Obesity Has No Effect on the Sensitivity of NT-ProBNP for Detection of Systolic and Diastolic Dysfunction: Results From the ProBNP Investigation of Dyspnea in the Emergency Department (PRIDE) Echocardiography Substudy

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Background: Obese patients have lower plasma levels of amino-terminal pro-B-type natriuretic peptide (NT-proBNP) than their lean counterparts. Whether the sensitivity of NT-proBNP for detection of echocardiographic abnormalities is significantly reduced in obese patients is unknown. Methods: Routine echocardiography was performed in 134 patients with dyspnea enrolled in a study of NT-proBNP testing. The sensitivity of an NT-proBNP level >300 pg/ml to detect LVEF <50% and diastolic dysfunction was determined in patients stratified by body-mass index (BMI) into categories of <25, 25 to 30, and >30 kg/m2. LVEF was determined by the modified Simpson’s method using biplane measurements of LV volumes. Diastolic dysfunction was defined as early diastolic tissue Doppler velocity at the lateral mitral annulus (Ea) >8 cm/s, ratio of the early diastolic mitral inflow velocity (E) to Ea >1.5, or diastolic dysfunction based on standard transmitral and pulmonary venous velocity criteria. Proportions were compared using the χ² test. Results: There were 35, 41, and 48 patients in the 3 BMI groups. The percent of patients in each BMI group with echocardiographic abnormalities is shown in the Table. The sensitivity of an NT-proBNP level >300 pg/ml to detect an LVEF <50% for the 3 BMI groups was 100%, 95% and 94% (p = 0.65). When diastolic criteria were added, the sensitivity was 96%, 90% and 91% (p = 0.72). Conclusion: Our study suggests that intensive tennis practice increases left ventricular systolic dysfunction. The practice of intensive sports may lead to cardiac changes No previous study has focused on tennis players. The aim of this prospective study was to analyze the cardiac changes due to intensive tennis practice. Methods: We have systematically proposed a complete screening echocardiography to the professional tennis players participating in the 2004 Roland-Garros grand slam tournament in France. The study population consisted of 80 tennis players divided into 50 men (group Im) and 30 women (group Iw) and a control group matched to sex and age (groups IIm (n=50) and IIw (n=30)). All subjects included in this study underwent a complete echocardiography (2D, M-mode, Doppler and TDI). All 2D-M-mode measurements were indexed by surface body area. LV mass >106 g/m² (woman) and >111 g/m² (man)defined LVH. The practice of intensive sports may lead to cardiac changes No previous study has focused on tennis players. The aim of this prospective study was to analyze the cardiac changes due to intensive tennis practice. Results: LV mass was significantly higher in groups Im and lw (p<0.001). For men, 18 tennis players (36%) presented with LHV vs. 3 of the control group (p<0.002). LV diameter and LVEF were not significantly different between groups. Right and left atrial measurements were significantly higher in tennis players (p<0.003, see Figure). Significant correlations were observed for tennis players between age and right atrium (r=0.45, p=0.004) and between age and left atrium (r=0.35, p=0.04), but not for control groups. Conclusions: Our study suggests that intensive tennis practice increases left ventricular mass and professional tennis players present a significant arial remodeling.
Background: Top-level training induces morphologic cardiac adaptations; the most significant change is cardiac hypertrophy. There are not yet clear the effects of training in young subjects' heart. The aim of study was to assess physiological cardiac adaptations in professional soccer players and swimmers from 8 to 18 years old.

Methods: A study was conducted on 321 elite athletes (group A: 119 swimmers, group B: 304 soccer players) and 131 sedentary controls (group C) matched by age and BSA and divided in ten subgroups according to BSA, starting by 1.00 m² and increasing to 1.99 m². The two-dimensional study was performed with biplane and single plane mode. Echocardiographic parameters analyzed Etdiastolic diameter (DD) and volume (DV), Posterior wall (Pw) and Interventricular septum thickness (IVS), Left ventricular mass (LVM) and LVM index (LVMI).

Results: Athletes showed cardiac parameters greater than controls (IVS: 8.24±1.18-7.60±1.04 mm, PW: 29.6±9.3-26±8.2 mm, IVS: 25.3±8.2-24.8±9.9 mm, LVMI: 91.31±20.77-77.30±17.73 g/m²). In BSA subgroups IVS was higher in soccer players only by 1.60 m² (B: 8.75±0.65 vs C: 8.05±0.90 mm, p<0.003) and by 1.70 m² in swimmers (A: 9.29±0.86 vs C: 8.18±0.84 mm, p<0.000). PW showed a highly positive difference for the two athletic groups by 1.80 m² (C: 4.83±0.64; A: 5.05±0.82, p<0.05; B: 9.35±1.04 mm, p<0.003). DD was significantly larger in athletes than in controls by 1.60 m² (C: 10.75±3.73 vs C: 9.67±15.5.0 mm, p<0.02). Soccer players had greater cardiac diameter than controls by 1.60 m² (C: 19.26±1.80 mL, p<0.03). Significant differences were seen, in all BSA classes over 1.60 m², between the athletic and non-athletic groups in LVM (C: 131.38±26.67; A: 162.22±29.87, p=0.002; B: 141.83±11.67 g, p<0.005) and LVMI (C: 79.46±18.32; A: 98.22±17.63, p=0.002; B: 97.25±16.82 g/m², p<0.02).

Conclusions: Exercise induces morphologic cardiac modifications also in young athletes. These become significant when BSA was greater than 1.60 m² (14.0±1.47 yrs).

Left Atrial Ejection Fraction Does Not Predict Decline in Atrial Fibrillation Following Pulmonary Vein Ablation as Assessed by Echocardiography

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Background: Pulmonary vein isolation (PVI) by radiofrequency ablation is now accepted as a standard procedure in treating patients with atrial fibrillation in a selected group of patients. Between 30-40% of patients will have recurrence of atrial fibrillation after the first procedure. The relation between the improvement of left atrial size and function and the recurrence of atrial fibrillation is not clear. Following catheter based PVI in the treatment of atrial fibrillation in selected patients, the left atrial volume decreases and its function improves and these changes are correlated with decline in the recurrence of atrial fibrillation.

Methods: In 33 consecutive patients with paroxysmal atrial fibrillation who underwent PVI with complete echocardiographic data, we retrospectively analyzed the left atrial end diastolic volume (in cc) in the apical 4 chamber view using area method volume method and indexed it to the body surface area. Left atrial ejection fraction was calculated by subtracting the end atrial systolic volume from the end atrial diastolic volume and dividing it by end diastolic volume. Recurrence of atrial fibrillation was identified by holter monitoring.

Results: Compared to 1 day pre PVI, the left atrial volume index at a mean time of 6 months and 12 months after PVI declined by a mean value of 4.5±25.3 cc and 11.8±19.4 cc (p = 0.062 and 0.006 respectively).The left atrial ejection fraction at the same intervals improved by 7.1±13.6% and 3.7±12.9% (P = 0.001 and 0.001) respectively. However there was no difference in the left atrial volume index change or left atrial ejection fraction change between patients with recurrence or non recurrence of atrial fibrillation.

Conclusions: There is significant decline in left atrial volume and improvement in left atrial function at 6 months following PVI. This continued to improve at 12 months. However there was no association between recurrence of atrial fibrillation and the magnitude of improvement in left atrial size or function.

Effects of Isolated Obesity on Cardiac Functions: A Tissue Doppler and Strain Rate Imaging Study

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Background: Obesity is an independent risk factor for the development of heart failure (HF), even after accounting for other co-morbid conditions that cluster with it, such as diabetes, smoking, hyperlipidemia and hypertension. However, the impact of obesity on cardiac function is less well documented.

Methods: 29 obese and 20 controls were investigated. Obesity was defined as a BMI of ≥ 25/m², with clear evidence physical examination of excessive subcutaneous adipose tissue. All patients underwent two-dimensional and Doppler echocardiographic examination including TDI and SR imaging using Vivid 7 (General Electric). The patients were divided into two groups. BMI ≥ 30 was defined as severely obese group (BMI > 30) and BMI ≤ 30 was defined as moderately obese group.

Results: BMI was significantly higher in the obese group (37.2±6.1 kg/m²) than in the control group (21.5±2.2 kg/m²); the average duration of obesity was 12.1 years. The duration of obesity and BMI showed a good correlation with LVED (r=0.58, p<0.001; n=40, p=0.006) and LAV (r=0.39, p<0.000; n=44, p=0.003). BMR derived global peak SRI is lower in obese patients (1.07±0.14) than controls (1.38±0.12, p=0.001) suggesting that regional myocardial contractility may be depressed in obese patients. On speckle multivariate analysis, after adjusting for sex, systolic and diastolic blood pressure and
heart rate, the duration of obesity (9.0-7.6, p<0.001), BMI (9.0-3.5, p=0.023) and age (9.0-2.9, p<0.009) were shown to be the independent predictors of lateral mitral annular Em/Am ratio. In obese group tricuspid annular Em velocity was significantly decreased than in controls (10.9±2.8 vs 15.3±3.1 cm/s, p<0.001). Duration of obesity was shown to be the only independent predictor of RV Em/Am ratio (9.0-5.6, p=0.001) as an RV diastolic parameter.

Conclusions: As a result both left and right ventricular systolic and diastolic functions of left and right ventricles are impaired in obesity. Duration of obesity, age and BMI have an adverse impact on cardiac function, among those the duration of the obesity is the most important independent factor that affects the left ventricular systolic function.

Conclusions: Measurement of EAT thickness might have an additional agreement of echocardiographic EAT with VAT. (Figure 2) Bland-Altman plot regression analysis revealed a good correlation (r = 0.576, p = 0.025). (Figure 1) Bland-Altman plot regression analysis revealed a good correlation of echocardiographic EAT with VAT. (Figure 2)

Conclusions: These results suggest that echocardiographic EAT could be applied as a reliable imaging indicator of visceral adipose tissue of the time interval between onset of E and E' (T_E-E') for the prediction of high LVEDP. (p=0.01).

Conclusions: T_E-E' may have incremental value in the estimation of LV function in the patients with normal systolic function and indeterminate E/E'.

Brain Natriuretic Peptide Plasma Levels Combined to Diastolic Filling Pattern Predict Ventilatory Response to Exercise in Patients With Chronic Heart Failure

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Background: Reduced peak VO2 (VO2peak), combined to enhanced ventilatory response to exercise (EVR) during cardiopulmonary exercise test (CPX), has shown to be one of the main markers for risk stratification in chronic heart failure patients. Conversely, diastolic dysfunction (DD), measured by Doppler echocardiography, and brain natriuretic peptide plasma levels (BNP) represent a first-step approach for the prediction of outcome in these patients. The aim of our study was to assess the predictive accuracy of high BNP levels combined to DD for the identification of reduced VO2peak and EVR during CPX in patients with mild-to-moderate symptoms of chronic heart failure.

Methods: Two hundred and four consecutive outpatients with chronic heart failure were considered. 14 ml/Kg.min was the cut-off value for a reduced VO2peak during CPX. The EVR was assessed as ventilation / carbon dioxide production ratio (VE/VCO2) slope > 35. Echocardiographic selected parameters were transmitral peak E (E) and A wave (A) velocity (cm/sec), E/A ratio and E velocity deceleration time, msec (EDT). Severe DD was defined as E/A ratio > 1 and EDT < 140 msec. BNP plasma level was measured using a modification of the triage system (Biosite Diagnostic TRIAGE® BNP Test). Independent predictors of VO2peak < 14 ml/Kg.min and VE/VCO2 slope > 35 were determined by a multivariate regression analysis with candidate variables added to a model containing VO2peak and VE/VCO2 slope as dependent variables and BNP level, DD (yes/no), age, left bundle branch block, atrial fibrillation as covariates. Discrete variables were compared using Chi-square analysis.

Results: Seventy-three out of 204 patients had Severe DD (36%). Mean BNP plasma level was 254±141 ng/ml. In the logistic multivariate model the combination of BNP plasma level > 100 ng/ml and severe DD independently predicted a reduced VO2peak and EVR at CPX (OR: 3.4, 95% confidence intervals: 1.10-10.0; p=0.03).

Conclusions: The combination of BNP test and severe DD at Doppler echocardiography seems to be a reliable marker of reduced VO2peak and EVR during CPX.
Feasibility of Transhilar Doppler-determined Coronary Flow Reserve for the Assessment of Left Main Trunk Stenosis

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Background: Coronary flow reserve (CFR) measurement by transhilar Doppler echocardiography (TTDE) was a useful method to assess significant coronary artery stenosis. However, it remains unknown about the feasibility of CFR for the assessment of left main trunk stenosis (LMTS). The purpose of this study was to evaluate the adequate cut-off value of CFR for significant LMTS.

Methods: 81 patients suspected of coronary artery disease were examined. We performed CFR measurement of left anterior descending artery (LAD) by TTDE and coronary angiography to assess LMTS. The patients with LAD stenosis, previous anterior myocardial infarction, collateral coronary artery from LAD to right coronary artery or severe valve disease were excluded. CFR was calculated as the ratio of the hyperemic to basal coronary flow velocity 2-minute after intravenous injection of adenosine triphosphate. Coronary angiography was performed within 3 days before and after the CFR measurement.

Results: Of 81 patients, 5 patients had significant LMTS (70%) and 18 patients had intermediate LMTS (50% to 69%). There were significant linear trends between percent diameter stenosis (%DS) and CFR (r=0.40, p<0.0001), and also minimum luminal diameter and CFR (r=0.40, p<0.0001). Receiver-operating characteristics curves for detection of significant LMTS showed that a cut-off value < 1.5 of CFR was precise. Sensitivity, specificity, and positive and negative predictive values of a cut-off value < 1.5 of CFR were 100%, 96.0%, 62.5%, and 100%, respectively. By using multivariate analysis, %DS<70% and diabetes mellitus significantly contributed to the CFR < 1.5.

Conclusions: The cut-off value < 1.5 of CFR by TTDE seems to be adequate for the diagnosis of significant LMTS.

Left Ventricular Apical Rotation is Impaired in Patients with Dilated Cardiomyopathy: Quantitative Analysis by Two-Dimensional Tissue Tracking System

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Background: Left ventricular (LV) twisting, the longitudinal gradient of circumferential strain, has been feasible with newly developed two-dimensional echocardiographic (2DTT) system. The center of rotation was determined and the rotation angles were calculated by customized software. The LV torsion was defined as the difference between basal and apical rotation angle.

Methods: To quantify LV circumferential rotation, LV basal and apical short-axis images were digitally acquired in 11 normal subjects (N) and 11 patients with DCM. Four points at anterior, lateral, posterior and septum were manually set on Endo and Epi separately in LV short-axis view. The movement of these points during a cardiac cycle was tracked by 2DTT (HITACHI, EUB-8500). The center of rotation was determined and the rotation angles were calculated by customized software. The LV torsion was defined as the difference between basal and apical rotation angle.

Results: There were 579 of 9,350 patients (6.2%) with a small pericardial effusion. The presence of a small asymptomatic pericardial effusion is associated with shortened survival.

Coronary Flow Reserve for the Assessment of Left Ventricular Systolic Dysfunction

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Background: Exercise induced changes in pulmonary artery systolic pressure (PASP) are used in clinical decision making. Values of PASP often considered pathologic can be achieved by highly trained athletes during exercise. PASP is the product of pulmonary vascular resistance (PVR) and cardiac output. An estimate of resting PVR using Doppler echocardiography has been previously described by our group. The purpose of this study is to evaluate, noninvasively, the relationship of exercise induced changes in PASP to PVR.

Methods: Fifteen athletes and 15 patients with moderate obstructive lung disease (forced inspiratory volume of 40-80% of predicted) were evaluated using 2D and Doppler echocardiography at rest and during supine bicycle exercise. Peak triusoids regurgitant velocity (TVR) and right ventricular outflow tract velocity integral (RVOTvi) were obtained at baseline and at peak exercise. PVR was determined using the equation: 10TRV/RVOTvi + 0.16. Comparisons were made using the Wilcoxon rank-sum test.

Results: Patients and athletes were able to significantly increase their PASP with exercise. Both the patient and athlete groups showed an increase in PVR with exercise, however the patients had a rise in PVR to >2 Wood units (Wu).

Conclusions: PASP can be derived noninvasively using Doppler echocardiography. A measure of PVR may have useful clinical implications when attempting to define pathologic increases in exercise induced PASP.
98A ABSTRACTS - Diagnostic Testing

S0016
End Diastolic Pulmonary Regurgitation Gradient Predicts Adverse Cardiovascular Outcomes: Data from the Heart and Soul Study

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Background: The Doppler-derived tricuspid regurgitation (TR) gradient estimates pulmonary artery systolic pressure, but the TR gradient is not available on every echocardiogram. We hypothesize that the end diastolic pulmonary regurgitation (EDPR) gradient, an estimate of pulmonary artery diastolic pressure, predicts cardiovascular (CV) outcomes as well as the TR gradient.

Methods: We measured EDPR and TR in 741 ambulatory adults with coronary artery disease who were recruited for the Heart and Soul Study. We determined age-adjusted odds ratios and 95% confidence intervals for heart failure hospitalization (CHF), CV mortality, and all-cause mortality at 3 years. We calculated area under the receiver operating characteristic (ROC) curves for EDPR and TR as predictors of events.

Results: Of the 741 participants, 99 (13%) had an elevated EDPR gradient (>5 mmHg). One hundred thirty (18%) had an elevated TR gradient (>30 mmHg). Elevated EDPR gradient was associated with adverse CV outcomes (Table). Area under the ROC curves were similar for EDPR gradient (range 0.64 - 0.69) and TR gradient (range 0.59 - 0.67) as predictors of outcomes.

Conclusions: An elevated EDPR gradient (>5 mmHg) predicts adverse CV outcomes. The association of EDPR gradient with CV outcomes is substantial and similar to that for TR gradient.

Table. Cardiovascular outcomes by EDPR gradient

<table>
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<tr>
<th>EDPR gradient</th>
<th>&lt;5mmHg</th>
<th>5-14mmHg</th>
<th>=15mmHg</th>
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<td>CHF</td>
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<td>0.04</td>
<td>0.03</td>
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<tr>
<td>CV mortality</td>
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<td>9.03</td>
<td>9.02</td>
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<tr>
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<td>CHF or CV mortality</td>
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<td>CHF or all-cause mortality</td>
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</tbody>
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S0024
Wireless Transmission of Images Obtained During Ambulatory Echocardiography With a Novell Low Profile Ultrasound Transducer.

Premindra A. Chandraratna, Huy Pham, Kent Tran, Don Wauchope, Justin Bragg, VA Medical Healthcare Center, Long Beach, CA

Background: Wireless transmission of ultrasound images is likely to increase the feasibility of ambulatory echocardiography. This study was designed to assess the feasibility of wireless transmission of ambulatory echocardiographic images obtained with a novel low profile ultrasound transducer (Corison). Wireless transmission of ultrasound images is likely to increase the functionality of ambulatory echocardiography. This study was designed to assess the feasibility of wireless transmission of ambulatory echocardiographic images obtained with a novel low profile ultrasound transducer (Corison).

Method: Five normal subjects were studied. The 2.5 MHz transducer is spherical in its distal part and mounted on an external housing to permit steering in 360 degrees. The external housing was attached to the chest wall using an adhesive patch. The transducer was placed at the left sternal border to permit imaging of the left ventricular short axis and attached to the chest wall. The transducer was interfaced with a lightweight echocardiography system (Acuson Cypress, Siemens Inc.) which was placed on a mobile cart and powered by a capacitor (UPS device). The subjects were then asked to walk along the corridor while pushing the cart. The images were captured using the Pyramid Digital image (DVDO) from Pyramid Medical Inc. using the S-Video output from the echo machine. Five second movies were captured for each normal subject at 1 minute intervals automatically timed by the software. Movies were captured as raw uncompressed AVI files and then compressed with MPEG-4 compression. The compressed files were then wirelessly transmitted over a 54 Mbps wireless router to a laptop computer approximately 50 feet away from the patient.

Results: Good quality images of both the resting and ambulatory echocardiograms of the left ventricular short axis were noted on the monitor of the ultrasound machine. The images obtained by wireless transmission and displayed on a computer screen were of similar quality to the original images on the monitor of the ultrasound machine. Excellent definition of the endocardium throughout the entire circumference of the left ventricular short axis was noted during walking.

Conclusion: Wireless transmission of ultrasound images obtained during walking with excellent presentation of image quality is feasible. Further development and miniaturization of this technology could potentially add a new dimension to monitoring and evaluation of cardiac patients.

S0025
Left Ventricular Untwisting Was Delayed and Reduced in Patients With Hypertensive Left Ventricular Hypertrophy: Demonstration by 2-Dimensional Speckle Tracking Imaging

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Background: Newly developed 2D ultrasound speckle tracking imaging allows to measure left ventricular (LV) rotation and torsion. Because LV untwisting predominantly occurs during isovolumic relaxation, its assessment reflects the process of LV relaxation. The aim of this study was to examine whether left ventricular hypertrophy (LHV) would adversely affect LV untwisting. Methods: We acquired basal and apical LV short-axis images in 50 hypertensive patients. Using custom software (Echopac PG, GE), a time-domain speckle tracking was performed, and mean value of LV rotation was obtained at each plane. LV torsion was defined as the net difference of LV rotation at basal and apical planes. The time sequence was normalized to the percentage of systolic duration (ie, at end-systole (ES), t was 100%). The degree of LV untwisting was calculated as percentage of systolic torsion: untwisting = (Tor ES - Tor 1/Tor ES x 100), where Tor t is torsion at time t. Untwisting at ES was the torsion rate. The untwisting rate was defined as (Tor ES - Tor MVO / Tor ES) x 100 / isovolumic relaxation time, where Tor MVO is torsion at mitral valve opening. Results: Although peak systolic torsion was not different, LV untwisting and untwisting rate was significantly delayed and reduced according to the severity of LHV. Conclusions: A delayed diastolic untwisting in hypertensive LVH may contribute to LV relaxation abnormality. 2D speckle tracking imaging provides a novel parameter for the noninvasive assessment of LV relaxation.

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S0031
Reproducibility of Echocardiographic Assessments of Mitral Regurgitation for Percutaneous Endovascular Edge to Edge Repair

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Background: Successful percutaneous edge-to-edge mitral valve repair for moderate to severe (3) or severe (4) mitral regurgitation (MR) using a clip device (MitraClip™, Evalve, Inc. Menlo Park, CA) was recently reported in a feasibility study. To determine eligibility, we quantified MR according to recommended ASE criteria requiring 3/6 parameters as 3+ or 4+. Inter-observer variability was routinely tested.

Objective: To evaluate inter-observer variability in echo measurement of MR grade determination between 2 researchers.

Methods: Twenty patients receiving clips were randomly chosen for re-measurement of MR grade on screening echos. The 6 variables included 2 qualitative: color Doppler flow mapping (CFM) (n=0) (1 to 4), pulmonary venous flow pattern (PVFP) (n=15) (systolic dominant (1), diastolic dominant (2), systolic blunting (3), and systolic flow reversal (4)); and 4 quantitative: effective regurgitant orifice area (EROA) (n=16), regurgitant volume (RV) (n=19), regurgitant fraction (RF) (n=19) and vena contracta width (VC) (n=19), where n is the number with adequate data for analysis. Bland-Altman analysis was applied to test the bias and agreement between observers.

Results: Good correlations were found in the 4 quantitative variables (all Pearson r>0.05), and there were no systematic differences in VC, RV or EROA between observers (all p>0.05). Although highly correlated, the only statistically significant difference between readers was in RF with a mean difference of 3.47% (p<0.01). The difference was clinically meaningless and could be resolved through adjudication. RF was further classified categorically from mild to severe according to defined ranges: 16/19 remained in the same category. 19/20 were classified as CFM 3 or 4 which yielded 95% concordance in this parameter for eligibility. Pivotal classification was concordant in 11/15 pairs.

Conclusions: Our results suggest both qualitative and quantitative measures of MR are highly reproducible and should be considered comprehensively. This integrated approach can be reliably used for determining study eligibility and evaluating device efficacy.

S0032
Tissue Doppler and 2-Derived Measurements of Peak Endocardial Systolic Velocity, Strain and Strain Rate in Senior Athletes

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BACKGROUND: Transient abnormalities in left ventricular (LV) systolic function have previously been documented during endurance sports. However, these described alterations may be limited by the techniques applied. We aimed to determine the effects of completion of a marathon using both conventional and newer less-load dependent measures of LV systolic function including 2-D and tissue Doppler imaging (TDI) derived peak endocardial systolic velocities (V, strain) and strain rate (SR).

METHODS: 25 senior marathon participants were screened with echocardiography pre and post the 2005 Boston Marathon. Echocardiography included conventional measures as well as TDI and 2-D derived V, strain and SR measured at the base, mid and apex of the septal and lateral walls of the LV.

RESULTS: Our cohort had an average age of 50±6 years, a corrected LV mass of 109±9 g/m² and a finish time of 4 hr 14 mins 24 sec. Whilejection fraction remained unchanged, and despite an increase in heart rate, both 2-D and TDI-derived V, strain and SR decreased. There was a good correlation between the TDI and the 2-D derived V, strain and SR in all segments analysed (r = 0.9, p < 0.001; r = 0.9, p < 0.001, mid-septal and lateral walls respectively; r = 0.8, p < 0.001, r = 0.8, p < 0.001, mid-septal and lateral walls respectively).

CONCLUSIONS: We found that participation in an endurance event is associated with a reduction in LV systolic function and also that TDI and 2-D derived measures of V, strain and SR correlated closely both at rest and after exercise.
**902-33**

**Tissue Doppler Imaging for Cardiac Resynchronization Therapy Are the Current Guidelines Sufficient**

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**Background:** CRT is an effective therapy for intractable heart failure (HF). Guidelines for patient selection are successful in only 2/3 of patients. CRT has been suggested for a better selection, however it is not known that it will be the real solution for the >30% of non-responders. We prospectively studied 38 patients, conventionally indicated for CRT, using TDI to investigate its value and clinical application in a busy teaching hospital.

**Methods:** Thirty-eight consecutive patients (28 males 73.7%, age 60.15 ± 10.9), 37(97.36%) NYHA IV, with QRS duration of 163.31±23.8 msec, and LVEF <35% were prospectively studied before CRT using 2D Echocardiography with TDI of the basal septal and lateral walls of LV Assessment of ventricular dysynchrony based on visual analysis in apical standard views, and TDI using 3 different measurements from onset of QRS to onset, peak and of systolic wave, using 60 ms cut-off point. Eighteen (47.36%) had Dilated cardiomyopathy (DCM) and the rest had ischemic cardiomyopathy (ICM).

**Results:** All the patients underwent successful CRT and had clinical improvement of one clinical class. Dysynchrony was visually detected in 34(89.5%). TDI cut-off point >60 msec was found in (50%, 56%, and 66.6%) respectively in ICM patients, while in (60%, 60%, and 35%) in DCM patients.

**Conclusions:** CRT is effective therapy for intractable HF as shown before. PW-TDI measurement did not influence the clinical decision making process. Therefore will not add to the current guidelines for CRT.

**902-34**

**The Effect of Aging on Torsion-Displacement Loop Using 2-Dimensional Speckle Tracking Imaging**

Masaki Takahashi, Tomomi Nakai, Michiko Kokumai, Tomoki NiNiMage, Toshiki Nagakura, Shinichiro Otani, Tone General Hospital, Osaka, Japan

**Background:** Newly developed 2D speckle tracking imaging provides both left ventricular (LV) rotation and radial displacement data, thus allowing for making torsion-displacement (TD) loop non-invasively. The aim of this study was to examine the effect of aging on TD loop.

**Methods:** We acquired 2D basal and apical LV short-axis images with a high frame rate in 45 healthy volunteers. Using custom software (Echopac PC, GE), time-domain speckle tracking imaging (TDI) was used to measure LV torsion and radial displacement. Torsion was defined as the net-difference of LV rotation at end-diastole, t was 200% of LV rotation at end-systole. We studied 99 consecutive patients (male 55, female 44, age 64.5± 14.5 years). TDI was performed using 2D speckle tracking imaging (Echopac PC), and basal septal and lateral walls of LV. We calculated the Onset-End (∆) and Onset-Peak (∆) values for LV torsion and radial displacement.

**Results:** LV torsion was defined as the net-difference of LV rotation at end-diastole, t was 200% of LV rotation at end-systole. We studied 99 consecutive patients (male 55, female 44, age 64.5± 14.5 years). TDI was performed using 2D speckle tracking imaging (Echopac PC), and basal septal and lateral walls of LV. We calculated the Onset-End (∆) and Onset-Peak (∆) values for LV torsion and radial displacement.

**Conclusions:** Younger age significantly affects TD loop, which provides new insights for evaluating LV function.
Comparison of Usefulness of Newer Echo-Doppler Variables to Left Ventricular End-Diastolic Pressure in Predicting Heart Failure

Hsin-Yueh Liang, Sanderson Cauduro, Patricia Pellikka, Kent Bailey, Brandon Grossardt, Eric H. Yang, Chiranjit Rihal, James Seward, Fletcher Miller, Theodore P. Abraham, Mayo Clinic, Rochester, MN

Background: The value of newer echocardiography (ECHO) variables for prediction of heart failure (HF) is unclear. Aim: We determined which ECHO variables best predicted HF and if the prediction was mediated by prediction of left ventricular end-diastolic pressure (LVEDP).

Methods: We reviewed data from 289 patients who underwent ECHO and cardiac catheterization in close proximity. The primary endpoint was HF (new onset or recurrent HF). ECHO was diagnosed by a physician and requiring initiation or modification of treatment. Cox models were used to assess the relationship of ECHO variables and LVEDP to occurrence of HF. HF-free survival was estimated by Kaplan-Meier method, and survival curves were compared by log-rank test.

Results: Mean age was 64±13, men 63%, hypertension 33%, diabetes 15%, dyslipidemia 39%, mean ejection fraction 52±14, mean ejection fraction of the left ventricle remains mostly visual. Parametric analysis of main motion (PAMM) Despite several attempts of post-processing, the visual analysis of loops...in myocardial ischemia.

Conclusions: MAC occurs in a proportion of patients with ESPRD and is associated with increased mortality and the presence of severe CAD. These patients have increased LV cavity size, poorer LV systolic function, higher LV filling pressures, compared to those without MAC.

Mitrail Annuar CalciumPredicts Mortality and Coronary Artery Disease in Patients With End Stage Renal Disease

Rajan Sharm, Denis Pellerin, David C. Gaze, Paul O. Collinson, Helen Gregson, Stephen Jd Brecker, ST Georges Hospital, London, United Kingdom, The Heart Hospital, London, United Kingdom

Background: The significance of mitral annular calcification (MAC) in patients with end stage renal disease (ESRD) remains unclear. We sought to determine whether MAC predicts mortality and cardiac disease in a group of renal transplant candidates.

Methods: 140 patients (mean age 52 ± 12 years, 90 male, mean creatinine 608 ± 272 µmol/L) were prospectively studied. All had echocardiography and coronary angiography. Severe coronary disease (CAD) was defined as luminal stenosis > 70% by visual estimation of at least one coronary artery.

Results: There were 21 deaths over a follow-up period of 2.2 ± 0.7 years. MAC was seen in 56 patients (40%). Kaplan - Meier survival curves for those with and without MAC are shown in the figure. Patients with MAC had significantly higher mortality (log - rank p = 0.06). Those with MAC were older (p < 0.001), had larger LV end systolic (p = 0.05), larger left atrial diameter (p = 0.001), lower LV fractional shortening (p = 0.003), higher E/Ea ratio (p = 0.03) compared with those with no MAC. The proportion diabetic (p = 0.03) and with severe CAD (p = 0.001) was significantly higher in those with MAC. Stepwise logistic regression analysis identified severe CAD (OR 15, 95% CI 3.30, p = 0.011) as the only independent associate of MAC.

Conclusions: MAC occurs in a proportion of patients with ESPRD and is associated with increased mortality and the presence of severe CAD. These patients have increased LV cavity size, poorer LV systolic function, higher LV filling pressures, compared to those without MAC.
Echocardiographic Parameters of Right Heart Function in Patients With Symptoms of Heart Failure

Sarinya Puwanang, Tiffany Priester, Farouk Moskodan, Sudith Kushwaha, Krishnawamy Chandrasekaran, Mayo Clinic, Rochester, MN

Background: Left ventricular (LV) dysfunction in patients with heart failure (HF) is well defined, but little is known about right ventricular (RV) dysfunction.

Objective: To assess RV function by echocardiography (ECHO) in patients with symptoms of HF and describe its relationship to LV function and pulmonary hypertension (PHF).

Methods: Fifty patients with symptoms of HF were prospectively enrolled. RV systolic dysfunction was defined by the presence of ≤ 2 of 3 parameters: RV ejection fraction (RVEF) > 50% by planimetry, right ventricular index of myocardial performance > 0.4, and lateral tricuspid annular motion <1.5 cm. RV diastolic dysfunction was determined by Doppler of the tricuspid valve and hepatic vein and tissue Doppler of the lateral tricuspid annulus. PHF was defined as tricuspid regurgitant velocity > 3 m/s.

Results: Twenty-two patients (44%) had RV systolic dysfunction.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>RVEF (%)</td>
<td>&lt;50</td>
</tr>
<tr>
<td>RV end diastolic diameter (cm)</td>
<td>3.5 ± 0.3</td>
</tr>
<tr>
<td>RV end systolic diameter (cm)</td>
<td>2.5 ± 0.3</td>
</tr>
<tr>
<td>Pulmonary vein S velocity (cm/s)</td>
<td>5.7 ± 1.3</td>
</tr>
<tr>
<td>RV end diastolic area (cm²)</td>
<td>7.1 ± 1.3</td>
</tr>
<tr>
<td>RV end systolic area (cm²)</td>
<td>5.5 ± 0.8</td>
</tr>
<tr>
<td>RV end diastolic diameter (cm)</td>
<td>2.7 ± 1.1</td>
</tr>
<tr>
<td>RV end systolic diameter (cm)</td>
<td>2.2 ± 0.8</td>
</tr>
<tr>
<td>RV end diastolic area (cm²)</td>
<td>4.2 ± 1.0</td>
</tr>
<tr>
<td>RV end systolic area (cm²)</td>
<td>3.8 ± 0.9</td>
</tr>
</tbody>
</table>

Conclusion: Left ventricular dysfunction as measured by interventricular mechanical activation delay was associated with increased mitral regurgitation in patients with inferior MI as compared to anterior MI.

Diastolic Dysfunction Predicts Enhanced Ventilatory Response to Exercise in Patients With Chronic Heart Failure

Angela Beatrice Scardovi, Claudio Coletta, Nadia Aspromonte, Silvia Perna, Paola D'Ertico, Manuela Greggi, Roberto Ricci, Vincenzo Ceci, S Spinto, Rome, Italy

Background: Enhanced ventilatory response to exercise (EVR), determined during cardiopulmonary exercise test (CPX), seems to be able to identify patients (pts) with chronic heart failure (CHF) with poor prognosis. Conversely, EVR, considered alone, might have a limited prognostic weight. It is well known that diastolic dysfunction (DD) and pulmonary hypertension (PH) play a major role for the prediction of outcome in CHF pts.

The aim of this study was to evaluate the possible correlation between EVR, pulmonary hypertension and DD, measured by Doppler echocardiography (DE), in CHF pts with left ventricular ejection fraction (LVEF) < 45%.

Methods: 120 consecutive stable pts were considered (age 62 ± 12, females 28 %; beta-blockers 56 %; ischemic CHF 52 %; NYHA functional class I 8 %, II 60 %, III 32 %). The LVEF was assessed as ventilation and carbon dioxide production ratio (VE/VCO₂ slope) > 35.

Conclusion: EVR is an early sensitive signal of deranged cardiopulmonary reflex control. We speculate that the link between EVR, PI and severe DD lies in the altered central hemodynamics. Our data show a good correlation between those risk markers. The combination of echocardiographic and ventilatory parameters might offer a useful tool to improve risk stratification in CHF-pts.

Myocardial Adaptation to Short-Term High-Intensity Exercise


Background: We aimed to clarify the myocardial adaptation to acute high-intensity exercise among trained athletes.

Methods: We screened 17 participants in the 2004 World Indoor Rowing Championships prior to and immediately post completion of a 2000 meter sprint. Echocardiography included conventional measurements as well as tissue Doppler (TD) strain, strain rate (SR) imaging and speckle tracking (ST) imaging for left ventricular (LV) torsion.

Results: Subjects included 12 males and 5 females with a mean age of 37 years (range 22-56) and an LV mass at the upper limits of normal (LV mass 114±14 g/m²).

Conclusion: EVR is an early sensitive signal of deranged cardiopulmonary reflex control. We speculate that the link between EVR, PI and severe DD lies in the altered central hemodynamics. Our data show a good correlation between those risk markers. The combination of echocardiographic and ventilatory parameters might offer a useful tool to improve risk stratification in CHF-pts.

Inferior Myocardial Infarction is Associated with Greater Left Ventricular Dysynchrony and Mitral Regurgitation Compared to Anterior Myocardial Infarction

Winston Lee, Kenneth Gin, Pui-Kee Lee, John Jue, University of British Columbia, Vancouver, BC, Canada

Background: Inferior myocardial infarction (MI) is associated with a higher incidence and severity of mitral regurgitation (MR) as compared to anterior MI. The mechanism of increased ischemic MR in inferior MI is controversial. The purpose of the study is to assess whether inferior MI is associated with a greater degree of left ventricular dysynchrony than anterior MI and to study whether left ventricular dysynchrony will contribute to increased MR in inferior MI as compared to anterior MI.

Methods: In 36 consecutive patients with acute ST-segment elevation MI (16 anterior and 20 inferior MI), echocardiographic Doppler and strain imaging was performed 2.4 ± 0.9 days following the cardiac event. The time to peak strain was measured at the anterolateral papillary muscle (APM) and the postero medial papillary muscle (PPM) insertion sites. LV dyssynchrony was assessed as the time difference in mechanical activation (time to peak strain) between the APM and PPM. The severity of MR was quantitatively evaluated. Mitral valve annular area, annular diameter, PPM-to-tibero distance, LV sphericity index, LV volumes and ejection fraction were assessed.

Results: In patients with inferior MI, there was a significant inter-patency delay (postero medial papillary muscle minus anterolateral papillary muscle) in time to peak strain of 53 ± 11 ms compared to anterior MI, which was -10 ± 7 ms (p=0.001) with an absolute time difference of 63 ms. This finding of left ventricular dyssynchrony after acute inferior MI was associated with a greater degree of MR than anterior MI: MR jet to left atrial area ratio 16% ± 14% vs 7% ± 4%, p=0.02; regurgitant volume 77 ± 21 ml vs 1.2 ± 1.8 ml, p=0.03. There were no significant differences between the two MI groups in other parameters that may affect the degree of MR: mitral annular area, annular contraction, PPM-tibero distance, and diastolic volume, sphericity index, LV volumes and ejection fraction were assessed.

Conclusions: Left ventricular dysynchrony as measured by interventricular mechanical activation delay was associated with increased mitral regurgitation in patients with inferior MI as compared to anterior MI.

ABSTRACTS - Diagnostic Testing 101A

Myocardial Adaptation to Short-Term High-Intensity Exercise


Background: We aimed to clarify the myocardial adaptation to acute high-intensity exercise among trained athletes.
### 102A ABSTRACTS - Diagnostic Testing

<table>
<thead>
<tr>
<th>HR</th>
<th>Baseline</th>
<th>Post Exertion</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transmural E (m/sec)</td>
<td>0.9±0.1</td>
<td>0.7±0.4</td>
<td>0.01</td>
</tr>
<tr>
<td>Transmural A (m/sec)</td>
<td>0.6±0.2</td>
<td>0.7±0.1</td>
<td>0.32</td>
</tr>
<tr>
<td>L/A</td>
<td>1.6±0.4</td>
<td>1.0±0.2</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>E/e'</td>
<td>8.4±1.6</td>
<td>9.1±1.7</td>
<td>0.21</td>
</tr>
<tr>
<td>A/e'</td>
<td>7.9±2.2</td>
<td>9.2±2.4</td>
<td>0.03</td>
</tr>
<tr>
<td>FPV (cm/sec)</td>
<td>58±4</td>
<td>58±10</td>
<td>0.02</td>
</tr>
<tr>
<td>LVEF (%)</td>
<td>54±4</td>
<td>61±5</td>
<td>0.1</td>
</tr>
<tr>
<td>Lateral E (cm/sec)</td>
<td>2.5±1</td>
<td>2.8±3.3</td>
<td>0.51</td>
</tr>
<tr>
<td>Lateral A (cm/sec)</td>
<td>2.6±0.9</td>
<td>3.5±0.9</td>
<td>0.03</td>
</tr>
<tr>
<td>LV Systolic SR (m/s) (lateral)</td>
<td>1.4±0.5</td>
<td>1.8±0.4</td>
<td>0.19</td>
</tr>
<tr>
<td>LV Systolic Strain (%) (lateral)</td>
<td>-19±4</td>
<td>21±3</td>
<td>0.21</td>
</tr>
<tr>
<td>Basal Torsion (degrees)</td>
<td>8.1±4</td>
<td>8.2±2.1</td>
<td>0.02</td>
</tr>
<tr>
<td>Apical Rotation (degrees)</td>
<td>8.6±4</td>
<td>10.6±3.2</td>
<td>0.07</td>
</tr>
<tr>
<td>LV Torsion (degrees)</td>
<td>10.3±3.2</td>
<td>15.3±5.5</td>
<td>0.03</td>
</tr>
<tr>
<td>RV Apex (cm)</td>
<td>3±6</td>
<td>3±0.6</td>
<td>0.03</td>
</tr>
<tr>
<td>RV SR Apex (°)</td>
<td>2.6±0.9</td>
<td>2.3±0.6</td>
<td>0.21</td>
</tr>
</tbody>
</table>

#### 925 Recent Clinical and Technical Developments in Evaluation of Tissue Motion and Tissue Characterization

**Sunday, March 12, 2006, 1:30 p.m.-5:00 p.m.**

**Georgia World Congress Center, Hall B1**

**Presentation Hour: 1:30 p.m.-2:30 p.m.**

**925-36**

**Baseline Dysynchrony Derived by Strain Imaging Correlates With the Effect of Cardiac Resynchronization Therapy at 1-Month Follow-Up**

Chiharu Miyazaki, Yuval E. Espinosa, David L. Hayes, Margaret M. Redfield, Fletcher A. Miller, Jee K. Oh, Mayo Clinic, Rochester, MN.

**Background:** Cardiac resynchronization therapy (CRT) has emerged as one of the standard therapy for patients with heart failure. The aim of this study is to evaluate the effect of CRT at the 1 month follow-up period on left ventricular volume and its relationship with LV dyssynchrony parameters.

