) In 3 patients a so called late-systolic contraction wave appeared in the sign of ischemia; if these cases were excluded from the statistical analysis, the increase in the E wave was significant both in the septum and in the inferior wall. 5.) There was not a significant correlation between the EF and the S, but when the elevation in S was more than 25%, the increase in S was more than 5 cm/sec. Conclusions: 1.) The administration of dobutamine is accompanied by marked increases in the wall velocities (except in the ischemic area), and the late-systolic rise in S is paralleled by a more than 25% elevation in EF. 2.) The late-systolic contraction in the ischemic area appeared earlier than the wall motion abnormality.

249 A new safe and effective accelerated dobutamine stress echocardiography protocol for the evaluation of coronary artery disease
A.J. Burger, M.P. Notarianni, D. Aronson
Cardiology Dept., Beth Israel Deaconess Medical Center, Boston MA, United States of America
Introduction: Although dobutamine (dob) infusion requires up to 10 min to achieve peak stress, do stress echocardiography (DSE) is nearly performed using stepwise increments at 3-min intervals. Consequently, the full effect of dobutamine is not attained before the dobutamine dose is advanced to the next level. This study sought to test the safety and efficiency of a high-dose, single-stage continuous dobutamine infusion protocol. Methods: 100 consecutive patients underwent an accelerated protocol using a constant dobutamine infusion of 50 μg/kg/min. In the absence of an end point (85% of maximal predicted heart rate, new wall motion abnormalities, hyper tension, or arrhythmia), do infusion was terminated at 10 min. Hemodynamic responses and adverse effect profile were compared to 100 patients who underwent a standard stepwise DSE protocol (3-min dose increments, starting at 5 μg/kg/min and increasing to 10, 20, 40, and 90 μg/kg/min). Results: Peak heart rate and systolic blood pressure (BP) were similar in both protocols. Accelerated dobutamine infusion produced a faster increase in heart rate (12.5±6.2 vs. 7.5±6.2 beats/min, p<0.001), and a substantial reduction in test duration (Table). The mean weight-adjusted cumulative dobutamine dose was lower in the accelerated protocol group. No significant differences were noted between the 2 groups with respect to the occurrence of arrhythmic or hemodynamic side effects. Conclusion: These data demonstrate that a high-dose, single-stage DSE protocol is a feasible, well-tolerated alternative to the standard stepwise DSE protocol, and results in a substantial reduction in test time while maintaining a low complication rate.

250 Myocardial perfusion in akinetic segments predicts infarct-related vessel patency in patients with recent or previous myocardial infarction
MA. Morales, D. Royal, F. Amoros, A. L’Abbate
Cardiology Dept., CNR Clinical Physiology Institute, Pisa, Italy
The aim of this study was to assess whether detection of myocardial perfusion by contrast echocardiography predicts patency of the infarct-related artery in patients (pts) with post-infarction left ventricular dysfunction. We studied 27 pts with recent (10) or previous (17) myocardial infarction, Q in 19 pts and non-Q in 8, showing at least two contiguous akinetic segments in the apical 4-chamber view. All patients were in stable clinical condition and underwent coronary angiography within a week from the echo-contrast study. Myocardial contrast enhancement was obtained by intravenous administration of a galactose-based contrast agent (Levovist, Schering, Germany) in conjunction with Power Doppler Harmonic Imaging. Wall motion score index, myocardial perfusion analysis within the infarc region were done independently by two experienced observers, blinded to patient data and coronary arteriography. Interpretable contrast echo images were obtained in all patients. Out of a total of 74 akinetic segments, homogeneous myocardial perfusion was observed in 9 segments, partial or sub-endocardial perfusion in 48, while no perfusion was detected in 27 segments. Study population was divided in 2 groups: 14 pts with normal or partial perfusion (Group 1) and 13 with absent perfusion (Group 2) in akinetic segments. The two groups did not significantly differ in time delay from acute infarction (19±9 vs 13±6 months), presence of Q waves and angiographic collateral circulation. However, the degree of coronary stenosis of the infarct-related artery was significantly higher in Group 2 (99±1% vs in Group 1 pts 48±2%, p<0.001, as well as the number of ≥50% stenotic vessels: 2.5±0.2 in Group 2 vs 1.9±0.2 in Group 1, p<0.001). In conclusion, in pts with post-infarction left ventricular dysfunction, a preserved myocardial perfusion by contrast echocardiography in akinetic segments predicts a minor degree of coronary stenosis of the infarct-related artery and a lower extent of coronary artery disease.