**Methods:** 14 patients who received clinically indicated CRT were studied by standard echocardiography and tissue Doppler (TDI) before and after CRT. Time to peak systolic velocity and time to peak strain were measured in 12 mid and basal segments in apical views by TDI. The standard deviation of those among 12 segments (T_s-SD, T_v-SD) was calculated as a parameter for mechanical dysynchrony.

**Results:** At one month follow-up, EF, ESV and EDV significantly improved compared to baseline in entire patient population. There was an additional ESV reduction at 1 month follow up compared to 1 day after CRT, and 8 out of 14 (57%) patients showed >15% reduction in ESV (responder). Baseline TV-SD did not differ between responder and non-responder (56±22 vs.35±20 p=NS). T_v-SD was significantly larger in responder compared to non-responder. Reduction in ESV at 1 month was significantly correlated with the baseline parameter T_v-SD (r=0.74, p<0.001).

**Conclusions:** Baseline strain imaging compared with TDI could be a predictor of the reverse remodeling after CRT.

**925-37**

**Comparison of Tissue Doppler and Speckle Tracking Based Strain Methods in a Physiological Bonding and Twisting Porcine Heart: An In Vivo Model Study**

Michael W. Wu, Tommy L. Tee, Muhammad Ashraf, Greg Lee, Evan Fulphere, Bo Ren, Robert Burris, Pelle S. Niemann, Xiao Ku Li, David J. Sahm, Oregon Health & Science University, Portland, OR.

**Background:** We tested a new 2D strain rate (2DS) method compared to tissue Doppler imaging based strain (TDIS) in a physiological bonding and twisting porcine model.

**Methods:** We studied 5 fresh porcine left ventricles (LV). A latex balloon connected to a closed circuit pulsatile pump was inserted into the LV through the mitral valve and a rotary pump attached to the LV apex to produce a constant 30° twist synchronized with each pump cycle at a heart rate of 50 bpm; 5 stroke volumes (20-60 ml/beat) were used. Three sonomicrometry crystals were embedded along the LV circumference. Imaging was performed in a short axis view with a GE/VingMed Vivid 7 at 11.5 MHz (frame rate =150). Inflation and expansion of the myocardium was the active phase in our model, so images were analyzed for peak positive circumferential strain by 2DS in EchoPac and then compared with TDIS and sonomicrometry data.

**Results:** Regional strain values computed by 2DS showed an excellent correlation with sonomicrometry (R²= 0.85, p= 0.002) with mean difference of 13% ± 10. Strain values computed by TDIS showed a relatively good correlation with sonomicrometry (R²= 0.75, p= 0.05) with mean difference of 19% ± 10.

**Conclusions:** 2DS showed a better correlation with the reference data than TDIS, due to its lack of Doppler angle dependence and its ability to track radial or circumferential strain without artifacts caused by exaggerated additional twisting motion.
were determined in the region of interest. Pathologic postisometric shortening (PSS) was defined as 1 - Ss/Smax > 0.3 and Ss < 15%. SRs increased during hyperemia only in the patient group with FFR > 0.75 and decreased markedly during balloon inflation. Pathologic PSS was found in 19 in 41 patients during vessel occlusion, but its occurrence had a low stress (18%) for the more subtle changes during hyperemia (Table). 

**Conclusion:** Adenosine stress echocardiography with tissue characterization cannot serve as a noninvasive alternative to FFR for functional assessment of mild-to-moderate coronary stenosis.

<table>
<thead>
<tr>
<th>p &lt; 0.05</th>
<th>* vs baseline, &quot;* vs inflation</th>
</tr>
</thead>
<tbody>
<tr>
<td>TDI/SRI ratio</td>
<td>Smax (%)</td>
</tr>
<tr>
<td>CRFR</td>
<td>FR &gt; 0.75</td>
</tr>
<tr>
<td>Baseline</td>
<td>27.1 ± 0.3</td>
</tr>
<tr>
<td>Smax (%)</td>
<td>11 ± 0.20</td>
</tr>
<tr>
<td>Pathologic PSS</td>
<td>11 ± 0.20</td>
</tr>
</tbody>
</table>

Intraventricular Dyssynchrony Measured by Tissue Doppler Echocardiography Study

**Background:** Hypertensive patients (pts) with clinical heart failure (HF) and preserved left ventricular ejection fraction (LVEF) usually present with apparent diastolic dysfunction (DD). However, whether or not intra-LV contractile dyssynchrony (ICD) coexists with DD and contributes to clinical manifestation in the hypertensive population remains uncertain.

**Methods:** We hypothesized that ICD is frequently coexistent and clinically relevant in hypertensive pts with DD. Conventional echocardiographic coupling tissue Doppler imaging (TDI) was performed in 60 medically well-controlled hypertensive pts (32 men and 28 women, mean aged 63±12 years) who had narrow QRS, preserved LVEF (≥50%), and no active ischemia. Among them, 31 pts who had at least 2 of the following 3 echocardiographic characteristics: LVEF≥1, E deceleration time <220 m/sec, or E/e' (mitral annular early diastolic velocity)>10, were considered to have DD. All pts received 6-minute (stage 2) treadmill exercise test by Bruce protocol. Both peak myocardial systolic velocity (Sm) and ICD (Sm) were measured in the mitral annular plane (SD-T12) and the standard deviation of the time difference between the QRS onset to the peak systolic velocity of the 6-basal and 6-mid LV segments were recorded by TDI before and immediately after exercise.

**Results:** In baseline, pts with DD (n=31) were older (69±9 vs. 57±12 y/o, p<0.001), and had higher LV wall thickness index (0.52±0.09 vs. 0.47±0.07, p=0.028) and greater LV mass index and preserved ejection fraction (64±11%). AVR was performed in 11 patients. LV mass index and mitral A wave. SR-LAs only correlated inversely with body surface area, area. LV fractional shortening (P=0.001) and LA dimension (P=0.024) were independent determinants of mean SR-LAs in healthy subjects.

**Conclusion:** In healthy subjects, mean SR-LAs, which can be an index for LA reservoir function, is associated with LA size and LV systolic function and these variables need to be considered when interpreting LA function by SRI.
### 104A ABSTRACTS - Diagnostic Testing

#### 104A-24

**Subclinical Left Ventricular Abnormalities Predict Outcome in Chronic Kidney Disease and Are Reversible With Renal Transplantation**

Dhruv J. Rathi, X. H. Zhang, R. Leano, K. A. Armstrong, N. M. Isbel, T. H. Manick, University of Queensland, Brisbane, Australia.

**Objective:** Overt left ventricular (LV) abnormalities and ischemia predict outcome in chronic kidney disease (CKD). We hypothesized that subclinical LV dysfunction predicts outcome and reverses with renal transplantation (Tx).

**Method:** Resting and dobutamine echo were used to identify LV dysfunction or ischemia in 176 CKD pts. In 129 pts with normal echo findings, subclinical dysfunction was determined by tissue Doppler imaging (velocities, strain, strain rate). Clinical and echo parameters were recorded at baseline, and pts were followed for cardiac events and mortality over 2.4 years. Follow-up echo (wall thickness and volumes) and tissue Doppler parameters were performed in 80 pts, of whom 45 had undergone Tx and 35 were dialysis-dependent.

**Results:** The composite event rate was higher in pts with ischemia or resting LV dysfunction than the normal group (p=0.0001). In the normal group, prior cardiac history (p=0.002) and serum phosphate (p=0.001) were independent predictors of events (r=0.16). Systolic strain rate (p=0.007) was an independent predictor of events, and added incremental prognostic information to clinical variables (r=0.22, p=0.004). Pts who underwent Tx had improvements in wall thickness, volumes, diastolic tissue velocity and strain, whereas these worsened in pts who stayed on dialysis (table).

**Conclusion:** In CKD pts, ischemia and both overt and subclinical LV dysfunction predict outcome. Subclinical disease can be improved by Tx but progresses in pts who stay on dialysis.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Pre-Tx</th>
<th>Post-Tx</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Systolic velocity (cm/s)</td>
<td>5.0 ± 1.6</td>
<td>4.0 ± 1.1</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Diastolic velocity (cm/s)</td>
<td>3.4 ± 1.8</td>
<td>2.5 ± 1.6</td>
<td>0.007</td>
</tr>
<tr>
<td>Strain rate (s−1)</td>
<td>1.2 ± 0.3</td>
<td>1.0 ± 0.3</td>
<td>0.001</td>
</tr>
<tr>
<td>Strain (%)</td>
<td>18.9 ± 3.4</td>
<td>21.7 ± 3.4</td>
<td>0.001</td>
</tr>
<tr>
<td>Max diastolic volume index (mL/m²)</td>
<td>15 ± 12</td>
<td>12 ± 10</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Max systolic volume index (mL/m²)</td>
<td>23 ± 6</td>
<td>20 ± 6</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Septal wall (cm)</td>
<td>1.4 ± 0.4</td>
<td>1.3 ± 0.3</td>
<td>0.001</td>
</tr>
<tr>
<td>Posterior wall (cm)</td>
<td>1.4 ± 0.4</td>
<td>1.3 ± 0.3</td>
<td>0.001</td>
</tr>
</tbody>
</table>

#### 104A-45

**Effect of Growth Hormone on Cardiac Contractility in Patients With Growth Hormone Deficiency**

Goo-Yeong Cho, In-Kyung Jeong, Min-Kyu Kim, Woo-Jung Park, Dong-Jin Oh, Hyung-Joon Yoo, Hallym university, Seoul, South Korea.

Background: Growth hormone deficiency (GHD) is associated with impairment in myocardial function, but an effect of GH therapy on cardiac structure in normal LV function is inconsistent. We sought whether GH therapy was associated with improvement of subclinical myocardial disturbances and strain imaging and tissue characterization could adequately detect it.

Methods: Nine patients (age 46 ± 14, ejection fraction (EF) > 50%) of GHD were evaluated before and after 6 months GH and compared with normal control (n = 11). Conventional echocardiography, Doppler-derived systolic annular (Sm) and early diastolic velocity (E), strain (s) and strain rate (SR) imaging and tissue characterization with cyclic variation (CIV), and calibrated integrated backscatter (CSB) were obtained. Results: In patients with GHD, LV mass (117 ± 39 vs 106 ± 22 g/m²), EF (59 ± 6 vs 60 ± 3 %), and E/A ratio (1.2 ± 0.4 vs 1.4 ± 0.5) were not different from control and did not change significantly after GH therapy. However, CIV at septum, mean peak s and SR of 12 LV segments showed significantly lower than control. After 6 months therapy, s and SR were significantly improved.

Conclusion: GHD without overt myocardial dysfunction has subclinical changes of cardiac structure and function. Six months GH therapy results in improvement of cardiac contractile performance. Myocardial strain and strain rate are useful for the early detection of subclinical myocardial contractile abnormality and its follow-up in GHD.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Before-GH</th>
<th>After-GH</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sm (cm/s)</td>
<td>9.1 ± 1.5</td>
<td>8.5 ± 2.4</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Sm (cm/s)</td>
<td>27.5 ± 6.3</td>
<td>27.2 ± 7.0</td>
<td>0.034</td>
</tr>
<tr>
<td>CIV (septum, dB)</td>
<td>4.9 ± 2.9</td>
<td>3.5 ± 1.1</td>
<td>0.056</td>
</tr>
<tr>
<td>Peak strain (%)</td>
<td>10.8 ± 2.4</td>
<td>11.5 ± 2.1</td>
<td>0.032</td>
</tr>
<tr>
<td>Peak SR (s/s)</td>
<td>1.03 ± 0.15</td>
<td>1.28 ± 0.29</td>
<td>0.049</td>
</tr>
</tbody>
</table>

#### 926

**Nuclear Cardiology: PET**

**Poster Session**

**Sunday, March 12, 2006, 1:30 p.m.-5:00 p.m.**

**Georgia World Congress Center, Hall B1**

**Presentation Hour: 1:30 p.m.-2:30 p.m.**

**926-92**

**Impaired Left Ventricular Systolic Function Predicts Increased One-Year Mortality Following Normal Positron Emission Tomography Stress Myocardial Perfusion Imaging**

Bret A. Rogers, Thomas D. Callahan, IV, Claire E. Pothier, Richard D. Brunk, Wasi A. Jabar, The Cleveland Clinic Foundation, Cleveland, OH

**Background:** Little data is available regarding prognostic factors in assessing mortality risk following a normal rubidium (Rb-82) positron emission tomography (PET) pharmacologic stress myocardial perfusion imaging (MPI) study. We examined left ventricular (LV) systolic dysfunction as a potential risk factor.

**METHODS:** We reviewed over 4500 studies from 1997 to October 2004 to identify 380 consecutive patients with normal Rb-82 PET and normal perfusion imaging. One-year mortality data were available from the United States Social Security Database on 339 of these patients. Left ventricular ejection fraction (LV EF) data, as measured by echocardiography or gated MPI, were available for 205 of these patients in our hospital medical record system. Abnormal LV EF was defined as < 55%.

**Results:** The overall one-year mortality rate of these 205 patients with normal Rb-82 PET was 11.2%. Of these, 98 patients had an abnormal LV EF; 16 had died at one year (16.3%) compared to 7 of the 107 patients with a normal LV EF (6.5%). This results in a significantly increased mortality risk for patients with LV functional impairment (p=0.02).

**Conclusion:** Despite a normal Rb-82 PET pharmacologic MPI study, any impairment...
in LV systolic function results in a 2.5-fold higher predicted mortality at one year. This result further confirms the prognostic value of LV EF in the setting of normal stress MPI; further studies are necessary to identify other possible adverse prognostic factors.

---

**Diagnostic Performance of Combined Rubidium-82 Cardiac Positron Emission Tomography and X-Ray Computed Tomography (PET-CT) in the Detection of Coronary Artery Disease**


**Background:** By combining the high sensitivity of positron emission tomography (PET) with the detailed anatomic delineation of x-ray computed tomography (CT), hybrid PET-CT is emerging as a potentially powerful diagnostic imaging technology for evaluating outcome (pts) with known or suspected coronary artery disease (CAD). However, its accuracy for detecting CAD is unclear. We sought to determine the diagnostic performance of rest-stress rubidium-82 cardiac PET-CT in the detection of CAD.

**Methods:** We evaluated 64 consecutive pts with suspected CAD undergoing rest-stress rubidium-82 cardiac PET-CT and coronary angiography within six months of each other. Pts with known CAD, prior myocardial infarction or revascularization were excluded. In addition, 38 pts with low likelihood (LL) for CAD were also studied. Obstructive CAD was defined as ≥ 70% luminal narrowing on angiography.

**Results:** The mean age (years) and body mass index (kg/m²) were 62 (SD, 15) and 31 (SD, 8) respectively. Hypertension (52%), dyslipidemia (34%), and diabetes (23%) were the major risk factors for CAD, while chest pain (45%) and/or dyspnea (44%) were the predominant reasons for CAD evaluation. Stress perfusion defects were detected in 41 of the 44 pts with obstructive CAD, and in 10 of 20 pts with non-obstructive CAD (stenosis >70% - sensitivity 93%, CI 87 ± 9; specificity 90%, CI 83 to 91; accuracy 87%, CI 68 to 89). The normalcy rate (proportion of low LL pts with normal scans), a surrogate for test specificity given the potential verification bias, was 100% (38/38), CI 91 to 100. For detecting CAD in pts with one- vessel (1VD) and multi-vessel (≥2 VD) disease was 92% (23/25), CI 90 to 96, and 95% (18/19), CI 90 to 98, respectively. Of the 19 pts with 2VD on angiography, 74% (14/19) had concordant extent of disease on rest stress rubidium-82 cardiac PET-CT in the detection of CAD.

**Conclusions:** We found that PET-CT had high sensitivity and overall accuracy for detecting CAD much higher than that reported for any other technique. However, further studies are necessary to identify other possible adverse prognostic factors.

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**One-Year Mortality According to LV Systolic Function**

**Surviving Patients (%)**

<table>
<thead>
<tr>
<th>EF</th>
<th>0.55-65</th>
<th>65-75</th>
<th>75-85</th>
<th>85-90</th>
<th>90-95</th>
<th>&gt;95</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patients</td>
<td>0.95</td>
<td>0.97</td>
<td>0.98</td>
<td>0.99</td>
<td>0.99</td>
<td>0.99</td>
</tr>
</tbody>
</table>

p < 0.02

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**ABSTRACTS - Diagnostic Testing**

was quantified as the heart-to-mediastinum ratio (HMR) using 4 hours delayed images. Myocardial perfusion abnormality (MPA) of TF was evaluated by semi-quantitative analysis of "take-up" in the polar map technique.

**Results:** Twenty-four cardiac events (4 cardiac deaths and 20 ICD discharges) were documented during the follow up period. Patients with both HMR of ≤50 and MPA of ≤21 demonstrated significantly higher incidence of cardiac events compared with those with both HMR of >50 and MPA >21 (78% vs. 30%, p = 0.005, respectively). The Kaplan-Meier event-free curve revealed that the former group had a significantly higher event rate than the latter group (p = 0.005).

**Conclusions:** Combined assessment of cardiac sympathetic nerve activity and myocardial perfusion can provide crucial information for identifying patients likely to benefit from ICD.
Dipyridamole-Exercise Tc-99m Sestamibi Gated Single-Photon Emission Computed Tomography Provides Effective Risk Stratification of Elderly Patients

Igor Mandirsky, Sarits B. Bhagdasarian, Aris Athar, Gavin Noble, Alan W. Aihberg, Deborah M. Katten, Gary V. Heller, Henry Low Heart Center, Hartford Hospital, Hartford, CT, University of Connecticut School of Medicine, Farmington, CT

Background: Exercise capacity is a powerful predictor of coronary events. We examined the value of exercise combined with dipyridamole (Dip/Ex) Tc-99m sestamibi gated single-photon emission computed tomography (SPECT) in the risk stratification of elderly patients.

Methods: We identified 1052 elderly patients ≥ 65 years old who underwent Dip/Ex SPECT between 01/06-12/02. Patients with early revascularization (<60 days, n=92), and incomplete follow up data (n=13) were excluded. Images were interpreted in a blinded consensus manner using a standard 17-segment model. Values of summed stress score (SSS) >3 and an ejection fraction (EF) <50% were considered abnormal.

Results: We analyzed 947 patients with a 99% follow up over 2.6 ± 3.7 years. The mean age was 74 ± 6 years. The annualized cardiac death (CD) rate with normal gated SPECT was 0.6% and this increased to 1.1% when either SSS or EF were abnormal and to 3.3% when both were abnormal (p<0.001). Patients who achieved ≥ 5 METS (41%) had lower CD rate than those who achieved < 5 METS (0.7% vs 1.7% respectively, p<0.04). The addition of METs to gated SPECT was most effective among patients in which SSS and/or EF were abnormal (figure).

Conclusions: In elderly patients undergoing dipyridamole-Tc-99m gaged SPECT, exercise duration provides powerful risk stratification in addition to perfusion and function.
Chronic Kidney Disease Is a Powerful Predictor of Adverse Outcomes in Patients With Abnormal Myocardial Perfusion Imaging and Insignificant Coronary Artery Disease

Fadi Al-Agoobi, Fahad Albadran, Zehra Jaffery, Gordon Jacobson, Kahrith Ananthasubramaniam, Henry Ford Hospital, Detroit, MI

Background: Abnormal myocardial perfusion imaging stress test (AMPI-ST) is a known risk factor for future development of major adverse cardiac events (MACE). We aimed to identify the prognostic value of chronic kidney disease (CKD) in patients with abnormal MPI-ST and insignificant coronary artery disease (ICAD). Methods: Retrospective study of consecutive patients between January 1997 to December 2002 who had AMPI-ST and subsequent coronary angiography (CA) showing ICAD within 6 months of the index scan. Abnormal MPI-ST was defined as the presence of reversible perfusion defect suggestive of ischemia, not attributable to attenuation artifacts. ICAD was defined as the absence of visually assessed diameter stenosis of >50% by CA. CKD was defined as glomerular filtration rate (GFR) <60 ml/min at the time of the AMPI-ST. Patients were followed up for the development of the first MACE; cardiac death, myocardial infarction, unstable angina or cerebrovascular disease. Subgroup analysis for predictors of outcomes was done with log rank test and multivariate predictors were assessed using Cox proportional regression analysis. Survival curves were constructed for freedom from MACE.

Results: One hundred and twenty five patients with AMPI-ST and ICAD were included in the study. Mean age was 61.4 ± 12.5 years. Males were 46.8% and 62.4% were African Americans. Twenty four patients (19.2%) had CKD. Mean follow up period was 39.5 ± 24 months. MACE rate for the study group at 24 months was 15.2%. Patients with CKD had significantly worse outcome compared to those without, with MACE rates at 24 months 40% vs. 10% respectively (p<0.001). Univariate predictors of MACE were CKD (HR 4.99; ST-T changes with stress (HR 2.30), and DM (HR 1.91). In a multivariable Cox regression model, CKD was the only statistically significant independent risk factor for development of MACE. (p< 0.001).

Conclusions: Patients with AMPI-ST and ICAD have an adverse outcome. CKD at the time of AMPI-ST is an independent powerful prognostic factor of adverse outcomes. This may reflect significant endothelial dysfunction causing flow reserve abnormalities not appreciated by CA. These patients warrant aggressive risk factor modification.

Lack of Correlation Between Coronary Artery Calcium and Myocardial Perfusion Imaging

Jonathan Bozeman, Michael Shapiro, Anuragini Pandey, Andrew VanTosh, Steven R. Bergmann, Beth Israel Medical Center, New York, NY

Background: Coronary artery calcium (CAC) provides evidence of coronary atherosclerosis and has significant prognostic power. However, the relationship between CAC and hemodynamically significant coronary artery stenosis is still not clear. Studies have suggested a correlation between CAC and stress myocardial perfusion imaging (MPI), but the relationship was not strong.

Methods: We evaluated 126 consecutive patients who underwent EBCT CAC scoring using the Agatston scoring system and stress gated SPECT MPI (using a dual isotope approach) within 3 months. There were no intervening events. CAC scoring was performed by an experienced cardiologist. MPI was interpreted by three experienced, nuclear cardiologists blinded to the clinical history or CAC score. MPI was considered normal if stress and rest scans were homogenous and wall motion was normal. Abnormal scans reflected either ischemia or infarction by standard criteria.

ABSTRACTS - Diagnostic Testing 107A

Delayed Heart Rate Recovery After Adenosine Stress Testing With Supplemental Exercise Predicts Mortality

Yasuo Akutu, Henry Gewertz, Arash Kardan, Shawn A. Gregory, Gerassimos D. Zervos, Gregory S. Thomas, Tsunehiro Yasuda, Cardiac Unit, Massachusetts General Hospital, Boston, MA, Mission Internal Medical Group, Mission Viejo, CA

Background: Delayed heart rate (HR) recovery one minute after treadmill exercise predicts mortality. However, many patients are unable to undergo treadmill stress testing. We hypothesized that a blunted HR recovery after adenosine stress testing with supplemental exercise would be associated with increased mortality.

Methods: Stress 99m-Tc-hexamethyl gallium myocardial perfusion imaging was performed in 522 consecutive patients unable to perform treadmill exercise (mean ± standard deviation, age: 70 ± 12 years, 50% men) with adenosine stress (0.14 mg/min/kg for 4.5 minutes) and supplemental exercise (one arm pumping with 2.5 lbs weight). HRs were recorded at rest, continuously during infusion, then at 1 min. and 5 min. post-infusion. HR recovery was defined as the decrease in heart rate 5 min. post-infusion from the peak HR obtained during infusion. Delayed HR recovery was defined as a decline of ≥12 bpm from peak HR. Images were analyzed 60 min. post-stress for ejection fraction (EF) using an automated program. Resting EF was also measured by two-dimensional echocardiography. Five year clinical follow up was available in 514 patients.

Results: Patients achieved peak HRs of 85 ± 16 bpm (57.6% of target HR) from a baseline of 68 ± 13 bpm at rest, 80 ± 16 bpm at 1 min. (5 ± 8 bpm less than peak), and 71 ± 13 bpm at 5 min. (15 ± 11 bpm less than peak) post-stress. In a multiple regression analysis, blunted HR recovery at 5min. was associated with increasing age (p<0.0005), lower post-stress EF (p<0.0005), a history of typical chest pain (p<0.01), and administration of beta-blocker (p<0.05), but not to resting EF. Over 5 years of follow up there were 93 deaths from all causes and 38 cardiac events (cardiac death or non-fatal myocardial infarction). In a Cox proportional hazards model, delayed HR recovery at 5 min. predicted mortality (hazard ratio: 2.13, 95% Confidence Interval: 1.38 to 3.29, p<0.0007) and cardiac events (hazard ratio: 2.59, 95% Confidence Interval: 1.29 to 5.17, p<0.007) after adjustment of covariation.

Conclusions: Delayed HR recovery 5 minutes after adenosine stress testing with supplemental arm stress exercise is a powerful predictor of overall 5 year mortality and cardiac events.

The Prognostic Value of Pharmacologic Nuclear Stress Testing in Elderly Patients Undergoing Moderate to High-Risk Surgery

Amagd Makaryus, Marc Veneziano, Nina Kohn, Joseph Diamond, North Shore-LIJ Health System, New Hyde Park, NY

Background: Preoperative pharmacologic nuclear stress testing (NST) is often done in the very elderly (≥85 years) to evaluate cardiac risk. The utility of such testing in has yet to be evaluated. We sought to assess the ability of NST to predict peri-operative cardiac outcomes in these patients.

Methods: Retrospective descriptive analysis of 68 patients ≥85 years of age undergoing
Background: Diagnostic testing is useful to assess pre-operative risk for elderly patients ≥ 85 years undergoing moderate-to-high-risk surgery. Abnormal NET, and more specifically a SSS ≥ 29, are highly predictive for the development of MACE in the immediate peri-post-operative period.

Results:

<table>
<thead>
<tr>
<th>Major Adverse Cardiac Events</th>
<th>Yes (%)</th>
<th>No (%)</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>NST Result</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Normal (n=34)</td>
<td>77%</td>
<td>23%</td>
<td>0.001</td>
</tr>
<tr>
<td>Minor (n=14)</td>
<td>73%</td>
<td>27%</td>
<td>0.167</td>
</tr>
<tr>
<td>EF</td>
<td>74 (34%)</td>
<td>26 (66%)</td>
<td>0.491</td>
</tr>
<tr>
<td>SSS</td>
<td>33 (11%)</td>
<td>67 (89%)</td>
<td>0.066</td>
</tr>
<tr>
<td>SDS</td>
<td>12 (40%)</td>
<td>28 (60%)</td>
<td>0.491</td>
</tr>
</tbody>
</table>

Conclusions: Pharmacologic nuclear stress testing is useful to assess pre-operative risk for elderly patients ≥ 85 years undergoing moderate-to-high-risk surgery. Abnormal NET, and more specifically a SSS ≥ 29, are highly predictive for the development of MACE in the immediate peri-post-operative period.

Overall Myocardial Perfusion Changes by Position Emission Tomography Throughout the Entire Coronary Vascular Tree but Not Changes Limited to the Region With the Most Severe Baseline Defect Predict Cardiac Events

Stefano Sdringola, Fernando Boccalandro, Wamique S. Yusuf, Catalin Loghin, Lance K. Gould, The Weatherhead P.E.T. Center and the University of Texas at Houston, TX

Background: Net overall changes in regional myocardial perfusion throughout the entire coronary tree, as opposed to changes in regional perfusion, have not been described during long-term regression or progression of coronary artery disease (CAD) or related to clinical outcomes.

Methods: 407 patients (pts) with CAD undergoing dipyridamole positron emission tomography (PET) at baseline and after 2.6±1.4 years were followed over 5 more years for cardiac events. PET images were objectively quantified by automated software for changes in severity of the (i) Baseline worst quadrant indicating the worst flow limiting stenosis at baseline PET (ii) Follow-up worst quadrant, indicating the worst stenosis on follow-up PET (iii) Maximal change quadrant, indicating the largest change of any same quadrant pair from baseline to follow-up images.

Results: At follow-up PET, new perfusion defects were seen in 40% of pts. In 77% of pts, the greatest change was in a quadrant different from the worst baseline defect. The maximal change quadrant improved in 70% of pts on intense lifestyle/pharmacologic treatment, in 53% on moderate treatment and in 39% on poor treatment (p<0.001).

Conclusion: Changes in perfusion defects integrated throughout the entire heart independently predicted cardiovascular events at long-term follow-up (OR 3.2, 95% CI 9.92-91.2, p<0.01). In contrast, changes in the severity of the baseline worst defect (OR 0.99, 95% CI 1.00-1.0, p=0.5) or of any single baseline-to-follow-up quadrant pair did not.

Conclusions: By multivariate regression analysis involving clinical and PET variables adjusted for size/severity of the baseline PET defects, overall combined quadrant changes integrated throughout the entire heart independently predicted cardiovascular events at long-term follow-up (OR 3.2, 95% CI 9.92-91.2, p<0.01). In contrast, changes in the severity of the baseline worst defect (OR 0.99, 95% CI 1.00-1.0, p=0.5) or of any single baseline-to-follow-up quadrant pair did not.

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ABSTRACTS - Diagnostic Testing 109A

Up-Regulation of Pro-Platelet Basic Protein in Older Men with Obstructive Coronary Disease as Determined by Positron Emission Tomographic Perfusion Imaging: A New Noninvasive Marker for Coronary Artery Disease?

Michael E. D’Angelo, Deborah Leonard, Robert Greene, Christopher Greene, Brian Leonard, Shannon Frank, Joseph G. Oliverio, Victoria Shelton, Jennifer Moore, Lenore McDonald, Michael E. Merhige, The Heart Center of Niagara, Niagara Falls, NY, Niagara University, Lewiston, NY

Background: Coronary disease (CAD) patients have been found to have 18F genes which are differentially expressed compared to controls without CAD. Three of these, the chemokines Pro-Platelet Basic Protein (PPBP), and Platelet Derived Factor 4 (PF4), and Coagulation Factor 13 (F13-A) up-regulate producing plasma proteins. We hypothesized that expression of these three markers in blood would identify patients with obstructive CAD.

Methods: 35 sequential patients referred for rest / dipyridamole stress PET myocardial perfusion imaging (PET MPI) underwent assessment of gene expression in peripheral blood lymphocytes for PPBP, PF4, and F13-A. Venous blood was collected in PAX gene storage tubes, and total RNA was isolated with Versa-gene RNA purification and on-column DNase treatment; purified RNA was then stored at -80°C, for quantitative reverse transcription polymerase chain reaction (PCR). Each unknown cDNA sample was run in triplicate, compared to pooled cDNA from 6 normals and relative gene expression was then calculated.

Results: Stress induced perfusion defects were found in 1 of 15 women and 8 of 20 men. Gene expression was similar for PF4 and F13-A in men and women with and without stress induced perfusion defects. Gene expression of PPBP is shown below.

Conclusion: PPBP gene expression is significantly up-regulated in older compared to younger men, and is associated with a high incidence (70%) of obstructive CAD. PPBP may serve as a non-invasive marker of obstructive CAD in men over 60.

Relative Expression of PPBP

<table>
<thead>
<tr>
<th>Patient Group</th>
<th>Relative Expression</th>
</tr>
</thead>
<tbody>
<tr>
<td>Men &gt; 60</td>
<td>1.05***</td>
</tr>
<tr>
<td>Men &lt; 60</td>
<td>0.61*</td>
</tr>
<tr>
<td>Women &gt; 60</td>
<td>1.28*</td>
</tr>
<tr>
<td>Women &lt; 60</td>
<td>1.17</td>
</tr>
</tbody>
</table>

Diagnostic Testing

Can Exercise Myocardial Perfusion SPECT Continue to Predict Patient Outcomes Long After Testing? Results of a 10-Year Follow-Up Analysis

Daniel S. Berman, Heidi Gransar, Xingping Kang, Leslee J. Shaw, Rory Hachamovitch, Ishac Cohen, Sean W. Hayes, John D. Friedman, Guido Germano, Romalisa Miranda-Peals, Alan Rozanski, Cedars-Sinai Medical Center, Los Angeles, CA

Background: While myocardial perfusion SPECT (MPS) defect size is a strong independent predictor of short-term mortality risk, its incremental value for prediction of long-term risk is virtually unknown. Thus, we evaluated the ability of MPS to predict all-cause mortality (ACM) long after testing in a group of diagnostic pts undergoing exercise MPS.

Methods: We identified 5,689 consecutive pts (61% men, 61±13 yrs) with suspected CAD undergoing exercise MPS and followed up for 10±1.7 years. Pts with known CAD, valvular disease or nonischemic cardiomyopathy were excluded. Pts were divided into groups by <2%, 2-4%, 5-10%, 11-20%, and >20% myocardium (myo) with stress defect, defined from normalized summed stress score.

Results: There were 757 deaths [annualized ACM rate 1.4% (95% CI 1.3-1.5%)]. Stress defect was predictive for ACM (p<0.001) after adjusting for other multivariable predictors of outcome including pretest likelihood of CAD, sex, hypertension, high cholesterol, smoking, abnormal resting ECG, and shortness of breath. Risk adjusted survival by % myo with stress defect is shown (Figure). Hazard ratios (95% CI) for stress defect 2-4%, 5-10%, 11-20%, and >20% were 1.40 (1.10, 1.78), 1.99 (1.62, 2.44), 2.32 (1.82, 2.96), 2.84 (2.23, 3.61), respectively.

Conclusion: Stress defect by MPS was a potent independent predictor of long-term ACM in diagnostic patients. Risk of ACM increased in each category of MPS, including the equivocal group with stress defect of only 2-4%.

Diagnostic Testing

Prognostic Value of Regional Left Ventricular Functional Assessment in Patients Undergoing Exercise or Pharmacologic Gated SPECT

Athanasios Kapatos, Alan W. Whiberg, David M. O’Sullivan, Deborah M. Katten, Gary V. Hailer, Henry Low Heart Center, Hartford Hospital, University of Connecticut, School of Medicine, Hartford, CT

Background: Patients undergoing pharmacologic gated SPECT have higher cardiac event rates than those who undergo exercise with either perfusion or global left ventricular (LV) parameters. We examined the prognostic value of regional LV function with exercise and pharmacologic gated SPECT.

Methods: A prospectively gathered database of 10,337 patients, who underwent rest/stress Tc-99m sestamibi gated SPECT was analyzed. Patients with early (< 60 days) revascularization were excluded. Follow-up was 92% for 29 +/- 17 months. Summed wall motion score (SWMS) was calculated using the 17-segment model and EF generated using the OGGI software. Multivariate analysis determined the independent predictors of cardiac death (CD) and myocardial infarction (MI). Global and regional LV function was considered “preserved” (EF>55% / SWMS<4), “mildly-moderately impaired” (EF>30-44%, SWMS=4-30), and “severely impaired” (EF<30% / SWMS>31).

Results: Patients had exercise (n=4063), or pharmacologic (n=6318) stress. Pharmacologic stress, EF and SWMS were independent predictors of CD (n=926, 29.558, 46.181, 8.33, p<0.01). Using either SWMS or EF there was an increase in the annualized CD rate as LV function deteriorated, and pharmacologic stress was associated with a higher CD rate compared to exercise (figure).

Conclusion: Visual assessment of regional wall motion from gated SPECT is highly effective in risk stratification for cardiac death, even in the subgroup of patients undergoing pharmacologic stress.

Diagnostic Testing

Prognostic Value of Cardiac Sympathetic Activity Evaluated by Scintigraphic 123I-MIBG Imaging Pre and Post Resynchronization Therapy

Martino Martellini, Silvana D’Orio Nishikoa, Simone Cristina Soares Brandão, Clementina Di Giorgi, Claudio Meneguetti, Marcozio Veira, Viviana Hotta, Aníssio Pedrosa, Sérgio Siqueira, Eduado Sossa, José F. Ramires, Heart Institute (InCor) Medical University School, São Paulo, Brazil

Background: sympathetic nervous system (SNS) activation plays an important role in the physiopathology of heart failure (HF). Heart imaging with an analogue of noradrenalin, 123I-metaiodobenzylguanidine (123I-MIBG), can be used for the non-invasive SNS assessment, and could be considered an useful prognostic tool as well as for the therapeutic follow up of such patients (pts). We ought to analyze SNS behaviour comparing 123I-MIBG imaging pre and post Cardiac Resynchronization Therapy (CRT), and to correlate such data to survival.

Methods: prospective study, 21pts (60±18years, 52%males), with HF (FC II-IV), left bundle branch block (LBBB=130ms), LV ejection fraction<35%, under pharmacological treatment, underwent CRT. We analysed Heart/Mediastinum (HM) later index and the 123I-MIBG washout rate (WO), pre and in the 3 month follow up. Statistical analysis was performed with Wilcoxon and Mann-Whitney tests, p<0.05.

Results: Pre CRT, 2 (12.5%) pts were in NYHA FC II, 13 (81%) pts in FC III, 1 (6.5%) pts in FC IV. Post CRT, 9 (56%) pts were in NYHA FC I, 4 (25%) pts in FC II, 2 (12.5%) pts in FC III, 1 (6.5%) pts in FC IV. Six (37.5%) pts died. HM index ranged from 1.39(95%CI) to 1.57 (post) (p<0.05), WO ranged from (pre) 48.03% to 39.84% (post) (p<0.05). HM index showed different values (pre CRT) relative to pts who survived (H/M=1.58) or died (H/M=1.17)(p<0.001).

Conclusion: In pts with HF, CRT improved FC and SNS cardiac activity. Adverse clinical outcome (death) was associated to lower H/M later 123I-MIBG index, pre CRT.
Background: Myocardial perfusion abnormalities even in the absence of any organic heart disease. We investigated the association of dyslipidemia with myocardial adrenergic innervation disturbances using ¹²³I-meta-iodobenzylguanidine (MIBG) and assessed the effect of atorvastatin (A) therapy thereon.

Methods: We included 15 hyperlipidemic subjects with no organic heart disease (10 men, aged 49±10 years, total cholesterol>240 mg/dl, LDL-C>160 mg/dl), while 15 healthy volunteers served as a control group. All the subjects underwent planar and SPECT imaging of the heart after an intravenous infusion of 5mCi MIBG. Heart to mediastinum ratio (H/M) was used for quantitative assessment of adrenergic innervation, while SPECT scintigraphy evaluated the regional distribution of adrenergic activity. All the hyperlipidemic subjects received A 40 mg/day for 6 months and the MIBG study was repeated.

Results: The H/M ratio at 10 min and 4 hours in hyperlipidemias was 1.80 ± 0.21 and 1.75 ± 0.20 respectively; significantly lower than normals (2.25 ± 0.9 and 2.19 ± 0.10 respectively, p=0.05 for both) and was improved under A treatment (1.95 ± 0.7 and 1.9 ± 0.10 respectively, p=0.05). During SPECT scintigraphy, ten hyperlipidemic subjects (66.6%) showed defects in the inferior wall, five (33.3%) displayed additional regional disturbance in myocardial adrenergic activity in the anterior wall and five subjects (33.3%) in the apex, which were ameliorated on re-evaluation, mostly in the inferior and anterior wall. No regional disturbances were detected in healthy subjects.

Conclusions: This is the first study to show a high prevalence of myocardial adrenergic innervation disturbances in hyperlipidemic subjects, while the A effect further intensifies the beneficial role of statins.

Abstract 805 Transthoracic Echocardiography: Still Viable

Monday, March 13, 2006, 7:00 a.m.-8:30 a.m.
Georgia World Congress Center, Room B314

Time Resolved Sequence of Left Ventricular Flow Redirection during Isovolumic Intervals of the Cardiac Cycle

Parwati P. Sengupta, Bipjy K. Khandheria, Josef Korinek, Arshad Jahangir, Shiro Yoshifuku, Ilija Milosevic, Marek Belohlavek, Mayo Clinic, Rochester, MN

Background: Asynchronous deformation of the left ventricle (LV) during isovolumic contraction (IVC) and relaxation (IVR) has been suggested to represent a transient feature of the myocardial wall mechanics that reshuffles the direction of blood flow. We sought to clarify the role of isovolumic intervals during a cardiac cycle by visualizing the features of intracavitary flow directly in vivo by using high resolution flow Doppler and digital particle image velocimetry (DPIV).

Methods: In 10 porcine hearts beating in situ, changes in LV cavity flow during a cardiac cycle were recorded using Doppler (> 200 frames/s, Vivid 7, GE Healthcare) and contrast echocardiography (Definity™). Variations in the direction of LV flow, and timing of aortic and mitral valve movements were recorded at baseline and following LV epicardial (n=5) and right atrial pacing (n=5). Two dimensional digital particle image velocimetry (DPIV) images were analyzed offline from high temporal resolution B-mode contrast images (Insight 6, TSI Inc.).

Results: A good correlation was seen between DPIV and Doppler echocardiography (r = 0.92, P < 0.001) for the timing of longitudinal velocities obtained during different phases of the cardiac cycle. During IVC, LV flow accelerated towards the outflow forming a large anterior vortex. Whereas, IVR produced an intracavitary flow which was initially directed towards the apex, followed by a brief reversal towards the LV base. Epicardial pacing from the LV base resulted in an electromechanical delay which altered blood flow redirection and delayed mitral valve closure (31±13 vs. 62±16 ms, P = 0.004) and peak of aortic IVV flow velocity (55±27 vs. 88±30 ms, P = 0.04).

Conclusions: Isovolumic intervals are not periods of hemodynamic stasis. Rather, dynamic flow rearrangements stabilize and redirect streams into an axial momentum that transit smoothly into phases of suction and ejection. An aberrant electromechanical activation alters flow redirection and delays mitral valve closure. Normal electromechanical activation through the His-Purkinje system in mammalian hearts is inherently suited for reinforcing an efficient intracavitary flow redirection during isovolumic periods.

7:15 a.m.

Does Standard Normalization for Body Size Variables Actually Work?

Tomas G. Neelan, Anura D. Pradhan, Arthur E. Weyman, Massachusetts General Hospital, Boston, MA

Background: Because body dimensions (height [HT], weight [WT], body surface area [BSA], and body mass index [BMI]) influence a wide range of physiologic variables and the size of cardiac chambers, it is common practice to correct for differences by the process of scaling. Scaling, the process of normalization of a physiological variable, such as
cardiac dimensions, to body size, has traditionally been performed via isometric methods which involves dividing the variable of interest by one of these measures of size to the first power. This assumes a linear, proportional relationship between the physiological and the body size variable, and may be flawed. Allometric modeling increased. Translating this allows for estimation of non-linear associations between variables. Therefore, using left atrial dimensions (LAD), we aimed to determine the optimal scaling technique in a large group of adult echocardiographic normals.

Methods: We studied 15,667 consecutively echocardiographically normal adults. Mean age 40±14 years; LAD 32±4 mm; BW 72±17 kg; HT 1.7±0.2 m; BSA 1.8±0.2 m²; BMI 25±6 kg/m². LAD was normalized by each size variable using both isometric and allometric methods.