251 Influence of coronary revascularization on left ventricular remodeling and myocardial function: perfusional and functional correlates
L. Agati, S. Funaro, C. Volponi, G. Pignatelli
Cardiology Dept., "La Sapienza" University, Rome, Italy
To further investigate the impact of coronary revascularization on the natural history of left ventricular (LV) remodeling in patients with recent myocardial infarction and residual myocardial viability, six-months follow-up was obtained in 23 consecutive patients, 12 who underwent coronary revascularization (Group A) and 10 who were medically treated (Group B). LV remodeling was assessed using 2D echocardiography and myocardial perfusion by contrast echocardiography (MCE). MCE was performed using Harmonic Anglo (Hewlett Packard, Sonos 5500) with Levovist® (400mg/ml, IV pump infusion, trigger intervals 1:4-1:8). Myocardial perfusion was assessed using a 12-segment model (4-chambers apical views). The contrast score index (CSI 0-2) and the endocardial length of the residual contrast defect within the infarct area were calculated. Inclusion criteria for this study were ongoing heart failure in LV ejection fraction <50% at rest, LV ejection fraction <40% at peak stress, transmural perfusion in 48, while no perfusion was detected in 27 segments. Study population was divided in 2 groups: 14 pts with normal or partial perfusion (Group 1) and 13 with absent perfusion (Group 2) in akinetic segments. The two groups did not significantly differ in time delay from acute infarction (19±9 vs 13±6 months), presence of Q waves and angiographic collateral circulation. However, the degree of coronary stenosis of the infarct-related artery was significantly higher in Group 2 (99±1% vs in Group 1 pts 48±2%, p<0.001, as well as the number of ≥50% stenotic vessels: 2.5±0.2 in Group 2 vs 1.9±0.2 in Group 1, p<0.001). In conclusion, in pts with post-infarction left ventricular dysfunction, a preserved myocardial perfusion by contrast echocardiography in akinetic segments predicts a minor degree of coronary stenosis of the infarct-related artery and a lower extent of coronary artery disease.
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Long-term prognostic value of early wall motion score in the coronary care unit after acute myocardial infarction in the thrombolytic era
Cardiology Dept., VU Medical Center, Amsterdam, Netherlands

Objectives: To assess the prognostic value of early wall motion score (WMS) after acute myocardial infarction (AMI) in the thrombolitic era.

Background: The value of early WMS in the coronary care unit in patients (pts) treated with thrombolytics is open to question due to myocardial stunning. Moreover, it can be debated whether early WMS contains prognostic information in high-risk pts not treated with thrombolytics due to contraindications or late arrival.

Methods: From 1989 until 1996, 765 consecutive pts with AMI and without thrombolytics (n=300). Analyses were performed separately for pts treated with and without thrombolytics (n=300).

Results. During a mean follow-up of 53 months (±24), 92 (19.8%) pts with and 119 (39.7%) without thrombolytic treatment died. A poor early WMS was associated with mortality in pts treated with and without thrombolytics. Moreover, it can be debated whether early WMS contains prognostic information in high-risk pts not treated with thrombolytics (n=300).

Conclusions: Early WMS is a valid prognostic indicator regardless whether pts received thrombolytics. However, in pts not treated with thrombolytics, early WMS in the coronary care unit did not add prognostic information to in-hospital complications, eg. Indigibility for exercise, heart failure, Good early WMS selects a low-risk subset and has the potential to guide in early-discharge decision making.

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The transthoracic Doppler echocardiographic CFR measurement of arteria mammaria interna bypass detects its functional status. A comparison of non-invasive and invasive results
H. Lethen, H.P. Tries, O. Ekinci, H. Lambertz
Cardiology dept., Deutsche Klinik für Diagnostik, Wiesbaden, Germany

Introduction: Transthoracic Doppler echocardiography allows non-invasive visualization of arteria mamma interna (IMA) after bypass operation. Coronary flow measurement using transthoracic PW-Doppler in an IMA-bypass before and after induced vasodilatation detects its coronary flow reserve (CFR). The relevance of noninvasive CFR-measurement (Acuson, Sequoia) in an IMA-bypass to judge its functional status was investigated in this study. The results were compared with invasive derived CFR-measurements.

Methods: In 44 patients coronary flow in IMA after bypass surgery was measured using non-invasive maximal hyperemia induced by infusion of Adenosine (140 μg/kg/min i.v.). CFR was then calculated by the ratio of the mean systolic-diastolic maximal velocities. Coronary angiography was performed in all patients; additionally, invasive CFR-measurement was done in 20 patients using Doppler Flow Wire.

Results: In all 44 patients CFR could be measured noninvasively after IMA-bypass surgery. Angiographically an occlusion or relevant stenosis (50% diameter) of IMA-bypass was detected in 20/44 patients (group I); in 24/44 (group II) no relevant stenosis was seen. In 11 patients of group I and 9 of group II CFR was measured invasively using Doppler Flow Wire. In group I noninvasive CFR was 1.4±0.4, compared to 1.5±0.5 after invasive measurement (n.s.). In group II without relevant stenosis of IMA-bypass CFR measured noninvasively was 2.7±0.7 compared to 2.5±0.6 derived invasively (n.s.). CFR was significant different with p<0.05 between group I and group II.

Conclusion: Transthoracic Doppler echocardiographic measurement of IMA-bypass CFR is comparable to invasive derived results. A CFR above 2.1 identifies with a sensitivity of 88% and a specificity of 81% a significant IMA-bypass stenosis.

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Anomalous transthoracic coronary Doppler flow pattern at rest predicts angiographically-proven coronary artery disease
P. Voci, F. Pizzuto, E. Mariano, G. Testa, G. Di Nuoci
Cardiac Surgery Dept., University of Rome "La Sapienza", Rome, Italy

High-resolution transthoracic color-Doppler echocardiography can be used to detect coronary blood flow velocity in the left anterior descending (LAD) coronary artery at rest and stress. Patients with coronary artery disease may have normal resting blood flow, but an anomalous Doppler flow velocity pattern.

Methods: To test this hypothesis, we have studied 73 consecutive patients. The LAD could be imaged in 68 (93%) of them: 12 normal subjects and 56 patients (age 61±14 years, weight 45-108 kg) with angiographically-proven stenosis of the middle-distal tract of the LAD. The middle-distal tract of the LAD was carefully scanned in the interventricular groove to the apex, using a dedicated transthoracic transducer (7 MHz, imaging and 3.5 MHz, Doppler) connected to an Acuson Sequoia C256 ultrasound system.

Results: Coronary flow was laminar in normal subjects, with a peak diastolic velocity of 23±5 (range 19-32) cm/sec. Three different anomalous patterns were identified in 27/56 (48%) patients: 1) Peak diastolic velocity greater than 50 cm/sec; 2) Greater than 2 times velocity increase at any point of the LAD, suggesting a coronary gradient; 3) Demodulation of diastolic flow. There were 1 false positive and 29 false negative tests, with a specificity of 92% and a sensitivity of 48%.

We conclude that high resolution color Doppler imaging of the coronary arteries may disclose an anomalous pattern at rest, and may be used as a screening tool to detect disease of the LAD.

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Transcutaneous ultrasound in evaluation of flow in normal mammary arteries after minimally invasive coronary surgery.

Z. Gasio*, M. Cieowski*, A. Bochenek*
1st Cardiology Dept., Silesian Cardiological Center, Katowice, Poland 1, 1st Cardiology Dept., Silesian Cardiological Center, Katowice, Poland 2

Different techniques of less invasive coronary bypass surgery has recently been developed. The aim of the study was to compare flow characteristics between normal in situ right internal mammary artery (RIMA) and normally-functioning left internal mammary artery bypass graft (LIMA-LAD) in patients after minimally invasive coronary surgery. The revascularization of the LAD was carried out by mini-thoracotomy on the beating heart, after harvesting of the left internal mammary artery (LIMA) by video-thoracoscopic. 29 pts were studied in the postoperative period (4-8 days) by means of transcutaneous ultrasound Doppler scanning. Peak systolic (Vs) and diastolic (Vd) velocity, time-velocity integral in systole (TVIs) and diastole (TVId) were measured. Doppler spectrum of RIMA flow was quantifiable in all pts, but Doppler sonogram from LIMA-LAD was obtained in only 20 pts.