Results: LAD correlated with all size variables (r=0.20 to r=0.45). Simple isometric normalization (e.g. LAD/BSA) actually increased the correlation with all body size variables (r=0.27 to r=0.08). Correction by the optimal allometric exponent (AE) (BW=0.262; HT=0.428; BSA=0.449; BMI=0.266) removed the effects of the indexed variable, with BW and BSA best removing the effects of all measures of body size. The proportion of variance of LAD explained by BW was 21.4% compared to only 0.9% for HT. There were minimal, but statistically significant, age-, gender- and obesity-related differences in the AE (e.g. BW for males = 0.257 vs females 0.253).

Conclusion: The standard isometric corrections for body size fail to make appropriate correction and in fact increase the relationship of the indexed parameter to all body size measures. Correction using the optimal AE removes the effect of that variable, with WT and BSA best removing the effect of body size. In adults, HT accounts for a relatively small percentage of the variance in LAD.

7:30 a.m.

8055

Serial Echocardiograms in Patients With Cardiogenic Shock: Analysis of the Shock Trial

Loran Yehuda, Harmony R. Reynolds, Scott A. Schwarz, Shannon M. Harkness, Michael H. Picard, RaviDavidoff, Judith S. Huchman, NYU School of Medicine, New York, NY

Background: Previous analysis of echocardiograms at presentation with cardiogenic shock (CS) has shown that LV EF and mitral regurgitation (MR) severity were predictors of 1 yr survival. We hypothesized that early revascularization is associated with improvement in LV function, LV size and MR.

Methods: The SHOCK trial randomized pts with acute MI and CS to emergency revascularization or medical stabilization. This study analyzed pts by treatment received. Echocardiograms done at presentation (early echo) and again at 2 wks (or discharge, whichever came first; late echo) were analyzed for quantitative (n=87) and quantitative (n=64) changes.

Results (See Table): Mean age was 64 ±11, 61% were male and 64% white. Pts with late echo had better 30 day survival than pts without (86.2% vs. 33.3%, p<0.001). Early revascularization was associated with most improvement and less worse LV function (improved in 39.4 vs 24.1%, no change in 54.5 vs 53.7%, worse in 6.1 vs 22.2%, p=0.04) but not with changes in LV size or MR.

Conclusions: There was wide variation in changes in LV volume, EF and MR from early to late echo. Early revascularization is associated with improvement in LV function; however, a sizeable proportion of survivors of CS have no change or worsening of EF by 2 wks. These data must be interpreted in the context of survivor bias relative to pts who did not have late echo. These findings may suggest that the mechanism of benefit of emergency revascularization is not simply an improvement in LV function.

7:45 a.m.

8056

Is Echocardiographic Atrio-Ventricular Ventilation in Patients With Biventricular Pacemakers Needed? An Acute Hemodynamic Study

Kumudha Ramasubbu, Marti L. McCulloch, Nadim Nasir, William A. Zoghbi, Methodist DeBakey Heart Center, Houston, TX, Baylor College of Medicine, Houston, TX

Background: Echocardiography has been used to optimize intra- and inter-ventricular synchrony and select patients for bi-ventricular (BV) pacing. Whether atrio-ventricular delay (AVD) optimization leads to further improvement in left ventricular (LV) function and diastolic properties has not been evaluated.

Methods: Patients who had a BV pacemaker implanted within 48 hours for standard indications were enrolled. LV systolic and diastolic function were assessed at incremental AVD between 70ms and the intrinsic AVD of the patient. Optimal AVD was defined as the highest time velocity integral (TVI) at the aortic valve - a measure of systemic cardiac output. Parameters of LV systolic and diastolic function were assessed at baseline and optimal AVD.

Results: Sixty-three patients were enrolled (19 female). Mean AVD at implantation was set empirically at 127±14 ms and optimal AVD with echo was 139±31 ms (p=0.032). For the group, mean aortic valve TVI at baseline was 20.7±6.7 cm and increased to 22.3±6.8 cm at optimal AVD (p=0.11). A >10% increase in TVI from baseline to optimal AVD was seen in 22/63 patients (35%). This increase tended to be seen more often in patients with a longer intrinsic AVD (21±16 vs 20±4ms, p=0.13). Patients with a >10% increase in TVI also demonstrated an improvement in diastolic filling properties. E/A ratio decreased by 0.4 in patients with >10% TVI increase and increased by 0.02 in patients with <10% increase in TVI (p=0.06).

Conclusions: In the majority of patients, optimal AVD did not confer an acute significant improvement in cardiac output compared to initial AVD set at implantation. However, in a subset of patients identified by a longer intrinsic AVD, LV output appears to increase cardiac output and improve LV filling properties. Since AV optimization modulates diastolic properties, a significant impact on LV systolic properties may not be noted immediately. Whether AV optimization improves long-term clinical outcome remains to be evaluated.

8:00 a.m.

8057

Acute Left Atrial Reverse Remodeling After Pulmonary Venous Ablation: Evaluation With Tissue Doppler Myocardial Velocities

Ana Clara T. Rodrigues, Marcia Caldás, Mauricio I. Scanavacca, Viviane T. Hotta, Cristiano F. Fisani, Eduardo A. Sosa, Wilson Mathias, Jr., Heart Institute (InCor), Sao Paulo, Brazil

Background: Non-invasive evaluation of left atrial (LA) function is challenging due to limitations in current methods. Tissue Doppler (TD) is an alternative means of assessing LA function.

Methods: We assessed 28 patients (24 male, aged 53±2.4 years) with paroxysmal atrial fibrillation (AFib) referred for RF ablation. TD measurements were obtained at the lateral and septal mitral annulus (Sm, Em and Am) at baseline and 24 hours after ablation. LA emptying fraction (EF), estimated from LA volumes (apical 2 and 4 chamber), was given as the ratio of maximal - minimal LA volume/ maximal LA volume and used as surrogate of LA function. A control group with 23 subjects of similar age (52±2.6 years) and sex (15 male) was assessed.

Results: Heart rate was similar for AFib and control. While LAEF was lower for AFib group, LA diameters and volumes were increased. Transmitral A and TD Am velocities were lower for AFib group, with a moderate correlation between LAEF and septal Em (r =0.83) and lateral (r = 0.67). Am. After ablation, a decrease in LAEF occurred in parallel with an increase in systolic LA volume. Septal Am decreased, with a modest correlation between the percent of change in LAEF and septal Am (r =0.44). The acute decrease in LAEF did not correlate with the number of RF pulses or clinical variables.

Conclusions: Patients with paroxysmal AFib show a decrease in LA function that is not correlated to LA size. Shortly after ablation, there is further impairment in LA function that can be adequately estimated by TD velocities.

Comparison between Control and Baseline Afib Groups, and Afib Group at Baseline and after Ablation

8:15 a.m.

8058

Left Atrial Size Can Identify the Highest Risk Multicenter Automatic Defibrillator Implantation Trial-II Patients for Ventricular Arrhythmic Events

Andrew Zohman, Lori B. Croft, Davendra Mehta, Martin E. Goldman, Mount Sinai Medical Center, New York, NY

Background: In the Multicenter Automatic Defibrillator Implantation Trial (MADIT-II), implantable defibrillators (ICD) reduced mortality from 19.8% to 14.2% in patients with reduced left ventricular (LV) function and coronary artery disease over 20 months. However, in the control group, >80% of patients survived. Variables including QRS width, New York Heart Association class, LV ejection fraction (EF) or age were not predictive of survival. With 400,000 new eligible patients annually, the cost of ICD’s would overwhelm the health care budget. Left atrial volume has been identified as a predictor of morbidity and mortality. Therefore we sought to evaluate whether left atrial area (LAA) or other echocardiographic (echo) parameters could identify the highest risk MADIT-II patients.

Methods: We retrospectively reviewed all patients over the last eight years that had an implantable cardiac defibrillator (ICD) placed from 1997 to 2005 and had an echocardiogram (echo) within a year of implantation. LAA, LV EF, 2-D LV size, wall stress, and ventricular events (episodes of ventricular fibrillation and/or ventricular tachycardia) requiring shock as documented by their ICDS were analyzed.

Results: Of 122 patients with ICD implanted and a recent echo, 54% met MADIT-II criteria. There was no difference in age, gender, EF, blood pressure or wall stress between patients with ventricular events and non-event patients. However, LAA (31 cm² versus 25 cm², p<0.0009) and LV diastolic dimension (6.6 cm versus 6.2 cm, p=0.05) was greater in those with at least one ventricular event.

Conclusion: LAA was strong correlate of a ventricular event whereas which and potentially better identify the highest risk MADIT-II ICD eligible patients.
Stress Echocardiography: Clinical Observations and Technical Developments

Monday, March 13, 2006, 7:00 a.m.-8:30 a.m.  Georgia World Congress Center, Room B407

7:00 a.m.

Noninvasive Diagnosis of Coronary Vasospasm by Detection of Regional Left Ventricular Delayed Relaxation Following Hyperventilation With Color Kinesis

Katsumi Ishi, Takahiro Sakurai, Aya Kintaka, Takamoto Wada, Takaharu Saito, Takeshi Aoyama, Kunihisa Miwa, Kansai Denryoku Hospital, Osaka, Japan, Hamamatsu Rosai Hospital, Shizuoka, Japan

Background: The hyperventilation test (HV) has been used as a clinical tool to induce coronary spasm, however the diagnostic usefulness is limited because of low sensitivities and possible danger of hemodynamic instability during a provoked attack. Regional left ventricular (LV) diastolic dysfunction may persist without systolic dysfunction after an episode of coronary spasm. Color kinesis (CK) is an echocardiographic technology that facilitates the evaluation of regional wall motion.

Methods: Consecutive 56 patients (28 even age 50 ±10 years) with the last chest symptoms within 3 weeks (12 ±5 days) were studied echocardiographically following HV. The patients hyperventilated with a frequency rate of 30 breaths/min for 3 min, and CK image was obtained 3 minutes after HV. The CK-diastolic index (CK-DI) was determined as the LV segmental filling fraction in the short-axis view calculated during the first 30% of the diastolic filling time and used to identify regional diastolic endocardial delay during rapid filling phase (normal value: 75±8% (mean SD)).

Results: During diagnostic coronary angiography by intracoronary injection of acetylcholine (ACH), 31 patients had coronary spasm and diagnosed as CSA and the other 25 with chest pain syndrome (CPS). Nine patients (30%) of CSA were diagnosed as significant coronary spasm. CK-DI decreased from 58 ±6 to 21±4% (p<0.001) in the territories perfused by the spasm vessels induced by intracoronary injection of ACH in the patients with CSA, whereas it essentially remained unchanged from 72±5 to 70±6% (NS) in the patients with CPS following HV. Regional LV delayed diastolic motion or decreased CK-DI<60% following HV was detected in at least one region in 25 (81%) of CSA, whereas it was not detected in CPS. The sensitivity and specificity for the diagnosis of CSA by detection of regional delayed relaxation using CK following HV were 81% and 100%, respectively.

Conclusions: Regional LV delayed diastolic outward wall motion following HV can be sensitively detected in most patients of CSA. Detection of regional LV delayed relaxation following HV using CK is a safety and sensitive method for diagnosis of CSA, differentiating them from patients with CPS.

7:15 a.m.

Stress Echocardiography is More Cost-Effective Than Stress Electrocardiography for Risk Stratification of Troponin Negative Acute Chest Pain Patients: A Prospective Randomised Controlled Trial

Paramjit Jeetley, Leah Burden, Brikaat Stoykova, Roxy Senior, Northwick Park Hospital, Harrow, United Kingdom

Background: The assessment of patients with coronary risk factors presenting to hospital with cardiac-sounding chest pain, non-diagnostic EGG and negative Troponin is clinically challenging. We hypothesised that stress echocardiography (SE) is more cost-effective and accurate than exercise ECG (ExECG) for the risk stratification of these patients.

Methods: Patients were randomised to either ExECG or SE within 24 hours of admission. Patients with a low post test risk were discharged from hospital. Patients with a high post-test risk were treated for coronary artery disease (CAD) and underwent coronary arteriography. The remaining classified as intermediate post-test risk were managed according to standard hospital protocol. A cost analysis of tests was performed using UK government figures.

Results: Of a total of 433 patients, 215 underwent SE and 218 ExECG. Significantly more patients in the SE group were discharged without further tests compared to ExECG group (77% vs 33% p<0.001 with no difference in hard cardiac event rates (cardiac death and myocardial infarction) at follow-up of 5.0 months (0% vs 1.2% for ExECG and SE respectively p=0.5). More patients in the ExECG group vs SE required further tests to confirm the diagnosis of CAD (47% vs 20%, p<0.001). Cardiac death, myocardial infarction and revascularisation in the SE arm in low, intermediate and high post-test risk groups were 5%, 14% and 53% respectively, compared to 3%, 16% and 33% (p=0.02 vs high risk SE). Cost to investigate in the SE group was significantly less than ExECG group (£364 vs £518 per patient; p<0.001). The difference was seen in all pre-test TIMI risk groups i.e. low (£211 vs £446), intermediate (£408 vs £511) and high risk (£139 vs £435).

Conclusions: In patients presenting to hospital with acute cardiac-sounding chest pain, non-diagnostic ECG and negative troponin, SE resulted in earlier hospital discharge, required fewer further tests and was more cost-effective and accurate than ExECG for risk stratification of these patients.
Impact of the Change of Myocardial Velocity on Exercise-Induced Functional Mitral Regurgitation in Patients with Non-Ischemic Cardiomyopathy

Boon-Jin Kang, Jung-Hyun Choi, Byung-Joo Choi, So-Yeon Choi, Myoung Ho Yoon, Seung-Jea Tahk, Gyo-Seung Hwang, Joon-Han Shin, Ajou University Medical Center, Suwon, South Korea

Background: Although recent data have emphasized on the clinical impact of exercise-induced change of functional mitral regurgitation (MR), its mechanism has not been established.

Methods: Supine bicycle exercise was performed in 21 patients with non-ischemic cardiomyopathy (age 50±11 yr, LV EF=40±4, mild MR). At baseline and peak exercise, 2D-echocardiographic images and tissue Doppler imaging (TDI) analysis were undertaken. Vp, was defined as the average of peak systolic velocities of 6 basal LV segments by TDI. ∆Vp was calculated as: peak exercise Vp, − baseline Vp, reflecting myocardial contractile reserve.

Results: With exercise (10±2 min), Vp, increased from 4.0±0.8 to 5.5±1.0 cm/s and was positively correlated to exercise-induced change of MR (ERO and ESWS (at baseline & peak exercise). ∆Vp was negatively correlated with ∆ERO and ESWS (at baseline & peak exercise). ∆Vp was negatively correlated with ERO.

Conclusions: In patients with heart failure, exercise caused dynamic change of MR with variable degree, impaired contractile reserve and inappropriately increased wall stress may independently affect to exercise-induced change of MR.
Minimal Coronary Artery Calcium Score Alone Fails to Reliably Detect Significant Lesions in Acute Chest Pain Patients

Michael J. Gallagher, Gilbert Raff, James A. Goldstein, Michael A. Ross, Brian O'Neil, James Wegner, Aparna Balichetty, Rajan Kousiri, William W. O'Neil, William Beaumont Hospital, Royal Oak, MI

Background: Normal to minimal coronary artery calcium (CAC) scores by electron beam computed tomography have been reported to accurately risk stratify emergency department (ED) patients with acute chest pain. Multi-detector CT angiography (CTA) provides high resolution coronary angiograms. Our objective was to evaluate whether CTA provides incremental information compared with CAC alone in low risk ED chest pain patients.

Methods: We prospectively evaluated 173 ED patients with acute chest pain considered at low risk (TIMI risk score ≤3). Exclusion criteria included positive cardiac biomarkers, ischemic electrocardiographic changes, or history of known coronary artery disease (CAD). All patients underwent 64-slice multi-detector CT detection of CAC and CT coronary angiography. Patients with CAC ≥1 and significant CAD (≥75% luminal stenosis) underwent additional evaluation (stress radionuclide imaging and/or cardiac catheterization). Reference outcomes were defined as catheterization proven acute coronary syndrome (ACS), coronary stenosis (core lab ≥50%, and 30 day MACCE (death, acute myocardial infarction, hospitalization for angina or heart failure). Results: There were 137 patients (79.2%) with absence (CAC=0), N=110 or minimal (CAC=1-10, N=23) coronary artery calcification. In such patients, CTA revealed normal coronary arteries in 113 (82.5%), mild coronary disease (1-25% stenosis) in 10 (7.3%), and significant coronary disease (≥25% stenosis) in 9 (6.8%) patients. Overall, 14 (8.1%) of the 173 study patients had catherization proven stenoses felt to represent a culprit for ACS. In 3/14 (21.4%) of these lesions we found absent (N=2) or minimal (N=1) coronary artery calcification.

Conclusions: Reliance on absent/minimal CAC alone failed to identify moderate or significant CAD in nearly 14% of low risk ED patients with acute chest pain. Further, in those patients with ACS proven by catheterization, CAC alone failed to detect culprit stenoses in 1 out of 5 cases. CTA identified all such significant lesions.

Usefulness of 64-slice Multi Detector Computed Tomography to Improve Diagnostic Yield in Patients With Chest Pain and Negative or Equivocal Exercise Treadmill Tests

Ronen Rubinstein, David A. Halon, Tamar Gaspar, Nathan Peled, Jorge E. Schlaimser, Nissan Yavin, Moshe Y. Flugelman, Ron Ammar, Basli S. Lewis, Lady Davis Carmel Medical Center, Haifa, Israel

Background: Exercise treadmill testing (ETT) has limited sensitivity for diagnosis of coronary artery disease (CAD). We assessed the incremental benefit of 64-slice multi-detector computed tomographic (MDCT) scanning for detection of obstructive coronary disease in pts with chest pain and negative/equivocal ETT findings.

Methods: We examined 133 consecutive pts (58±11.8y, 66% men) with chest pain and negative/equivocal ETT (>1 mm horizontal, or upsloping, ST segment depression) by non-invasive coronary CT angiography (CTA). We compared MDCT findings of significant CAD with invasive coronary angiograms (ICA). Our primary endpoint was detection of MDCT findings of significant CAD ≥50% in arterial segments proximal to arterial stenosis on MDCT by ICA (%). Confirmation of significant CAD was defined as TIMI ≥3.0 flow. Our study was powered to detect a 10% difference in sensitivity with a 90% power and α error of 0.05.

Results: MDCT showed significant CAD in 19/76 (25%) pts with negative and 25/57 (44%) pts with equivocal ETT (Table). Invasive coronary angiography (ICA) confirmed MDCT findings of significant CAD in 40/44 (91%) pts. MDCT detected obstructive CAD in a quarter of pts with negative ETT and excluded CAD in over half the pts with equivocal ETT. MDCT is an excellent tool for improving diagnostic accuracy in pts with chest pain, moderate pre-test probability of CAD and negative/equivocal findings on ETT.

MDCT and invasive angiographic findings after ETT

No significant stenosis on MDCT (% of ETT) No significant stenosis on MDCT (% of ETT) Confirmation of MDCT by ICA (%)

<table>
<thead>
<tr>
<th>ETT: N=133</th>
<th>N=76</th>
<th>N=57</th>
</tr>
</thead>
<tbody>
<tr>
<td>Negative ETT</td>
<td>19 (25)</td>
<td>27 (35)</td>
</tr>
<tr>
<td>Equivocal ETT</td>
<td>25 (44)</td>
<td>25 (56)</td>
</tr>
<tr>
<td>Total (N=133)</td>
<td>44 (33)</td>
<td>52 (60)</td>
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</table>

Conclusions: MDCT of ED pts is feasible, safe and highly sensitive and specific for detection of significant CAD ≥50% stenosis on MDCT by ICA (%). MDCT findings of significant CAD ≥50% in arterial segments proximal to arterial stenosis on MDCT by ICA (%). Confirmation of significant CAD was defined as TIMI ≥3.0 flow. Our study was powered to detect a 10% difference in sensitivity with a 90% power and α error of 0.05.

Immediate Coronary Artery Computed Tomographic Angiography Rapidly and Definitively Excludes Coronary Artery Disease in Low-Risk Acute Chest Pain

Gilbert Raff, Michael J. Gallagher, William W. O'Neil, Michael A. Ross, Brian J. O'Neil, James A. Goldstein, William Beaumont Hospital, Royal Oak, MI

Background: Evaluation of acute chest pain by traditional “rule-out” myocardial infarction protocols followed by stress imaging is expensive and time-consuming. Coronary artery computed tomographic angiography (CTA) has been shown to have high negative predictive value for the exclusion of significant coronary disease (CAD). We hypothesized that immediate CTA would rapidly and definitively exclude CAD as the cause of acute chest pain.

Methods: We prospectively randomized 200 patients with low-risk acute chest pain to either immediate 64-slice CTA or a standard of care (SOC) evaluation including serial cardiac enzymes, EKGs and es-tablist rest-stress nuclear scanning. Exclusion criteria included positive cardiac enzymes, EKG ST-T changes of ischemia or Thrombolysis in Myocardial Infarction risk score > 3. Patients undergoing CTA were discharged for luminal stenosis < 25%, referred to invasive angiography (CATH) for stenoses > 70%, and crossed over to stress testing for intermediate stenoses between (25% - 70%) or an unreliable CTA.

Results: The CTA group (N = 96) and the SOC group (N = 94) were similar in demographics, risk factors and Thrombolysis in Myocardial Infarction risk scores. The most important results of this study are that patients undergoing CTA had a significantly shorter length of stay compared with SOC patients (median 6.0h vs 14.1h, p < 0.0001). In addition, patients with CTA had a shorter time to cardiac diagnosis (median 3.3h vs 12.0h, p = 0.0001) and lower cost of care compared with SOC patients (median $1,595 vs $1,784, p = 0.035), although the latter did not achieve statistical significance. More patients from the CTA group underwent invasive angiography (11 vs 3, p = 0.028), CTA correctly predicted cath results in 10/11 (91%), and SOC correctly predicted cath results in 2/3 (67%). There were no significant differences in the occurrence of major adverse cardiac events, which were low in both groups.

Conclusions: CTA can rapidly and definitively exclude CAD as the cause of acute chest pain. Immediate CTA reduces length of stay and cost of care without increasing risk.

Radiation Dose and Predictable Cancer Risk in Multidetector-Row Computed Tomography Coronary Angiography (CTCA)

Andrew J. Einstein, Javier Sainz, Dante Dellegotteglia, Margherita Milte, Milena Minutillo, Sanjay Rajagopalan, The Mount Sinai Medical Center, New York, NY, Siemens Medical Solutions, Forchheim, Germany

Background: Recent technological advances have led to a rapid increase in the number of CTCA studies performed. Despite this, there is little data on radiation doses and cancer risks in clinical CTCA studies, nor comparisons with other modalities.

Methods: Radiation doses and predictable lifetime attributable risks (LARs) of cancer were determined for 50 patients having CTCA performed for clinical indications on a 16 slice scanner. Effective doses (ED) and organ equivalent doses were determined using scan parameters as well as a computer model using Monte Carlo methods. Predictable LARs were determined with models developed in the National Academies’ Biological Effects of Ionizing Radiation VII (BEIR VII) report.

Results: The ED of a complete CTCA averaged 9.3 mSv, while that of a complete ETT averaged 11.5 mSv in CTCA were comparable to calculated EDs in standard nuclear stress testing protocols using 99mTc (8.5 to 9.7 mSv) and less than in 2011 (18.9 mSv). EDs in CTCA were higher than those in most reports of average ED in conventional coronary angiography, although great variability is found in the latter (2.7 to 22.7 mSv). The mean predictable LAR of cancer incidence was 1 in 1600, and of cancer mortality was 1 in 1900, although these varied widely between patients, with worst-case risk nearly 1 in 600. Most risk was due to lung cancer.

Conclusions: CTCA is comparable in terms of radiation dose to other common noninvasive tests for coronary artery disease.
A Novel Plasmid Vector for Quantitative and Noninvasive Positron-Emission Tomography Imaging of the Therapeutic Cardiac Transgene Expression

Guanggen Cui, Hiroshi Furukawa, Hyde Rusetel, David Stout, Hill Lakes, Sanjive Gambhir, Luong Sui, David Geffen School of Medicine in UCLA, Los Angeles, CA

Background: Previously we have shown the feasibility of noninvasively monitoring therapeutic gene expression in the whole heart of large animals using positron emission tomography (PET) imaging a co-transfected reporter gene that were contained in the separate plasmids.

Methods: To achieve more stable and balanced reporter and therapeutic gene expression, recently, we constructed two new plasmid vectors. Plasmid I (PI) contains a herpes simplex virus type 1 mutant thymidine kinase (HSV1-sr39tk) as the reporter gene and a recombinant human interleukin-10 (hIL-10) as the therapeutic gene. Plasmid II (PII) contains a CMV promoter-driven reporter gene and a SV40 promoter-driven therapeutic gene. We systematically examined the gene transfer efficiency and the correlation between the retention of a PET reporter probe-[18F]-FHBG, expression of sr39tk and hIL-10 genes in the donor hearts. Twenty-three rabbits underwent heterotopic heart transplantation. Plasmids were coimplanted with liposome, than ex vivo intracoronarily delivered into the donor hearts before implantation.

Results: In all grafts treated with PI, the gene transfer efficiency was similar for reporter and therapeutic genes (15±2% vs. 15±2%). In contrast, in heart treated with PII, the efficiency for reporter gene was significantly higher than therapeutic gene (15±2% vs. 15±2%, p<0.05). A significant correlation was observed between the expression of sr39tk gene and the total myocardial [18F]-FHBG accumulation quantified in percent of intravenously injected [18F]-FHBG dose in both groups (r=0.01). In all grafts transferred with PI, the correlation between hIL-10 and sr39tk gene expression was significantly higher than that in allografts transferred with PII. The activity of [18F]-FHBG was also highly correlated with hIL-10 expression in both groups, however, a significant higher correlation was observed in the allografts transfered with PII. The activity of [18F]-FHBG dose in both groups (p<0.001) and border (p=0.05) regions relative to remote, reflecting a dysfunctional border zone.

Conclusions: The combined non-invasive evaluation of regional myocardial strain and MMP activity early post-MI provides a more accurate assessment of the extent of MI, defining a dysfunctional border zone.
116A ABSTRACTS - Diagnostic Testing

Methods: We studied 367 consecutive patients (body mass index (BMI) 30.0±14.3) who underwent dipyridamole PET and were followed for 3.1±2.9 years. Among these patients, 134 (36.5%) had BMI>30 and were considered to have obesity. PET images were visually assessed using a 17 segment model scored on a 5 point scale (0=normal, 4=abnormal). The summed stress score (SSS) was calculated (<4=normal; 4=abnormal).

Results: Among the 134 patients with obesity, 23 (17.2%) cardiac events occurred, of which 12 (8.9%) were hard events (death and MI) and 11 (11.2%) were soft events (late revascularization and 7 hospitalization). Patients with an abnormal SSS had a high annual hard cardiac event rate (6.7±4.1 vs. those with normal SSS (0±4); log-rank P<0.001). Total cardiac event rates were greater with abnormal vs. normal SSS (11.1±4 vs. 1.5±3; log-rank P<0.001). With multivariate risk adjusted Cox model analysis, PET SSS and age > 65 were independent predictors of hard and total cardiac events in patients with obesity. Each of the event rates for normal and abnormal SSS groups were not different for obese versus non-obese populations.

Conclusions: In obese patients, abnormal dipyridamole-Rb-82 PET myocardial perfusion SSS has significant prognostic value for predicting cardiac events including hard events (cardiac death and MI). The use of Rb-82 PET can contribute to the cardiac risk stratification in patients with obesity.

1124 Comparative Value of Resting Left Ventricular Dysfunction and Left Ventricular Response to Stress as Predictors of Cardiac Mortality in Patients Undergoing Gated Myocardial PerfusionPECT

Aiden Abdov, Alan Roczanski, Sean W. Hayes, John D. Friedman, Xingping Kang, Ihac Cohen, Guido Germano, Daniel S. Berman, Cedars Sinai Medical Center, Los Angeles, CA

Background: The prognostic value of stress-induced decrease in LVEF in pts with rest LV dysfunction as assessed by gated myocardial perfusionPECT (SPECT) is unclear.

Methods: We evaluated conventional dipyridamole and Dobutamine SPECT in 239 pts with LVEF<45% who underwent 6±2 year follow-up for cardiac mortality (CD) and hard cardiac events (HCE). LVEF was measured using R-82 PET PET at rest and stress.

Results: During follow-up, 135 CD occurred. By ROC analysis, LVEF<35% was an independent, incremental predictor of cardiac mortality which together with other independent predictors like HCM, prior MI, age, gender and smoking status, provided an AUROC of 0.76 (p<0.001). LVEF<30% was identified as the best threshold to predict CD with a sensitivity of 66% and specificity of 55%

Conclusion: LVEF<30% is a more prominent predictor than LVEF<5%, the combination of these predictors had the strongest predictive value.

1125 Direct Ultrasound Measurement of the 3 Principal Components of Left Ventricular Regional Systolic Strain

Heather M. Huntburg, Gerard P. Aurigemma, William H. Gaasch, Craig S. Vinch, Dennis A. Tighio, Jeffrey C. Hilt, Theo E. Meyer, University of Massachusetts Medical School, Worcester, MA

Background: Tissue Doppler Imaging (TDI) permits assessment of LV regional systolic strain (ε) based on velocity gradients, but this technique is limited by angle dependence. Thus, the parameter most commonly studied is longitudinal strain (εl). However, εl is only one of three principal components of regional function. An ideal technique would also measure wall thickening (radial strain, εr) and circumferential shortening (circumferential strain, εc). 2D strain (2Dc) methodology, by contrast, is based on B-mode signal intensity, is angle independent, and thus permits determination of all 3 strain components. Our aims, therefore, were to use 2Dc to (1) establish normal values for εl, εr, and εc and (2) compare εc values with circumferential shortening as assessed by M-mode midwall shortening (FSMW).

Methods: We studied 35 normals with 2D (Vivid 7, GE): 21 male, 14 female, age 32±11.

Results: Mean εl, εr, and εc values were shown below. Apical εc was significantly higher than basal values, likely due to a preponderance of longitudinal fibers in this region. Posterior and lateral εc were lower than anterior and septal values (see figure). However, radial strain (εr) was uniform across the LV circumference. Mean εc values correlated well with FSMW.<0.05).

Conclusion: After consideration of %Myo, clinical and historical data, rest and stress-induced reduction in LVEF carry an additive independent and incremental value in predicting CD. In pts with rest LV dysfunction, ε<35% is associated with the worst long-term cardiac prognosis.

948 Recent Clinical and Technical Developments in Stress Echocardiography

Monday, March 13, 2006, 9:00 a.m.-12:30 p.m.
Georgia World Congress Center, Hall B1
Presentation Hour: 9:00 a.m.-10:00 a.m.

949 Tissue Doppler Imaging Predicts NYHA Functional Class and Plasma BNP Levels in Patients With Hypertrophic Cardiomyopathy

Darshak H. Karla, Kevin M. Harris, Andrew G. Zevonov, Barry J. Marion, University of Minnesota, Minneapolis, MN; Minneapolis Heart Institute Foundation, Minneapolis, MN

Background: Hypertrophic cardiomyopathy (HCM) is characterized by diastolic dysfunction. However, classic diastology echocardiographic parameters, such as mitral inflow velocities (E/A), isovolumic relaxation time (IVRT) and deceleration time (DT) have not been useful in predicting symptoms. Doppler Tissue Imaging (DTI) has not been well studied to predict symptoms in HCM.

Objectives: We sought to determine whether DTI in HCM patients correlates with NYHA functional class and plasma brain natriuretic peptide (BNP) levels.

Methods: We evaluated conventional diastolic Doppler and DTI indices with assessment of functional class and plasma BNP levels in 164 consecutive HCM patients.

Results: Early tissue septal velocities (Es') were lower (7.4±2.8 cm/s vs 9.6±2.7 cm/s) in NYHA class III/IV compared to NYHA class I (p<0.001, ANOVA). Mean E/E' in NYHA class I was 9±3 vs 13±5 in NYHA class III/IV patients (p<0.001, ANOVA). Mean BNP was significantly different across NYHA classes (p<0.001, ANOVA).

Conclusions: Early Es' correlated strongly with plasma BNP levels (p=0.001). Furthermore, E/E' correlated strongly with plasma BNP levels (p=0.001). Correlations were significant for E', E/A, and E/e' in all regions.
Kazuki Nakaj, Keizo Yamamoto, Kazuyoshi Hina, Shouzou Kusachi, Yasuyoshi Iwado, Masakazu Kohno, Cardiovascular Institute, Sakakibara Hospital, Okayama, Japan.

Background: Biventricular pacing has been reported to show superior effects than those of right ventricular pacing in patients with heart failure. The effects of biventricular pacing were, however considerably different from patient to patient. Objectives is to predict efficacy of biventricular pacing by Doppler derived strain measurements.

Methods: To evaluate effects of biventricular pacing, we performed (15O) PET in 12 patients with heart rate (HR)=50 ±/min. To determine myocardial work efficiency calculated as follows: [systolic blood pressure(mmHg) x HR (beats/min) x left ventricular ejection fraction (%)]/myocardial oxygen consumption (ml/min). Myocardial work efficiency was obtained during biventricular pacing and compared with that during right ventricular pacing. Differences in time to peak strain and peak strain value between septum and lateral wall were measured and compared with myocardial work efficiency differences between right and biventricular pacing.

Results: Significant correlation of the differences in time to peak strain (n=0.66, p<0.05) between septum and lateral wall with improvement of myocardial work efficiency from right ventricular pacing to biventricular pacing was obtained (n=0.66, p<0.05). Moreover, lower values of strain between septum and lateral wall significantly correlated with the improvement of myocardial work efficiency (n=0.56, p<0.05).

Conclusion: The present results characterized by significant relation of strain to improvement of myocardial work efficiency from right to biventricular pacing indicate that Doppler derived strain measurements may be clinically useful to distinguish responders from non-responders before cardiac resynchronization therapy.

Can Displacement or Strain Imaging Predict a Favorable Response to Cardiac Resynchronization Therapy?
Qing Zhang, Y. S. Chan, Jeffrey WH Fung, Chi Kin Chan, Gabriel WK Yp, Leo CC Kum, Eugene B. Wu, Pui Wai Leo, Yat Yin Lam, Sineh Chan, Li Wen Wu, Cheuk Man Yu, The Chinese University of Hong Kong, Hong Kong, People's Republic of China

Background: Direct assessment of systolic asynchrony by echocardiographic methods is useful to predict a favorable response to cardiac resynchronization therapy (CRT). This study compared the predictive values of 3 different forms of tissue Doppler imaging (TDI) processing in predicting left ventricular (LV) reverse remodeling, namely tissue velocity, displacement mapping and strain mapping.

Methods: Echocardiographic TDI with TDI was performed at baseline and 3-month in 55 patients (66±11 yrs, 72.7% male) receiving CRT. During off-line TDI analysis, the time to peak systolic velocity in the LV apex and LV basal septal and lateral segment was measured. Time to peak velocity and displacement and strain mapping were calculated as standard deviation of 12 (SD-12) and 6 basal segments (SD-6), maximal difference among 12 (Di-12) and 6 basal segments (Di-6), basal septal-to-lateral segmental differences (sep-lat) and basal septal-to-posterior segmental difference (sep-post). These parameters were correlated with percentage reduction in LV end-systolic volume (SVEVBS) and absolute gain in ejection fraction (ΔEF).

Results: Among the 3 TDI processing technologies, all of parameters tissue velocity correlated with LV reverse remodeling (r value from -0.49 to -0.76, all p<0.001) and gain in EF, but the predictive value was strongest in models with 12 LV segments. For displacement mapping, only the 2 parameters that included 12 LV segments correlated modestly with LV reverse remodeling (n=0.36, p<0.05) and gain in EF. However, none of the strain mapping parameters was able to predict a favorable echocardiographic response. The ROC curve areas were higher for parameters of tissue velocity that based on 12 LV segments (area=0.88 and 0.94) than the corresponding ones by displacement mapping (area=0.72 and 0.71).

Conclusion: Tissue velocity parameters of systolic asynchrony are superior to that of displacement and strain mapping in predicting LV reverse remodeling response after CRT. Furthermore, it is suggested to measure more segments for more comprehensive evaluation.

Usefulness of 2-dimensional Longitudinal Strain of Apical Septum to Predict Functional Recovery After Successful Primary Revascularization Procedure in Anterior Wall Myocardial Infarction
Young Hyun Park, Seo-Jin Kang, Changbum Park, Se Whan Lee, Young-Hoon Jeong, Eui Seok Haeng, Jong Min Song, Duk Hynn Kang, Jee-Kwan Song, Asan Medical Center, Seoul, South Korea

Background: Even after successful primary reperfusion therapy (PRT), adverse left ventricular remodeling (LVR) could occur in some patients and prediction of LVR remains a challenging task. We sought to test if measurement of 2-dimensional longitudinal strain (SLS) is useful to predict LVR after successful PRT in patients with anterior wall myocardial infarction (AMI).

Methods: Fifty consecutive patients (56% male, mean age 64±13 years) underwent conventional tissue Doppler imaging (TDI) with SLS (Echocap PC version 4.0.4) within 24 h after PRT. All patients showed akinesia at the apical septum, where SLS was measured. Follow-up echocardiography was done at least 3 months later and increase of LV end-diastolic volume (>15%) was defined as development of LVR.

Results: Twenty three patients (46%) showed LVR at follow-up echocardiography, who showed significantly higher peak CK-MB level (363+154 vs 193+164 ng/ml), lower baseline EF (44+7 vs 50+9%), higher basal wall motion score index of left anterior descending artery territory (2.4±0.4 vs 2.0±0.5), and higher SLS (0.3±0.6 vs 77.2)

Conclusion: Measurement of LSV was useful to predict LVR after successful PRT in patients with AMI.

Acute Volume Loading Influences Left Ventricular Apical Twist: Studies in an Animal Model
Petra S. Niemann, Timothy Thigpen, Ling Hui, Edward Hickey, Mohammad Asmath, Xiaoli Li, David J. Sahn, Oregon Health & Science University, Portland, OR

Background: Ultrasound 2D speckle tracking (STI) can apparently define left (LV) twisting and torsion. We evaluated LV twisting with STI at different stages of acute volume loading.

Methods: We studied 5 (0.5-3.5 kg) open-chest male piglets at 2 weeks of age. Images were acquired with a Vivid 7 Dimension system at 14 MHz and frame rate of 165/sec, imaging a short-axis apical view at baseline (stage 1), post addition of 10% of total intravascular volume given as normal saline (NS) bolus (stage 2), and post 20% of total intravascular volume given as NS bolus (stage 3). Imaging at each stage was performed after stabilization for 5-10 min. Blood pressure, heart rate and intraventricular pressures were recorded simultaneously. Images were analyzed offline for 2D strain and twist using EchoPac PC.

Results: Synchronous ventricular activity at stage 1 started at the septum and propagated counterclockwise to the inferior, posterior, lateral and anterior region of the left ventricle. No change in activity was found at stage 2. Stage 3 volume load did influence LV torsion. A decrease in mean twist from 11.7±8 to 7.6±2.8 and a delay in mean sequential activation time from first to last segment (2.28±2.3 increasing to 3.12±3.7) was observed in all 5 piglets. Stage 3 LV twisting progressed in asynchronous fashion starting at the anterior segment and propagating through the septal, inferior, posterior and lateral region.

Conclusions: LV torsion and its propagation is influenced by acute volume loading.

Prolongation of Time to Peak Strain During Adenosine Triphosphate Stress Is a Marker of Impaired Coronary Flow Velocity Reserve
Tsunoru Takagi, Atsushi Takagi, Takagi Cardiology Clinic, Kyoto, Japan, Tokyo Women’s Medical University, Tokyo, Japan

Background: Impaired coronary flow velocity reserve (CFVR) smaller than 2.0 is recognized as being a strong marker of significant coronary artery disease. Prolongation of myocardial shorting evaluated with strain imaging during adenosine triphosphate (ATP) stress has been reported to be a marker of myocardial ischemia.

Methods: To determine the relation between CFVR and prolongation of myocardial shorting, 61 patients were studied. All patients underwent ATP stress strain imaging and CFVR measurement using transthoracic Doppler echocardiography simultaneously. Time to peak strain (TPS) were measure at baseline and during intravenous ATP infusion
### Longitudinal Systolic Motion Assessed by Doppler Myocardial Imaging Is Impaired in Children With Acute Kawasaki Disease

**Abstract Title:** Longitudinal Systolic Motion Assessed by Doppler Myocardial Imaging Is Impaired in Children With Acute Kawasaki Disease

**Authors:** You-Bin Deng, Jing-Hua Liu, Xiao-Jun Bi, Hao-Yi Yang, Chun-Lei Li, Tongi Hospital, Huaizhong University of Science and Technology, Wuhan, People's Republic of China

**Background:** Although the pathological study showed the myocarditis in children with acute Kawasaki disease (KD), the radial systolic motion assessed by ejection fraction (EF) and fractional shortening is still normal. This study sought to evaluate the longitudinal systolic motion in children with KD by Doppler myocardial imaging.

**Methods:** The study population consisted of 31 children with acute KD and 20 healthy children. The Doppler myocardial images were recorded in apical long-axis, two-chamber and four-chamber planes. The longitudinal systolic velocity (LSV) and displacement (LSD) were measured at the mitral annulus, basal segment and mid-segment at 6 sites in the left ventricle corresponding to anteroseptal, anterior, lateral, posterior, inferior and posteroseptal walls. Left ventricular EF was calculated with a biplane Simpson’s method.

**Results:** The longitudinal contraction TESV best correlated with TMC in a broad population group. TESV has the lowest inter-observer variability and may be the best measurement for identifying the true LV mechanical asynchrony.

**Conclusions:** Tissue Doppler imaging can identify cardiac asynchrony. Time to maximal contraction (TMC) in M-mode is a direct measure of mechanical LV synchrony. We hypothesized that in TDI, time to end systolic velocity (TESV) the time from QRS onset to the point at which the systolic velocity reaches 0 m/s represents the time from QRS onset to maximal contraction measured in M-mode. We sought to determine if these measures correlate for longitudinal contraction, and to assess the inter-observer variability.

**Methods:** In 51 patients (13 patients with heart failure and QRS>120 ms) we measured in apical 3 chambers in M-mode the longitudinal TMC of the antero-septal and of the posterior walls and in TDI the TESV, time to peak systolic velocity (TPV) and time to peak strain (TPS) for the same segments. Linear regression and Bland-Altman plots with posterior walls and in TDI the TESV, time to peak systolic velocity (TPV) and time to peak strain (TPS) for the same segments. Linear regression and Bland-Altman plots with posterior walls and in TDI the TESV, time to peak systolic velocity (TPV) and time to peak strain (TPS) for the same segments. Linear regression and Bland-Altman plots with posterior walls and in TDI the TESV, time to peak systolic velocity (TPV) and time to peak strain (TPS) for the same segments. Linear regression and Bland-Altman plots with posterior walls and in TDI the TESV, time to peak systolic velocity (TPV) and time to peak strain (TPS) for the same segments. Linear regression and Bland-Altman plots with posterior walls and in TDI the TESV, time to peak systolic velocity (TPV) and time to peak strain (TPS) for the same segments. Linear regression and Bland-Altman plots with posterior walls and in TDI the TESV, time to peak systolic velocity (TPV) and time to peak strain (TPS) for the same segments. Linear regression and Bland-Altman plots with posterior walls and in TDI the TESV, time to peak systolic velocity (TPV) and time to peak strain (TPS) for the same segments. Linear regression and Bland-Altman plots with posterior walls and in TDI the TESV, time to peak systolic velocity (TPV) and time to peak strain (TPS) for the same segments. Linear regression and Bland-Altman plots with posterior walls and in TDI the TESV, time to peak systolic velocity (TPV) and time to peak strain (TPS) for the same segments. Linear regression and Bland-Altman plots with posterior walls and in TDI the TESV, time to peak systolic velocity (TPV) and time to peak strain (TPS) for the same segments. Linear regression and Bland-Altman plots with posterior walls and in TDI the TESV, time to peak systolic velocity (TPV) and time to peak strain (TPS) for the same segments. Linear regression and Bland-Altman plots with posterior walls and in TDI the TESV, time to peak systolic velocity (TPV) and time to peak strain (TPS) for the same segments. Linear regression and Bland-Altman plots with posterior walls and in TDI the TESV, time to peak systolic velocity (TPV) and time to peak strain (TPS) for the same segments. Linear regression and Bland-Altman plots with posterior walls and in TDI the TESV, time to peak systolic velocity (TPV) and time to peak strain (TPS) for the same segments. Linear regression and Bland-Altman plots with poster...
Doppler imaging of the RV. Peak myocardial systolic velocity and peak longitudinal systolic strain were measured at the mid and basal segments of the interventricular septum (IS) and RV free wall (RVF) from the apical 4-chamber view. RV fractional area change (RVFAC) was calculated from the same view to assess global RV function. 25 patients with normal biventricular function and normal pulmonary artery pressures served as controls.

Results: PH patients demonstrated significantly reduced peak systolic strain of RVF compared to controls (see table). Significant correlations were present between both peak strain of the RVF and RVFAC (r = 0.54; p < 0.01) and peak strain of the RVF and peak pulmonary artery systolic pressure (r = 0.42; p = 0.05). Peak myocardial velocities were not reduced in PH patients and there was no correlation between peak velocity of the RVF and RVFAC.

Conclusions: Compared to myocardial velocity strain, myocardial strain was better able to identify RV dysfunction in PH patients.

### 34A-12

**Discrimination of Left Ventricular Radial Wall Motion Dysynchrony From Contractile Synchronicity on the Basis of Displacement and Strain Imaging by Two-Dimensional Echocardiography in Patients With Pulmonary Hypertension**

Kazuhiro Ohashi, Katsuya Onishi, Yuku Sakurai, Satoshi Ota, Norikazu Yamada, Tetsuya Kitamura, Masaaki Ito, Naoki Isaka, Takeshi Nakano, Mie University School of Medicine, Tsu, Japan

**Background:** Deformation of left ventricle (LV) caused by right ventricular overload is one of the strongest markers of poor outcome in patients with pulmonary hypertension (PH). However, little is known whether and how LV radial deformation alters its mechanical synchronicity and performance.

**Methods:** Twenty patients with PH (mean age 51 ± 13 years and peak systolic pulmonary pressure 69 ± 28 mmHg) and 20 age-matched normal subjects had echo study. LV radial dysynchrony was evaluated both with strain and displacement imaging using two-dimensional echocardiography (GE Vivid 7).

**Results:** Strain imaging showed uniform segmental radial thickening both in patients and normal subjects, which indicates there were no intrinsic contractile dysynchrony. However, large degrees of mechanical dysynchrony were observed from displacement imaging in patients with PH and was associated with LV eccentricity index with linear regression (r = -0.76). These impairments of radial synchronicity of segmental wall motion were significantly larger compared to normal subjects (21 ± 6% in PH and 16 ± 4% in normal, p<0.01) and were strongly correlated with LV myocardial performance index (0.54 ± 0.16 in PH and 0.39 ± 0.05 in normal, p<0.05) with linear regression (r = -0.73).

**Conclusions:** Left ventricular deformation impaired radial wall motion synchronicity without intrinsic contractile dysynchrony in patients with pulmonary hypertension and was associated with impairment of global systolic and diastolic performance.

### 34B-14

**Adenosine Triphosphate Stress Strain Measurements Before and After Percutaneous Coronary Interventions**

Motoko Hosaka, Atsushi Takagi, Kotaro Ara, Tsutom Takagi, Kyom Tanimoto, Nako Ishizuka, Yuko Tsurumi, Hiroshi Kasanuki, Tokyo Women’s Medical University, Tokyo, Japan

**Background:** Tissue Doppler derived strain measurements provide quantitative assessment of left ventricular regional wall motion. Ischemic myocardium is known to present post-systolic shortening which can be detected as a prolongation of time to peak strain (TPS). We aimed to clarify the significance of TPS measurements during adenosine triphosphate (ATP) stress in detecting coronary disease.

**Methods:** A total of 25 patients who were referred for percutaneous coronary intervention (PCI) underwent strain measurements before and after PCI. TPS in target regions and in control regions were measured both at baseline and during ATP infusion (0.14mg/kg/min). TPS ratio was obtained as a ratio of TPS at ATP stress to baseline TPS.

**Results:** At baseline before PCI, TPS in target regions were equivalent to that in control regions (340.4 ± 46.8 ms vs. 342.2 ± 54.0 ms, p = 0.96). In target regions, TPS before PCI significantly increased during ATP infusion from 340.4 ± 46.8 ms to 400.6 ± 62.4 ms, p<0.0001, which was significantly greater than hyperemic TPS in control regions (400.6 ± 62.4 ms vs. 330.7 ± 63.9 ms, respectively, p= 0.0005). Accordingly, TPS ratio in target regions before PCI was significantly greater than that in control segments (1.19 ± 0.17 vs. 0.97 ± 0.93, respectively, p<0.0001). PCI was successfully performed in all patients without any elevation of cardiac enzymes. Following PCIs, TPS ratio in target regions significantly decreased to 0.99 ± 0.73, p<0.0001. On the contrary, TPS ratio in control regions did not change following PCIs (from 0.97 ± 0.93 to 0.96 ± 0.13, p = 0.96).ROC analysis provided a cutoff value of 1.07 in TPS ratio for detecting myocardial ischemia with sensitivity of 70% and specificity of 93%.

**Conclusions:** Measurements of TPS during ATP stress quantitatively differentiates ischemic from non-ischemic myocardium. Prolonged TPS during ATP immediately normalized following successful PCIs. ATP stress strain imaging appeared to be useful in detecting coronary diseases.

### 34B-15

**Regional Left Ventricular Myocardial Contraction by Quantitative Automated 2D Strain Echocardiography and Thallium–201 Single-Photon Emission Computed Tomographic Perfusion Imaging**

Mica S. Feinberg, Aaron Miller, Gil Zwie, Solange Akselrode, Pierre Chouraqui, Sheba Medical Center, Tel Hashomer, Israel, Tel Aviv University, Tel Aviv, Israel

**Background:** 2D strain echocardiography is a novel imaging modality with enhanced quantitative qualifications for the assessment of regional and global myocardial contraction. Hibernating and stunned myocardium may cause inconsistencies between regional myocardial contraction and perfusion.

**Methods:** Twenty-six hospitalized patients with suspected myocardial ischemia (mean age 65±14, 8 females, mean LVEF 49±14%) have had an echocardiogram (Vivid 7, GE Healthcare) followed by a thallium-201 SPECT perfusion imaging (Varian rotating scintillation camera, GE Healthcare) on the same day. Echocardiographic data obtained in the apical 4-chamber, 2-chamber, and long-axis views have been processed by a 2D strain segmental semi automatic algorithm, to produce six peak-longitudinal-strain measurements in each view, one per segment. The resulting measurements have been compared to the corresponding mean gray scale intensity within the SPECT left-eye perfusion map regions at rest. In order to handle inaccuracies in registration of the two datasets, translation of up to 0.3 segment and rotation of up to 30° of each echo view have been allowed, with respect to the theoretical geometric configuration. The linear correlation coefficient at the optimal configuration has been computed for each view.

**Results:** The mean correlation coefficients for the apical 4-chamber, 2-chamber, and long-axis views were 0.64, 0.75, and 0.57 respectively (negative correlation coefficients have been considered as 0). The overall mean correlation coefficient was 0.66. In 18 (32 %) views the correlation coefficients were \(> 0.9\), however in 5 (9 %) they were \(< 0.1\). The standard deviation for each view separately, and for the entire dataset, was 0.3.

**Conclusions:** Segmental echocardiographic 2D strain and the corresponding regional twist velocities and twist angle at 3 short axes planes, base, mid and apex of the LV. Longitudinal strain and systolic, and diastolic strain rate were measured at 3 septal and 3 lateral wall segments.

**Results:** Age, BSA, Doppler mitral and pulmonary inflow velocities were similar for the 2 groups. Left atrial (LA) volume index (40.2 v. 24.2 c. m, p=0.0005) and LA pressure (16.0 v. 9.4, p=0.04) were higher in the HCM group. Systolic twist and torsion angle were similar at the base but greater at the mid level for HCM (0.60±0.62 vs. 0.29±0.48; p<0.001) and (1.83±2.05 v -1.51± -2.16 p<0.0001). The table shows other differences:

<table>
<thead>
<tr>
<th></th>
<th>HCM</th>
<th>Normal</th>
<th>p Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Septal Thickness</td>
<td>1.91±0.57</td>
<td>1.01±0.19</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Apical Untwist Velocity</td>
<td>0.83±0.57</td>
<td>2.45±0.30</td>
<td>0.004</td>
</tr>
<tr>
<td>Radial Velocity: base</td>
<td>2.03±0.10</td>
<td>1.62±0.49</td>
<td>0.01</td>
</tr>
<tr>
<td>Torsion (ms)</td>
<td>54.1±17.13</td>
<td>40.8±18.3</td>
<td>0.001</td>
</tr>
<tr>
<td>Deflection (ms)</td>
<td>44.17±10.16</td>
<td>27.55±8.42</td>
<td>0.001</td>
</tr>
<tr>
<td>Longitudinal Strain (avg)</td>
<td>-16.7±4.32</td>
<td>-22.2±3.9</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Longitudinal Strain Rate S</td>
<td>0.86±0.27</td>
<td>1.18±0.4</td>
<td>0.008</td>
</tr>
<tr>
<td>Longitudinal Strain Rate E</td>
<td>0.81±0.4</td>
<td>1.25±0.5</td>
<td>0.004</td>
</tr>
</tbody>
</table>

**Conclusions:** 1. Systolic abnormalities in HCM include increased basal radial velocity, apically displaced twist, faster torsion time and decreased longitudinal strain and strain rate. 2. Diastolic / late systolic abnormalities include increased apical untwist, slowed torsion time, decreased diastolic strain rate and higher LA pressure. 3. These abnormalities provide further insights into the pathophysiology of HCM.
myocardial perfusion by thallium 201 SPECT imaging have a comparable association as has been previously reported with conventional 2D echocardiography and further support the validity of the 2D strain analysis software.

Assessment of “Dysynchrony” in Normal Subjects by Myocardial Velocity, Displacement and Strain

Kensuke Uto, Katsumi Takenaka, Aya Ebihara, Yoko Eto, Kenichi Asada, Kazu no Sasaki, Takako Komuro, Haruko Iida, Tyo Nagai, University of Toky o, Hospital, Tokyo, Japan

Background: Myocardial velocities measured by tissue Doppler imaging (TDI) have been shown to predict response to cardiac resynchronization therapy. However, “dysynchrony” based on velocity criteria can be found even in normal subjects. Myocardial velocity, displacement and strain can be measured by either TDI or 2D tracking system. We hypothesized that applying the indexes other than TDI velocity to normal subjects would help increase the specificity.

Methods: In 19 normal volunteers with normal electrocardiogram and echocardiogram, 3 apical views including LV long-axis (LAX) as well as parasternal LV short axis view (SAX) at mid-LV were recorded by both TDI and 2D tracking system (TDI). Using TDI and 2D, the time from QRS to the peak longitudinal velocity, displacement and strain of myocardial motion was measured at 6 basal segments. Also, the time from QRS to the peak radial velocity, displacement and strain was measured at 6 segments. From each 6 data set, both maximum time delay (maxD) and standard deviation (SD) were calculated. According to the published cut-off values for velocity data, maxD>100 ms or SD>32ms were defined “dysynchronous” (false positive) in our study.

Results: False positive rate was shown in the table.

Conclusion: Longitudinal strain was not available (NA) by TDI because of angle problem at basal segments, and velocity data calculated by 2D were not reliable in this study. Radial strain measured on SAX using 2D and longitudinal velocity measured by TDI gave high specificity.

Results

maxD TDI LAX SD TDI LAX maxD 2DT LAX SD 2DT LAX
longitudinal velocity NA 10% 18% 22% 18%
longitudinal displacement NA 10% 14% 22% 18%
strain LA-SR LAX 22% NA 14% 32% 22%
radial velocity maxD 2DT LAX SD 2DT LAX maxD 2DT SAX SD 2DT SAX
radial displacement NA 10% 14% 14% 14%
strain LA-SR 19% 16% 14% 16% 12%

948-17 Left Atrial Mechanics in Type 2 Diabetes

Marja J. Eriksson, Christina Jarnter, Pernilla Jacobsson, Margareta Ring, Lars Rydén, Kenneth Cadzalh, Anders Molich, Karolinska University Hospital, Stockholm, Sweden

Background: Left ventricular (LV) diastolic dysfunction is prevalent in Type 2 Diabetes. We applied a new 2-D based quantitative technique to evaluate the mechanics of the LA walls in relation to established Doppler-derived indexes of diastolic function and LA volume changes.

Methods: 29 patients with uncomplicated Type 2 Diabetes, mean age 59±7 years, with normal systolic LV function and no hypertrophy or mitral regurgitation underwent Doppler-echo. LA wall deformation was evaluated by a new 2-D based technique (Velocity Vector Imaging, VVI; Siemens). Mitral inflow velocities (E and A wave) and tissue velocity in the septal part of the mitral annulus (E’ waves) were measured and E/A and E/E’ ratios were calculated. VVI measurements included systolic strain (LA-Strain) and systolic (LA-SRs) and diastolic strain rate (LA-SRe and LA-SRa) correlated neither to LA-EF.

Results: Mean values for E/A 1.1±0.4, E/E’ 7.6±2.1 and LA EF 58±8%. E/A correlated to age (p<0.01), while E/E’ and LA-Strain did not. E/E’ related to minimal LA VOL (p<0.01), and LA EF (p<0.01). Table shows correlations between LA-Strain, LA-SRs and E/A, E/E’, LA-Strain, LA-SRs and LA-EF correlated neither to LA-EF or to E/A or E/E’ for any atrial wall.

Conclusions: LA strain and strain rate for all atrial walls are related to established measures of diastolic LV function in terms of E/A and E/E’, and LA emptying in patients with uncomplicated Type 2 Diabetes.

Results

LA-Strain maxi LA-Strain maxi LA-Strain maxi LA-Strain maxi LA-Strain maxi LA-Strain maxi
LA-Strain Sep LA-Strain Lat LA-Strain Sep LA-Strain Lat LA-Strain Sep LA-Strain Lat LA-Strain Sep LA-Strain Lat
E/A 0.42 ±0.07 0.42 ±0.07 0.42 ±0.07 0.42 ±0.07 0.42 ±0.07 0.42 ±0.07
E/E’ 7.6±2.1 7.6±2.1 7.6±2.1 7.6±2.1 7.6±2.1 7.6±2.1
LA EF 0.58 ±0.09 0.58 ±0.09 0.58 ±0.09 0.58 ±0.09 0.58 ±0.09 0.58 ±0.09

948-18 Difference in the Left Atrial Function Between Patients With Hypertensive Hypertrophy and Hypertrophic Cardiomyopathy Evaluated by Tissue Imaging Strain

Tomotetsu Tabata, Hirotsugu Yamada, Shinichiro Atsumi, Atsushi Watanabe, Daishi Mukaide, Kenji Tamura, Hiroatsu Yokoi, Masanori Nomura, Fujita Health University, Nagoya, Japan, Tokushima University, Tokushima, Japan

Background: Left atrial (LA) function highly contributes to left ventricular (LV) filling in patients with LV hypertrophy. Recently developed tissue strain imaging (TSI) potentially evaluates left atrial (LA) reservoir and pump functions directly by measuring LA systolic (S) and late diastolic (A) tissue strains, respectively.

Purpose: To assess LA reservoir and pump functions in patients with hypertensive hypertrophy (HHD) and hypertrophic cardiomyopathy (HCM) using LA tissue strains.

Methods: Subjects consisted of 15 normal volunteers (N), 18 patients with HHD and 16 with HCM. The S and A at LA lateral wall were measured from color tissue Doppler image using a custom TSI system ApIQ (Toshiba, Japan). Data acquisition was performed before and during preload increase by lower body positive pressure (LBPP).

Results: At baseline, there was no difference in the S’ among 3 groups. The A’ in HHD was significantly greater than that in N. During LBPP; 1) The S’ and A’ significantly increased in N and HHD reflecting Frank-Starling mechanism. 2) In contrast, both the S’ and A’ did not change significantly in HCM. 3) Rate of change in the S’ (p<0.001) and A’ (p<0.01) was significantly lower in HHD than in HHD.

Conclusions: LA reservoir and pump functions evaluated by LA strain were functional in HHD. However, those in patients with HCM were deteriorated evidenced by poor response to the preload increase. There might be pathological change involved in LA myocardium in patients with HCM.

Changes in the LA strains during LBPP

Baseline S’ Baseline A’ LBPP S’ LBPP A’
N (n=15) 0.89±0.28 0.34±0.17 0.23±0.09 0.50±0.12
HHD (n=16) 0.80±0.27 0.29±0.12 0.51±0.29 0.75±0.30
HCM (n=16) 0.82±0.27 0.12±0.29 0.35±0.16 0.38±0.12

948-29 Enhancement of Cardiac Rotation as a Possible Mechanism of During Dobutamine Stress

Makoto Kato, Satoshi Nakatani, Tsuyoshi Yoshimura, Hirohiko Motoki, Haruhiko Abe, Takuya Hasegawa, Masafumi Kitakaze, National Cardiovascular Center Research Institute, Suita, Japan

Background: It has been reported that during dobutamine stress echocardiography, myocardial strain increases at low dose, but decreases at high dose because of high heart rates. Nevertheless, stroke volume is usually well maintained in the normal heart at least up to 20 µg/kg/min. We hypothesized that cardiac rotation might compensate for the decrease in myocardial strain at high heart rates.

Methods: We measured radial strain and rotation of the left ventricle at the basal short-axis imaging using 2-dimensional strain imaging (Echo PAC, GE) in 20 normal subjects (70-10 years) during dobutamine stress echocardiography. Average radial peak strain of the anterior, antero-septal and septal walls (septum) and that at lateral, posterior and inferior walls (free wall) and global peak rotation degrees were obtained at rest, 5, 10 and 20 µg/kg/min.

Results: Radial strain of the free wall was higher than that of the septum at each stage. Both of these strain values initially increased but subsequently reached a plateau and decreased at 20 µg/kg/min with the increase in heart rate (from 62±12 to 117±31/min).

In contrast, the cardiac rotation degree linearly increased with dobutamine infusion and never reached a plateau.

Conclusions: Although radial strain decreased at high heart rate during dobutamine stress echocardiography, cardiac rotation was enhanced in a compensatory manner. This could help maintain stroke volume under tachycardia.

Dual-frequency Intravascular Ultrasound Imaging: A Novel Approach to Plaque Vulnerability

Genta Hashimoto, Takafumi Hiro, Takashi Fujii, Takayuki Okamura, Jutaro Yamada, Yusaku Fukumoto, Hiroko Kanou, Masanori Matsuzaki, Yamaguchi University Graduate School of Medicine, Ube, Japan

Background and Purpose: Visualization of tissue characteristics within atherosclerotic plaque is now being greatly needed as a modality approaching to the plaque vulnerability. We recently have developed a new intravascular ultrasonic (IVUS ) imaging system that can use two ultrasounds of different frequency with the same catheter. This study investigated the feasibility of this dual frequency intravascular ultrasound imaging in identifying tissue characteristics of plaques particularly for determining the thickness of fibrous cap.

Methods and results: Twenty formalin-fixed human atherosclerotic plaque segments
from neocapry were imaged in vitro with IVUS imaging systems using dual frequencies of 40MHz and 50MHz. The difference in echo-intensities of the two images obtained with both frequencies was first calculated on the pixel-to-pixel basis. The results were colorized, and then superimposed onto the regular IVUS images. This procedure was performed to detect the difference of frequency-dependent echo-intensity attenuation among the types of tissue components. A clearly bordered area with large variation in echo-intensity was revealed for each plaque surface in the colorized IVUS images. The thickness (x, mm) of this area correlated significantly with that of fibrous cap (y, mm) measured from histologically prepared sections as y = 0.85x + 0.07 (r = 0.86, p < 0.0001).

Conclusions: The color mapping of plaque with dual frequency IVUS provided an accurate representation of the thickness of the fibrous cap in atherosclerotic plaque. This method may be useful in assessing plaque vulnerability to rupture in atherosclerosis.

Homming of 111In-oxine Radiolabelled Endothelial Progenitor Cells in Ischemic or Inflamed Mice

Hindlimbs: Differential Cytochrome and Chemokine Profile

Diana Di Stefano, Paola Fimia, Chiara Barossi, Tanatia Santoni, Chiara Armani, Elena La Lazzaro, Paolo Collecchi, Giuliano Mariani, Alberto Babbarini, University of Pisa, Pisa, Italy

Background: Endothelial progenitor cells (EPCs) have been shown to induce neovascularization of ischemic tissues. Because the expression of cytochromes/chemokines has been postulated as a determinant for stem cell homing, understanding their role would lead to further knowledge of their mechanism of action.

Aim of this work was to evaluate cytochrome and chemokine expression after the induction of mice hindlimb ischemia or inflammation, and before and after 111In-oxine labeled EPCs injection.

Methods: Human EPCs were cultured from peripheral blood mononuclear cells in EGM-2 MV for a week, labelled with 111In-oxine and tested for cell viability before i.v. injection into balb/c mice (5.7 MBq, groups of 5 animals). Ischemia was induced by femoral artery ligation; inflammation by terpentine injection into hindlimb muscles. EPCs biodistribution was evaluated 8 hrs after i.v. injection. Determination of 62 cytokines and chemokines was carried out with RayBio Mouse Cytochrome Antibody Array III.

Results: A consistent pattern of overall tissue biodistribution was observed in normal, ischemic and inflamed mice with an average of 2.68 ± 0.01 %ID/g in the normal muscle. Both the ischemic and the inflamed muscle accumulated significantly more radioactivity (5.19 ± 0.03 and 5.14 ± 0.04 %ID/g, respectively) than the controlateral ones. A differential pattern of expression was found in ischemic and inflammatory condition. High levels of TIMP-1 were present only in ischemic tissue while MCP-1, VCAM-1 and VEGF were found in both ischemic and inflamed tissues. The predictive value of increased birefringence (less than 50%) with both frequencies was first calculated on the pixel-to-pixel basis. The results were colorized, and then superimposed onto the regular IVUS images. This procedure was performed to detect the difference of frequency-dependent echo-intensity attenuation among the types of tissue components. A clearly bordered area with large variation in echo-intensity was revealed for each plaque surface in the colorized IVUS images. The thickness (x, mm) of this area correlated significantly with that of fibrous cap (y, mm) measured from histologically prepared sections as y = 0.85x + 0.07 (r = 0.86, p < 0.0001).

Conclusions: The color mapping of plaque with dual frequency IVUS provided an accurate representation of the thickness of the fibrous cap in atherosclerotic plaque. This method may be useful in assessing plaque vulnerability to rupture in atherosclerosis.

Collagen Content of Coronary Plaque Measured by Polarization Sensitive Optical Coherence Tomography (PS-OCT)

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Background: Recent studies have determined that plaques often classified as vulnerable do not contribute to unstable angina or myocardial infarction. Most acute coronary syndromes result from small thin walled lipid-laden plaques that often escape detection by traditional imaging technology. Collagen depletion in the intima overlying lipidic collections appears to be a critical component of unstable plaques. In this study, polarization sensitive optical coherence tomography (PS-OCT) was used to quantitatively assess intimal cap collagen by measuring the birefringence using perpendicular polarization states.

Methods: Twenty-two coronary artery segments were imaged with PS-OCT using a light source with a median wavelength of 1310 nm and a resolution of 11 microns in the radial direction. Perpendicular polarization states (maximum and minimum) were acquired for all samples every 50 microns along the entire length of each arterial segment (5-7 mm). Tissue samples were prepared for paraffin embedding and sections obtained at appropriate intervals to match the OCT images. All samples were stained with thionine blue and picrosirius red (a measure of collagen intensity and fiber size). A-scans of PS-OCT images, using NIH ImageJ software, were used to quantify the tissue’s polarization sensitivity and were compared to luminosity measurements of the picrosirius red staining (Adobe Photoshop).

Results: The comparison between PS-OCT changes and measured collagen intensity yielded a correlation coefficient value of 0.465 (p < 0.007). The predictive value of a PS-OCT measurement of high birefringence (greater than 66% change) for high collagen concentrations was 89%, while the predictive value of negligible birefringence (less than 33% change) for minimal collagen was 95%. The fiber concentration, rather than the fiber type (chemical composition), was found to have a greater effect on the intensity changes of PS-OCT images.

Conclusion: The ability of PS-OCT to generate high resolution structural assessments, as well as determine intimal cap collagen content, make it a potentially powerful technology for identifying high risk plaques.
Inotropic Stimulation Enhanced Left Ventricular Endocardial Apical Twisting in Normal Subjects: Evaluation by a Novel Automated Tracking Technique

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Background: Although endocardium contributes to systolic myocardial thickening more than epicardium, the difference of left ventricular (LV) twisting in endo- (Endo) and epicardial (Epi) is unknown.

Methods: To evaluate the effect of inotropic stimulation on LV twisting and radial strain, LV basal and apical short-axes images were recorded during a cardiac cycle in 10 normal subjects at rest and during dobutamine infusion (Dob: 10 μg/kg/min). Total eight points were manually placed on anterior, lateral, posterior and septum both at the Endo and Epi in each base and apex. The movement of these points during a cardiac cycle was tracked by 2-dimensional tissue tracking system (HITACHI, EUB-8500). The distance between Endo and Epi was measured and systolic radial strain was calculated. The rotation angle of each point was calculated and averaged by customized software.

Results: In LV apex, endocardial rotation increased (7.2 ± 2.6° –13.3±4.9°, p<0.01), however, epicardial rotation unchanged after Dob. Apical rotation in Endo was significantly greater than that in Epi after Dob. In base of LV although both endo- and epicardial rotation increased (Endo: 3.0±2.0° –6.4±2.8°, Epi: 2.4±1.6 –5.4±2.9, p<0.05, respectively), there was no difference between Endo and Epi. The apical radial strain increased from 41.9±8.7 to 65.8±15.5 (p<0.01).

Conclusion: Inotropic stimulation augment apical LV twisting especially in Endo, which may contribute to increase of myocardial systolic radial strain of LV apex.

Flow-Function Relationship in Left Anterior Descending Artery Territory: Correlation of Adenosine Induced Strain Rate Changes and Simultaneously Estimated Flow Reserve

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BACKGROUND: Adenosine (AD) has been used as stressor to induce myocardial ischemia through coronary flow reserve redistribution in coronary artery (CA) stenosis. It is also used to assess coronary flow reserve (CFR) of the left anterior descending (LAD) coronary artery. Effects on Doppler tissue imaging (DTI) indices of left ventricular longitudinal systolic function have not been studied. We assessed the AD induced changes in DTI indices of LAD territories and correlated them with the degree of stenosis and CFR.

PATIENTS-METHODS: 30 patients were studied (age: 62±9). None had akinesis in the LAD territory. 8/30 pts had a >50% LAD diameter stenosis. LAD CFR (normal values ≥2) were estimated by AD 140 μg/kg/min for 4 min by transathoracic echo. Peak strain during cardiac cycle (Peak strain) and peak strain rate (Peak strain rate) during systole were measured by DTI in the territories supplied by LAD (mid-apical anterior (A) and septal (S) wall from 2/4 chamber apical views respectively).

RESULTS: Pts with CFR-LAD<2 had lower Peak strain rate at both apical S (0.91±0.21 vs 1.23±0.38, p=0.006) and apical A (0.94±0.23 vs 1.22±0.31, p=0.04) at R and after AD infusion (apical S: 1.0±0.12 vs 1.39±0.48, p=0.06/ apical A: 0.73±0.25 vs 1.31±0.51, p=0.037). % increases of Peak strain rate with AD were related to LAD CFR in A and S territories (r=0.63, p=0.012 and r=0.41, p=0.05 respectively). Using ROC analysis for prediction of >50% LAD stenosis, AD Peak strain rate in apical A >0.78/sec had sensitivity 0.77, specificity 0.90 (area under curve 0.78, p=0.01). Zone apical A had a further trend during AD (0.95±0.63 vs 1.28±0.43). Peak strain was different in pts with CFR-LAD<2 vs both at R and during AD. However, with AD Patrarin at apical A was smaller in pts with >50% LAD stenosis (AD: 15±7 vs 22±6, p=0.04).

CONCLUSIONS: Strain rate in LAD territory is related to the local CFR. AD infusion induces changes in strain rate, which are dependent on the respective CFR of the LAD. In contrast, peak strain, which expresses myocardial deformation and not regional contractility, as strain rate does, does not reveal relevant relationships.

How Should Dobutamine Stress Echocardiography and Multislice Computed Tomography Be Used to Assess Coronary Heart Disease in the Clinical Settings?

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Background: Diagnostic testing of coronary artery disease (CHD) is becoming more complex as the number of procedures available to the physician continues to increase. Both multislice computed tomography (MSCT) and dobutamine stress echocardiography (DSE) have been proved useful to detect CHD. However, it is still unclear when each test should be used.
Performed on patients with chest pain to diagnose CHD. We examined DSE and MSCT on patients with chest pain to seek how these tests be used in the clinical settings. We examined 391 patients (52 male, mean age: 68 years old) with analgesia on effort using both DSE (Siemens 750 Phillips Medical System, Andover, USA) and MSCT (M-16; detector CT scanner, SOMATOM 16, Siemens Medical Systems, Forchheim, Germany). Myocardial ischemia was diagnosed by following methods; 1) wall motion abnormality (WMA) in the LAD territory (MSCT), 3) either WMA in DSE or stenosis in MSCT, 4) both WMA in DSE and stenosis in MSCT (DSE and MSCT), 5) WMA in DSE in cases with inconclusive and stenosis in MSCT (MSCT followed by DSE).

Results: Coronary angiography was performed on 35 patients with positive findings by either DSE or MSCT and revealed significant stenosis in 23 patients (36 of 109 coronary territories). In MSCT, 9 patients (17 diseased coronary arteries) were not able to be assessed, because of motion artifact and calcification. The sensitivity and specificity for diagnosis of significant coronary stenosis were 100% (100%); 86%, 82%, 2) MSCT: 97%, 88%, 3) DSE or MSCT: 97% and 62%, 4) DSE and MSCT: 64%, 100%, 5) MSCT followed by DSE: 78% and 99%, respectively. Conclusions: MSCT would be feasible for a screening test of CHD because of high sensitivity and relatively low specificity. With MSCT followed by DSE, the specificity was improved and this strategy could be feasible for detecting CHD in patients suspected of angina pectoris.

**Left Coronary Artery Flow Reserve Measured Transhoracically Improves the Diagnostic Value of Routine Dipyradymole-Atrione Stress Echocardiogram**

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Aim. Coronary flow reserve (CFR) of left interior descending (LAD) branch of the left coronary artery can be studied using transhoracic Doppler echocardiography and vasodilator challenge. We hypothesized that CFR in LAD can be effectively studied during peak phase of high-dose dipyradymole-atrione stress protocol (DIP).

Methods. We studied 64 patients (pts, age 58±6, 20 females) undergoing routine workup for myocardial ischemia using rapid high-dose DIP with atrovent to up to 1mg in negative cases. 20 pts had previous MI and mean CCS class was 2.4. All patients underwent coronary angiography and gated SPECT (55% as reference) for contrast. CFR was measured without contrast enhancement during DIP peak using MHz 7.8 probe (Siemens Secoma 250).

Results. Significant (≥50%) LAD disease was present in 42 pts, including 7 with total occlusion. CFR calculation was feasible in 93 pts (83%). 11 pts had undetectable distal LAD flow signal due to total occlusion in 6 cases or critical (35%) stenosis of LAD in 3 cases (specificity 81% for severe LAD disease). Recorded CFR ranged 1.3-4.1 (2.2±.7), which corresponds with peak and resting LAD flow of 14-60 (28±5) and 29-119 (85±21) cm/s, respectively. Lower CFR was characteristic for significant LAD disease: 1.97±.62 vs. 2.55±.57, p=0.0015 and correlated with LAD %stenosis: r=0.44, p=0.008. Optimal cutoff for 50% stenosis was CFR=2.1 (ROC AUC 0.77, sens.68% and spec. 84%). There were no false positives with CFR=1.8 and no false negative results in CFR. In 17 patients without WMA in the territory abnormal CFR identified LAD disease with 82% (14/17) positive predictive value. In WMA-negative DIP 6/9pts with disease LAD had abnormal CFR whereas in WMA-positive DIP 12/13 pts with normal LAD had normal CFR. Accuracy using either abnormal WMA or CFR as criterion for positivity increased from 75% to 85%. No test with both abnormalities was false positive.

Conclusions. CFR of LAD can be measured as an extension of routine DSE with rate of 83%. The method is 74% accurate and improves the detection of multivessel disease involving LAD even in studies without inducible WMA. This is translated into 10% gain in test accuracy. Study supported from KBN grant P03B 03623.

**Conclusion:** TID on SE predicts incremental prognostic value over historical, clinical, Resting and Stress Echocardiographic Variables

Ajoy S. Shah, Rawu Sarj, Narine Koteich, Sripal Bangalore, Xiaochen Zhang, Shrilal Shah, Sai-Sun Tao, Farooq Chaudhry, St. Luke's-Roosevelt Hospital Center, New York, NY

Background: The prognostic value of transient ischemic dilatation (TID) during stress echocardiography (SE) is not well defined.

Methods: We evaluated 155 pts (63±10 yrs, 50% male) with SE (61% exercise). Left Ventricule (LV) was scored as per standard 16segment (seg) model. The no. of LV seg with PIL response was assessed and 3) either WMA in DSE or stenosis in MSCT (DSE or 2) stenosis in MSCT, 3) either WMA in DSE and stenosis in MSCT (DSE and MSCT), 4) both WMA in DSE and stenosis in MSCT (DSE and MSCT), 5) WMA in DSE in cases with inconclusive and stenosis in MSCT (MSCT followed by DSE).

Results: PIL provokes a positive ECG response in 7 of 16 patients (43.8%). LV diastolic dimension, LVF and QRS duration and 2 wave amplitude in ECG were measured. Positive ECG response with PIL was defined as >200mV elevation of SJ wave amplitude after PIL infusion. Results: TID challenge provoked a positive ECG response in 7 of 16 patients (43.8%). LV diastolic dimension, LVF and QRS duration and 2 wave amplitude in ECG were measured. Positive ECG response with PIL was defined as >200mV elevation of SJ wave amplitude after PIL infusion.

**Incremental Prognostic Value of Transient Ischemic Dilatation of Left Ventricular Cavity Dilatation on Stress Echocardiography Over Historical, Clinical, Resting and Stress Echocardiographic Variables**

Ajoy S. Shah, Rawu Sarj, Narine Koteich, Sripal Bangalore, Xiaochen Zhang, Shrilal Shah, Sai-Sun Tao, Farooq Chaudhry, St. Luke's-Roosevelt Hospital Center, New York, NY

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124A ABSTRACTS - Diagnostic Testing

124A-04

Colour-coded Tissue Tracking Is an Accurate, Fast, and Simple Tool for Identification of Non-ischemic Patients in the Hand in Experienced Stress Echocardiography Reader

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Background: Colour-coded tissue tracking (TT), derived from colour coded tissue Doppler imaging, is a novel technique allowing fast and simple "pattern recognition" of myocardial longitudinal displacement. TT is a regional colour coded presentation of the magnitude of longitudinal displacement of the myocardium. TT is easily obtainable and therefore a potential tool for first step stress echo reading in order to quickly identify non-ischemic patients without need for additional time consuming procedures involving trained and highly specialised experts. The aim of this study was to determine whether TT could really be used in such a way and, furthermore, to establish TT cut-off values for rapid identification of patients without signs of myocardial ischemia during dobutamine-atrovent stress echocardiography (DASE). Methods: DASE recordings from 70 consecutive patients referred for stress echocardiography were presented to a blinded, inexperienced reader for postprocessing using TT. The reader obtained only minimal, 30 minutes' training involving assisted TT reading of 3 patients and a very fast (1 - 2 min) simple reading procedure using three apical views.

A four-grade scale for basal displacement was employed as follows: 1) >12 mm displacement in all basal segments, 2) minimal value of >10 < 12 mm displacement in at least one basal segment, 3) minimal value of >8 < 10 mm displacement in at least one basal segment, 4) minimal value of <8 mm displacement in at least one basal segment.

Results: Using grade (3) as a cut-off point, high sensitivity (96%) and negative predictive value (95.7%) were obtained whereas the area under the receiver specific curve was only 27% and positive predictive value 33%. Accordingly, using this cut-off point, an inexperienced stress echo reader could identify 30% of the non-ischemic patients with minimal time expenditure. The TT reading time was 1 - 2 minutes per patient and the estimated time saving due to rapid identification of non-ischemic patients was 5.8 hours.

Conclusions: TT analysis of apical views at peak stress seems to provide a feasible, highly sensitive and time-saving means for simple and fast identification of a considerable fraction of non-ischemic patients.

124A-05

Acute Changes in N-terminal pro-Brain Natriuretic Peptide Induced by Dobutamine Stress Echocardiography

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Background: Exercise-induced myocardial ischemia has been associated with increase in circulating BNP levels. The aim of this study was to determine the effect of stress echocardiography-induced ischemia on circulating levels of N-terminal pro-brain natriuretic peptide (NT-pro-BNP).

Methods: One hundred and twenty eight patients underwent dobutamine stress echocardiography. NT-pro-BNP levels were measured before and one hour after completion of DSE.

Results: NT-pro-BNP levels were similar before and after DSE regardless of whether patients had >50% luminal narrowing (96.5±70.5 vs 96.5±70.5 pg/ml, p=0.017 and p<0.025 respectively) and after DSE (124.4±36.5 vs 100.5±71.1 pg/ml, p<0.05). Patients with severe inducible ischemia had significantly higher NT-pro-BNP levels compared to patients with mild or moderate inducible ischemia and patients without inducible ischemia, both before (208.5±125.5 vs 96±78.9 vs 96.5±70 pg/ml, p=0.017 and p=0.55) and after DSE (124.4±36.5 vs 124.2±108.3 vs 96.5±70 pg/ml, p=0.37) and after DSE (212.5±138.1 vs 94.8±81.1 vs 100.5±71.1 pg/ml, p=0.025 respectively).

Conclusions: NT-pro-BNP levels were measured before and one hour after completion of DSE.

124A-06

Wall Motion Score by Stress Echocardiography Is Superior to Angiographic Jeopardy Score for Risk Stratification and Prognosis

Sripal Bangalore, Ajay Shah, Devi Gopinath, Emad Aziz, Arund Haridas, Shadi Abdolreza, Madhuri Devabashkari, Deborah Cantales, Siu-Sun Yau, Farooq A. Chaudhry, St Lukes Roosevelt Hospital, New York, NY.

Background: Angiographic jeopardy score (AJS) is a method for estimating the amount of myocardium at jeopardy on the basis of location of coronary stenosis. The extent of ischemic myocardium can also be estimated by stress echocardiography. Data on comparison of the two modalities is limited.

Methods: We evaluated 212 consecutive patients (57 ± 16 years, 70% male) who had coronary angiography and stress echocardiography within a 3-month period. Peak wall motion score index (WMSI) was derived from cumulative sum of 16 segments at maximum heart rate. Followup (4.1 ± 2.3 years) for all-cause mortality (n = 62) was obtained.

Results: Patients with event had a higher AJS (4.7 ± 4.2 vs 3.4 ± 3.8, p = 0.04), higher rest WMSI (2.3 ± 1.0 vs 1.6 ± 0.8, p = 0.0001), higher stress WMSI (2.3 ± 0.9 vs 1.7 ± 0.8, p = 0.0001) and lower ejection fraction (38 ± 18 vs 49 ± 14, p = 0.0001) compared to the no event group. Receiver operating characteristic curve showed that stress WMSI for the prediction of all-cause mortality (Global chi-square increased from 6.7 to 17.5, p < 0.0001).

Conclusion: Stress wall motion score index is superior to angiographic jeopardy score and provides independent and incremental prognostic value beyond angiographically determined jeopardy score for the prediction of all-cause mortality.
Background: Although CT low-density plaques defined by multislice computed tomography (MSCT) correspond to soft plaques defined by intravascular ultrasound (IVUS), whether or not they represent vulnerable plaques is unknown.

Methods: MSCT was performed in 34 patients with coronary artery disease using an Aquilion 16 with collimation of 0.5mm and gantry rotation of 4.0rotation. Plaque CT densities were measured in at least 4 randomly selected regions of interest within the plaque and the minimum CT density was determined. Based on IVUS, plaques were classified into soft, fibrous and hard plaques. The minimum CT plaque density was compared to the IVUS-derived plaque texture. The plaques were also evaluated by coronary angiography and divided into white and yellow plaques according to the 4-point scoring system (0-white, 1-light yellow, 2-yellow, 3-intense yellow). Plaques with color grade 0-1 were defined as white plaques and plaques with color grade 2-3 were defined as yellow plaques.

Results: The CT densities in soft, fibrous and hard plaques were 47±22 Hounsfld units (HU), 101±29 HU, and 573±203 HU, respectively. When compared with CT density < 50 HU were defined as soft plaques, the sensitivity and specificity of CT to detect IVUS-defined soft plaques was 95% and 97%, respectively. The sensitivity and specificity to detect angiographically defined yellow plaques were 75% and 56%, respectively.