Parameter | RIMA | LIMA-LAD | p
--- | --- | --- | ---
Vs(cm/s) | 86±27 | 57±17* | <0.001
Vd(cm/s) | 31±14 | 32±15 | NS
Va/Vd | 2.9±0.5 | 2.0±0.7 | <0.001
TVI(cm) | 15.5±4.4 | 12.2±4.2 | <0.05
TVId(cm) | 13.1±5.6 | 11.4±5 | NS
TVI/TVID | 1.4±0.3 | 1.0±0.2 | <0.001

In conclusion, grafted LIMA has a biphasic, systolic and diastolic pattern of forward flow as opposed to a predominant systolic flow pattern in an ungrafted RIMA. Transcutaneous Doppler is a useful method for assessment of flow in normal and grafted internal mammary artery.

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Validation of the corrected TIMI frame count for the different culprit coronary arteries with comparable luminal areas measured by intravascular ultrasound.

N. Oxdemir, C. Kaymaz, C. Kyrma, O. Karakaya, M. Akay, M. Yildiz, S. Daodelen, B. Yacmyaz, F. Turan, M. Ozkan
Cardiology Clinic, Kosyolu Heart & Research Hospital, Istanbul, Turkey

The corrected TIMI frame count (CTFC) is a quantitative angiographic coronary flow, and adjustment in CTFC is used for the accuracy. Validation of this adjustment for LAD has not been investigated in association with intravascular ultrasound(VUS)parameters, defining luminal area and stenosis characteristics of the culprit arteries. The purpose of this study is to investigate the VUS-derived correlates of the CTFC measured in the different culprit coronary arteries before coronary stenting, and to assess whether CTFC relates to a territory difference despite comparable basal and final luminal areas measured with IVUS. The study population comprised 38 patients(M31,F7;age 51±15)studied with IVUS before and after intracoronary stenting(LAD21,Cx8,RCA 9). All angiograms were performed with 8F catheter and were filmed at 12.5 frames/sec, one films were measured with a frame counter.An adjustment were performed by multiplying the CTFC by a factor of 3.0 divided by the actual number of filming speed. For left anterior descending(LAD) coronary artery, CTFC was quantifiable in all patients, but CTFC sonogram from LIMA-LAD was obtained in only 20 pts. For right coronary artery(RCA) and circumflex artery(Cx), CTFC was quantifiable in 9 and 8 pts respectively.

Parameter | LAD | RCA | Cx | p
--- | --- | --- | --- | ---
Vs(cm/sec) | 8+0.8 | 8+1.2 | 8+1.0 | <0.001
Vd(cm/sec) | 8+0.8 | 8+1.2 | 8+1.0 | <0.001
TVIs(cm/sec) | 1.4±0.3 | 1.4±0.3 | 1.4±0.3 | <0.001
TVId(cm/sec) | 1.4±0.3 | 1.4±0.3 | 1.4±0.3 | <0.001
TVI/TVID | 1.4±0.3 | 1.4±0.3 | 1.4±0.3 | <0.001

The non-invasive assessment of coronary flow reserve by high-resolution transonic Doppler-Doppler during venous infusion of adenosine is an emerging clinical tool for the diagnosis of left anterior descending (LAD) coronary artery disease. However, a question about the cost of the test has been raised. In particular, the use of long adenosine infusion time and contrast agents may significantly increase the cost of the test.

Methods: We have compared a standard contrast echo approach (3.5 MHz probe, 4 g Levovist plus 5 min adenosine infusion,140 mcg/kg/min) with a non-contrast approach (7 MHz transonic probe, 90 sec adenosine infusion, 140 mcg/kg/min). The cost of 1 vial of Levovist is 219 USD, and that of adenosine 1.34 USD/min. The non-contrast, short adenosine infusion approach was tested in 171 consecutive patients. The test was feasible in 161 (94%) patients, 12 with normal coronary arteries, 47 with LAD disease, 44 with LAD stent, and 58 with LAD graft. Maximal coronary flow velocity reserve was already obtained at 30-70 sec and did not further increase with time. The cost for a patient weighting 70 kg, is 284 USD using the contrast echo approach vs only 20 USD using the non contrast, 90-sec approach. In conclusion, the assessment of LAD flow reserve is feasible by a 7 MHz transonic probe, and maximal response is already obtained at 30-70 sec. The non-contrast short-dose adenosine approach is 14 times less expensive than the standard contrast approach, which should be reserved to patients with a difficult acoustic window.