Conclusions: MSCT may permit accurate assessment of coronary artery soft plaques, but it is insensitive to detect yellow plaques which are sensitive markers of vulnerable plaques. The significance of CT low-density plaques awaits further prospective clinical observations.

Detection of Angiographically Silent In-Stent Restenosis in Multislice Computed Tomography
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Background: Angiographically mild coronary artery stenoses sometimes cause significant myocardial ischemia. Multislice computed tomography (MSCT) is a promising tool for noninvasive coronary artery assessment. Methods: We evaluated the angiographic and MSCT findings of 342 lesions in 209 consecutive patients who underwent both conventional coronary angiography (CA) and pre-CA MSCT. MSCT images were analyzed for in-stent lumen visibility, and the assessment of the presence of in-stent restenosis (ISR) was performed, and then, in-stent minimum lumen area (MLA) was measured in cross-sectional MSCT images using digital caliper. ISR was defined as diameter stenosis ≥ 50% in CA, and diagnostic performance of MSCT was assessed with CA used as a standard of reference. All ISR lesions in MSCT were also evaluated by intracoronary ultrasound (ICUS) at the time of CA. Results: Three hundred nine lesions (91.4%) were evaluable for in-stent lumen. MSCT permitted the detection of 44 of 45 significant stenosis (sensitivity 97.8%), and correctly identified the absence of restenosis in 243 of 264 (specificity 92.0%). These values correspond to positive predictive value of 87.7% (44 of 46), negative predictive value of 99.5% (243 of 244), diagnostic accuracy of 95.8% in the whole lesions. In 65 ISR lesions in MSCT, 21 lesions were false positive. ICUS revealed minimum stent area less than 4mm² in 63 of 65 ISR lesions diagnosed as restenotic both by CA and MSCT, and in 17 of 21 bira positive lesions in MSCT MLA in MSCT was 2.4±0.4 mm and 2.7±0.3 mm in CA, respectively. MLA in MSCT was significantly correlated with that in ICUS (r = 0.73, p < 0.01). Conclusion: MSCT accurately detected angiographically silent but ICUS MLA less than 4mm² lesions, if image quality was sufficient.

Comparison of Left Atrial Volume and Left Atrial Appendage Contribution in Patients With and Without Persistent Atrial Fibrillation
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Background: Enlargement of the left atrial (LA) cavity has been shown to correlate with increased mortality. Traditionally, echocardiography has been used to quantify LA volume, but the measurements rely on geometric assumptions and do not include the contribution of the left atrial appendage (LAA). Therefore, we sought to quantify LA volume and the contribution of the LAA in patients with and without persistent atrial fibrillation (AF) using multislice cardiac computed tomography (CT).

Methods: Cardiac CT studies performed using a 16-slice spiral system (Sensation 16, Siemens, Erlangen, Germany) with electrocardiographic gating for the assessment of pulmonary venous anatomy were retrospectively analyzed in 35 patients (18 in sinus rhythm (SR), 17 in persistent AF) using multiplanar reconstruction phases at end-diastolic (ED) and end-systolic (ES) were analyzed by multiplanar reformation of the left atrium into multiple parallel images. Volume rendering and virtual coronary angiographic images were reconstructed for morphologic assessment of the LAA. Exercise myocardial perfusion single-photon emission computed tomography was performed in all patients using a dual Thallium-201/Technetium-99m tetrofosmin dual isotope, separate acquisition protocol.

Results: A total of 39 patients (3.9%) were incidentally found to have abnormal origins of the RCA. The RCA arose from the left main coronary artery in 9 patients, whereas it arose from the left main coronary artery in 1 patient as a single coronary artery. 6 patients had acute angle take-off of the RCA from the aorta and 4 patients had intramural course within the aortic wall. Virtual coronary angiography revealed a ‘mole hole’ appearance of the RCA ostium in these 4 patients. In all patients, the RCA course between the ascending aorta and pulmonary artery. 4 patients with exercise-induced ischemia were those exhibiting a combination of acute angle take-off from the aorta and intramural course within the aortic wall. These morphological features were thought to be the primary cause of exercise-induced myocardial ischaemia in patients with anomalous origins of the RCA.

Conclusions: MSCT permits evaluation of possible causes of ischemia in patients with anomalous origins of the RCA.
**Multislice Computed Tomography in Detection of Coronary Artery Disease in Heart Transplant Patients**

Philipp Pichler, Christian Ewens, Suzanne Roedler, Bonni Syeda, Till Bader, Arezu Alabadi, Christoph Schukro, Florian Wolf, Herwig Himot, Dieter Glogar, Medical University of Vienna, Vienna, Austria

**Background:** Post-transplant follow-up of heart transplant patients consists of regular angiography after transplantation and goes along with a significant amount of costs, discomfort and risk. We sought to assess whether Multislice computed tomography (MSCT) permits the exclusion of coronary artery disease in asymptomatic heart transplant patients.

**Methods:** MSCT-scans (Philips “CT MX 8000 IDT”) and invasive angiography were performed in 66 consecutive heart transplant patients in sinus-rhythm scheduled for routine non-invasive coronary angiography. 100 ml non-ionic iodinated contrast medium were applied for CT-angiography. All scans were performed during one breath-hold. In axial MSCT images and multiplanar reconstructions, all coronary arteries and side branches were assessed for the presence of stenoses exceeding 70% diameter reduction. Coronary segment analyses were performed according to a modified American College of Cardiology/American Heart Association (ACC/AHA) classification in vessel with a diameter exceeding 1.5 mm. Results were compared with quantitative coronary angiography analysis.

**Results:** MSCT was performed successfully in 60 patients enrolled in our analysis; Fourteen patients (21%) had at least one significant stenosis, 9 (14%) suffered from coronary artery disease without significance and the remaining 43 (65%) were totally free from graft sclerosis. Forty-one out of 43 patients (95%) who were estimated to be totally evaluable were correctly classified. On a per-segment-basis, 10 out of 19 high-grade stenoses were assessed correctly. 4 were underestimated and 5 were incorrectly classified non-significant (sensitivity: 53%, specificity: 94%). After exclusion of 45 out of 764 coronary segments (6%) due to motion artifacts or severe calcification, sensitivity, specificity, positive and negative predictive values were 67%, 100%, 91% and 99%, respectively.

**Conclusions:** Despite a low sensitivity, the high negative predictive value allows the exclusion of significant CAD with a large certainty in a big number of patients. From the clinical point of view, this might spare this patient cohort an additional invasive coronary angiography.

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**Comparison of Computed Tomography Coronary Angiography with Conventional Coronary Angiography for the Detection of Significant Coronary Lesions in the Pre-Operative Valve Surgery Patient**

Willem B. Meijboom, Carlos A. Van Mieghem, Patrizia Malagutti, Ad J. Bogaers, Gabriel K. Kreist, Pim J. de Feyter, Erasmus Medical Center, Rotterdam, The Netherlands

Conventional coronary angiography (CCA) is recommended in patients scheduled for valve surgery. The diagnostic performance of the latest 64-slice Computed Tomography Scanning Coronary Angiography (CTCA) is compared with CCA in heart transplant patients.

Methods: 60 heart transplant patients were studied. 27 patients were scheduled for valve surgery for severe heart failure. 33 patients had no signs of coronary disease. All patients had undergone a non-invasive coronary angiography prior to their hospitalization. The latest 64-slice CTCA was performed using the Aquilion 64 scanner (Toshiba, slice thickness 0.5 mm) in 58 patients ( 26 men, 60.8±12.2 years). The diagnostic performance of the latest 64-slice Computed Tomography Scanning Coronary Angiography was compared with CCA using a standard 4-view angiography set-up.

Results: MSCT was performed successfully in 60 patients enrolled in our analysis; Fourteen patients (21%) had at least one significant stenosis, 9 (14%) suffered from coronary artery disease without significance and the remaining 43 (65%) were totally free from graft sclerosis. Forty-one out of 43 patients (95%) who were estimated to be totally evaluable were correctly classified. On a per-segment-basis, 10 out of 19 high-grade stenoses were assessed correctly. 4 were underestimated and 5 were incorrectly classified non-significant (sensitivity: 53%, specificity: 94%). After exclusion of 45 out of 764 coronary segments (6%) due to motion artifacts or severe calcification, sensitivity, specificity, positive and negative predictive values were 67%, 100%, 91% and 99%, respectively.

Conclusions: Despite a low sensitivity, the high negative predictive value allows the exclusion of significant CAD with a large certainty in a big number of patients. From the clinical point of view, this might spare this patient cohort an additional invasive coronary angiography.

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**Symptomatic Obese Patients Undergoing 64-Slice Multi Detector Computed Tomography Are Younger and Have Lower Prevalence of Significant Coronary Stenosis**

Ronan Rubinstein, David A. Halon, Tamarin Gaspar, Nathan Peled, Saim Adawi, Basil S. Lewis, Lady Davis Carmel Medical Center, Haifa, Israel

**Background:** Obesity is a risk factor for both coronary artery disease (CAD) and all cause mortality. Better short term outcome has been reported, however, after myocardial revascularization in obese pts. To examine if differences exist in the nature of CAD in symptomatic obese and non-obese subjects we examined the relation between body mass index (BMI) and prevalence of significant coronary stenosis in symptomatic pts evaluated with multi-detector computed tomography (MDCT).

**Methods:** We examined 243 consecutive symptomatic pts (59±11 yrs, 69% men) by invasive coronary angiography using a 64-slice MDCT scanner (Brilliant 64, Philips) for the presence of significant CAD defined as ≥1 coronary artery narrowing ≥50% (arterial segments proximal to functional bypass grafts excluded). 96 pts (40%) had prior revascularization.

**Results:** Significant CAD was found in 17/58 (29%) pts with BMI>30 kg/m² vs 81/185 (44%) in pts with BMI<30 kg/m² (p=0.05). Obese pts were younger (55.6±10.9 vs 60.1±11.7 yrs, p=0.0001) and had higher prevalence of hypertension [43/58(74%) vs 109/185(58%), p=0.04], but similar rates of other CAD risk factors.

**Conclusions:** 1. Obese pts had lower prevalence of significant CAD on MDCT, higher prevalence of hypertension and were younger. 2. Obese pts may reveal symptoms and be examined at an earlier stage of their disease explaining the obesity paradox in calcium reports of better short-term outcome after cardiac procedures. 3. 64-slice MDCT may prove to be a useful tool to assess CAD severity in symptomatic obese pts.

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**Fluvastatin Reduces Coronary Plaque and Increases Luminal Volume: Assessment by Multislice CT**

Takashiha Saeg, Takeshi Kondo, Hirofumi Ano, Masayoshi Sato, Keita Oshima, Kaci Inoue, Sadako Motoyama, Hiroshi Shirakawa, Hiroshi Hishida, Sho Narita, Jaga Narula, Fujita Health University, Toyko, Japan

**Background:** It is controversial whether statins can reduce coronary artery plaque volume. Using MSCT angiography for characterization of the plaque, we evaluated the effect of Fluvastatin (which also exerts high pleiotropic effects) on relative alterations in plaque and lumen volume (PV, LV).

**Methods:** MSCT was performed by Aquilion 16, 32, 64 (Toshiba, slice thickness: 0.5mm) in 12 patients with coronary artery disease (CAD) (M/F=10/2, age: 64.9±6.0). PV and LV were calculated using novel plaque analysis software before and after 12-month treatment with Fluvastatin (20mg qd). Complete lipid profiles were obtained before and after statin treatment, within 7 days of CT imaging.

**Results:** Fluvastatin significantly reduced PV (104.3±47.8 to 91.2±36.1 mm³, p=0.045) and increased LV (97.0±51.9 to 118.2±57.5 mm³, p=0.011) compared to baseline. After 1 yr of chelation treatment, progression in calcium volume score was observed in 4 chelation therapy subjects but in none of the control group. The annualized absolute change in calcium volume score was also greater in the controls (93.9 vs 66.8, p=0.029). A decrease in calcium volume score was observed in 4 chelation therapy subjects but in none of the control group.

**Conclusions:** After 1 yr of chelation treatment, progression in calcium volume score was less than in case controls even though 75% of controls were on statins.
We performed a meta-analysis to examine MDCT compared to conventional coronary angiography. **Methods:** A MEDLINE literature search was performed for MDCT and coronary angiography keywords. Inclusion criteria included prospective, blinded design and performance of CT and cardiac catheterization within a pre-specified period of time. Exclusion criteria included evaluation of coronary grafts or stents. The rates of true positives, true negatives, false positives, and false negatives for detection of stenosis greater than 50% were abstracted, and sensitivities and specificities weighted by sample size were calculated.

**Results:** 18 eligible studies involving 1158 subjects were included. Each of the 18 studies included angiographic segments with femoral, radial, or brachial access. 83% of study subjects were male. Average age was 61.6 years (range 19-91). Mean heart rate at the time of the scan was 62.3 beats per minute (range 40-94). Coronary segments with significant obstruction were evaluated in 1181 segments. 593 segments were defined as non-obstructed. 588 segments were defined as obstructed. 544 segments were evaluated by cardiac catheterization. The mean calcium score for these 544 segments was 555.2. 114 segments were defined as having high calcium burden (930 or greater). The sensitivity and specificity for detection of significant stenosis was calculated. The sensitivity was 90.52% and the specificity was 99.16%.

**Conclusions:** The sensitivity and specificity of MDCT angiography for detection of significant coronary stenosis is high. MDCT angiography is highly specific for detecting coronary stenosis greater than 50%.

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**ABSTRACTS - Diagnostic Testing 127A**

### 970.15

**Noninvasive Coronary Angiography: Agreement of 64-Slice Cardiovascular Computed Tomography and Selective Catheter Angiography**

**Jeffrey J. Fing,** Patrick A. Hall, Christie B. Hopkins, F Carter Newton, South Carolina Heart Center, PA, Columbia, SC

**Background:** Cardiovascular computed tomography (CVCT) via 64-slice technology increases spatial resolution while decreasing acquisition times and slice thickness. We evaluated the accuracy of 64-slice CVCT referenced by catheter angiography to determine if improved performance metrics offer a low risk and patient friendly mode of coronary angiography, which in selected clinical situations may replace the need for catheter angiography.

**Methods:** We studied 66 sequential subjects having 64-slice CVCT and catheter angiography within 30 days. CVCT was performed using the commercially available Siemens Sensation 64 CT. Results were analyzed for study quality, detectable lesions >50%, left ventricular ejection fraction (LVEF), and graft patency, when applicable. Vessels with a diameter <1.5 mm were excluded from the analysis. Subjects were referred to CVCT by their cardiologist or primary care provider after presentation of symptoms or after perfusion testing supported myocardial ischemia. Data are expressed as percentages and descriptive statistics (sensitivity, specificity, positive predictive value, negative predictive value). A P-value of <0.05 was considered statistically significant.

**Results:** 245 coronary arteries were evaluated. 64-slice CVCT identification of stenotic lesions >50% within measured coronary vessels were: sensitivity 95%, specificity 96%, positive predictive value 97%, and negative predictive value 92%. Vein grafts evaluated within this study had 100% agreement between CVCT and direct angiography (9/9). Left ventricular ejection fraction calculations were nearly identical between CVCT and catheter angiography (58.7 and 58.6 respectively, p = 0.0001).

**Conclusion:** Our results suggest that the 64-slice generation of cardiovascular CT has increased sensitivity and positive predictive values, allowing CVCT to be considered for routine diagnostic evaluations. The strong agreement between 64-slice CVCT and catheter angiography when evaluating the patency of vein grafts, calculating LVEF, and among vessel-by-vessel comparisons supports the strength of the latest generation of cardiac CT imaging.

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**Diagnostic Accuracy of Multislice CT Coronary Angiography in Patients Presenting With Non-Diagnostic Chest Pain**

Gaurav Minocha, Poonam Khurana, Mittu Aranl Minocha, Simmi Manocha, Sameer Sinistavsa, Praveen Agarwal, Ravi P, Kasiwi, Tarlochan S. Kler, Nareesh Trehan, Escorts Heart Institute, New Delhi, India

**Background:** Non-invasive coronary angiography with 16 slice Multislice Computed Tomography (MSCT) has shown potential in detecting significant coronary stenosis. Aim of this prospective clinical trial was to assess the diagnostic accuracy and clinical relevance of MSCT coronary angiography in patients presenting with non-diagnostic atypical chest pain.

**Methods:** 70 patients (mean age 63 ± 16 years, 90% male) presenting to hospital with acute chest pain, underwent coronary MSCT angiography followed by a conventional angiography. Patients with definite acute coronary syndrome, prior CABG and patients requiring immediate catheterisation were excluded. Further major exclusion criteria were atrial fibrillation and renal impairment. Coronary MSCT was acquired with a 16 slice CT using retrospective ECG gating. Blinded visual assessment of coronary MSCT was performed on a 11 segment model after image quality assessment. The accuracy of coronary MSCT was compared with conventional coronary angiography (CCA) to detect significant stenoses (> 50%).

**Result:** 70 patients underwent both MSCT coronary angiography & CCA. Risk factor analysis revealed 42.8% diabetic, 54.2% hypertensives, 17% smoker & 42.8% with positive family history of CAD. 31.4% patients had ≥ 2 major risk factors. Prevalence of significant coronary artery disease was 55.7%. 770 segments were assessed by MSCT of which 7.1% were non analysable. Mean calcium score was 364.1 & 17.1% patients had coronary calcium score > 800. The overall ability of coronary MSCT to detect the presence of significant stenosis in native segments, on exclusion of patients with significant lesion calcification, had a sensitivity of 84.4%, specificity of 98.7%, PPV of 89.0% and NPV of 98.1%. The ability of MSCT to detect the presence of at least one significant coronary stenosis in all native segments had a sensitivity of 86% and specificity of 100%.
Diagnostic Testing

Methods: analysis based on the hypothesis that post-acquisitional image processing using a novel method of signal newer 64-slice machines, further plaque characterization into lipid-rich pultaceous debris wall in coronary arteries and readily identify calcific deposits. However, even with the Background:

Heart Institute, Houston, TX, University of Houston, Houston, TX

Frazier, Alireza Zarrabi, Don B. Elrod, James T. Willerson, S. Ward Casscells, Texas angiography may enhance its use as a PAD screening and diagnostic tool.

Conclusion

value 100%, and negative predictive value 95%. Accuracy results for 64-slice CT among of study subjects. Accuracy results for 64-slice CT of renal arteries were sensitivity 92%, results were analyzed independently by two expert readers, each blinded to the opinion MDCT and MRI also allowed to identified all 7 bicuspid valves, 3 of which had been missed by TTE. Estimates of Vmax assessed by MD and MRI were not significantly different (2.31±1.6 m/s vs 2.29±1.6 m/s, p=ns, respectively). Vmax were highly correlated (r=0.94, p<.001). Bland-Altman analysis showed the same dispersion for MDCT and MRI versus TTE, with the same stcreumlation of AWA.

Conclusion and MRI can accurately estimate Vmax at the time of non-invasive imaging. This suggests that these techniques might be clinically useful in the non-invasive assessment of patients with aortic valve disease.

Background: 64-slice computed tomography increases spatial resolution while decreasing acquisition times and slice thickness. The non-invasive nature of this diagnostic test may allow for efficient non-invasive assessment of Peripheral Arterial Disease (PAD). The accuracy of 64-slice peripheral CT angiography, referenced by catheter angiography, was investigated.

Methods: We studied 211 cases in which 64-slice peripheral CT and catheter angiography were performed within 30 days for suspicion of PAD. Our analysis included assessment of the renal, carotid, and lower extremity arteries. Peripheral CT was performed using the Siemens Somatom Sensation cardiac 64 CT, Catheter and peripheral CT angiography results were analyzed independently by two expert readers, each blinded to the opinion of the other, and to the results of the second angiographic procedure. Results were analyzed for image quality and hemodynamically significant lesions (>50%). Accuracy and diagnostic power comprised our analysis.

Results: Among 211 subjects, 977 peripheral arteries were evaluated. 64-slice peripheral CT provided images of technical quality allowing for diagnosis of 99.9% (210/211) of study subjects. Accuracy results for 64-slice CT of renal arteries were sensitivity 98%, specificity 92%, positive predictive value 88%, and negative predictive value 92%. Results for 64-slice CT of carotid arteries were sensitivity 96%, specificity 100%, positive predictive value 100%, and negative predictive value 96%. Accuracy results for 64-slice CT among lower extremity arteries were sensitivity 88%, specificity 96%, positive predictive value 91%, and negative predictive value 90%

Conclusion: Our analysis suggests 64-slice peripheral CT angiography is an accurate and reliable method of non-invasively assessing PAD. The non-invasive nature of this diagnostic test allows for PAD detection that is time efficient for both the patient and medical care providers. Collectively, these advantages of 64-slice peripheral CT angiography may enhance its use as a PAD screening and diagnostic tool.

970-26

Extraction of Latent, Computed Tomographic Images of Coronary Artery Plaque Components by Isotropic, Three-Dimensional Wavelet Analysis

S. David Gert, Paul Cherukuri, Deborah Vela, Bernhard G. Bodmann, Ibrahim Aboobady, Georgy Gladish, Jodie L. Corynes, Wayne T. Wilner, Manos Papadakis, Donald Kouri, Reza M. Mavraiashah, Serhy Lukovenko, Mohammad Majid, Lomaine Frazier, Airina Zambri, Don B. Eilot, James T. Willerson, S. Ward Casscells, Texas Heart Institute, Houston, TX, University of Houston, TX

Background: Multi-detector CT (MDCT) can assess the thickness of the atherosclerotic wall in coronary arteries and readily identify calcific deposits. However, even with the newer 64-slice machines, further plaque characterization into lipid-rich pultaceous debris and fibrous tissue, a prerequisite for identification of the majority of putative vulnerable lesions, is not yet a workable reality. Recent studies in this laboratory have been testing the hypothesis that post-acquisitional image processing using a novel method of signal analysis (isotropic, three-dimensional wavelets) permits extraction of latent images of plaque components not seen with currently used CT protocols.

Methods: Coronary artery segments (5-15 mm) of individuals with coronary artery disease were excised at necropsy. Specimens were imaged using a GE RS-9 micro-CT scanner and processed for histological correlation. Novel isotropic wavelets were applied to the CT data to distinguish tissue textures of varying scales and intensities. Image voxels were classified and plaque characterization achieved by comparing the relative magnitude of these wavelet constituents to that of several reference plaque tissue components.

Results: Processing of micro-CT images via these wavelet algorithms permitted three-dimensional, color-coded, high resolution discrimination between lumen, calcific deposits, lipid core, and fibromuscular tissue providing detail not possible with conventional thresholding based on Hounsfield intensity units. Calcific deposits as small as 50 microns and lipid pools beyond the resolution of 16 and 64-slice MDCT in its current configuration were also extracted.

Conclusions: Post-acquisitional analysis of CT data based on these methods of wavelet analysis may improve the capability of MDCT for the non-invasive identification of atherosclerotic plaques prone to rupture. Consecutive imaging of potentially vulnerable lesions using this strategy could also permit non-invasive evaluation of the effects of risk factor or treatment modification on these morphological features.

Identification of Plaque Types and Distribution Patterns by Multi-detector Computed Tomography Enhances Prediction of Clinically Significant Coronary Artery Disease

James K. Min, Richard B. Devoures, Rick Koch, R. Parker Ward, Donald Russo, Nicholas Lippolis, Tracy O. Callister, Well Cornell Medical College, New York, NY

Background: Multi-detector cardiac computed tomographic angiography (CTCA) has demonstrated high accuracy for detecting coronary artery stenosis. The clinical relevance of plaque types and distribution as assessed by CTCA is not well described. We hypothesized that differentiation of plaque type and distribution patterns would enhance prediction of clinically significant CAD (CS-CAD) in patients undergoing invasive coronary angiography (ICA).

Methods: In 133 consecutive patients, clinically indicated CTCA and ICA were independently reviewed. CS-CAD was defined as >50% stenosis in any major epicardial vessel on ICA. CTCA for each patient were evaluated for overall plaque type, distribution and extent by investigators blinded to ICA result. Plaque type for each patient was defined as “soft” (>75%), “stable” calcified (“>75% calcified), or “mixed” plaque distribution was classified as focal (≤5 sites), diffuse (>5 sites or ≤5 sites with continuous plaque encompassing ≥1/3 of the vessel). Plaque by CTCA was classified as none, mild (<25% stenosis), moderate (25-50% stenosis), or severe (>50% stenosis).

Results: The mean age of the study group was 66 years and 59% were male. Compared to those without, patients with CS-CAD had significantly more mixed plaque (75.7% vs 45.7%, p<.002), while prevalence of other plaque types was similar in both groups. Patients with than without CS-CAD had severe (90.2 vs 37.8%) and moderate plaque (76.3 vs 19.6%) and exhibited diffuse plaque (77.6 vs 36.5%) (all p<.001). Patients with both mixed and diffuse plaque (versus those without) had high rates of CS-CAD (91.7% vs 33.3%, p<.001).

Conclusions: Mixed plaque, diffuse plaque, and severe plaque are independently associated with CS-CAD. These findings suggest that evaluation of plaque types and distribution patterns may help predict CS-CAD in patients undergoing CTCA.

Intra-individual Comparison of Radiation Dose Exposure between Multislice Computed Tomography and Conventional Coronary Angiography

Susanne Möllmann, Anja Deeten, Guido Connadi, Michael Weber, Christian W. Hamm, Thorsten Dill, Kershoff Heart Center, Bad Nauheim, Germany

Background: Multislice computed tomography of the coronary arteries (MSCTA) is gaining clinical importance. However, only estimates are available for the amount of radiation absorbed in comparison to conventional coronary angiography (CA). Thus, the aim of this study was to compare the intraindividual effective radiation doses being necessary for both techniques.

Methods: 56 patients (68±8 years, 49 male, body surface area 1.9±0.13 m²) underwent MSCTA and CA. The standard protocol for MSCTA consisted of pre-monitoring, monitoring, calcium scoring, and CA angiography using a 16 slice dedicated CA scanner. A conversion factor was used for the equation of the effective dose: E = xk·DLP. CA was performed using 8 standard projections for LCA and RGA together (lateral, LAO, RAO, PA) on an actual system with automatic selection of X-ray beam filtration. In 50 of 56 patients left ventriculograms were performed additionally. To compare the radiation doses of both investigations the effective dose was chosen as parameter. Following the guidelines proposed by the European Working Group for the Guidelines on Quality Criteria in CT a conversion factor was used for the equation of the effective dose: E = xk·DLP. In conventional angiography effective dose was estimated using the dose-area product and a conversion factor according to data published by Le Heron.

Results: For patients without prior coronary artery bypass (CABG) surgery (n=46) the mean effective dose was 9.7±6.4 mSv for MSCTA and 2.6±1.7 mSv for CA. If calcium scoring was performed additionally in MSCTA, the effective dose was 2.7±0.3 higher than without. For patients with prior CABG (n=10) the effective dose was 12.9±5.1 mSv for MSCTA and 6.2±4.0 mSv for CA. Subgroup analyses showed increasing effective doses for MSCTA in comparison to CA for patients with high body surface area and high pulse rate.

Conclusions: This intraindividual comparison demonstrates that even with new cardiac scanners, MSCTA is still associated with an approximately three times higher radiation dose exposure than with CA. Calcium scoring represents a relatively low radiation dose procedure. This study emphasizes that indications for MSCTA have to be thoroughly defined.
Identification of Plaque Composition in Multislice Computed Tomography

Taisi Yonetsu, Tsuneikazu Kakuta, Shigeki Kimura, Shingo Maeda, Tomoyuki Umemoto, Asami Suzuki, Hideomi Fujisawa, Tsuchiura Kyodo Hospital, Tsuchiura, Japan

Background: Multislice computed tomography (MSCT) can visualize coronary plaques, and CT density of plaque has been correlated with plaque stability. The composition of coronary plaques has been studied non-invasively by multislice spiral computed tomography (MSCT). The purpose of this study was to discover the association between CAC and the major CAD risk factors, endothelial dysfunction, C-reactive protein (CRP), and interleukin-1β (IL-1β) in asymptomatic individuals at risk for CAD. Methods: we studied 112 subjects (73 were males) with a mean age of 49.6±6.7 years. CAD was measured by MSCT using Agatston method. Endothelial-dependent flow-mediated dilatation (FMD) and endothelial-independent nitroglycerine-mediated dilatation (NGMD) were measured non-invasively by high-resolution external beam brachial ultrasound. Serum high-sensitive CRP and IL-6 levels were measured by particle-enhanced immunoturbidometric latex agglutination assay and high-sensitivity immunossay respectively. Results: significant positive correlations were found between CACS and age (r=0.332, p<0.001), total cholesterol (r=0.384, p<0.001), low-density lipoprotein cholesterol (r=0.378, p<0.001), triglycerides (r=0.412, p<0.001), IL-6 (0.287, 0.032), risk factor number (RFN) (r=0.576, p<0.001) and metabolic score (MetSc) (r=0.303, p<0.001). CACS values correlated negatively with high-density lipoprotein cholesterol (r=-0.269, r=0.004) and FMD (r=-0.573, p<0.001). Correlations

Study of Coronary Calcium Score by Multislice Computed Tomography in Relation to Endothelial Function, C-Reactive Protein, and Interleukin-6 in Asymptomatic Individuals

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Background: coronary artery calcification (CAC) and its score (CACS) has been correlated with the presence and extent of coronary artery disease (CAD); and can be estimated non-invasively by multislice spiral computed tomography (MSCT). The purpose of this study was to discover the association between CACS and the major CAD risk factors, endothelial dysfunction, C-reactive protein (CRP), and interleukin-1β (IL-1β) in asymptomatic individuals at risk for CAD. Methods: we studied 112 subjects (73 were males) with a mean age of 49.6±6.7 years. CAD was measured by MSCT using Agatston method. Endothelial-dependent flow-mediated dilatation (FMD) and endothelial-independent nitroglycerine-mediated dilatation (NGMD) were measured non-invasively by high-resolution external beam brachial ultrasound. Serum high-sensitive CRP and IL-6 levels were measured by particle-enhanced immunoturbidometric latex agglutination assay and high-sensitivity immunossay respectively. Results: significant positive correlations were found between CACS and age (r=0.332, p<0.001), total cholesterol (r=0.384, p<0.001), low-density lipoprotein cholesterol (r=0.378, p<0.001), triglycerides (r=0.412, p<0.001), IL-6 (0.287, 0.032), risk factor number (RFN) (r=0.576, p<0.001) and metabolic score (MetSc) (r=0.303, p<0.001). CACS values correlated negatively with high-density lipoprotein cholesterol (r=-0.269, r=0.004) and FMD (r=-0.573, p<0.001). Correlations

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Background: Multislice computed tomography (MSCT) can visualize coronary plaques, and CT density of plaque has been correlated with plaque stability. The composition of coronary plaques has been studied non-invasively by multislice spiral computed tomography (MSCT). The purpose of this study was to discover the association between CAC and the major CAD risk factors, endothelial dysfunction, C-reactive protein (CRP), and interleukin-1β (IL-1β) in asymptomatic individuals at risk for CAD. Methods: we studied 112 subjects (73 were males) with a mean age of 49.6±6.7 years. CAD was measured by MSCT using Agatston method. Endothelial-dependent flow-mediated dilatation (FMD) and endothelial-independent nitroglycerine-mediated dilatation (NGMD) were measured non-invasively by high-resolution external beam brachial ultrasound. Serum high-sensitive CRP and IL-6 levels were measured by particle-enhanced immunoturbidometric latex agglutination assay and high-sensitivity immunossay respectively. Results: significant positive correlations were found between CAC and age (r=0.332, p<0.001), total cholesterol (r=0.384, p<0.001), low-density lipoprotein cholesterol (r=0.378, p<0.001), triglycerides (r=0.412, p<0.001), IL-6 (0.287, 0.032), risk factor number (RFN) (r=0.576, p<0.001) and metabolic score (MetSc) (r=0.303, p<0.001). CACS values correlated negatively with high-density lipoprotein cholesterol (r=-0.269, r=0.004) and FMD (r=-0.573, p<0.001). Correlations
Diagnostic Testing

between CACS and both CRP & NGMD were non-significant (r=0.111, p=0.234; and r=-0.081, p=0.398; respectively). In multivariately-adjusted logistic regression analysis; age, RFNo, IL-6, and FMD were independently associated with CAC presence. Conclusions: RFNo was a more sensitive predictor for CAC presence. Further studies that should not focus on nitric oxide alone are needed to precisely determine the released endothelial factor(s) implicated in CAC pathogenesis and progression.

Image Quality of 64-Slice Multi-Detector Computed Tomography Coronary Angiography in Heart Transplant Recipients

Methods:

80.

Diagnostic Accuracy

30

Comparison of Predictive Value Between 16-Slice and 64-Slice Multidetector Computed Tomography to Detect Significant Obstructive Coronary Artery Disease

Results:

98.9%, NPV 99.2%, PPV 92.7%). The mean amount of contrast was 59.7 ml. There were 51/54 stenoses were detected in visible segments (sensitivity 94.4%, specificity 98.6%, NPV 96.8%, PPV 40.4%). The mean CNR was 167±22. Overall, 96.8% of the total visualized vessel lengths were free of motion artifacts (LM 98±6%, LAD 93±14%, LCX 96±7%, RCA 96±5%). Mean heart rate was 62±11 bpm. We predicted these predictors of that event. Further analysis of the percent stenosis in all measured coronary arteries was 10.9±4.1, and it was higher in proximal (11.7±3.8) compared to distal segments (10.0±3.8; p=0.01). High BMI was the only significant predictor of a low CNR (p<0.001). Image quality was rated as excellent or good in 85% of segments (235/278). MDCT vessel diameter measurements correlated well with QCA measurements (R=0.88, bias 0.10±0.3 mm).

Conclusions: 64-slice MDCTA safely provides excellent or good image quality in heart transplant recipients. Further, there are very low motion artifacts, the majority of both proximal and distal vessels are well-visualized with a consistently high CNR, and measurements of lumen diameter are accurate. These findings suggest that MDCTA may provide a lower risk alternative to invasive coronary angiography for the routine evaluation of transplant vasculopathy.

Assessment of Anatomical Relationship Between Papillary Muscle and Coronary Veins by Multi-detector Computed Tomography

Methods:

29.

Detection of Coronary Artery Disease

Results:

Background:

Diagnostic accuracy of CT coronary angiography performed with 4-slice CT scanners is lower than that allowed for by newer generation systems. Among the 4-slice CT scanners, HR=57bpm, 1.3 lesion/patient). In the 4-slice group, 113/442 (26%) segments were excluded from analysis because of poor image quality. All segments >2 mm diameter were evaluable in the other groups. Sensitivity, specificity, PPV and NPV were 58%, 94%, 61% and 94% for 4-slice CT; 90%, 93%, 65% and 99% for 16-slice CT; 97%, 88%, 87% and 99% for 16-slice CT; 99%, 96%, 80% and 99% for 64-slice CT. In the 64-slice CT group, including the assessable <2 mm diameter coronary branches (26%), the respective values were 99%, 95%, 76% and 99%.

Conclusions: Diagnostic accuracy of CT coronary angiography performed with 4-slice CT scanners is lower than that allowed for by newer generation systems. Among the others, a trend increase in diagnostic accuracy is seen. 64-slice CT has high diagnostic accuracy even when smaller coronary branches are included.

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JACC February 21, 2006

Noninvasive Coronary Angiography Performed With 4-Slice, 12-Slice, 16-Slice and 64-Slice CT: Comparison of Diagnostic Accuracy

Background:

From initial applications of EBCT and 4-slice CT, multidetector CT technology has evolved to 16- and 64-slice CT scanners capable to noninvasively image coronary arteries in less time. The rapid pace of change has not permitted large-scales access to the newest systems, thus different generations of CT equipment are currently available at different centers. Although investigations have explored the diagnostic performance of each CT imager in coronary applications, no studies have evaluated the diagnostic accuracy of such different generations of CT scanners simultaneously. We compared the diagnostic accuracy of 4 generations of multidetector CT scanners featuring 4, 12, 16 and 64 slices per rotation in the assessment of coronary artery disease (CAD) with conventional coronary angiography as the reference standard.

Methods:

Four groups were formed including the first 51 patients undergoing CT coronary angiography after the installation of each of the 4 CT systems. All patients (n=204) were referred for conventional angiography for suspected CAD. Subjects with previous percutaneous angioplasty, stent placement and CABG were excluded. Gantry rotation times were 500 ms for the 4-slice, 420 ms for the 12-slice, 375 ms for the 16-slice and 330 ms for the 64-slice scanner.

Results: Heart rates and prevalence of CAD were comparable among the groups (mean HR=75±8, 1.3 lesion/patient). In the 4-slice group, 113/442 (26%) segments were excluded from analysis because of poor image quality. All segments >2 mm diameter were evaluable in the other groups. Sensitivity, specificity, PPV and NPV were 58%, 94%, 61% and 94% for 4-slice CT; 90%, 93%, 65% and 99% for 16-slice CT; 97%, 88%, 87% and 99% for 16-slice CT; 99%, 96%, 80% and 99% for 64-slice CT. In the 64-slice CT group, including the assessable <2 mm diameter coronary branches (26%), the respective values were 99%, 95%, 76% and 99%.

Conclusions: Diagnostic accuracy of CT coronary angiography performed with 4-slice CT scanners is lower than that allowed for by newer generation systems. Among the others, a trend increase in diagnostic accuracy is seen. 64-slice CT has high diagnostic accuracy even when smaller coronary branches are included.

Assessment of Anatomical Relationship Between Papillary Muscle and Coronary Veins by Multi-detector Computed Tomography

Background:

Anatomical relationship between left ventricular (LV) pacing site and papillary muscle (PM) may have a major influence on the improvement of mitral regurgitation (MR) in cardiac resynchronization therapy (CRT). However, little has been reported on this anatomical relationship.

Methods:

We studied 31 patients by MDCT. Among these patients, 15 patients were low ejection fraction (EF) patients, and other patients were preserved EF patients. We measured the angle between papillary muscle and coronary veins (left vein and posterolateral vein) in axial cross section of papillary muscle level (Ang.1). Furthermore, we measured the angle between the anterior edge of LV free wall and anterior papillary muscle (Ang.2).

Results:

In all patients, left ventricle runs between anterior papillary muscle and posterior papillary muscle. Ang.1 of left ventricle are 19.7±8.8 degree in low EF patients and 27.6±12.8 degree in preserved EF patients (p=0.11). And Ang.1 of posterolateral vein in low EF patients are significantly smaller than that of preserved EF patients (54.5±11.7, 68.7±15.8 degree respectively, p=0.02). Furthermore, Ang.2 were 106±12.2 degree in low EF patients and 87.3±10.7 degree in preserved EF patients (p=0.01).

Conclusions: This study suggests that anterior papillary muscle tends to be located on more posterior wall in low EF patients. This may be one of the reasons that CRT effect is greater when LV lead was implanted in posterolateral vein than in anterolateral vein.
Assessment of Myocardial Perfusion and Wall Motion Abnormalities During Adenosine Stress Multi-detector Computed Tomography Perfusion Imaging

Caterina Silvi, Richard T. George, Marco AC Cordeiro, Joao A.C. Lima, Albert C. Lardo, Johns Hopkins University, Baltimore, MD

Background: The purpose of this study is to determine if the severity of wall motion abnormalities observed during adenosine augmented multi-detector computed tomography (MDCT) perfusion imaging correlate with myocardial perfusion in a dog model of left anterior descending artery (LAD) stenosis.

Methods: Nine dogs were prepared with an LAD stenosis using an open chest model. Contrast enhanced 32 X 0.5 mm MDCT with segmented reconstruction was performed 5 minutes into adenosine infusion (0.14-0.21 mg/kg/min). Based on a 16 segment model we graded wall motion with a global wall motion score index (WMSI) (0-normokinetic, 1-hypokinetic, and 2-akinetic) and the transmural extent of perfusion using a global perfusion index (PI) (0-normal, 1-subendocardial, 2-transmural perfusion defect) of the entire left ventricular myocardium. Wall thickening (WT) was computed as a percentage of the end diastolic wall thickness.

Results: Global functional parameters were: the ejection fraction 30±15%, end-diastolic volume 92±18ml, and end-systolic volume 65±22ml. All sectors were analyzable in all animals. Mean WMSI was 1.25±0.58 and average WT 21±10%. There was a strong correlation between WMSI and PI (r = 0.86, p = 0.003) as well as WT (r = -0.76, p = 0.017) (Figure). Conclusions: During adenosine stress MDCT perfusion imaging, wall motion and wall thickening correlate well with the transmural extent of myocardial perfusion.

Comparison of Atherosclerotic Plaque Characteristics by IVUS and Multislice CT

Sadako Mohyama, Takeshi Kondo, Hirofumi Arno, Masayoshi Sarai, Kaoru Inoue, Keita Hishida, Jagat Narula, Fujita Health University, Toyoake, Japan, University of California, Irvine, California

Background: Multi-slice computed tomography (MSCT) is being proposed as a noninvasive tool for the detection of atherosclerotic plaque characteristics. The correlation between intravascular ultrasound (IVUS) characteristics of plaques and 1mm-slice CT density has been reported earlier, wherein partial volume effect rendered CT evaluation of small coronary plaques less accurate. Because 0.5mm-slice CT has now become obtained in Hounsfield units [HU]; the HU density of coronary lumen was also noted. Stratifed as soft, fibrous, calcific based on IVUS echogenity. MSCT plaque density was obtained in Hounsfeld units [HU]; the HU density of coronary lumen was also noted.

Methods: The plaques, by IVUS, were classified as soft (n=18), fibrous (n=40) and calcified (n=40). Based on the IVUS data, 331 small ROIs were evaluated for MSCT plaque density has been reported earlier, wherein partial volume effect rendered CT evaluation of small coronary plaques less accurate. Because 0.5mm-slice CT has now become obtained in Hounsfeld units [HU]; the HU density of coronary lumen was also noted. Stratifed as soft, fibrous, calcific based on IVUS echogenity. MSCT plaque density was obtained in Hounsfeld units [HU]; the HU density of coronary lumen was also noted.

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Compared to 10-12%, undergoing SPECT (p=0.02). Of these 10 patients 9 demonstrated septal perfusion abnormalities. MCE demonstrated normal perfusion in all these 10 patients. Amongst the 2D echocardiography parameters assessed only interventricular septal wall thickness was significantly correlated to those without (1.15cm±0.23). There was no significant difference in posterior wall thickness, LVEF and left ventricular volumes between those with or without perfusion defects.

Conclusions: SPECT perfusion abnormalities are common in patients with LBBB without CAD in absence of true myocardial perfusion defects as assessed by MCE. The likely explanation of this defect appears to be a partial volume effect.