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Assessment of coronary flow reserve by non contrast, short venous infusion of adenosine and transonic echo-Doppler: cost-effective analysis.

P. Voci, F. Pizzuto, G. Testa, G. Plaustro, E. Marano, G. Di Nucci, PE. Puddu
Cardiac Surgery Dept., University of Rome "La Sapienza", Rome, Italy

The non-invasive assessment of coronary flow reserve by high-resolution transonic color-Doppler during venous infusion of adenosine is an emerging clinical tool for the diagnosis of left anterior descending (LAD) coronary artery disease. However, a question about the cost of the test has been raised. In particular, the use of long adenosine infusion time and contrast agents may significantly increase the cost of the test.

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Intravascular ultrasound correlates of the corrected TIMI frame count in patients who underwent intracoronary stenting

N. Ozturk, C. Kaymaz, C. Kyrma, M. Yuce, M. Aksoy, S. Odetola, B. Yamanci, F. Turan, M. Ozkan
Cardiology Clinic, Kosuyolu Heart & Research Hospital, Istanbul, Turkey.

The corrected TIMI frame count (CTFC) is considered to be a quantitative index of coronary blood flow relating to angiographic minimal luminal diameters of the culprit coronary arteries. However, the relationship between CTFC and intravascular ultrasound (IVUS) parameters defining luminal area and stenosis characteristics of the culprit arteries has not been investigated. The purpose of this study is to investigate IVUS-derived correlates of the CTFC in the culprit arteries before and after intracoronary stent intervention. The study population comprised 38 patients (M = 31, F = 7, age = 58 ± 15) studied with IVUS before and after intracoronary stenting (LAD = 21, CX = 8, RCA = 9). All angiograms were performed with 8 F catheters via the common femoral arteries and 2 were filmed at 12.5 frames/sec and cineframes were measured with a frame counter. An adjustment was performed by multiplying the CTFC by a factor of 30 by divided by the actual number of filming speed. For left anterior descending (LAD) angiograms, a correction was made by dividing the frame count by 1.7. Proximal (P) and distal (D) reference (VA) and lumen area (LA), target lesion (TL) VA and LA were measured by IVUS. Mean stenosis and luminal area stenosis were calculated. Pre-intervention LAS and RLA were 8.2 ± 3.1 mm² vs 8.9 ± 2.1, LLA = 11.3 ± 2.6 mm² vs 14.4 ± 2.2 mm² and postintervention TLLA (1.04 ± 0.5 mm² vs 8.9 ± 3.5 mm², p = 0.01) and CTFC (35.7 ± 16.7 vs 16.4 ± 3.0, p = 0.01) and postintervention acute luminal gain were 6.5 ± 1.2 mm², respectively. In the analysis of the overall 76 pre and postintervention IVUS studies, CTFC showed a negative correlation to TLLA (r = -0.70, p < 0.001) and a positive correlation to LAS (r = 0.63, p = 0.001). However, improvement in the CTFC after stenting showed a moderate correlation to acute luminal gain (r = -0.50, p < 0.05).

Conclusion: Although CTFC is a simple quantitative index for coronary flow that may represent IVUS-derived TLLA and LAS, improvement in the CTFC was found to be moderately correlated to the acute luminal gain after coronary stenting.

Visualization of coronary stenoses with transthoracic colour Doppler echocardiography

M. Saraste, J. Koskenvuo, J. Mikkola, L. Pettitari, J. Hartiala
Clinical Physiology Dept., Turku University Central Hospital, Turku, Finland; Radiology Dept., Turku University Central Hospital, Turku, Finland; Internal Medicine Dept., Turku University Central Hospital, Turku, Finland; Radiology Clinic, University Central Hospital, Turku, Finland.