ORAL CONTRIBUTIONS

Contrast Echocardiography: Part I

Monday, March 13, 2006, 4:00 p.m.-5:00 p.m.
Georgia World Congress Center, Room B312

Reduced Septal Wall Thickness not Hypoperfusion is the Cause of Perfusion Defects on Single Photon Emission Computed Tomography in Patients With Left Bundle Branch Block Without Coronary Artery Disease: Comparison With Myocardial Contrast Echocardiography

Sajad A. Hayat, Ghirsh Devedi, Tiong Kong Lim, Alexander N. Jacobsen, Roxy Senior, Northwick Park Hospital, Harrow, United Kingdom

Background: Complete Left Bundle Branch Block (LBBB) may be associated with organic heart disorders including ischemic heart disease. Perfusion abnormalities have been noted to occur both at rest and during vasodilator stress on single photon emission computed tomography (SPECT) even in the absence of flow limiting coronary artery disease (CAD). The mechanism underlying this remains unclear. We hypothesised that the likely mechanism of such defects could be due to partial-volume effect rather than true myocardial perfusion abnormalities.

Methods: Accordingly 24 patients (mean age 66±8yrs, mean LVEF 43±18%) with LBBB and no evidence of flow limiting CAD on coronary arteriography underwent 2D echocardiography, and simultaneous vasodilator stress myocardial contrast echocardiography (MCE). Patients were assessed for left ventricular volumes (systolic and diastolic), left ventricular ejection fraction (LVEF), and left ventricular wall thickness (septal and posterior walls) on 2D echocardiography. Myocardial perfusion was assessed by MCE using a destruction-replenishment low power technique during Sonovue infusion. Perfusion defects, both at rest and stress, were scored by independent blinded observers on a matching 17 segment left ventricular model for both imaging modalities.

Results: Of the 24 patients only 1 demonstrated a perfusion abnormality on MCE compared to 10-12%, undergoing SPECT (p=0.02). Of these 10 patients 9 demonstrated septal perfusion abnormalities. MCE demonstrated normal perfusion in all these 10 patients. Amongst the 2D echocardiography parameters assessed only interventricular septal wall thickness was significantly correlated to those without (1.15cm±0.23). There was no significant difference in posterior wall thickness, LVEF and left ventricular volumes between those with or without perfusion defects.

Conclusions: SPECT perfusion abnormalities are common in patients with LBBB without CAD in absence of true myocardial perfusion defects as assessed by MCE. The likely explanation of this defect appears to be a partial volume effect.
Effect Of Coronary Stenosis On Adjacent Bed Microvascular Flow Reserve: Assessment Using Myocardial Contrast Echocardiography

John Papale, Enkeong Lu, Joan Grettom, David Fischer, Rekhi Varghese, Vijay Ramanath, Floirdella Villanueva, University of Pittsburgh, Pittsburgh, PA

Background: During coronary artery stenosis (STN), flow reserve in the adjacent nonstenotic bed decreases. Although coronary steal via collaterals originating from the non-stenotonic artery has been implicated, the microvascular events in the non-stenotic bed which mediate or accompany this phenomenon are ill-defined. Because myocardial contrast echo (MCE) can uniquely assess microvascular physiology, we used it to relate abnormal flow reserve to capillary (CAP) blood volume and red blood cell (RBC) velocity in the perfusion bed of a coronary artery adjacent to a coronary STN.

Methods: In 7 open chest dogs, flow probes were placed on the left anterior descending (LAD) and circumflex (CX) arteries. Mean arterial and distal LAD pressures were measured. Hyperemia (HYPER) was induced with a selective A2A receptor agonist. A non flow limiting LAD STN was created with an occluder (mean resting gradient 17±3 mmHg). MCE was performed using intravenous lipid microbubbles and ECG-triggered ultrasonic imaging. Data were collected at: Baseline; HYPER; HYPER + STN; MCE videointensity in the LAD and CX regions were fit to: (A=1−e−t), where ‘A’ and ‘t’ reflect CAP volume and RBC velocity, respectively, and A = 8 represents flow.

Results: During HYPER without LAD STN, CX probe flow and CX MCE RBC velocity increased relative to baseline (from 28±5 to 116±20 ml/min, p<0.002; and from 0.53±0.05 to 0.96±0.17 sec, p<0.030, respectively); there was no change in MCE CAP volume. Adding LAD STN during HYPER decreased CX probe flow (from 116±20 to 95±14 ml/min, p<0.088), MCE-derived CX bed flow (from 87±16 to 67±17 sec, p<0.03), and RBC velocity (from 0.95±0.17 to 0.65±0.18 sec, p<0.007). CX CAP volume concurrently increased (from 93±9 to 106±9, p<0.05).

Conclusions: Non critical coronary STN impairs flow reserve in the adjacent bed, where RBC velocity decreases and CAP volume increases. Mechanisms underlying the unexpected increase in CAP volume in this setting may involve compensatory recruitment of adjacent bed CAP and/or microvascular collateral networks. Our MCE data suggest that the adjacent microcirculation may actively participate in the regulation of collateral flow and requires further study.

4:24 p.m.
Comparison of a New Submaximal Prognostic Marker to the Duke Treadmill Score

Sweep Y. Tan, Jonathan Myers, Vwiam Abeti, Joshua Abetia, Marcus Sandri, Jose R. Lazaro, Victor Froelicher, Palo Alto Veterans Affairs Health Care System, Palo Alto, CA
Stanford University Hospital, Palo Alto, CA

Background: It is often difficult or dangerous to try to achieve maximal effort in high-risk patients; therefore, a submaximal prognostic marker of similar power to those requiring maximal effort would be clinically useful. We hypothesized that the rate of rise in heart rate with respect to METs (HR slope) would be a useful variable to estimate prognosis in patients referred for exercise testing. To determine if the submaximal HR slope during exercise testing is as prognostic as the Duke Treadmill Score (DTS) for all-cause mortality.

Methods: 1,415 consecutive patients undergoing treadmill testing for clinical reasons at the Palo Alto Veterans Affairs Medical Center from 1997 to 2002 were studied. Heart rate and METs estimated from the ramp work rate were calculated during the first 3 minutes and regressed to calculate the HR slope.

Results: After a mean follow-up of 2.8±1.8 years, there were 110 deaths. Age-adjusted HR slope was both univariately and multivariately predictive of all cause mortality. In a multivariate model, the hazard ratio for the DTS (>4) was 1.8 (95% CI, 1.1-2.9) and the hazard ratio for the HR slope (>30bpm/MET) was 1.7 (95% CI, 1.1-2.6). The HR slope was comparable to the DTS (a well established prognostic marker) in predicting mortality.

Conclusion: Submaximal HR slope during exercise is a comparable predictor to the DTS of all-cause mortality but has the advantage of not requiring maximal effort.

The Prognostic Value of Peak Oxygen Consumption in Men and Women with Severe Systolic Heart Failure

Seetharaman Chandrasekara, Eileen Heich, Eugene H. Blackstone, Michael S. Laufer, Cleveland Clinic Foundation, Cleveland, OH

Background: Although peak oxygen consumption (VO2) during exercise is frequently used to help predict optimal timing for heart transplantation, its prognostic value in women has not been well defined.

Methods: We followed for 5 years 2105 adult systolic heart failure patients, including 525 (25%) women who underwent metabolic stress testing between January 1995 and December 2002. Multivariable proportional hazards modeling related VO2 to survival with adjustments for over 30 confounders and with transplantation considered as a time-dependent covariate.

Results: During follow-up 129 women (26%) died, as did 572 men (36%). There were 175 transplants, including 34 among women. Men and women were similar in age (56 vs. 54 years), but women less likely to have coronary disease (28% vs. 56%), VO2 was strongly predictive of time to death in men (adjusted hazard ratio [HR] for VO2 falling from 15 to 14 ml/kg/min: 1.12, 95% CI 1.08-1.16, P<0.0001) and in women (adjusted HR 1.11, 95% CI 1.05-1.18, P=0.0001). There was no gender interaction (Figure; P=0.80), but for any given VO2, women were at lower risk (adjusted HR for men 2.22, 95% CI 1.58-3.10, P<0.0001). VO2 predicted outcome in women whether or not coronary disease was present, but an interaction was noted between coronary disease, gender, and survival (P for interaction <0.01).

Conclusions: In patients on beta-blocker referred for stress echocardiography, HR is an effective measure of chronic incompetence and superior to 85% MPHR. A low HR was a predictor of cardiac events even after controlling for chronic stress EKG, echocardiographic myocardial ischemia and LV dysfunction and better than 85% MPHR and effectively further risk stratified patients undergoing SE (Figure).
Calculation of Pulmonary Vascular Resistance Reclassifies Patients Identified as Having Pulmonary Hypertension in Routine Echocardiography

Kimberly C. Bartmess, Malcolm Burgess, Terri Baglin, Thomas H. Marwick, University of Queensland, Brisbane, Australia

Calculation of Pulmonary Vascular Resistance Reclassifies Patients Identified as Having Pulmonary Hypertension in Routine Echocardiography.

Background. Doppler estimation of pulmonary systolic pressure (PASP) from tricuspid regurgitation velocity (TRV) is a simple approach to pulmonary hypertension (PH) screening, but may be influenced by RV stroke volume. Pulmonary vascular resistance (PVR) calculation from Doppler has been recently validated by invasive measurements. We sought the clinical utility of incorporating PVR into determination of PH.

Methods. In 578 consecutive pts with TR, we calculated PASP (TRV^2/RAP), and PVR (PVR = TRV^2/RAP). Right atrial pressure (RAP) was estimated from IVC dimensions and collapsibility. PH was classified on the basis of a) PASP (PAS>35mmHg), b) age-based and c) PVR criteria (McQuillan et al., 2005). 26% of pts who were reclassified between methods were assessed.

Results. The most common etiologies for PH were LV dysfunction (37%), mitral or aortic valve disease (25%), and no known etiology (21%). Standard PASP identified PH in 58% vs. 38% of pts, with a sensitivity of 83.2% and a specificity of 80.1% when CV was more than the mean+2SD. Longitudinal dyssynchrony was defined when CV of Err and Ecc were 0.042±0.035 and 0.094±0.044 respectively. Radial or circumferential strain dyssynchrony was defined as hyperenhancement over 50% with a sensitivity of 83.2% and a specificity of 80.1% (cut-off value 19.38%). Circumferential strain was of similar diagnostic accuracy. Referring to these groups radial strain was 27.7±7%, 21.9±10.6%, 18.9±8.3%, 13.6±6.1% and 8.3±6.4%, respectively (p<0.001). Radial strain allowed detection of transmural infarction defined as hyperenhancement over 50% with a sensitivity of 83.2% and a specificity of 80.1% (cut-off value 19.38%). Circumferential strain was of similar diagnostic accuracy.

Conclusions. Frame-to-frame tracking of acoustic markers in 2D echocardiographic images for analysis of myocardial deformation allows accurate discrimination between different transmurality states of myocardial infarction.

Assessment of Longitudinal, Radial and Circumferential Dyssynchrony Using Speckle Tracking and Tissue Doppler in Patients With Systolic Heart Failure and Narrow QRS

Takashi Arita, Maria A. Pennetz, Sharon Howell, Michael F El-Chami, Stamatis Lakeros, Dan Borescu, Stephen D. Clements, Randall P Martin, Emory University, Atlanta, GA

Background: Tissue Doppler echocardiography (TDE) is a method of choice to diagnose mechanical dyssynchrony in patients with systolic dysfunction and wide QRS. There is limited information of about role of TDE in patients with systolic dysfunction and narrow QRS (SD-QRS). We evaluated the degree of dyssynchrony as assessed by radial and circumferential strain (derived from 2D) and peak longitudinal velocity (TDV) in SD-QRS patients.

Methods: B-mode and color tissue Doppler images were obtained by Vivid 7 (GE Vingmed, Norway) on 30 patients with heart failure with low EF(<40%) and narrow QRS(<120ms) and 18 controls with normal EF(>55%) and normal QRS. TDV was determined at 6 midventricular sites by novel speckle-tracking software (GE corp.) applied to routine echo images. Dyssynchrony was defined as the time difference from earliest to latest peak segmental strain.

Results: Control pts had synchronous peak strain 46±30 ms. Wide QRS pts had severely dyssynchronous 398±97 ms (p<0.001 vs. control) characterized by early anteroseptal activation and delayed posterior wall strain. Narrow QRS pts had significantly less dyssynchrony (155±85 ms) than wide QRS pts overall (p<0.001), however 70% had radial dyssynchrony >130 ms and 22% had dyssynchrony >200 ms (p<0.001 vs. control).

Conclusion: Speckle tracking strain imaging demonstrated that radial dyssynchrony exists in the majority of HF pts with narrow QRS, but is less severe overall than in pts with wide QRS and has a different mechanical pattern.
Cardiac CT: Expanding Applications

Tuesday, March 14, 2006, 7:00 a.m.-8:30 a.m.
Georgia World Congress Center, Room B406

7:00 a.m.

Prediction for Stent Underexpansion by Pre-procedural Multidetector Computed Tomography

Taisi Younetu, Tsucharu Kyodo Hospital, Tsucharu, Japan

Background: Inadequate stent expansion has been reported to be a risk factor of restenosis or subacute thrombosis. The aim of this study is to investigate the predictors for stent underexpansion (SU) by multidetector computed tomography (MDCT) performed before coronary intervention (PCI).

Methods: A total of 162 angiographically significant coronary lesions from 127 patients were investigated. PCI procedures were performed with intravascular ultrasound (IVUS) guidance with varying size-up balloon high-pressure post-dilation if needed. Twenty-eight debulked lesions and 15 non-stented were excluded. MDCT measurements included reference diameter (RD), mm, lesion length, and mean CT density of plaque (CTD, HU). Mean CT density was determined from the mean of CT densities obtained from five randomly sampled ROIs inside the plaque. All lesions were divided into three groups of calcified plaque (CTD>150HU), fibrous plaque (80-CTD<150) and soft plaque (CTD<80) by CTD. Lesion eccentricity and degree of calcification were also evaluated by MDCT. After stent implantation, minimal stent area (MSA) and reference lumen area (RLA) were examined by IVUS. Stent underexpansion was defined as MSA less than 80% of the RLA or less than 90% of the RLA if cross-sectional area was <9mm². Predictors for stent underexpansion were identified with univariate logistic analyses.

Results: Thirty lesions (27.7%) of remaining 119 lesions were not evaluable because of insufficient CT image quality, then 86 lesions were analyzed in the present study. Mean MSA was 9.3±2.8mm². SU was observed in 32 lesions (37.6%). In the univariate analysis, significant predictors for SU were small RD (RD<2.5mm, OR 3.42, 95%CI 1.25-9.35) and fibrous plaque (OR 2.57, 95%CI 1.04-6.32) in a calcified plaque, length, heavy calcification and eccentric lesion were not significant predictors (OR = 1.02, 1.62, 2.63, 1.89 respectively).

Conclusions: MDCT performed before PCI is useful for predicting substantial stent deployment. Non-calcified fibrous lesions with small RD in pre-procedural MDCT should be susceptible to stent underexpansion.

7:12 a.m.

Multislice Spiral Computed Tomography for the Evaluation of Stent Patency after Left Main Coronary Artery Stenting: A Comparison with Conventional Coronary Angiography and Intravascular Ultrasound

Van Mieghem Caroos, St., Erasmus MC, Rotterdam, The Netherlands

Background: Surveillance conventional coronary angiography is generally recommended 3 to 6 months after stent-supported left main coronary artery (LMCA) percutaneous coronary intervention due to the unpredictable occurrence of in-stent restenosis, with its attendant risks. Multislice computed tomography (MSCT) is a promising technique for non-invasive coronary evaluation. We evaluated the diagnostic performance of high-resolution MSCT to detect in-stent restenosis after stenting of the LMCA.

Methods: Fifty-six patients were prospectively identified from a consecutive patient population scheduled for follow-up coronary angiography after LMCA stenting and underwent MSCT before conventional angiography. Until August 2004 a 16-slice MSCT (n=28), and since then a 64-slice MSCT (n=28), was used.

Results: Sixty-four percent of patients received additional i-blockers resulting in a mean peri-scan heart rate of 57±8 beats/min. Among patients with technically adequate scans (n=53) MSCT correctly identified all patients with in-stent restenosis (7/53), but misclassified 4 patients without in-stent restenosis (false positives). The overall accuracy of MSCT for detection of angiographic restenosis was 92%. The sensitivity and specificity was 100% and 91%, respectively. Accuracy was 97% when restricting the analysis to patients with stenting of the LMCA stem alone or where the stent extended into a single major side branch. Where both branches of the LMCA bifurcation were stented, accuracy was reduced to 84%.

Conclusions: Current MSCT technology, in combination with optimal heart rate control, allows reliable evaluation of selected patients after LMCA stenting. Non-invasive evaluation with MSCT as a first-line strategy to detect in-stent restenosis is a feasible alternative to conventional angiography.

7:24 a.m.

Comparison of 64-Slice Computed Tomography and Transthoracic Echocardiography in Quantification of Native Aortic Valve Stenosis

Michel Habis, Beatrice Dasoud, Said Ghoutie, Christophe Caussin, Marie Laure Bourschot, Fodli Hadjia, David Pesenti Rossi, Stephane Silberman, Ramzi Ramadan, Alexandre Azaoun, Remi Notin, Bernard Lancelin, Jean Francois Paul, Centre Chronique Marie Lannelongue, Le Plessis Robinson, France

Background-Aim of the study: To compare planimetry of aortic stenosis (AS) by 64 slice computed tomography (CT) and continuity equation transthoracic echocardiography (TTE).

Methods: Our population included 48 patients with pure aortic and 2 patients with aortic and mitral stenosis evaluated before a potential cardiac surgery. AS area was quantified by the continuity equation. Planimetry of aortic valve was performed on systolic phase using 3 mm thick reformatted images in a plane perpendicular to the aortic root, crossing at the level of the leaflets and commissures. Aortic valve area was drawn manually by two experienced observers blinded to each other and to TTE data. We excluded patients in NYHA class IV, those with iodine allergy, renal impairment and dynamic sub aortic gradient. Both evaluations were made within 15 days.

Results: Patients had sinus rhythm (43), atrial fibrillation (5) or pace maker (2). Correlation between both techniques was good (R=0.79) and excellent between the two CT observers (R=0.92). Compared to echocardiography sensitivity, specificity, positive and negative predictive value of CT for the diagnosis of a significant AS (<1 cm²) were 87.5%, 90%, 94.5% and 69% respectively. CT was able to detect two bicuspid aortic valves and correctly measured the area of 4 patients with an ejection fraction below 30%.

Conclusions: 64 slice computed tomography is a promising method for quantification of aortic valve stenosis compared to the reference method (TTE).

7:36 a.m.

Pathological Analysis of the Culprit Lesions with Unique Intra Plaque Enhancement in Multislice Computed Tomography

Asami Suzuki, Tsunekeiakama, Shigeki Kimura, Taishi Younetu, Shingo Maeda, Hidomi Fujikawa, Cardiovascular Center, Tsucharu Kyodo Hospital, Tsucharu, Japan, Tokyo Medical and Dental University, Tokyo, Japan

Background: Unique appearance of intra-plaque enhancement (IPE) in multislice computed tomography (MSCT) is sometimes observed in diseased coronary arteries. No pathological assessment has been reported regarding this MSCT finding. The aim of this study is to determine the histological characteristics of IPE.

Methods: We studied 17 significantly stenotic coronary lesions with IPE in pre-PCI 16-slice MSCT, and 6 lesions without IPE. IPE was defined as an enhanced high CT density area located at epicardial side of coronary plaque with non-enhanced plaque of low CT density at luminal side in cross-sectional MSCT images. All lesions were treated with directional coronary arteriotomy before stenting. DCA samples were stained with HE and following immunohistochemical methods: CD68 against macrophages, CD36 against glycoprotein A (a protein specific to erythrocye membranes), and compared between IPE(+) and IPE(-) groups.

Results: Macrophage infiltrations were detected significantly more frequent in IPE(+) samples than in IPE(-) samples (P<0.05). Frequencies of rich cholesterol crystals and microcalcium deposits tended to be higher in IPE(+) lesions. Immunohistochemical staining showed no significant differences between the two groups in the present study. However, glycoporin A tended to be higher in IPE(+) lesions.

Conclusions:IPE appearance may be related with progressing atherosclerosis with macrophage infiltrations, and indicate the presence of high risk vulnerable plaques. Outer plaque enhancement in IPE(+) lesions might be a supportive evidence of intraplaque hemorrhage in vulnerable plaque.

7:48 a.m.

MSCT and MRI for the Assessment of Reperfused Acute Myocardial Infarction

Timo Baas, Filippo Cadamartiri Cadamartiri, Amber Moelker, Bob Meijboom, Robert-Jan van Geuns, Dirk Duncker, Pim de Feyter, Erasmus MC, Rotterdam, The Netherlands

Background: The diagnostic value of delayed enhancement Multislice Computed Tomography (DE-MSCT) for the assessment of acute reperfused myocardial infarction is currently unclear. We evaluated the accuracy of in-vivo DE-MSCT and delayed enhancement Magnetic Resonance Imaging (DE-MRI) for the assessment of acute reperfused myocardial infarct size and used post-mortem histochromy as standard of reference.

Methods: In 10 domestic swine (25-30kg), the circumflex coronary artery was balloon occluded for 2 hours followed by complete reperfusion. At 5 days, DE-MRI (1.5 Tesla) was performed 15 minutes after administration of 0.2 mmol/kg gadolinium-DTPA using an inversion recovery gradient echo technique. Within 2 hours of DE-MRI, DE-MSCT (64-slice) was performed 15 minutes after administration of 1 g/kg of iodinated contrast material. One day following imaging, all heart were excised, sectioned in 8 mm short axis slices and stained with triphenyltetrazonium chloride (TTC). Infarct size was defined as the...
Noninvasive Detection of Coronary Artery Disease in Patients With Left Bundle Branch Block Using 64-Slice Computed Tomography

Said Ghostine, Christophe Caussin, Beatrice Ducud, Michel Habib, Eric Perrier, David Pisetti Rossi, Anne Sigal Cinqualbre, Bernard Lancelin, Mostan Granihi, Stephane Silbernan, Jean Francois Paul, Marie Lannelongue Hospital, Le Plessis Robinson, France

Background: Presence of left bundle branch block (LBBB) is an important independent predictor of cardiovascular mortality during long-term follow-up in patients with chronic coronary artery disease (CAD). The identification of CAD in patients with LBBB is primordial to stratify the risk and manage the therapy. Non-invasive methods have poor sensitivity and specificity and conventional coronary angiography (CCA) is usually required to confirm diagnosis. The aim of this study was to evaluate 64-slice computed tomography (CT) for the detection of CAD in patients with complete LBBB.

Methods: Fifty-two consecutive patients with complete LBBB admitted for CCA were enrolled in the study. We excluded patients in arrhythmia, those with severe renal failure or with a presentation of acute coronary syndrome. The accuracy of 64-slice CT to detect significant stenosis was evaluated regarding quantitative coronary angiography (QCA) as the standard of reference (mean diameter narrowing >50%). The American Heart Association 15-segment model was used. CT was performed 24 hours before CCA.

Results: Of all patients studied, 49/52 (94%) were correctly diagnosed with CT. CAD was detected in twenty-six patients (50%). Among 780 segments analyzed, a total of 72 significant lesions were assessed by QCA. The 64-slice CT correctly detected 51 lesions. Twenty-one lesions were missed or incorrectly understimated (primarily in the distal circumflex and right coronary arteries). All lesions on the left main or proximal coronary segments were correctly identified by CT. Sensitivity, specificity, positive predictive value and negative predictive value to detect significant stenosis were respectively 71%, 99%, 91% and 97%.

Conclusions: Sixty-four-slice CT permits reliable non-invasive detection of CAD in patients with complete LBBB and in sinus rhythm.

8:00 a.m.
Prevalence of Recognized and Unrecognized Myocardial Infarction: The ICELAND MI Substudy to the AGES-Reykjavik Study

Andrew E. Ang, Jie J. Cao, Sigurdur Sigurdsson, Torfi Jonasson, Pamela Vincent, Peter Kellman, Anthony H. Aletras, Thor Aspefeldt, Guðmundur Thorgeirsson, Lenore Launer, Gudny Eiriksdottir, Tamara Harris, Vímaldur Guðnason, National Institutes of Health, Bethesda, MD, Icelandic Heart Association, Reykjavik, Iceland

Background: The National Institute on Aging and the Icelandic Heart Association are characterizing approximately 6000 persons aged 67 to 96 in the Age, Gene/Environment Susceptibility Study (AGES-Reykjavik Study). For the ICELAND MI ancillary study to AGES-RE, we hypothesized that the prevalence of unrecognized myocardial infarction (MI) is high in an elderly cohort and more MI will be detectable with gadolinium enhanced MRI than by ECG or clinical criteria.

Methods: A random sample of 458 participants enrolled in AGES-RE underwent cardiac MRI (CMR) at 1.5T. A steady state free precession cine MRI was used to measure myocardial mass, LV volumes, and LV ejection fraction. Gadolinium enhanced inversion recovery MRI was performed to detect MI. Strict criteria and consensus of two cardiologists was used to diagnose myocardial infarction and exclude atypical delayed enhancement. Minnesota Codes were used to detect O-wave MI by ECG. Recognized MI was defined by hospital records and the MONICA registry.

Results: Of the 458 participants, gadolinium enhanced CMR quality was good or excellent in 87%, fair in 11%, non-diagnostic 0.4%, and not done in 2%. There were no complications. Thus, results were summarized for 447 subjects. Participants averaged 77±5 years, 54% were female, and 16% had a history of CABG or PCI. From hospital records and the MONICA registry, 42 subjects (9.4%) had known MI. By ECG at the time of the study, only 30 subjects (6.7%) met Minnesota Codes diagnostic for MI in the entire cohort. Combined, 62 subjects (13.9%) had MI identified by hospital records, MONICA criteria, or ECG. The prevalence of MI by gadolinium enhanced MRI was 97 (21.7%; 95% confidence limits 18-27%) and was greater than that determined by ECG (p<0.001) and vs clinically recognized MI (p<0.001). Accounting for overlap in criteria, the MRI determined prevalence of unrecognized MI was 12.5%.

Conclusions: The high prevalence of unrecognized MI led to a substantially higher overall prevalence of MI (21.7%) that predicted from the literature, even taking into account the age of the participants. MRI was substantially more sensitive in detecting MI than the ECG and/or clinical criteria.

Delayed Contrast Enhancement on Cardiac Magnetic Resonance Imaging in Patients with Pulmonary Hypertension

Javier Sanchez, Santo Dellegrottaglie, Mbabazi Karisa, Francesco Paneri, Maria Bastos, Rossana Silvia, Valentin Fuster, Sanjay Rajagopalan, Mount Sinai Medical Center, New York, NY

Background: Delayed hyper-enhancement (DH) of the myocardium with cardiac magnetic resonance imaging (CMRI) is usually seen in conditions associated with scarring or fibrosis. DH involving the interventricular septum at the right ventricular insertion points is observed in conditions associated with mechanical stress at these locations. The aim of this study was to define prevalence, severity and hemodynamic correlates of DH in the insertion point region in pulmonary hypertension (PH).

Methods: The study included 38 subjects (mean age, 51±14 years; 76% females) with known or suspected PH who underwent right heart catheterization and CMRI the same day. CMRI included short-axis images of the left ventricle 10 minutes post gadolinium-dTPA (0.125 mmol/kg) using a segmented inversion recovery sequence with inversion time set individually to null normal myocardium. DH involvement was described semi-quantitatively due to the focal nature of involvement: 0=no DH, 1=DH limited to the insertion points; 2=DH extending into the contiguous septum. A final score (Insertion Enhancement Score [IES]; range, 0-4) was obtained by adding the points assigned to each insertion point (anterior and posterior).

Results: PH [mean pulmonary artery pressure (PAP) >25 mmHg] was confirmed in 30 patients. Overall, significantly higher mean values of IES were obtained in PH patients compared with those without PH (2.9±1.1 vs. 0.8±1.4, respectively, p<0.003). CMR revealed DH involving the insertion point (IES≥1) in 29 (97%) patients with PH versus 2 subjects (25%) without PH (p<0.001). Ten (33%) PH patients presented diffuse involvement (IES=4). Only in 3 (10%) subjects (2 with prior myocardial infarction and 1 with sarcoidosis) DH was noted in additional locations. Spearman analysis revealed a significant correlation of the IES score with mean PAP (r=0.51, p<0.001) and systolic PAP (r=0.51, p=0.001). An IES≥2 identified the presence of PH with sensitivity and specificity of 94% and 86%, respectively.

Conclusions: DH involvement of the right ventricular insertion point to the interventricular septum represents a common finding in PH. The extent of DH in this region is directly related to the severity of PH.
### 991-31

**Three-Dimensional Echocardiographic Indices of Left Ventricular Dysynchrony: Normal Values**

Ebere O. Chukwu, Aasha S. Gopal, Michael L. Friedman, Rena S. Toolu, Nathaniel Rechek, St. Francis Hospital, Roslyn, NY; Stony Brook University, Stony Brook, NY

**Background:** CRT therapy criteria have been based on QRS width and on dysynchrony indices derived from tissue Doppler imaging based on longitudinal myocardial velocities. 3D echo (3DE) provides both global and regional time-to-minimum systolic volume (TMSV) in ms and its standard deviation or dysynchrony index (DI) and may serve as an attractive alternative. However, TMSV and DI have not been well defined in normal subjects.

**Methods:** 50 normal subjects were screened by physical exam, questionnaire and 2DE. They underwent 3DE (Philips) and data sets were processed to automatically generate global and regional volumes over the full cardiac cycle. Global TMSV, DI, mean regional TMSV and differences between opposing segments were determined. The values were compared after combining the corresponding basal and mid-segments.

**Results:** Global DI for all 16 segments was 16.10 ± 6.79 ms. Two-way ANOVA detected significant differences among the mean TMSVs of the regional segments (p < 0.0001) when examined individually. When corresponding basal and mid-regional segments were combined, there was no significant differences between the mean TMSVs of the anteroseptal and anterior segments by ANOVA.

<table>
<thead>
<tr>
<th>Global</th>
<th>Mean Tmsv (ms)</th>
<th>SD(ms)</th>
<th>2SD(mean)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Base-Mid</td>
<td>16.10</td>
<td>7.75</td>
<td>13.50</td>
</tr>
<tr>
<td>Seg</td>
<td></td>
<td></td>
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<td></td>
<td>Anterior</td>
<td>Superior</td>
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<tr>
<td>Base</td>
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<tr>
<td></td>
<td>Anterior</td>
<td>Superior</td>
<td>Posterior</td>
</tr>
<tr>
<td>Mid</td>
<td>14.28</td>
<td>11.97</td>
<td>26.28</td>
</tr>
<tr>
<td>Seg</td>
<td></td>
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<td></td>
<td>Anterior</td>
<td>Superior</td>
<td>Posterior</td>
</tr>
<tr>
<td>Mid-Sep</td>
<td>15.86</td>
<td>11.67</td>
<td>27.53</td>
</tr>
<tr>
<td>Opp diff</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>11.77</td>
<td>13.06</td>
<td>24.83</td>
</tr>
</tbody>
</table>

**Apex**

- Seg: Anterior, Inferior, Anterior + Inferior, Lateral + Superior
- Mean Tmsv: 19.03 ± 3.47 ms
- SD(ms): 7.65 ± 0.63 ms
- Opp diff: 9.59 ± 4.79 ms

**Conclusions:** 1) 3D global DI of 30 ms exceeds 2 standard deviations from the mean value found in normal subjects and should be classified as abnormal. 2) Differences among regional TMSVs are noted even in normal subjects, that may reflect nonuniform performance of the automatic boundary tracking algorithm.

### 991-32

**Three-Dimensional Imaging Surpasses Conventional Transesophageal Echocardiography for Preoperative Conceptualization in Mitral Valve Prolapse**

Silvana Müller, Ludwig Müller, Matthias Frick, Hannes Abler, Wolfgang Dichtl, Günther Lauffer, Olmar Pachinger, Thomas Bartes, Medical University Innsbruck, Innsbruck, Austria

**Background:** Transesophageal echocardiography (TEE) is not optimal to specify mitral valve prolapse. This study was conducted to compare the diagnostic values of TEE and three-dimensional image reconstruction (3DRI) in the Assessment of Carpentier type II mitral valve lesions.

**Methods:** In 74 patients (mean age 59 ± 13 years) with mitral regurgitation due to type II valve dysfunction, TEE and 3DRI were performed and analyzed by 2 experts prior to CRT therapy criteria have been based on QRS width and on dysynchrony indices derived from tissue Doppler imaging based on longitudinal myocardial velocities. 3D echo (3DE) provides both global and regional time-to-minimum systolic volume (TMSV) in ms and its standard deviation or dysynchrony index (DI) and may serve as an attractive alternative. However, TMSV and DI have not been well defined in normal subjects. Method: 50 normal subjects were screened by physical exam, questionnaire and 2DE. They underwent 3DE (Philips) and data sets were processed to automatically generate global and regional volumes over the full cardiac cycle. Global TMSV, DI, mean regional TMSV and differences between opposing segments were determined. The values were compared after combining the corresponding basal and mid-segments.

**Results:** Global DI for all 16 segments was 16.10 ± 6.79 ms. Two-way ANOVA detected significant differences among the mean TMSVs of the regional segments (F=58.2, p<0.0001) when examined individually. When corresponding basal and mid-regional segments were combined, there was no significant differences between the mean TMSVs of the anteroseptal and anterior segments by ANOVA.

<table>
<thead>
<tr>
<th>Global</th>
<th>Mean Tmsv (ms)</th>
<th>SD(ms)</th>
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</tr>
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**Conclusions:** 1) 3D global DI of 30 ms exceeds 2 standard deviations from the mean value found in normal subjects and should be classified as abnormal. 2) Differences among regional TMSVs are noted even in normal subjects, that may reflect nonuniform performance of the automatic boundary tracking algorithm.
Parameters of Cardiac Dyssynchrony Can Predict Chronic Phase Cardiac Function After Acute Myocardial Infarction: A Real-Time 3D Echocardiography Study

Nobuyuki Masaki, Yoshidei Maruyama, Kentaro Toyama, Masato Kimura, Osamu Sasaki, Yoshihiko Nishina, Hirokazu Ito, Yoshihiko Hada, Nobuo Yoshimoto, Satama Medical Center, Saitama, Japan

Objectives: To investigate whether acute phase parameters of dyssynchrony from real-time 3D echocardiography (RT-3D) predict the chronic phase cardiac function of AMI patients or not.

Methods: Forty-three AMI patients underwent RT-3D within 2 weeks from the admission and 6-month later using SONOS 7500. Left ventricular (LV) volumes were derived from RT-3D by offline method using a semiautomatic contour tracing system; TomTec/4DV analysis™ (TomTec, Munich, Germany). Systolic timing dispersion index (SDI) is defined as standard deviation of peak systolic phases in 16 cardiac segments. Systolic timing dispersion index (SDI) is defined as the difference between the global and the most delayed systolic phase in the 16 segments. Delta EF is the increasing rate of ejection fraction as a function of acute phase (EF-acute EF)/acute EF*100(%).

Results: There were positive correlation between SDI and delta EF (r = 0.846 p = 0.0001), and between SDI and delta EF (r = 0.688 p = 0.0001). Moreover, the increase in SDI and SDI were negatively correlated to delta EF (r = 0.715 p < 0.0001, r = 0.784 p < 0.0001, respectively). The correlation implies that EF improved when the acute phase left ventricular dyssynchrony decreased. Acute EF was also related to delta EF (r = 0.577 p < 0.0001). However, in multiple regression analysis, each of SDI, SDI was a significant predictor for delta EF (% standard deviation regression coefficient) (r value: SDI 0.879, 0.749, p<0.0001, SDI 0.879, 0.789, p<0.001, respectively). Acute EF was not a significant predictor in the analysis.

Conclusions: Suggestively, cardiac dyssynchrony after AMI is a rather good sign for recovery of cardiac function. The dyssynchrony parameters derived from RT-3D is useful to predict improvement of cardiac function.

3D Contraction Front Mapping: Initial Experience With a Novel 3D Echo Technique to Visualise Left Ventricular Mechanical Contraction

Iam Kapetanakis, Emily Ho, Stuart P. Turner, Mark T. Keamery, Mark J. Monaghan, King's College Hospital, London, United Kingdom, Iam Kapetanakis

Introduction: Contraction Front Mapping (CFM), a novel modality to combine temporal and spatial visualization of the contraction of the LV.

Methods: 20 patients were investigated on clinical grounds (65% male), 16 patients had LV dysfunction, of which 9 had left bundle branch block on Echo and one had a permanent pacemaker (PPM). Of the 4 patients with normal function, 1 had a PPM. CFM was derived by representing the myocardium that reaches peak contraction every 25 milliseconds, using a bull's-eye display of the LV, based on RT-3D.

Results: In 6 of the 9 patients with LBBB, a U-shaped contraction wave was noted, with maximum delay in the postero-lateral region. In 1 patient, a similar pattern was noted at the antero-septal region, while 2 patients had homogenous activation of the LV. In the 6 with normal conduction and LVF, 3 had homogenous conduction, while 1 had antero-apical delay (antero ML) and 2 had U-shaped activation, with delay in the postero-septal region. Pacing induced early activation of the septal region. There was homogenous contraction in those with normal function.

Conclusions: Contraction Front Mapping is a robust tool for non-invasive visualisation of spatial and temporal distribution of LVMY. In keeping with other studies utilising invasive mapping of LV electrical activation, LBBB activation is variable, while abnormal contraction patterns are seen even in patient with normal QRS morphology. This may be valuable in patient selection for CRT.
Diagnostic Testing

140A ABSTRACTS - Diagnostic Testing

Results: Transthoracic closure was performed successfully in 94% under echocardiography and fluoroscopy guidance. RT-3D provided superior views for ASDs and the spatial relationship between ASD and adjacent structures. The maximal diameter measured 23.5 ± 10.7 mm (range 10-36mm) by RT-3D, 21.8 ± 10.5 mm (range 9-34mm) by 2-DE, and 24.6 ± 11.3 mm (range 12-38mm) by transesophageal balloon method. Comparing with BSD, there was a good correlation (r = 0.94, y = 1.75 + 0.92x, p<0.01) between RT-3D measurements and BSD and a modest correlation between 2-DE and BSD (r = 0.82, y = 2.17 + 0.84x, p<0.05). Both RT-3D and 2-DE underestimated BSD but the 2-DE measurements were more pronounced.

Conclusions: Our study suggests that RT-3D provides a superior visualization of ASD and adjacent structures. RT-3D assessment of the ASD size correlates well with the BSD and is superior to 2-DE measurements. The new RT-3D technology provides a useful clinical tool for rapid and accurate assessment of ASD to aid transcatheter closure.

991-44 Noninvasive Assessment of Coronary Vasodilating Capacity Using Freehand 3D Echocardiography With Rotational Scanning

Ho-Joon Youn, Yun-Seok Choi, Dong-Hyun Lee, Ji-Hoon Kim, Sang-Hyun Lim, Chul-Soo Park, Jong-Min Lee, Yong-Soo Oh, Eun-Ju Cho, Hae-Ok Jung, Hui-kyung Jeon, Wook-Sung Chung, Jae-Hyung Kim, Kyu-Bo Choi, Soon-Jo Hong, The Catholic University of Korea, Seoul, South Korea

Background: The aim of this study was to investigate the use of free-hand 3D echocardiography (3DE) with rotational geometry for assessing epicardial coronary artery vasodilation.

Methods: 29 subjects (age 51±12 years, M/F=14:15, Control group) with normal coronary angiogram and 16 patients with multivessel CAD(age 62±12 years, M/F=9:7, CAD group) were studied. After obtaining the tubular color flow signals of distal left anterior descending coronary artery (LAD) using an ultra-band transducer (5-12 MHz), the peak(PDV), mean diastolic velocity (MDV) and velocity time integral(VTI) were measured before and after sublingual nitroglycerin (NTG) (0.3 mg) in all subjects, using a 3DE unit with magnetic tracking system (TomTec Imaging Systems) linked to the conventional 2D ultrasound system(Sonos 7500) 3DE image acquisition and reconstruction of the distal LAD flow was performed. Quantitative analysis of coronary vasodilation was performed on 3D cross-sectional images (Fig).

Results: 1. The LAD diameter on coronary 3DE increased from 2.28±0.79mm to 3.32±0.77mm (54.3±29.6%) in Control group and from 2.36±0.65mm to 2.89±0.81mm (23.7±23.9%) in CAD group after NTG (p<0.005 versus Control group) 2. The magnitude of vasodilation correlated with the % change of PDV (r=0.516, p<0.005), MDV (r=0.519, p<0.005) and VTI (r=0.392, p=0.008).

Conclusions: The 3D reconstruction of the distal LAD flow using free-hand 3DE is a promising noninvasive technique to study coronary vasomotor function.

991-45 The Accuracy of Real-time Three-dimensional Doppler Echocardiography for Computing LV Stroke Volume Compared to Phase Contrast Magnetic Resonance Imaging in Patients

James Pemberton, Michael Jerosch-Herold, Anhommeke Kenny, William J. Woodward, Michael Scharbach, Yao Kui Li, David J. Sahn, Oregon Health & Science University, Portland, OR, Freeman Hospital, Newcastle upon Tyne, United Kingdom

Background: We sought to assess the accuracy of real-time 3-dimensional color Doppler echocardiography (RT3DDE) for stroke volume (SV) assessment in adult patients against a gold standard of phase contrast magnetic resonance imaging (PCMRI).

Methods: 12 adult patients and volunteers underwent RT3DDE using a Philips 7500 Sonos Live 3D echo system with a 2-4 MHz xMTRAX™ probe. 3D images incorporating the LVOT and aortic valve (AV) were taken with the Nyquist limit and depth adjusted to maximize the frame rate. The raw DICOM data was analyzed using TomTec EchoView software to give the SV by integrating the 3D color Doppler signal at the level of the AV across the cardiac cycle. Patients underwent PCMRI, using a Philips 3 Tesla MRI system, immediately after the RT3DDE to avoid any change in hemodynamic status. The SV was calculated from the forward flow volume in the proximal ascending aorta. All patients were screened to exclude significant valvular pathology. The results of the PCMRI SV were compared to the RT3DDE derived SV by regression analysis.

Results: There was good correlation between the RT3DDE and the PCMRI methods of SV calculation (y=0.79x + 7.9, r² = 0.83). The RT3DDE method was more accurate compared to standard 2D echo derived SV from the spectral Doppler velocity through the aortic valve along with the valve hinge-point diameter (y=0.72 + 19.7, r² = 0.74).

Conclusions: This study shows that RT3DDE can be used to accurately calculate SV as compared to the gold standard of PCMRI.

991-47 The Role of Contrast-Enhanced Real-Time 3D Stress Echocardiography in Diagnosing Coronary Artery Disease

Constandina Aggeli, Platon Misovoulos, George Roussakis, Christos Kokkinakis, Georginos Giannopoulos, Euaggela Christoforatou, Stella Brili, Christodoulos Stefanadis, Athens University Medical School, Hippokration Hospital, Athens, Greece

Background: Stress echocardiography is a routinely used modality to diagnose coronary artery disease (CAD). Incomplete data and misaligned prestress and poststress views are known limitations of conventional stress echocardiography. We tested the hypothesis that left ventricular wall motion abnormalities during stress echo could be measured more accurately from RT3D data sets, which allow off-line selection of nontorsionspiral apical views, by comparing 2D and RT3D.

Methods: 50 patients (mean age 65±12, 27 men), referred for coronary angiography, underwent dobutamine stress echocardiography with 2D and RT3D echo. A bolus infusion of SonoVue was administered at rest and peak stress to better evaluate wall motion abnormalities. Wall motion score index (WMSI) was calculated for both techniques and regional wall motion score was also calculated for the left ventricular apex. All images were obtained at baseline and peak stress from 4-, 2-, 3-chamber views. 2D and 3D images were interpreted by two expert readers blinded for other data.

Results: 32 patients had CAD. The mean values of WMSI by 2D and RT3D echo were similar at rest but different at peak stress (1.27±0.3 vs. 1.35±0.29, p<0.001). Regional wall motion score at peak was different between 2D and 3D stress echo (1.28±0.4 vs. 1.38±0.3, p=0.001). Analysis by patient revealed overall similar sensitivity, specificity and accuracy for 2D and 3D stress echo (79% vs. 80%, 83% vs. 85% and 82% vs. 84%, respectively). Concordance between the two techniques for normal vs. abnormal perfusion was 87% (k=0.74), whereas discrepancies between them were more notable in the left anterior descending artery territory.

Conclusions: Contrast-enhanced RT3D stress echo is an accurate method to identify coronary artery disease. It has potential benefits for the evaluation of the left ventricular apex, largely eliminating off-axis acquisition errors.

991-48 Does Real Time Three-dimensional Dobutamine Stress Echocardiography Is the Method of Choice in Patients Qualification Towards Severe Ischemic Mitral Regurgitation to Cardiosurgical Treatment?

Janusz Kochanowski, Piotr Sioda, Piotr Suwalski, Danusz Kosior, Rafal Piatkowski, Grzegorz Opolski, Warsaw Medical University, Warsaw, Poland

Background: The aim of study was to evaluate the optimal surgical approach in pts with severe ischemic mitral regurgitation (IMR) based upon real time 3 dimensional dobutamine echocardiography (DSE RT3D) - coronary artery by-pass grafting alone (CABG) or CABG with mitral valve reconstruction(CABGmVr).

Method: Material: 40 pts (M:25, age 62±11) with severe MR assessed by echo 2-8 weeks after AMI. All pts were qualified to CABG due to multiple vessel coronary disease and LV dysfunction (EF<40%, WMSI 1.9±0.5). Control was 40 healthy subject.

Results: There were 32 patients had CAD. The mean values of WMSI by 2D and RT3D echo were similar at rest but different at peak stress (1.27±0.3 vs. 1.35±0.29, p<0.001). Regional wall motion score at peak was different between 2D and 3D stress echo (1.28±0.4 vs. 1.38±0.3, p=0.001). Analysis by patient revealed overall similar sensitivity, specificity and accuracy for 2D and 3D stress echo (79% vs. 80%, 83% vs. 85% and 82% vs. 84%, respectively). Concordance between the two techniques for normal vs. abnormal perfusion was 87% (k=0.74), whereas discrepancies between them were more notable in the left anterior descending artery territory.

Conclusions: Contrast-enhanced RT3D stress echo is an accurate method to identify coronary artery disease. It has potential benefits for the evaluation of the left ventricular apex, largely eliminating off-axis acquisition errors.
and MDI improvement, with non-significant improvement of WMSI during dobutamine infusion in comparison with Gr. I and II was considered as Gr. III (Table 1). Pts from Gr. I and II were offered CABGmr; Gr. III was assigned to CABGa.

After CABGmr (Gr. III) - 4 pts small MR, 3 mild and 0 severe. After CABGa (Gr. I + II) - 25 pts small MR, 8 mild and 0 severe.

**Conclusions:** DSE 3DRT is a precise method to evaluate the exact surgical approach to pts with severe IMR followed AMI assigned to CABG.

### Table 1.

Influence of DSE 3DRT on the mitral valve deformation indexes and WMSI.

<table>
<thead>
<tr>
<th>MDI and WMSI</th>
<th>Control</th>
<th>DASE</th>
<th>Decreased MR</th>
<th>Increased MR</th>
<th>decreased MR</th>
<th>increased MR</th>
</tr>
</thead>
<tbody>
<tr>
<td>No influence</td>
<td>12 pts</td>
<td>7 pts</td>
<td>(Gr. I)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MR</td>
<td>40 pts</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Testing area (cm²)</td>
<td>3.6±1.0</td>
<td>3.6±2.0</td>
<td>3.6±2.0</td>
<td>3.6±1.0</td>
<td>3.6±2.0</td>
<td>3.6±1.0</td>
</tr>
<tr>
<td>Coaptation height (cm)</td>
<td>3.0±1.0</td>
<td>3.0±1.0</td>
<td>3.0±1.0</td>
<td>3.0±1.0</td>
<td>3.0±1.0</td>
<td>3.0±1.0</td>
</tr>
<tr>
<td>Systolic mitral annulus area (cm²)</td>
<td>7.2±1.0</td>
<td>7.2±1.0</td>
<td>7.2±1.0</td>
<td>7.2±1.0</td>
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</tr>
<tr>
<td>WMSI</td>
<td>1.0</td>
<td>1.0±0.5</td>
<td>1.0±0.5</td>
<td>1.0±0.5</td>
<td>1.0±0.5</td>
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</tr>
</tbody>
</table>

### 991-44

**Flow-volume Loops From Three-Dimensional Echocardiography: A Novel Technique for Assessment of Left Ventricular Function and Hemodynamics**

Kambiz Shahgaldi, Emil Sedojnyisz, Ellen Ostenfeld, Reidar Winter, Jacek Nowak, Lars-Ake Brodin, Karolinska University Hospital, Stockholm, Sweden

**Background:** The principle of using flow-volume loops for assessment of function is a new technique in invasive measurement of cardiac function and hemodynamics. It is possible to reconstruct flow-volume loops from three-dimensional (3D) echocardiographic. The first derivative of the volume graph is equal to flow in and out of the left ventricle (LV). Using both volume and flow data it is possible to obtain flow-volume loops of LV hemodynamics.

**Methods:** Apical 3D full volume recordings of ten patients, three controls, three patients with mitral stenosis, and four patients having aortic stenosis, were made using Philips Sonos 7500. The digital 3D data was post processed using the Tomtec software. The global volume graph from this analysis was used for further analyses using our own software only using the true data points. Calculations of the derivative were made, and the results were plotted in a flow-volume loop, displaying LV flow on y-axis, and volume on x-axis.

**Results:** The typical pattern of aortic stenosis shows an inward curve in the graph due to the obstruction from the stenosis during systole, and a smaller volume compared to the normal study subject. A typical feature of the mitral stenosis is the smaller volume/flow ratio without atrial contribution compared to the normal pattern.

**Conclusion - Flow-volume loops obtained from 3D echocardiographic data could be used for differentiating between normal cardiac function and specific hemodynamic situations such as aortic stenosis and mitral stenosis.**

**991-45**

**Measurement of Cardiac Output by Real-Time 3-D Echocardiography in Patients Undergoing Assessment for Cardiac Transplantation**

Stephen P Hooja, James Boyd, Vlasis Ninios, Jayan Parameshwar, Rosemary A. Rusk, Papworth Hospital, Cambridge, United Kingdom

**Background:** Heart transplant assessment includes cardiac output calculation by right heart catheterisation. Real-time 3-D echocardiography (RT3D-E), unlike 2D echocardiography, can measure stroke volume without inaccurate geometrical assumptions. The purpose of this study was to assess the feasibility and accuracy of non-invasive RT3D-E cardiac output calculation.

**Methods:** Thirty consecutive patients referred for transplant assessment underwent transthoracic RT3D-E. Full volume 3D data sets were acquired from apical views with the iE33 ultrasound system (Philips Ultrasound, Bothell, USA). Four patients were excluded due to poor image quality. The remaining 26 patients had end-diastolic (LVEDV) and end-systolic (LVESV) left ventricular volumes manually traced. Cardiac output was subsequently calculated: ([LVEDV-LVESV] x heart rate). Fick derived cardiac outputs, under the same haemodynamic conditions, were used as reference for comparison.

**Results:** There was close correlation between RT3D-E and catheter derived cardiac outputs (r=0.90, y=0.86x+0.47, SEE 0.40 L/min, mean difference from reference 0.01 L/min, SD 0.41 L/min). RT3D-E data analysis took 3 minutes per case.

**Conclusion:** This study shows RT3D-E is an accurate method for calculating cardiac output. In patients requiring serial evaluation of cardiac function, this non-invasive test may be preferable to invasive right heart catheterisation.
Association of High Density Lipoprotein Levels and Carotid Atherosclerotic Plaque Burden and Lipid Content by High-resolution Magnetic Resonance Imaging

Binh An P. Phan, Baoceng Chu, Greg Brown, Thomas S. Hatzusuki, Joshua S. Morse, Chun Yuan, Xue-Qiao Zhao, University of Washington, Seattle, WA

Introduction: A low level of high density lipoprotein (HDL) is an independent risk factor for atherosclerotic disease. HDL-raising therapy is hypothesized to alter plaque composition and therefore improve plaque stability by inducing plaque regression and lipid content reduction. High-resolution magnetic resonance imaging (MRI) can provide detailed information on atherosclerosis and plaque components. We examined the association of HDL levels with carotid plaque burden and tissue composition as identified by MRI.

Methods: 34 patients with CAD and low HDL (<35 mg/dL) who had been receiving simvastatin (10-20 mg/day) plus niacin (2-3 g/day) or placebo for both 3 years in the HDL Atherosclerosis Treatment Study (HATS) were randomly selected to undergo MRI examinations of bilateral carotid arteries with a 1.5T scanner. Their carotid plaques were identified and luminal and wall volumes were measured using a computerized program. Plaque tissue components including lipid deposition, calcium, fibrous tissue, and loose matrix were identified based on signal intensity variation from 4 different MRI weightings (T1W, T2W, time-of-flight, and proton-density) used in previous studies. Each tissue composition was quantitatively measured and calculated as percent of plaque wall volume. All clinical and laboratory data were collected at the time of MRI scans.

Results: Mean wall volume or atherosclerotic plaque burden was inversely associated with HDL levels ($r = -0.39$, $p = 0.02$) and associated with LDL/HDL ratio ($r = 0.41$, $p = 0.01$) and treatment with simvastatin plus niacin ($r = -0.27$, $p = 0.03$). Plaque lipid content was inversely associated with HDL levels ($r = -0.39$, $p = 0.02$). Patients with low HDL levels (<35 mg/dL) had increased atherosclerotic plaque burden (97% $+$ 23% vs 81% $+$ 19% $p = 0.05$) compared to patients with HDL levels equal to or $>$ 35 mg/dL.

Conclusions: Among CAD patients, low HDL levels were significantly associated with increased carotid atherosclerotic plaque burden and lipid content as assessed by MRI. This finding supports the hypothesis that HDL-raising therapy could induce lipid depletion and plaque regression.

The Protection Device Reduced Infarct Size Measured by Serial Contrast Enhancement MRIs in STEMI patients

Jae-Yoon Moon, Young Gui Ko, Young Jin Kim, Sungha Park, Byung Wook Choi, Donghoon Choi, Jong-Won Ha, Yangsoo Jang, Namguk Chung, Won-Heum Shin, Seong-Yun Cho, Cardiovascular Hospital, Yonsei University College of Medicine, Seoul, South Korea

Background: It has been shown that delayed hyperenhancement area of contrast enhanced magnetic resonance imaging (MRI) correlates well with infarct size. The areas of infarction can now be defined noninvasively using MRI. Therefore, we investigated the time course of infarct resection after AMI and examined whether an occlusive balloon during primary PCI resulted in more reduction of delayed hyperenhancement infarct size in MRI follow-up.

Methods: Total 53 consecutive patients with STEMI who underwent PCI were investigated. Patients were classified into three groups: GroupA(n=18, age 54.8±10.9); primary PCI with protection devices within 6 hours from AMI onset. GroupB(n=23, age 56.2±8.6); primary PCI without protection devices within 6 hours from onset. GroupC(n=12, age 63.1±13.3); primary PCI or elective PCI after the initial 6 hours of symptom onset. Gadolinium enhanced MRI was performed 3-7 days after PCI and the thirty two patients examined follow up MRI at 3-4 months. We measured the initial 6 hours of symptom onset. Gadolinium enhanced MRI was performed 3-7 days after PCI and the thirty two patients examined follow up MRI at 3-4 months. We measured the extent of reduction of infarct size in MRI follow-up. Our data suggests that the using protection device during primary PCI is useful in delayed infarct resection, however the clinical importance of infarct reduction in delayed hyperenhancement of follow-up MRI need to be explored.

Increased Heart Rate is Associated with Reduced Regional Myocardial Function in Cardiovascular Asymptomatic Population: The Multi-Ethnic Study of Atherosclerosis

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Background: Increased sympathetic tone has been implicated in causing or triggering cardiovascular disease (CVD). Our purpose was to explore the association between heart rate (HR) and regional left ventricular (LV) function assessed as strain and strain rate (SR) measured by tagged magnetic resonance (MR) in asymptomatic participants of the Multi-Ethnic Study of Atherosclerosis (MESA).

Methods: Peak systolic circumferential strain (ECC) and diastolic SR were calculated from tagged MR harmonic phase analysis in 1100 MESA participants. Multivariate linear regression was performed with ECC or SR as dependent variables and baseline HR adjusting for confounding variables.

Results: Relationships between HR and strain are shown in Table. Linear regression analysis demonstrated that higher HR was associated with reduced ECC in all myocardial regions ($p<0.05$). This relationship was significant before adjustment, as well as after adjusting for age, gender, race, blood pressure (BP), and persisted in all regions (except inferior) after further adjustments (variables described in model 3 Table). In addition, higher HR was also associated with lower diastolic SR in the anterior and septal regions ($p<0.05$).

Conclusions: Higher heart rate is associated with reduced systolic myocardial strain and impaired regional diastolic function, indicating a potential relationship between increased sympathetic activity and impaired myocardial dysfunction in individuals free of clinical CVD.

### Relationship between myocardial strain and heart rate

| Regression Coefficients for Peak Midwall Systolic ECC (%) (95% CI) |
|-----------------------------|-----------------------------|-----------------------------|
| Anterior                     | Left                        | Inferior                    |
| 0.59 (0.34, 0.85)            | 0.53 (0.30, 0.70)            | 0.54 (0.25, 0.82)           |
| 0.33 (0.09, 0.58)            | 0.31 (0.06, 0.56)            | 0.32 (0.04, 0.60)           |
| 0.31 (0.40, 0.60)            | 0.32 (0.03, 0.61)            | 0.07 (0.24, 0.38)           |
| 0.80 (0.54, 1.02)            | 0.78 (0.50, 1.01)            | 0.78 (0.54, 1.05)           |

*p<0.05, tp<0.001

C- Unadjusted

Age, gender, race, systolic and diastolic BP were included in the multiple linear regression models as covariates (model 2)
The Utility of Cardiac Magnetic Resonance in Differentiating Hypertrophic Cardiomyopathy and Cardiac Amyloidosis

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Background: Both hypertrophic cardiomyopathy (HCM) and amyloid cardiomyopathy (AC) can manifest similar phenotypes with left ventricular hypertrophy. As a result, distinguishing between these two distinct clinical entities using traditional imaging techniques, such as 2-D echocardiography, has been challenging. Contemporary cardiovascular magnetic resonance imaging (CMR) techniques provide superior spatial resolution with complete 3-D, tomographic coverage of the entire heart with precise quantification of ventricular volumes and mass. In addition, a delayed enhancement (DE) sequence following intravenous injection of gadolinium-DTPA detects areas of myocardial fibrosis/scarring. Therefore, it is now timely to revisit whether a novel imaging technique such as CMR, will provide unique information to reliably differentiate HCM from AC.

Methods: Patients with nonobstructive HCM (n=13; age 37±15) and those with systemic AL-amyloidosis with cardiac involvement (n=13; age 61±12), were matched for gender, body surface area and maximal LV wall thickness (mean LVWT) (15mm±15; p=0.3) by 2-D echocardiography (echo), and underwent cine CMR with DE (T1DE). The DE studies were evaluated by one investigator blinded to diagnosis and graded according to 3 patterns: normal (no DE); diffuse “hazy” appearance of entire LV DE (myocardium ≥2 SD above the mean signal intensity of skeletal muscle); or focal (discrete) areas of DE.

Results: Although maximal LVWT by echo was similar between the two groups, CMR LVWT was greater in HCM (18mm±15; p=0.004), while total LV mass was significantly greater in AC (220±174g; p=0.001). The left ventricular end diastolic volume (LVEDV) were similar between the groups but the LVEDV/mass ratio (VMR) was significantly higher in HCM and the strongest volumetric parameter in differentiating between the two diseases (1.0±0.7; p<0.0004). Of note, a diffuse DE pattern was predominant in AC (9/13; 69%) and was significantly more commonly in AC than in HCM (3/13; 23%; p<0.01).

Conclusions: Our data show the power of CMR in noninvasively distinguishing HCM from AC by assessment of LV volumes, mass and delayed hyperenhancement pattern.

Different Effects of Rosuvastatin and Simvastatin on Myocardial High-Energy Phosphate Metabolism

Matthias Frick, Gert Kugl, Christian Wolf, Ralf H. Zwick, Michael F. Schcock, Monika Lechtleitner, Werner R. Jaschke, Bernhard Metzler, Innsbruck Medical University, Innsbruck, Austria

Background: In the last decade a variety of non-lipid lowering effects of statins have been described. However, it is unknown whether these pleiotropic effects are different between lipophilic and hydrophylic statins. Therefore we intended to compare the effects of rosuvastatin and simvastatin, which are considered to have different pleiotropic properties.

Methods: Participants with hypercholesterolemia (mean 276±56 mg/dl total cholesterol) were included. Patients were divided into 2 groups in a blinded fashion: group 1 received 10mg rosuvastatin (group 1: 178±31 vs. 95±33 vs. 101±18mg/dl, p=0.002; group 2: 178±31 vs. 95±33 vs. 101±18mg/dl, p=0.002). Lipid profiles were taken on the same time points to determine lipid profiles.

Results: There were no significant differences in lipid profiles between lipophilic and hydrophylic statins which deserves further metabolism despite a comparable lipid-lowering effect. Our data suggest differences between lipophilic and hydrophylic statins. Therefore we intended to compare the effects of rosuvastatin and simvastatin, which are considered to have different pleiotropic properties.

Conclusions: A novel imaging technique such as CMR, will provide unique information to reliably differentiate HCM from AC.

Impact of the Viable Rim and Periprocedural Necrosis on Functional Recovery After Revascularization in Patients With Chronic Ischemic Heart Disease: A Quantitative Delayed Contrast Enhanced MRI Study

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Background: Delayed Contrast Enhanced MRI (DCE) predicts functional recovery after revascularization in patients with chronic ischemic left ventricular (LV) dysfunction. However, functional outcome of segments with intermediate ranges of hyperenhancement is less clear: We sought to optimize the diagnostic accuracy of DCE by taking into account the presence of a significant viable rim and revascularization procedure related necrosis.

Methods: 45 patients with chronic ischemic LV dysfunction underwent cine MRI and DCE 1 month before and 3 months after revascularization. Segmental and global function, scar and presence of a viable rim (>4.5 mm) were quantified using standardized methods and objective thresholds.

Results: 60% of segments without hyperenhancement showed functional improvement at follow-up; no improvement was observed in segments with >75% segmental extent of hyperenhancement (SEH), while segments with 1-25%, 26-50%, and 51-75% SEH were 4, 8, and 20 times less likely to improve (multilevel analysis, p<0.001). Thickness of the viable rim paralleled total segmental wall thickness. Therefore, presence of a significant viable rim was of no additional diagnostic value beyond SEH alone. Periprocedural necrosis was found in 17% of non-improving segments with SEH≥25%. The presence of periprocedural necrosis was the only (negative) predictor of changes in LV volumes and ejection fraction (p < 0.05).

Conclusions: The presence of a significant viable rim did not additionally contribute to the prediction of regional functional improvement compared to the SEH alone. Periprocedural necrosis was a frequent finding, and proved to be the only predictor of changes in both global LV volumes and function.

Multivariate T2* Cardiovascular Magnetic Resonance Approach for the Detection of Myocardial Iron Distribution: Validation in Healthy Subjects and Thalassemia Major Patients

Alessia Popp, Eliana Cracolici, Vincenzo Postolino, Brunello Favilli, Daniele De Marchi, Liana Cuccia, Carmen Lo Pristo, Pasquale Rigano, Massimo Mitid, Massimo Lombardi, MR Lab Institute of Clinical Physiology CNR, Pisa, Italy, University of Palermo, Palermo, Italy

Background: T2* cardiovascular magnetic resonance (CMR) with a single measurement in the mid-ventricular septum has been validated as a quantitative evaluation of myocardial iron overload. Histological and CMR studies have suggested a marked heterogeneity of iron distribution in the myocardium. Aim of our study was to validate the multivariate T2*CMR approach, for the detection of the heterogeneous myocardial iron distribution, in healthy subjects and in thalassemia major (TM) patients.

Methods: Left ventricle were obtained using T2* multiecho sequences in 20 healthy subjects and in 53 TM patients. The myocardium was segmented into 12 segments. T2* value on each segment and the global T2* value were calculated. To assess the endomyocardial and epicardial iron distribution, each segment was divided in the inner and outer half.

Results: The coefficients of variation for intra-, inter-observer and inter-study reproducibility were 3.5%, 5.4%, 4.7% respectively. In healthy subjects the percentage of deviation (%D) of the slices from the global heart T2* mean was not statistically significant. The %D of the segments from the global heart T2* mean ranged from -20 to 18. Significant differences were only observed between the segments with higher %D (5/6 cases). The TM patients had considerable individual variation in the T2* values among the slices and the segments. In TM patients, the epicardial iron concentration was significantly higher in the slices and in 10/12 segments. Three groups of patients were identified: 15% with homogeneous myocardial iron overload (MO), 77% with no MO; 38% with an heterogeneous MO (T2* segments <20 ms and T2* segments >20 ms). Serum ferritin levels, liver iron concentrations and urinary iron excretions were significant different among groups.

Conclusions: Our data did not account for rejecting the analysis of certain slices or segments. T2* gradient from endocardium to epicardium is consistent with patterns of iron deposition described in histological studies. Multivariate T2* CMR approach provides a non-invasive and reproducible way for assessing myocardial iron distribution which may play a role in clinical arena.

Early Alteration in Pulmonary Artery Distensibility Detected With Cardiac Magnetic Resonance in Pulmonary Hypertension

Javier Sarg, Santo Dellegrottaglie, Andrew Einstein, Roxana Silca, Valentin Fuster, Michael Poon, Sanjay Rajagopalan, Mount Sinai School of Medicine, New York, NY

Background: Pulmonary artery distensibility (PAD) is reduced in subjects with pulmonary hypertension (PH). The extent of impairment in PAD and its precise relationship to the severity of PH is not well characterized. We evaluated PAD using phase contrast magnetic resonance imaging (PCMRI) in patients with known/suspected PH.

Methods: PCMRI and rest/exercise right heart catheterization were performed on the same day in 81 patients (age=64.6±15.6, 76% females). PH was defined as mean pulmonary pressure (mPAP) >25 mmHg at rest or >30 mmHg with exercise. PH was evaluated with PCMRI perpendicular to the pulmonary trunk, and was calculated as maximal change in cross-sectional area divided by the product of minimal area and pulmonary artery pressure pulse.

Results: On the basis of right heart catheterization, 11 subjects were normal, 6 had exercise-induced PH and 64 had PH at rest. Compared with normal subjects, median (interquartile range) PAD tended to be lower in the presence of exercise induced PH (0.019 (0.013) vs. 0.039 (0.019), p=0.07), while it was lowest in the presence of resting PH (0.004 (0.003) vs. 0.018 (0.001), p=0.001). PAD correlated negatively with mPAP (r= -0.68; p<0.0001) and systolic pulmonary pressure (sPAP; r=-0.57; p<0.0001). PAD varied in an exponential manner with sPAP (Figure 1).

Conclusions: PH results in impaired PAD which precoces, and strongly correlates with, sustained elevations in pulmonary pressures. These findings may have implications for early detection of PH.
Background: The db/db mouse, which develops severe obesity from a defective leptin receptor, is a well-established model of type 2 diabetes. Though cardiomyopathy has been described in db/db mice, its structural basis and progression, as well as the molecular events underlying this progression, have been inadequately studied.

Methods: Cardiac magnetic resonance studies using a 4.7 T magnet were performed on female db/db and heterozygous db/+ control mice at 5, 9, 13, and 17 weeks of age. 6 db/db and 4 control mice were scanned at each age. Left ventricular end-diastolic volume (LVEDV) and end-systolic volume were measured by tracing the endocardial border at end-diastole and end-systole. Fractional shortening (FS) and cardiac index (CI) were then derived from these data. Quantitative real-time RTPCR was performed on samples obtained from the myocardium of db/db and control mice sacrificed at 5, 10, and 15 weeks. Heart weight (HW) and body weight (BW) were measured at sacrifice.

Results: At 5 and 9 weeks, there were no significant differences in LVEDV between db/db and control mice. However, LVEDV was significantly increased at 13 (46 vs. 34 mL, p < 0.01) and 17 (49 vs. 38 mL, p = 0.02) weeks. Additionally, CI in db/db mice was significantly lower than control at 5 weeks (146 vs. 185 mL/min/m², p < 0.01), and worsened with age (p < 0.05). Finally, EF was nonsignificantly decreased at 9, 13, and 17 weeks (68% vs. 70% at each time point). Consistent with the known lack of hypertrophy in db/db mice, HW/BW ratio did not increase with age. Moreover, fetal gene expression (i.e. MHC, β-MHC, SERCA2, ANP) was unchanged between db/db and control mice at each time point. Notably, the expression of the cardioactive peptide apelin and its receptor APJ, while unchanged vs. control at 5 weeks, was decreased 2.9- and 18-fold, respectively, at 15 weeks (p < 0.01 for both).

Conclusions: As assessed by magnetic resonance imaging, cardiac structure and function in db/db mice worsen over time, indicative of progressive remodeling. This process occurs in the absence of significant hypertrophy. The remodeling is also associated with significant downregulation of apelin and APJ, suggesting a possible pathogenic role for this signaling pathway.
with low-concentration Gd-DTPA injection. Then first-pass contrast enhanced myocardial perfusion MR images were obtained during ATP stress and in the resting state. After correcting blood saturation and col sensitivity profile, myocardial perfusion/mimaging was quantified from arterial input and myocardial output functions by using a Patlak plot method. Quantitative MR measurements of regional myocardial perfusion reserve were compared with the results by Doppler flow wire in the corresponding vessels.

**Results:** The averaged myocardial perfusion reserve in 37 coronary arteries determined by quantitative assessment of rest-stress perfusion MR was 1.74±0.46. The averaged coronary flow velocity reserve measured by Doppler flow wire was 1.95±0.70. MR assessment of myocardial perfusion reserve showed a good linear correlation with Doppler measurements of coronary flow velocity reserve (R²=0.73, p=0.001).

**Conclusions:** Quantitative two-compartment analysis of stress-rest myocardial perfusion MRI using a Patlak plot approach can provide a non-invasive assessment of regional myocardial perfusion reserve in patients with coronary artery disease.

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**Quantitative Myocardial Magnetic Resonance Perfusion: Comparison With Invasive Physiologic Assessments and Quantitative Coronary Angiography**

Steven Shoemake, Marco Costa, Hitoshi Futamatsu, Chris Klassens, Minh Nguyen, Alan Sibulak, Paul Gilmore, Martin Zenni, Luis Guzman, Dominick Angiolillo, Theodore Bass, Norbert Wilke, University of Florida, Jacksonville, FL

**Background:** We hypothesize that quantitative myocardial magnetic resonance perfusion reserve (MPR) provides a non-invasive assessment of coronary artery disease (CAD) as compared to the fractional flow reserve (FFR) and quantitative coronary angiography (QCA).

**Methods:** 36 stable patients underwent coronary angiography and routine stress and rest first-pass perfusion MRI studies (0.04 mmol/kg gadolinium-DTPA bolus, 1.5T Sonata, Siemens) within 3 months. For both FFR and MPR, stress was induced with 140mcg/kg/min Adenosine IV. FFR was obtained during stress using p. 0.14 inch Jomed pressure wire. Automated QCA (CASS II 4.1 Pie Medical) was done in 2 views. MPR was calculated from the ratio of absolute stress and rest flows calculated from myocardial signal intensity time curves (Modis MASS). 26 patients were suitable for quantification performed by "Fermi" deconvolution analysis.

**Results:** The overall MPR mean was 1.99, median was 1.96, and standard deviation was .78.

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**JACC February 21, 2006**

**Time Course of Microvascular Obstruction in Patients with Acute Myocardial Infarction**

Caterina Sigg, Katharina C. Wu, Andre Schmidli, Natalie Preude, Joao A.C. Lima, Julie M. Miller, John MV

**Background:** Microvascular obstruction (MO) predicts worse remodeling and prognosis after acute myocardial infarction (AMI). In animal models, MO progressively increases in size over the first 48 hours following reperfusion. The temporal course in humans is not known.

**Methods:** Patients (n=14) with revascularized AMI by angioplasty underwent acute magnetic resonance imaging (MRI1) within the first 24 hours (11±5 hrs) and a repeat MPR MRI2 at 72 hrs (55±23 hrs) after reperfusion. Using a hybrid echo-planar gradient echo sequence after 0.1 mmol/kg gadodiamide, first pass MO was quantified as the size of the hypoenhanced region on the image showing peak enhancement in the remote normal myocardium. 10-15 minutes after a second 0.1 mmol/kg gadodiamide bolus, an inversion recovery sequence was used to quantify delayed enhanced MO (DeMO) and transmural size (IS) as the extent of the dark and dark plus hyperenhanced regions respectively. LV end-diastolic (EDV), end-systolic volume (ESV) and ejection fraction (EF) were also computed. Patients were grouped based on the median time of MRI1 from reperfusion (4 hrs).

**Results:** MO did not change significantly between MRI1 and MRI2 (10±5% vs 12±3% EVs, p=ns). However, IS decreased in the patients imaged in the first 4 hrs (8±7 %LVmass, p=0.03), as opposed to no changes seen in those first imaged 5-24 hrs after reperfusion (16±20 vs 16±17 %LVmass, p=NS). IS was unchanged for both the entire group (27±15 vs 26±13 %LVmass, p=NS) and by subgroup analysis. Despite a strong correlation between MO and DeMO at each exam (MRI1: r=0.91, p=0.001; MRI2: r=0.94, p=0.001), DeMO consistently underestimated the total extent of MO (MRI1: 12±15 vs 4±9 %LVmass, p=0.009; MRI2: 12±13 vs 4±5 %LVmass, p=0.001, MO and DeMO respectively). DeMO was unchanged between the two scans. No significant changes were found in EDV, ESV, EF.

**Conclusions:** MO increased significantly in the first 4 hrs after AMI in patients undergoing therapeutic angioplasty, with the final extent likely to be reached between 5 and 24 hrs after reperfusion. Therapies targeted at earlier intervention for MO in acute MI may reduce MO progression.

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**Spontaneous Evolution of Viability Indexes After Reperfused Myocardial Infarction. Implications on the Prediction of Late Systolic Function**

**Vicente Rodé, Juan Sanchis, Maria P. López-Leru, Julio Núñez, Cristina Gómez, Roberto Sanz-Requena, Francisco J. Chorro, Ángel Llácer, Hospital Clínico y Universitario, Universitat de València, Valencia, Spain, ERESA, Valencia, Spain**

**Background:** To investigate the spontaneous evolution of 4 myocardial viability indexes after reperfused myocardial infarction by means of cardiovascular magnetic resonance imaging (CMR) and its implications for predicting late systolic function.

**Methods:** We studied 40 patients with a first reperfused ST-elevation myocardial infarction, single-vessel disease and sustained open infarct-related artery. At the first week and 57.9mm, p=0.007) and LVEF was significantly improved (from 26.9 to 39.2%, p=0.004) then performed. Echocardiography was repeated at chronic period (mean 7 months after diagnosis). Delayed contrast-enhanced cardiac magnetic resonance imaging (DECMR) can be useful for non-invasive tissue characterization especially in fibrotic or necrotic myocardium. The aim of this study is to investigate the prognosis value of DECMR in non-ischemic dilated cardiomyopathy (DCM).

**Method:** Twenty newly diagnosed patients with DCM were recruited. After invasive and non-invasive diagnostic evaluation including coronary angiography and echocardiography, DECMR was studied and they were divided into two groups (delayed enhancement; DE+/-). Guideline-based medical therapy (ACEI and/or beta-blocker) were then performed. Echocardiography was repeated at chronic period (mean 7 months after diagnosis).

**Results:** Baseline left-ventricular dimension (LVDd) and ejection fraction (EF) did not differ between two groups. In DE+ group, LVDd was significantly decreased (from 67.6 to 57.9mm, p=0.007) and LVEF was significantly improved (from 26.9 to 39.2%, p=0.004) at the time of follow-up. However, in DE- group, both LVDd (from 63.1 to 61.3mm, p=0.03) and LVEF (from 29.8 to 32.8%) did not differ significantly (p=N.S.). Increase of LVEF was significantly greater in DE- than in DE+ (12.3% vs. 3.0%, p=0.006).

**Conclusion:** DECMR was strongly associated with refractory left ventricular dysfunction in patients with DCM. Irreversible damage may be present in delayed contrast-enhanced myocardium of DCM.
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**ORAL CONTRIBUTIONS**

3D Echocardiography: New Clinical Insights and Applications

**Tuesday, March 14, 2006, 9:00 a.m.-10:30 a.m.**

Georgia World Congress Center, Room B313

**Shota Fukuda, Hung Tran, Harry M. Lever, Jong-Min Song, Neil L. Greenberg, James D. Thomas, Takahiro Shiota, Cleveland Clinic Foundation, Cleveland, OH**

**Background:** Real-time three-dimensional echocardiography (RT3DE) provides accurate and physiologic estimates in assessing left ventricular (LV) geometry and function as well as LV outflow (LVOT) area (A_{LVOT}) in patients with hypertrophic cardiomyopathy (HCM). The purpose of this study was to investigate the clinical feasibility and accuracy of RT3DE to diagnose significant LVOT obstruction in a large number of patients with HCM.

**Methods:** This study consisted of consecutive 117 patients with HCM who had RT3DE by using either a Sonos 7500 (n=69) or a TomTec Volumetric System (n=58). The smallest A_{LVOT} during systole was determined by moving a 2D plane in 3-dimensional space. Maximal velocity (V_{max}) across LVOT was assessed by continuous-wave (CW) Doppler method to calculate the pressure gradient (PG_{LVOT}) using the simplified Bernoulli equation (PG_{LVOT} = 4V_{max}^2). Proven by nitrates, the maneuver (n=5) was performed in patients without significant LV outflow obstruction (PG_{LVOT} < 30 mmHg) at rest.

**Results:** In 117 patients, with poor image quality of RT3DE were excluded for a Sonos 7500 in 2 patients (3%) and a TomTec Volumetric System in 16 patients (33%). In the remaining 99 patients, significant LVOT obstruction was observed in rest at 57 patients (58%), and after provocation in 27 patients (27%). Fifteen patients (15%) showed no LVOT obstruction at rest or after provocation. An excellent correlation was observed between resting V_{max} and A_{LVOT} (r = 0.96, p < 0.001), while the thickness of LV septum was significantly weaker correlated with V_{max} (r = 0.22, p = 0.03). Significant but lesser correlation was observed between V_{max} and A_{LVOT} after provocation (r = 0.64, p < 0.001). Receiver-operating curve (ROC) analysis demonstrated that the value of A_{LVOT} < 1.1 cm² provided sensitivity of 97% and specificity of 74% to predict resting significant LVOT obstruction.

**Conclusions:** RT3DE was useful to quantify LVOT obstruction in patients with HCM. 3D derived LVOT area may serve as an indispensable alternative index for CW Doppler derived peak velocity and pressure gradient, especially when mitral regurgitation may obscure CW Doppler interrogation of LVOT.

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**Assessment of the Severity of Outflow Obstruction in Patients With Hypertrophic Cardiomyopathy: A Real-Time Three-Dimensional Echocardiographic Study**

**Monday, March 13, 2006, 9:00 a.m.**

Georgia World Congress Center, Room B313

**Hitinder Jain, Chizor Iwuchukwu, Joseph Levine, David Hoch, Stewart Schecter, Steven Greenberg, Vinny Jayam, Saad Siddiqi, Sunil Mathew, Nathaniel Reichek, St. Francis Hospital/ Stony Brook University, Roslyn, NY**

**Background:** Improved risk stratification is needed for debilitator implantation in MADIT II patients. We have previously shown that cardiac MRI (CMR) indices of left ventricular structure and function are more predictive of arrhythmias inducibility or early clinical events than clinical EF measures such as 2D echocardiography (2DEF). Signal averaged ECG (SAECG) indices also reflect arrhythmic risk. Therefore we compared 2DEF, CMR, and SAECG findings in MADIT II patients.

**Methods and Results:** 19 patients meeting MADIT II criteria were classified into low, intermediate and high risk categories based on SAECG (QRS duration >114 ms, a signal of >20 µv in the last 50% of the filtered QRS, voltage <40 µv in the terminal QRS for >38ms processed using a 40-Hz filter), CMR EF, LV volumes and mass were obtained using volumetric TrueISP short axis cine imaging and intact size as % LV mass using TurboFLASH delayed hyperenhancement imaging. Clinical 2D EF, CMR and SAECG were obtained within a 30 day period prior to ICD implantation. All but 2/19 (10.5%) were inducible at electrophysiology study. 2DEF correlated weakly with CMR EF with wide limits of agreement (-13.22 - 12.62) and 319 patients (15.8%) had CMR EF > 30% despite 2DEF < 30%. CMR EF showed a strong negative correlation (r = -0.65, p < 0.003) with 2DEF risk, whereas 2DEF did not (r = 0.03, p = 0.89). On multiple regression analysis using 2DEF, and CMR EF, LV mass, end diastolic volume and % scar, the strongest predictor for SAECG risk was CMR EF (p = 0.007), followed by 2DEF (p = 0.04) with % scar at borderline significance (p = 0.058). Using only QRS duration >114 ms for SAECG risk, CMR EF was the only significant predictor (p = 0.03) on multiple regression analysis.

**Conclusion:** CMR EF is a strong predictor of arrhythmic risk as estimated by either inducibility or early clinical events or SAECG. Thus multiple independent lines of evidence support the view that CMR EF is preferable to 2DEF as a marker of risk in MADIT II candidates.
Utility of Real-Time 3-D Echocardiography for Predicting Adverse Events in the MADIT II Post-Myocardial Infarction Patient Population

Ebere O. Chukwu, Aasha S. Gopal, Michael L. Friedman, Uzodinma R. Dim, Rena S. Toole, Jeanette McLaughlin, Shari O. Schecter, Steven Greenberg, Joseph H. Levine, Nathaniel Reichek, St. Francis Hospital, Roslyn, NY, Stony Brook University, Stony Brook, NY

Background: Post-myocardial infarction patients with an EF of ≤ 30% are benefited by a cardiac defibrillator (ICD) by the MADIT II study. However, these patients are prone to significant morbidity and mortality. We hypothesized that 3D echo (3DE) cardiac volume indices will be superior to clinical 2DE and EF alone for predicting adverse events in this population.

Methods: We studied 28 patients (56 ± 7 years, 12 males) who met MADIT II criteria for ICD placement based on an EF ≤ 30% by 2DE, nuclear or cine-ventriculography. 25 patients had ICDs implanted. Subjects were followed up for 293 ± 73 days for adverse events (death, sustained VT/VF and ICD discharges) and receiver operator curves were obtained to determine the association between 3D LV volumes indices and adverse events.

Results: Mean indexed end-diastolic (3DEDV) and end-systolic volumes (3DESV) were 123 ± 25 and 92 ± 20 ml/m² respectively with a mean 3D EF of 25 ± 4 %. Two deaths occurred. The incidence of ICD discharge & sustained VT/VF was 29%. ROC curve analysis showed that 3DESV (p = 0.009), 3DEDF (p = 0.003), and 3DEFSV (p = 0.01), but not 2DESV (p = 0.59), 3DEFSV (p=0.5), and clinical EF (p = 0.40) were significantly associated with adverse clinical events.

Conclusions: 1) 3DE derived LV volume indices at time of ICD placement are superior to EF determined by routine clinical methods for predicting adverse events. 2) 3DE derived LV volume indices have greater discriminant power compared to 3D EF alone for predicting increased risk of death, ICD firing and recurrent VT/VF within 6 months.
with AI. This data suggested that the TDI analysis of intraventricular asynchrony would be useful in heart failure patients with AI before and after cardiac resynchronization therapy.

Results: ATP caused no significant changes in heart rate (66±12 vs. 68±15), blood pressure (134±12 vs. 140±15), nor %FS (35±12 vs. 37±15). ATP did not induce any adverse event, chest discomfort, or apparent LV asynergy. Analyzable segments were 298 out of 312 (95%). In all segments of normal subjects as well as in normal segments of CAD patients, ATP increased subendocardial strain significantly (+33±7% and +32±8%). In contrast, segments that fed by significantly stenotic coronary arteries showed no increase or even slight decrease during ATP infusion (0±0.5%). In patients who underwent PCI, (S2-S1)/S1 increased to normal level after PCI (12±32% to +43±17%). Using 18% of strain increase by ATP as a cutoff value, the sensitivity and specificity to detect significant CAD were 83% and 88%, respectively.

Conclusion: ATP stress strain imaging is a useful novel method for making diagnosis of CAD, with the advantages of quantitative, objective, less time-consuming and less unpleasant compared to other stress test.

11:45 a.m.

846-7

Delayed Diastolic Untwisting in Chronic Mitral Regurgitation
Takuya Hanagami, Satoshi Nakatani, Hiroki Kanazawa, Haruhiko Abe, Masahiko Yamagishi, Masakazu Kikuzaki, National Cardiovascular Center, Osaka, Japan

Background: A novel ultrasound speckle tracking imaging (STI) allows the noninvasive assessment of left ventricular (LV) torsional deformations. There have been few data on the clinical implication of twisting-untwisting in volume overloaded hearts.