Purpose: Transthoracic colour Doppler echocardiography (TTE) has previously been used to measure isolated stenoses in the LAD based on the acceleration of the flow velocity due to stenosis (1, 2). The purpose of this study was to test whether it is possible to find all significant coronary stenoses in patients with 50% luminal diameter reduction in coronary angiography with TTE in the whole coronary tree.

Methods: TTE was performed for 40 patients before routine coronary angiography. In the TTE, expected routes of the coronaries were scanned using colour Doppler (Acuson Sequoia C 266 with 3.5 MHz transducer) from the proximal to distal direction using several imaging windows. Coronary stenoses were judged by local turbulence and aliasing and were evaluated using pulse wave Doppler flow velocity measurements or velocity scaling procedure with color Doppler. If flow velocity was found three times higher distal to stenosis compared to proximal part, stenosis was considered significant (2). These results were then compared with coronary angiographies.

Results: The sensitivity of TTE in diagnosis of significant coronary stenoses varied from 50% in left circumflex coronary artery to 100% in the left main coronary artery. The specificity of TTE was 100% in all patients.

Conclusions: We show that with noninvasive TTE it is possible to detect coronary stenosis even in the peripheral coronary arteries. The method clearly has potential in clinical work.


Sensitivity and specificity of TTE in diagnosis of significant coronary stenoses

<table>
<thead>
<tr>
<th>Territory</th>
<th>Sensitivity</th>
<th>Specificity</th>
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</thead>
<tbody>
<tr>
<td>LAD</td>
<td>37/35/100</td>
<td>78/71/100</td>
</tr>
<tr>
<td>LAD (overall)</td>
<td>20/20/100</td>
<td>50/50/100</td>
</tr>
<tr>
<td>LCX (overall)</td>
<td>16/16/100</td>
<td>16/16/100</td>
</tr>
<tr>
<td>RCA (overall)</td>
<td>16/16/100</td>
<td>16/16/100</td>
</tr>
<tr>
<td>LM indicates left main and RCA right coronary artery</td>
<td>Anterior descending circumflex</td>
<td>LAD left</td>
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</tbody>
</table>
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Endothelial function is impaired in peripheral arteries in syndrome X patients. Insights from pulse propagation and arterial vasodilator tests
M. Kieda 1, JZ. Peruga 2, JD. Kasprzak 2, W. Religa 2, E. Trzos 2, M. Krzeminska-Pakula 2
Department of Cardiology, Medical University of Lodz, Lodz, Poland 1, Cardiology Dept, Medical Univ. of Lodz, Lodz, Poland 2

BACKGROUND: In patients with syndrome X (SX) with or without the presence of symptoms, significant obstructive coronary artery disease cannot be demonstrated. The aim of this study was to evaluate the endothelium-dependent vasodilator response to acetylcholine in peripheral arteries in Syndrome X patients.

METHODS: Study included patients with positive risk factors for coronary artery disease (group 1), patients with Syndrome X (SX, group 2), and patients with a normal coronary angiogram without aortic stenosis (group 3). The coronary flow reserve (CFR) was measured in patients with Syndrome X (SX) and controls using an intracoronary ultrasound device with a 12 MHz linear transducer. Acetylcholine (ACH) was infused in a stepwise manner to achieve concentrations from $10^{-8}$ to $10^{-5}$ mol/l. Coronary artery disease was defined as a stenosis $>75\%$.

RESULTS: The peak systolic gradient measured by transthoracic echocardiography was on average $94.9\pm22.5$ mmHg in group 1. The CFR was significantly lower in groups 1 and 3 (group 1 = $1.86\pm0.52$ and group 3 = $1.84\pm0.44$ vs group 2 = $3.08\pm1.08$, p<0.01). However, the mean resting velocity was significantly lower in group 2 than in groups 1 and 3 (525.02±20.7 cm/s vs 663.27±7.3 cm/s and 643.7±28.7 cm/s, p=0.03). The maximum velocities behaved similarly (145.8±26.0 cm/s MS 123.5±40.7 cm/s and 159.6±42.0 cm/s, p<0.01). However, the mean resting velocity was significantly lower in group 2 than in groups 1 and 3 (525.02±20.7 cm/s vs 663.27±7.3 cm/s and 643.7±28.7 cm/s, p=0.03).

Conclusions: Patients with Syndrome X (SX) have an impaired CFR, but not NTG induced vasodilatation is abnormal in SX patients. Two types of impaired endothelial function were found: 1) EDR but not NTG induced vasodilatation is abnormal in SX patients. 2) There is a strong correlation between the ratio of diameter change at maximal ACH concentration and the basal intimal index on ICUS (denoted as v), with the regression line: $y = 0.17x - 0.029$, r=0.56, p<0.001. Result: In patients with Syndrome X, the CFR is significantly lower. This can be explained in part in terms of the higher LVM, but the measurement is influenced by the resting coronary flow velocity.

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Transmural and transcranial echocardiography allows detailed imaging of the entire aorta using a new phased-array ultrasound-tipped catheter
T. Bartel 1, S. Müller 2, G. Caspari 3, R. Erbel 1
Cardiology Dept, University Essen, Essen, Germany 1, Cardioangiography Dept, University Essen, Essen, Germany 2, Institute of Radiology, University Essen, Essen, Germany 3

Objective: Current intravascular ultrasound allows exclusively two-dimensional (2D) imaging of the aorta from the arterial side. Transcranial Doppler echo is able to provide information about the abdominal aorta and catheters placed into ascending aorta. We present the feasibility of a new catheter-tipped transfemoral ultrasound system with full Doppler capability in combination with transcranial Doppler imaging.

Methods: The present study was performed in 5 dogs (Beagles, 11.4±1.4 kg). The catheter (10F) was introduced into the femoral vein and artery and navigated through the inferior vena cava and the descending aorta, including particular layers as are the intima, media, and adventitia as well as flow of the aorta. Tissue Doppler imaging was only sufficient from the transarterial approach.

Conclusions: The newly developed intracardiac imaging device allows complete imaging of the abdominal aorta from the arterial side. Transoesophageal echo is unable to provide assessment of signals. Tissue Doppler imaging was only sufficient from the transarterial approach. Ultrasound-tipped catheter seems to be a suitable tool in order to guide implantation of stents in the case of aortic dissection.

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The coronary flow reserve in patients with aortic stenosis and a normal coronary angiogram
T. Forster, A. Nemes, A. Varga, M. Csanady
2nd Dept. of Medicine, University of Szeged, Szeged, Hungary

Background: The value of coronary flow reserve (CFR) is a well-known characteristic of the distensibility of the coronary arteries. It can be measured during transmural and transcranial stress echocardiography, which is semi-invasive method.

The aim of this study was to compare the CFR in patients with aortic stenosis and a normal coronary angiogram (group 1), in patients with a normal coronary angiogram without aortic stenosis (group 2), and in patients with significant left anterior descending coronary artery disease (group 3).

Patients and methods: The group 1 consisted of 22, the group 2 of 24, and the group 3 of 41 patients. The transesophageal stress echocardiography was carried out according to a standard protocol, using a vasodilator stimulus by dipyridamole in a dose of 0.56 mg/kg in 4 min.

Results: The peak systolic gradient measured by transthoracic Doppler echocardiography was on average $94.9±22.5$ mmHg in group 1. The CFR was significantly lower in groups 1 and 3 (group 1 = $1.86±0.52$ and group 3 = $1.84±0.44$ vs group 2 = $3.08±1.08$, p<0.01). However, the mean resting velocity was significantly lower in group 2 than in groups 1 and 3 (525.02±20.7 cm/s vs 663.27±7.3 cm/s and 643.7±28.7 cm/s, p=0.03). The maximum velocities behaved similarly (145.8±26.0 cm/s MS 123.5±40.7 cm/s and 159.6±42.0 cm/s, p<0.01). However, the mean resting velocity was significantly lower in group 2 than in groups 1 and 3 (525.02±20.7 cm/s vs 663.27±7.3 cm/s and 643.7±28.7 cm/s, p=0.03).

In conclusion: In patients with aortic stenosis and a normal coronary angiogram, the CFR is significantly lower. This can be explained in part in terms of the higher LVM, but the measurement is influenced by the resting coronary flow velocity.

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Impairment of coronary vasodilatory response to acetylcholine is related to plaque burden assessed by intracoronary ultrasound
R. Babic 1, M. Ostojić 2, G. Stankovic 2, B. Beleslin 2, S. Stojkovic 2, M. Nedeljkovic 2, A. Neskovic 1, D. Maras 1, M. Bojic 1
Cardiovascular Research Center, Dedijer Cardiovascular Institute, Belgrade, Yugoslavia 1, Cardiology Diagnostic Dept, Inst. for Cardiovascular Diseases, Belgrade, Yugoslavia 2

Endothelial vasodilatory function plays a pivotal role in controlling coronary vasomotor tone. Since endothelial dysfunction may precede angiographic development of coronary artery disease, study was aimed to determine relation of coronary response to acetylcholine (ACH) with presence and extent of atherosclerotic wall thickening assessed by intracoronary ultrasound (ICUS).

Methods: Study included patients with positive risk factors for coronary artery disease (CAD) referred for coronary angiography, without significant coronary stenosis (>75%) on angiography, age >50 years, male, 24 patients. Baseline brachial artery diameter was similar in SX and controls (4,02±0,63 mm vs 4,08±0,64 mm p=NS) Results were shown as baseline v. mobile vs control. Conclusions: In patients with Syndrome X (SX), the CFR is significantly lower. This can be explained in part in terms of the higher LVM, but the measurement is influenced by the resting coronary flow velocity.
Effect of simvastatin on restenosis after percutaneous transluminal angioplasty of femoropopliteal arterial obstruction

T. Hagenaars 1, E.J. Gussenhoven 1, HPA, Troost 1, J.L. Seelen 1, J.W. Jukema 3, H. Van Uik 4

Exp. Echocardiography Dept, Erasmus Medical Center, Rotterdam, Netherlands 1, Radiology Dept, Twee Steden Hospital, Tilburg, Netherlands 2, Cardiology Dept, Leiden University Medical Center, Leiden, Netherlands 3, Vascular Surgery, Erasmus Medical Center, Rotterdam, Netherlands 4

Purpose: Clinical studies using angiography have shown that statin therapy may reduce restenosis after coronary angioplasty. However, the precise effect of statin therapy on the mechanism of restenosis after percutaneous transluminal angioplasty (PTA) remains to be elucidated. The purpose of the present retrospective intravascular ultrasound (IVUS) study was to evaluate whether simvastatin therapy limits lumen area reduction 1 year after PTA by an effect on plaque growth, vascular remodelling or both.

Methods: Seventeen patients (n=17) with obstructive disease of the femoropopliteal artery underwent standard PTA. Angiographic and IVUS records immediately following intervention and at 1-year follow-up were acquired. A comparison was made between patients with and without simvastatin in clinical and angiographic restenosis (diameter stenosis >50%) and in lumen, media-bounded and plaque area change seen with IVUS at 1-year follow-up.

Results: At 1-year follow-up no clinical or angiographic restenosis was observed in patients with simvastatin (n=6); in patients without simvastatin (n=11) there was evidence for clinical restenosis (n=4) and/or angiographic restenosis (n=8). IVUS revealed a significant difference in lumen area change between patients with and without simvastatin (-4% and -25%, respectively) (p=0.03); this difference was due to a difference in change in media-bounded area (+4% and -23%, respectively) (p=0.06). In both groups of patients a similar increase in plaque area (+14% and +15%, respectively) (p=0.39) was encountered.

Conclusion: This retrospective observational IVUS study suggests that plaque growth at 1-year follow-up is a general response to aortic stenosis is preserved but deteriorates immediately after aortic valve replacement.

Conclusions: Our study has been demonstrated endothelial dysfunction in patients with coronary artery disease, stable angina, and patients with acute coronary syndrome compared with control subjects. Massive lipid-lowering therapy improves endothelial function in patients with unstable angina.

Effects of intensive lipid-lowering therapy (one session of plasmapheresis) in pts with CAD, unstable angina, therapy (one session of plasmapheresis) in pts with CAD, unstable angina, plasma TC decreased by 25% (p<0.001), LDL-cholesterol by 32% (p=0.002), flow-mediated dilation was increased by 4.5±3.3% to 11.4±4.5% (p<0.02).

Conclusion: Our study has been demonstrated endothelial dysfunction in patients with coronary artery disease, stable angina, and patients with acute coronary syndrome compared with control subjects. Massive lipid-lowering therapy improves endothelial function in patients with unstable angina.