Methods: We analyzed basal and apical LV short-axis images in 23 patients with chronic severe mitral regurgitation (MR) (ejection fraction, 67±6%, 56±12 years), and 23 normal subjects (56±13 years, p=ns) using STI (EchoPAC,GE). LV torsion was measured as the difference between LV apical and basal rotation.

Results: LV torsion before and after hemodialysis

Conclusion: LV torsion is not influenced by preload change and can be used as a parameter of cardiac performance without load dependency.

Left ventricular torsion before and after hemodialysis

12:00 noon.

846-8

Subendocardial LV Strain Measurements During ATP Infusion
Kansei Uno, Katsu Takenaka, Kenichi Asada, Yoko Eto, Aya Ebihara, Toshihiro Morita, Kazuno Saisai, Takako Komuro, Ryozo Nagai, University of Tokyo Hospital, Tokyo, Japan

Background: ATP (adenosine triphosphate) increases flow in normal coronary artery about 2 to 3 times, but flow remains unchanged or even decreased in stenotic coronary artery. A new method for measuring transmural myocardial strain gradient based on tissue Doppler imaging makes it possible to detect subendocardial ischemic damage. We assessed the hypothesis that subendocardial strain measurements during ATP infusion are useful for diagnosing coronary artery disease (CAD).

Methods: In 10 normal volunteers and 15 patients with CAD, LV short-axis views were recorded by tissue Doppler imaging at basal and papillary muscle levels below and during 5 min ATP infusion. Time-integration of the velocity data gave the displacement of the target myocardium toward the LV center, which was used to calculate the target motion.

Results: Subendocardial systolic strain was measured in the septum, inferior, posterior and lateral walls at rest (S1) and during ATP stress (S2) by using 3mm strain pitch and 5 parallel sample lines (width of 5 mm). Fractional change in strain (S2-S1)/S1 was calculated.

Conclusion: ATP stress strain imaging is a useful novel method for making diagnosis of CAD, with the advantages of quantitative, objective, less time-consuming and less unpleasant compared to other stress test.

11:30 a.m.
Tissue Doppler Is Superior to Conventional Echocardiography in the Diagnosis of Arrhythmogenic Right Ventricular Dysplasia/Cardiomyopathy

Kagana Prakasa, Jianwen Wang, Danhan Dalal, Cynthia James, Crystal Tichnell, Hugh Callens, Theodore Abraham, Johns Hopkins University School of Medicine, Baltimore, MD

Background: Arrhythmogenic Right Ventricular Dysplasia (ARVD) is a rare genetic cardiomyopathy characterized by fibro fatty replacement of right ventricular myocardium leading to heart failure and arrhythmias. Early ARVD is challenging to diagnose with conventional echocardiography. We examined whether tissue Doppler echocardiography (TDE) was superior to conventional echocardiography for the diagnosis of ARVD.

Methods: We prospectively imaged 30 ARVD patients (diagnosis confirmed by Task Force criteria) and 30 age-matched healthy volunteers. Two blinded observers measured right ventricular outflow tract diameter (RVOT) and fractional area change (FAC). Similary, peak systolic (RVS) and tissue displacement (RVD) were measured in the basal RV free wall.

Results: RVS (6.4±2.2 cm/s vs. 9±1.6cm/s, p<0.0001) and RVD (3.7±8.8mm vs. 18.7±3.9mm, p<0.0003) were significantly lower in ARVD compared to controls, respectively. Sensitivity and specificity was 67% and 89% for RVS, 77% and 71% for RVD, 53% and 93% for RVOT and 47% and 83% for FAC. Receiver Operating Characteristic was as follows: RVS (AUC=0.83, p<0.0001), RVD (AUC=0.77, p=0.002), RVOT (AUC=0.73, p=0.01) and FAC (AUC = 0.61, p=0.26). Inter and intra observer agreement for TDE parameters was high.

Conclusion: TDE is superior to conventional echocardiography in diagnosing ARVD. TDE may have incremental value over conventional echocardiography in assessment of patients with suspected ARVD.
Novel Transthoracic Triplane-Echocardiography to Assess the Acuity of Left Ventricular Volume Measurements: A Comparison With Magnetic Resonance Imaging

Karel Mrozaliski-Jamka, Gisso von der Recke, Christopher Hammerstingl, David Hardung, Jan Schnappauf, Harald Schmidt, Bernhard Saxler, Heyder Omran, St.-Marien-Hospital, Bonn, Germany

Background: Transthoracic two-dimensional echocardiography (2D-ECHO) is the most commonly used imaging modality for left ventricular volume measurements (LVVMs) but its accuracy is limited due to geometrical assumptions. We evaluated a novel transthoracic-echocardiography (TRI-ECHO) with and without intravenous contrast injection to standard clinical 2D-ECHO versus cardiac magnetic resonance (CMR) for determination of LVVMs.

Methods: Digital harmonic echocardiographic standard imaging by means of the standard and new triplane-transducer before and after intravenous contrast injection was performed in 109 consecutive patients referred for CMR. Meticulous care was taken to avoid foreshortening. CMR multiple (10-12) short axis sections of left ventricle were performed with a 1.5 T scanner by an independent blinded experienced observer. LVVMs were calculated offline by the method of disks and software provided by the triplane-transducer's producer.

Results: All echocardiographic methods underestimated left ventricle volumes versus CMR. Bland-Altman analysis revealed clinically significant bias in differences between 2D-ECHO, TRI-ECHO without and with contrast agent versus CMR (enddiastolic volume: 36.8%, 28.6% and 12.3%; end systolic volume: 35.3%; 29.9% and 13.0%; respectively). The underestimation and 95% limits of agreement were the smallest for both TRI-ECHO methods and narrowed significantly after contrast injection. Correlations versus CMR measurements were good for 2D-ECHO and very good for both TRI-ECHO methods. Ejection fraction triplane echocardiography (TRI-ECHO) without contrast agent differed by 210% (original units) versus CMR in 24, 18 and 5 patients, respectively. Compared with 2D-ECHO, TRI-ECHO lowered the feasibility for LVVMs from 92% to 87% but it was increased to 100% after contrast injection.

Conclusions: Compared to standard transthoracic technique triplane-echocardiography significantly improves accuracy of LVVMs and is even more accurate when adding an intravenous contrast agent.

Incremental Value of Quantitative Analysis of Myocardial Perfusion in Dobutamine and Adenosine Stress Real-Time Perfusion Echocardiography

Ingrid Kowatsch, Jeanne M. Tschoe, Alattiniego F. Osko, Augusto H. Uchida, Gilbert A. Marchioni, Lutz A. Cesar, Eugenio M. Martinez-Rhio, Jose A. Ramires, Wilson Mathias, Jr., Heart Institute (InCor)- University of Sao Paulo Medical School, Sao Paulo, Brazil

Real-time perfusion echocardiography (RTPE) is a new technique that allows the analysis of myocardial perfusion (MP). We determined the value of quantitative MP over clinical data, electrocardiography (ECG), wall motion (WM) and visual analysis of MP by RTPE during dobutamine and adenosine stress. Methods: 54 patients underwent effective stress RTPE and quantitative coronary angiography within 30 days. RTPE was performed using continuous infusion of contrast with flash-replenishment technique. Myocardial blood flow was obtained as: [(plateau acoustic intensity in the myocardium/cavity) x microbubble velocity]/tissue density.

Results: Accuracy of ECG, WM, MP and quantitative MP for detecting coronary artery disease (CAD) during dobutamine were 81%, 76%, 70% and 80%, and adenosine were 70%, 70%, 76% and 80%. Quantitative MP had incremental diagnostic value over clinical, ECG and WM during dobutamine ($p<0.001$). During adenosine, qualitative MP added incremental value over all variables ($p<0.01$). Qualitative MP further increased the likelihood of CAD ($p<0.001$) (Figure). Conclusion: Quantitative MP provides incremental diagnostic information over clinical, ECG, WM, and qualitative MP during dobutamine and adenosine stress RTPE.

Comparison of Continuous Infusion Versus Bolus Injection of Intravenous Microbubbles in Detecting Myocardial Perfusion Defects During Dobutamine Stress Echocardiography

Feng Xie, Thomas R. Porter, Heidi Mahrous, Saul Kalvaibit, Edward O'Leary, University of Nebraska Medical Center, Omaha, NE

Background: Real time perfusion imaging (RTPI) during dobutamine stress echocardiography (DSE) has been performed with both small intravenous (IV) bolus injections (BI) as well as a continuous infusion (CI) of ultrasound contrast agents. Both techniques can assess myocardial blood volume changes but CI has the added advantage of detecting changes in myocardial blood flow. The purpose of this project was to compare the ability of perfusion determined with IV BI versus CI to detect coronary artery disease during DSE.

Methods: We compared the independent assessment of perfusion and wall motion in 335 consecutive patients who underwent DSE with RTPI and quantitative angiography using either an IV BI (n=249 patients) or IV CI (n=86 patients). For IV BI, myocardial contrast enhancement was analyzed during the washout of either Optison (0.2-0.3 ml bolus) or Definity (0.1 ml bolus). IV CI was performed with 3% Definity visually analyzing myocardial contrast replenishment and plateau intensity following high mechanical index impulses.

Results: Mean age of patients in the IV BI group was 60±16 years, while it was 55±13 years for IV CI. Perfusion imaging had higher sensitivity and accuracy than wall motion when using either BI or CI (Figure). However, sensitivity and accuracy of perfusion analyzed with BI versus CI of contrast agents were not different.

Conclusions: For RTPI during DSE, the specificity and accuracy of myocardial perfusion analysis determined visually with a BI is similar to a CI of contrast agents.

Exogenous Adenosine Triphosphate Disodium During Primary Percutaneous Coronary Intervention Preserves Microvascular Integrity and Left Ventricular Function in Patients with Acute Myocardial Infarction Regardless of Antecedent Angina

Takamichi Sakuma, Takekiyo Tokuyama, Toshitaru Oka, Kentauro Maru, Ken Ishibashi, Takakuni Okada, Masaya Ohtsuka, Hikokazu Hiroa, Yai Murasaka, Henonor Ueda, Yoshihiko Masaoaka, Yasuhiko Hayashi, Akane Foundation Tsuchiy General Hospital, Cardiovascular Center, Hiroshima, Japan, Hiroshima University, Hiroshima, Japan

Background: Antecedent angina (AA) protects microvascular integrity via preconditioning effects. Adenosine also concerns to them during repetitive ischemia mainly prior to the onset of acute myocardial infarction (AMI). However, it has remained unknown whether exogenous adenosine triphosphate disodium (ATP) also contributes to the reduction in infarct size even in patients (pts) with AA in whom no AA was observed prior to primary percutaneous coronary intervention (PCI).

Methods: One hundred forty five consecutive pts with first anteroseptal AMI were enrolled, in whom total occlusion on proximal left anterior descending coronary artery was confirmed, and primary PCI was successfully performed within 12 hours after symptom onset. ATP at a dose of 150 µg/kg/min was infused intravenously for one hour during PCI in 58 of those pts (Group I). In other 87 pts, normalasia was administrated during PCI (Group II). Left ventriculography was carried out shortly before as well as 6 months after primary PCI. Risk area for AMI was defined as an asynergic region on echocardiography prior to PCI. No-reflow size was determined as no-reflow area normalized by initial risk area at 2weeks after PCI using 1.5 harmonic myocardial contrast echocardiography with intravenous levosast. AA was defined as greater than one episode of transient chest pain which occurs within 24hours before onset of AMI.

Results: AA was documented in 38 in Group I and 50 in Group II. 50% ST-segment resolution (56%, 53%, 47, 11%) AA with ATP (n=38), no AA with ATP (n=50), no AA without ATP (n=37) in these orders, shown as mean (%); * indicates p<0.05 in comparison to the group without AA as well as ATP, no-reflow size (19.2±32.3±6.3±2%). left ventricular ejection fraction (62.5±58.5±53.1±5%), left ventricular regional wall motion using centerline method (-1.29,-1.36,-1.36,-2.29); indicated by S/D/SD and left ventricular end-diastolic volume (104.9±101.7±106.9±) at 6months after PCI were better in pts with AA and/or ATP. These indices were similar in 4groups on day 0.

Conclusions: Exogenous ATP during primary PCI preserves microvascular integrity and left ventricular function in AMI pts regardless of AA.

Transient ST-Segment Depression Only During Paroxysms of Atrial Fibrillation in Patients Without History of Coronary Artery Disease. What Non-invasive Test to Unmask Severe Underlying Coronary Artery Disease?

Aris E. Andreoukaig, Constantinos Aznouzard, Constantina Aggel, George Roussais, Athanasos Karalis, Pavlos Stougianemos, Polyvromannis Dilaveris, Dimitrios Chrissos, Christodoulos Stefanatos, Ioannis Kalkazanos, Hippposternal Hospital, Athens, Greece, Athens University Medical School, Athens, Greece

Background: Sometimes paroxysmal atrial fibrillation (PAF) presents with ischemic ECG changes during the insult while the resting ECG during sinus rhythm is normal. Despite the extended medical literature, very little is known about the relation of PAF with significant
coronary artery disease (CAD) of an occult course, without typical symptoms or relative history in otherwise normal individuals presenting with the aforementioned features. We prospectively sought to identify any clinical factors as well as the best stress-test to non-invasively discriminate patients (pts) with severe underlying CAD from those without.

Methods: During the last 3.5 years, pts presenting ischemic ST-segment changes only during PAF, were thoroughly evaluated. Pts with acute coronary syndromes or any profound cardiac disorder were excluded. Those who accepted to undergo 3 months the following studies: cardiac and carotid ultrasoundography, treadmill stress test (TST), thallium-201 cardiac scintigraphy (TMS), myocardial contrast dobutamine stress-echo (MCE), myocardial coronary arteriography, comprised study pts.

Results: In this ongoing study, 78 pts (40 M, 38 F) aged 65.3±7.8 years were studied so far. Severe CAD was detected in 26 (33.3%). Clinical judgment for the presence of CAD was accurate in less than 50% of cases. In multivariate analysis cigarette smoking (39.7% vs. 21.2%), mitral valve annular calcification (53.8% vs. 21.2%), left ventricular hypertrophy (88.5% vs. 69.2%), and carotid IMT>0.85mm were independent predictors for CAD (p<0.05). The relative sensitivity and specificity of TST, TMS and MCE for the diagnosis of CAD were 73.9/54.5%, 84.6/57.7% and 92.3/89.4% respectively.

Conclusions: These findings suggest that in this so far rare category of patients, MCE is the best non-invasive method to diagnose CAD. If MCE is not available, a negative TMS seems to suffice and may be needed for further studies. While these tests provide functional data about myocardial perfusion, they might be considered as the first choice in the management of these pts regarding their risks from CAD.

High Resolution Myocardial Perfusion Imaging in Mice by Microbubble Depot and Delayed Opacification

Beat A. Kaufmann, Carolyn Z. Behm, Alexander L. Kilbanov, Miles Larkindie, Brent A. French, Jonathan R. Lindner, University of Virginia, Charlottesville, VA, Oregon Health Sciences University, Portland, OR

Background: The ability to assess myocardial perfusion in mice is important for studying models of disease. Myocardial contrast echocardiography (MCE) in mice at high frequencies (>10 MHz) has been limited due to low signal generation, need for high contrast doses and severe cavity attenuation. We developed a method to assess murine myocardial perfusion by microbubble (MB) depot injection after pulmonary shunt transit.

Methods: Intrapulmonary shunting in mice was determined by IV injection of 15 μm fluorescent microspheres and myocardial digestion. MCE with lipid-shelled MB was performed in mice anesthetized with 770 mg/kg of Avertin (Vivo). Acoustic intensity (AI) from the anterior myocardium was measured at 10 s and 10 min after IV injection of MB. MCE was repeated after separation of MB into large and small size fractions (3.5 vs 0.1 % population of <5 μm). MCE in complement-depleted mice was used to determine the mechanism of retention at 10 min (lodging versus complement-mediated attachment). In 5 mice, MCE was performed 24-48 hrs after LAAD ligation and defect was compared to fluorescent nanoprobe distribution on ex-vivo op-illumination.

Results: IV injection of a pulmonary shunt fraction of 3.5% for 15 μm particles. After IV injection of non-separated MB, strong LV cavity enhancement at 10 s produced complete attenuation of the posterior wall, with near complete clearance by 10 min. However, anterior myocardial AI was similar at 10 s and 10 min (18±11 vs 14±3, p=ns), indicating that later MB accumulation results in similar tissue concentration to that when blood pool concentration is high. Anterior AI at 10 min was greater for large vs small size populations (28±8 vs 2±3, p<0.001). Complement depletion resulted in minimal and non-significant decreases in AI at 10 min for all MB preparations. In mice with infarction, MCE defect size 10 min after MB injection was similar to that by fluorescent nanoprobe.

Conclusions: The presence of intrapulmonary shunts in mice permits the lodging of large microbubbles in the myocardial microcirculation and strong signal enhancement. Delayed opacification can be used to spatially assess perfusion of the entire heart at a time when attenuation from MB in the LV cavity have cleared.

Interactive Computer Detection of Nonperfused Myocardial Area in Attenuated Harmonic Contrast Images

Shin Yoshifuku, Shigao Chen, Eileen M. McMahon, Izuru Ochiai, Akiko Yoshikawa, Joseph Konietz, Marek Belohlavek, Mayo Clinic College of Medicine, Rochester, MN

Background: Attenuation of radiofrequency (RF) signals limits the use of contrast echocardiography. Harmonic to Fundamental Ratio (HFR) of the RF signals compensates for attenuation. We tested whether HFR analysis measures the left ventricular (LV) nonperfused area under simulated experimental attenuation.

Methods: RF image data from short axis systolic projections were obtained from 11 chest dogs. Left anterior descending or left circumflex coronary artery occlusion followed for 10 min. LV myocardial perfusion was simulated by silicon pads interposed between the epicardial surface and the transducer and calibrated to induce mild (7 dB) and severe (14 dB) reduction of the backscattered RF signals. HFR values were calculated for systolic frames of each image pixel for 6 dB, 7 dB, and 14 dB attenuation conditions and reproducibly showed “perfused area” and “nonperfused area”. A reference nonperfused area was obtained by perfusion defect delineation in high-quality contrast scans.

Results: At each stage by Strain echo. Quantitative coronary angiography (QCA) was utilized to evaluate CATs where disagreement between the two techniques existed.

Conclusions: At baseline, the lowest and highest MBV were noted in mid-systole (13.1±2.3%) and mid-diastole (20.4±1.5%). While the lowest value did not change with stenosis (15.9±3.3%, p=NS), the highest increased (24.8±4.6%, p<0.03) because of compensatory arteriolar dilation. Both lowest and highest values increased with adenosine (20.5±5.5%, p=0.05, and 29.7±7.0%, p<0.01) and dobutamine (20.5±6.0, p<0.05 and 32.1±5.2, p<0.01) probably from arteriolar dilation in the former and capillary recruitment in the latter. Regional function increased only with dobutamine.

Conclusions: Non-critical coronary stenosis, intramyocardial adenosine, and intravenous dobutamine, all affect cardiac contraction-induced phasic changes in MBV. While a non-critical coronary stenosis increases MBV only in mid-systole, adenosine and dobutamine increase MBV in both systole and diastole. In the presence of stenoses and adenosine these changes are independent of regional function.

Abnormal Stress Myocardial Contrast Perfusion Imaging: Comparison With Radionuclide SPECT

Thomas B. Porter, Heidi Mahmoud, Feng Xia, J. Hankins, Edward O'Leary, University of Nebraska Medical Center, Omaha, NE

Background: Although adenosine is routinely used with radionuclide imaging (SPECT) to detect myocardial perfusion abnormalities (MPA), higher resolution real time perfusion echocardiography (RTPE) has the potential to improve coronary artery disease detection by identifying subendocardial MPA that could go undetected with SPECT. The purpose of this study was to compare RTPE adenosine stress with conventional radionuclide imaging (SPECT) in detecting coronary artery disease.

Methods: In 40 patients, RTPE was performed with an intravenous infusion of 3% Definity (Bristol Myers Squibb) at rest and during a 140 μg/min adenosine (Fujisawa, Inc) infusion using Contrast Pulse Sequencing (Siemens Acuson Sequia). A dual isotope radionuclide SPECT study was performed simultaneously. Perfusion with RTPE was assessed by an independent reviewer who examined the rate of myocardial contrast replenishment following a high mechanical index (MI)impulse. Replenishment was considered abnormal if a subendocardial defect was observed in any coronary artery territory (CAT) that persisted for more than two seconds following the high MI impulse. Quantitative coronary angiography (QCA) was utilized to evaluate CATs where disagreement between the two techniques existed.

Results: Of the total 120 CAT analyzed, there were 23 indeterminate defects with RTPE, and 26 by SPECT. Overall agreement between SPECT and RTPE was 88% (Kappa=0.63). However, subendocardial defects were seen in five CAT’s that were normal by SPECT, all of which were confirmed to have a >50% diameter stenosis subtending this territory at QCA.

Conclusions: Although there is good agreement between SPECT and RTPE during adenosine stress imaging, the higher resolution of RTPE may permit the detection of subendocardial defects that are not resolvable with radionuclide imaging.
1016-45 Can Normal Myocardial Perfusion During Dobutamine Stress Echocardiography Predict a Good Long Term Prognosis in Women? 

Maria S. Doss, Michelle Bierg, Swathy Noli, Faheem Ahmed, Sameer Kasar, Jeanette St. Vrain, Bernard Chartman, Arthur J. Lazlovi, St. Louis University Hospital, St. Louis, MO

Background: Dobutamine Stress Echocardiography (DSE) is widely used in the evaluation of suspected coronary artery disease. However, the long term prognostic value of a normal myocardial perfusion during Dobutamine Stress Echocardiography in women has not been studied widely.

Methods: We therefore prospectively studied one hundred thirty four Dobutamine Stress Echocardiography studies in female patients. Of these 114 Dobutamine Stress Echocardiography were negative for ischemia with respect to myocardial perfusion. Cardiac risk factors and cardiac events (cardiac death, myocardial infarction, congestive heart failure, angina, revascularization) were identified.

Results: Mean age group was 56±14 years. Mean follow-up was 17.6 months (3 to 21 months). Risk factors include hypertension (49%); hyperlipidemia (32%); diabetes mellitus (14%); smoking (19%); previous coronary artery disease (21%). There was one cardiac death and one non fatal myocardial infarction. One patient underwent revascularization within 18 months. There were 3 readmissions after DSE; one female patient for chest pain but no intervention; two female patients for congestive heart failure. The myocardial infarction risk was 0.15% and cardiac death risk in this female population with negative Dobutamine Stress Echocardiography for ischaemia based on normal myocardial perfusion was zero. At 21 months 95% of the population was free of revascularization by Kaplan-Meyer analysis. The risk of revascularization was 0.1% per year for female patients with normal myocardial perfusion during Dobutamine Stress Echocardiography.

Conclusions: A normal myocardial perfusion during Dobutamine Stress Echocardiography in women can be used as a predictor for good long term prognosis.

1016-46 Quantitative Assessment of Regional Left Ventricular Wall Motion From Real-Time 3D Echocardiography: Effects of Dual-Triggered Contrast Enhancement Tested Against Magnetic Resonance

Cristina Corri, Patrick Coon, Sascha Goosendewanda, Lynn Weinert, Tamar S. Polonsky, Lisa Sugeng, Enrico G. Calani, Claudio Lamberti, Robert M. Lang, Victor Mon-Avi, University of Chicago, Chicago, IL, University of Bologna, Bologna, Italy

Background: In patients with poor acoustic windows, the accuracy of left ventricular (LV) volume quantification by real-time 3D echocardiography (RT3DE) is improved by contrast enhancement when used with selective dual triggering at end-systole (ES) and end-diastole (ED) to avoid excessive bubble destruction. We studied the effects of this acquisition strategy on the accuracy of quantitative assessment of regional wall motion (RWM), using cardiac magnetic resonance (CMR) as a reference.

Methods: CMR images (GE 1.5T) of the left ventricle (5-9 short-axis slices) and RT3DE datasets (Vivid 7) were obtained in 20 patients. In 14/20 patients with suboptimal endocardial definition, image acquisition was repeated with contrast enhancement (Definity, 1.3 ml in 50 ml saline, iv drip) and dual triggering at end-systole and end-diastole. CMR images were analyzed using commercial software (MASS Analysis) to semi-automatically detect endocardial contours, segment the ventricle (6 segments per slice) and calculate RWM values. These values were compared with CMR using linear regression and Bland-Altman analyses. To allow these comparisons, CMR-derived RWM data were “resliced” into 3 levels using weight coefficients.

Results: In 6/20 patients with good endocardial definition, RT3DE values of RWM correlated well with CMR (r=0.72, bias 1.1 mm) with dual-triggered contrast enhancement. In patients with poor acoustic windows, dual triggered contrast enhancement improved the accuracy of RT3DE quantification to a level similar to that noted in patients with good endocardial visualization without contrast.

Conclusions: Dual-Triggered Contrast Enhancement improves the accuracy of RT3DE to quantify RWM in patients with poor acoustic windows.

Poster Session

1017 New Advances in Exercise Physiology and Testing

Tuesday, March 14, 2006, 12:30 p.m.-4:00 p.m.
Georgiia World Congress Center, Hall B1
Presentation Hour: 12:30 p.m.-1:30 p.m.

1017-1 Success of Surgical Left Atrial Appendage Occlusion Techniques Assessed By Transesophageal Echocardiography

Anna S. Kandasia, A. Marc Gillinov, Gosta B. Peterson, Allan L. Klein, Cleveland Clinic Foundation, Cleveland, OH

Background: Atrial fibrillation is a major risk factor for stroke, and up to 90% of clots in the left atrium (lA) originate in the left atrial appendage (LAA). With LAA occlusion, theoretically, the stroke rate should decrease. Varying success rates of complete occlusion are reported. The aim of this study is to determine the success rates of different surgical techniques associated with LAA occlusion by transesophageal echocardiography (TEE).

Methods: 134 patients who underwent surgical LAA occlusion from 1993-2004 had a TEE 2 weeks to 9 years after surgery. Measurements include color Doppler flow in the LAA, and presence of thrombus. Incomplete occlusion is defined as patent LAA (by 2D), residual LAA remaining (partial ligation), or presence of flow in the LAA (assessed by color Doppler). Categorical variables were compared using Fisher exact test.

Results: LAA occlusion was performed by excision in 21 patients (14.3%), suture in 76 pts (54.6%) and by staple in 35 pts (24.8%). Incomplete LAA occlusion occurred in 2/21 pts with excision (p=0.001), 55/76 pts with suture (p=0.003) and 23/35 pts with staple (p=0.55), Table 1.

Conclusions: Excision appears to be the most successful surgical LAA occlusion technique. There is a higher prevalence of incomplete LAA occlusion with suture (72.4% of which most have flow in LAA), and with staple (65.7% of which most have residual LAA) techniques. Further studies are needed to determine whether these different surgical approaches are equally efficacious at reducing stroke.

1017-2 Warfarin Therapy Initiated Before Transesophageal Echocardiography Detected Left Atrial Thrombus Is More Beneficial Than When Started After

Xuedong Shap, Haagui Li, Chandra N. Kaur, Mark J. Holzberg, David Cloutier, Karen Hovang, Tom Hase, Aryan N. Misoss, Syed M. Mihiuddin, The Cardio Center of Creighton University, Omaha, NE

The purpose of this study are: 1) to investigate the incidence of cerebrovascularocclusion (CVA) among atrial fibrillation (AF) patients who received warfarin anticoagulation before and after left atrial thrombus (LAT) detected by transesophageal echocardiography (TEE) compared to those who received warfarin anticoagulation only after TEE demonstrated LAT and those did not receive warfarin anticoagulation; and 2) to evaluate the prognosis of patients with persistent LAT despite warfarin anticoagulation.

Methods and Results: Of the 90 consecutive AF patients with LAT (males 48, females 42, age 71.5±10.1 years), 49 received warfarin more than 3 weeks before TEE and continued thereafter (Group I); 29 did not receive warfarin before TEE but received warfarin afterward (Group II); and 12 did not receive warfarin throughout the study because of contraindication (Group III). The incidence of CVA in Group I (14%, 7/49, odds ratio 0.17, prior CVA 5, new CVA after TEE 2) was significantly lower than Group II (45%, 13/29, odds ratio 0.81, prior CVA 10, new CVA after TEE 3, p<0.006) and III (42%, 5/12, odds ratio 0.71, prior CVA 2, new CVA after TEE 2, p=0.047). Of the 50 patients who underwent repeat TEE prior to contemplated cardioversion (Group I 30 patients, Group II 8, and Group III 2), LAT resolved in 39 patients (78%) (Group I 22, Group II 16, and Group III 1) and persisted in 11 (22%) (31±11.7 months after the first TEE) (Group I 8, Group II 2, and Group III 1). Of the 39 patients with resolved LAT, only 9 patients (23%) had CVA (CVA before TEE 7, after TEE 2). Whereas the 11 patients with persistent LAT, 7 patients (64%) had CVA (CVA before TEE 2, after TEE 9). Thus, patients with persistent LAT had a significantly higher incidence of CVA than those with resolved LAT (41%, 7/17, odds ratio 1.75 versus 23%, 9/39, odds ratio 0.30, p<0.024).

Conclusions: The incidence of CVA among AF patients who received warfarin anticoagulation before and after LAT detected by TEE is significantly lower than those with persistent LAT after LAT detection or no warfarin therapy at all. Although early and continued warfarin therapy reduces the risk of CVA in patients with LAT, persistence of LAT is associated with a high risk of CVA.

1017-3 Atrial septal Aneurysm Predicts Persistent Residual Shunt Following PFO Closure With CardioSEAL/STARFlex Occluder Device

Michael E. Zubrow, Yaser Sinra, Francis J. Kierman, Raymond McKay, Isaac E. Shervman, Sheryl Horowitz, Linda D. Gilliam, Judy R. Mangion, Hartford Hospital, Hartford, CT

Background: Interventional closure of PFO using the CardioSEAL/STARFlex (CS) device has recently become a non-surgical option for pts with PFO, who have failed medical therapy, despite reported post procedure residual shunt rates of 21-52%. This study investigated the success of CS PFO device closure at preventing residual shunting in pts with initial PFO and/or TIA with either a PFO alone or with both PFO and atrial septal aneurysm (ASA).

Methods: 33 pts diagnosed with TIA or cryptogenic stroke, who also had PFO with right-to-left shunting identified by transesophageal echocardiography (TEE) underwent percutaneous device closure of their PFO under TEE guidance. The CS device was implanted either directly or by the transseptal puncture technique. Preliminary TEE study also assessed the presence of an ASA (interatrial septal excursion of >10 mm into the right atrium). Follow-up TEE was performed 6 months post-procedure to look for residual shunting (bubbles in left atrium within 5 cardiac cycles after opacification of the right atrium).
Results: The CS device was successfully implanted in 32/33 pts (97%), 14 (42%) with ASA + PFO and 19 (58%) with PFO only. At initial placement, 9/14 (64.3%) pts with ASA + PFO and 12/19 (63.2%) pts with PFO only had a shunt immediately after placement. 3/33 pts were lost to follow-up (6%). At 6 months, 6 of 13 (46.2%) pts with ASA + PFO had residual shunting across the device during TEE compared with only 3 out of 18 (16.7%) pts who had a PFO alone. Age, gender, size of baseline shunt and method of device implantation (direct or transapical puncture) were not statistically significant factors in determining residual shunt (p>0.05).

Conclusions: The presence of an ASA in association with PFO resulted in a higher rate of persistent residual shunt in our CVA pts receiving the CS occluder device, than in similar pts with PFO alone. This would suggest that other treatment options (medication, surgery) be employed in this higher risk pt population.

Left Atrial Functional Reserve Can Predict the Long Term Prognosis of the Cardioverted Chronic Atrial Fibrillation?

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Background: The presence of atrial mechanical reserve after cardioversion (CV) of atrial fibrillation (AF) was suggested to predict 1 month recurrence in our previous study. But the long term prognostic implication of atrial functional reserve is not known.

Methods: 37 electrically cardioverted chronic AF patients were studied (M/F=28/9, 55±6yrs). LAAEV (left atrial appendage emptying velocity) and LAFFV (left atrial appendage filling velocity) were measured using transesophageal echocardiography before CV, immediately after CV and after isoproterenol infusion with increasing doses.

Transesophageal echocardiography was done at baseline, 1 month and 3 to 6 months after CV. Patients were divided into 2 groups (Group 1=23; Group 2=20).

Results: 13 of 37 patients showed AF recurrence at 1 month. AF recurred in 2 more patients at 3 to 6 months. 87% of the recurrence occurred within 1 month of CV. Baseline clinical and echocardiographic findings were similar between the two groups except that LAAEV and LAFFV were greater in the group with recurrence.

Conclusion: We suggest that the prominent increase in LAAEV and LAFFV by isoproterenol infusion immediately after CV could be used as a long term predictor of SR maintenance as well as a short term predictor.

Incidence and Prognosis of Pacemaker Lead Associated Masses: A Study of 1569 Transesophageal Echocardiograms

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Background: Endovascular lead infection is an uncommon but serious problem. Transesophageal echocardiography (TEE) is a useful tool for identification of pacemaker lead vegetations. Additionally, incidental echocardiographic masses are occasionally identified by TEE. The prognosis and optimal treatment of either suspected lead infection or an incidental mass is poorly understood. The purpose of this study was to examine the incidence and clinical course of pacemaker lead masses.

Methods: 1569 sequential TEE examinations performed from January 2002 to January 2005 were reviewed. Retrospective chart analysis of patients with a pacing lead associated mass was performed to review the indication for TEE as well as clinical management.

Telephone follow-up was also performed.

Results: During 125 TEE examinations, pacemaker leads were visualized in the right-sided chambers. Fifteen studies demonstrated an echogenic mass associated with the lead. In nine of these studies endocarditis was suspected, and the mass was felt to be a vegetation: six were treated with antibiotics alone, with one death attributed to a complication of this study. Four patients had a massive pulmonary embolus, two patients were treated with lead extraction, both were alive at follow-up, one patient was lost to follow-up after the TEE. Six patients (5%) were found incidentally to have a mass on the pacing lead during TEE: three were treated with coumadin, two received no specific therapy, and one underwent surgical debridement of the lead during surgical surgery. All of the patients in this group were alive at follow-up and no significant clinical events attributable to the lead associated mass were observed.

Conclusions: TEE identified an echogenic mass on 12% of leads imaged, with 80% having suspected endocarditis. The mortality rate of lead vegetation was 11%. An incidental mass was noted on 5% of the leads, with no significant associated morbidity or mortality observed.

Effect of Pitavastatin Therapy on the Thoracic Aorta in Hypercholesterolemic Patients Evaluated With Integrated Backscatter and Wall Thickness by Transesophageal Echocardiography

Ko-Ohno, Ryuhe Takana, Noriaki Satou, Soutarou Suzuki, Takamoto Watanabe, Syoichiro Hirata, Takai Kojima, Takeki Shinaki, Takehiro Hira, Masahiko Koda, Haruki Takahashi, Tomonori Segawa, Hitoshi Matsu, Sachio Watanabe, Gifu Prefectural Gifu Hospital, Gifu, Japan

Background: There is no known study of the effect of pitavastatin (P) therapy on the thoracic aorta. The purpose of this study was to evaluate the effect of P therapy on plaque morphology in the thoracic aorta by transesophageal echocardiography and clarify the impact of the therapy on normal tissue (NL) versus plaque (PL) in patients with hyperlipidemia.

Methods: We investigated the effects of P on progression of NL and PL of the thoracic aorta in 18 patients (pts) with atrial fibrillation (AF). The integrated backscatter (IB) values in the intima-media complex and wall thickness (TI) at the same site, in addition to high sensitivity CRP (hsCRP) were measured before and after statin therapy or diet for 7 months (P=0.01, n=10). Moreover, IB values in NL were measured in 107 pts (age62±13.6yrs) with AF to estimate age-dependent changes. Corrected IB values (cIB) were determined by subtracting those of the tunica externa.

Results: cIB (y) of NL significantly increased with age (x) (y=0.17x+30.5, r=0.87, p<0.0001). hsCRP was significantly decreased from 2.3±1.5mg/L to 1.1±1.0mg/L by P therapy.

Conclusions: This study demonstrated that P therapy significantly decreased IB values and Th in NL of the thoracic aorta and that the therapy increased IB values and significantly decreased Th in PL. This suggests that P decreased the conversion of NL to atherosclerotic lesion and induced a structural stabilization and regression of PL in the thoracic aorta in association with decrease of hsCRP.

Beta-blockers, Chronotropic Incompetence, and Functional Capacity in Severe Congestive Heart Failure

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Background: The prevalence of chronotropic incompetence (CI) in CHF and its association with impaired exercise capacity and beta-blocker (BB) use have not been clearly defined.

Methods: Symptom-limited cardiopulmonary exercise treadmill tests (CPET) of consecutive patients with CHF secondary to systolic dysfunction (EF<40%) were analyzed. Subjects with LVEF >1.3 were excluded. Subjects who failed to reach 80% of age-adjusted MHR (220-age) were categorized as having CI.

Results: In 262 men and 86 women, mean age 51 yrs, CI was present in 44%. Prevalence of CI was not different (46% versus 39%; p=NS) in subjects chronically treated (n=241) or not (n=107) with BB. CI was more common in subjects with lower VO2 (CI in 79, 48, and 22% of subjects with VO2 less than 14.0 (n=88), 14.0-19.9 (n=133), and greater than 19.9 (n=127) respectively; p<0.01, Fig 1), however, beta-blocker use was less
Heart Rate Recovery is a Stronger Predictor of Mortality Than Chronotropic Index

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Background: Recent studies have shown that both heart rate recovery from exercise (HRR) and an inadequate heart rate response to exercise (chronotropic incompetence, or CRI) during exercise testing, predict mortality. A limitation of CRI is that many different and complex methods have been used to define it, whereas HRR is simple to measure. We aim to compare the power the relative prognostic power of these two measures.

Methods: Symptom-limited exercise treadmill tests were performed in 1,415 males at the Palo Alto Veterans Affairs Medical Center from 1997 to 2002. HRR (defined as the reduction in heart rate from peak exercise to 2 minutes into recovery) and CRI (defined as age-adjusted percentage of maximal heart rate achieved) were calculated, and proportional hazards analysis was performed with all-cause mortality as the endpoint.

Results: 110 deaths occurred over a mean follow-up period of 2.8±1.8 years. Both HRR and CRI were independently predictive of all-cause mortality (hazard ratio for HRR and CRI were 0.86, 95% CI 0.82-0.91) and 0.86, 95% CI (0.76-0.98) respectively, p<0.01). However, when both were considered in a multivariate model, only HRR remained significant, yielding a 20% reduction in mortality for each 5 beat decrease in HRR (p<0.0001), while CRI was not associated with mortality. Subjects whose HRR was 50 beats at 2 minutes post-exercise.

Conclusion: HRR more powerfully predicts mortality than CRI during exercise testing.

Can Exercise Induced Heart Rate Variability Spectral Slopes Provide Insights Into Autonomic Activity and Prognosis?

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Background - The heart rate (HR) increase seen during exercise is characterized by vagal withdrawal and increased sympathetic activity; the reverse occurs in recovery, thus lowering HR. This pattern provides an opportunity to evaluate current heart rate variability (HRV) spectral theories (i.e. low frequency components are sympathetic and high frequencies are vagally mediated).

Methods: Spectral analysis was performed on R-R interval data from 1,959 veterans (95% male, mean age 58 ± 12 years) undergoing exercise testing. Broadband log spectral slopes were computed across the band 0.04 to 1.0 Hz for six windows covering exercise and recovery and the resulting spectral slopes (HRVSS) were evaluated. Multivariate Cox survival analysis was performed using standard clinical and exercise test variables as well as HRVSS.

Results - For the entire population, the low frequency components of the spectra dominate at the start of exercise and during the later phase of recovery. Peak exercise

is characterized by a reversal of spectral slope, with the high frequency components, traditionally thought to represent vagal modulation of HR, dominating. During a mean follow-up of 5 years, 176 (9%) subjects died and 55 (31%) of these deaths were due to cardiovascular (CV) causes. The spectral slopes for the CV patients show a strongly

mutated response to exercise. In the age adjusted multivariate model, only METs, abnormal ST depression and the spectral slope difference between peak exercise and mid-recovery (MR-PE) were independent and significant predictors of CV mortality. MR-PE had a mean value of -0.74 ± 0.83 for CV deaths and -1.35 ± 0.82 for all others (P<0.001). MR-PE was second only to METs in predicting cardiovascular prognosis, with a hazard ratio of 3 for an increase of one standard deviation (95% CI 1.5-6.6, p<0.001).

Conclusions - The HRVSS difference between mid-recovery and peak exercise is an independent predictor of CV mortality in our study population but in a manner counter to current theories for the physiological genesis of the spectral components of HRV.

Impact of Age on the Prognostic Value of Cardiopulmonary Exercise Testing in Subjects with Heart Failure

Ross Arena, Jonathan Myers, Marco Guazzi, Virginia Commonwealth University, Richmond, VA

Background: Cardiopulmonary exercise testing (CPX) is frequently utilized in the heart failure (HF) population in part because of its prognostic value. The HF population is, however, far from homogeneous with respect to a number of factors, including the age at which cardiac dysfunction begins. The purpose of the present study was to examine the impact of age on the prognostic characteristics of peak oxygen consumption (VO2) and the minute ventilation/carbon dioxide production (VE/VO2) slope.

Methods: Four hundred and four subjects with HF participated in the study. Two hundred and twenty-six subjects (42.5% ischemic/37.5% non-ischemic, 21.2% female) were < 60 years of age [mean = 47.8 (±6.9) years]. The remaining 178 subjects (68.5% ischemic/31.5% non-ischemic, 15.2% female) were ≥ 60 years of age [mean = 68.4 (±6.5) years]. All subjects underwent CPX and tracked for cardiac mortality.
Exercise Testing Is Feasible, Efficacious and Cost-Effective in the Prediction of Cardiovascular Events in the Very Elderly as Compared With Dipyridamole Te-99m Sestamibi Spect

Luciano Vacari, Andrei Saposnik, Heart Institute - InCor-DF, Brasilia, Brazil

Background: To define the prognostic value and cost-effectiveness (CE) of treadmill test (TT) using the Duke treadmill score (DTS) as compared with Dipyridamole Te-99m Sestamibi (SPECT) in patients ≥75 years.

Methods: We studied 66 individuals (40% men) with a mean age of 81 ± 5 years. Among them, 65% had comorbidities, 28% presented with atrial fibrillation and 12% with typical angina. The TT protocol was a ramp modified of the Bruce protocol. Ischemia was diagnosed using current guidelines. Death, acute coronary syndromes and coronary revascularization were considered major cardiovascular events (MACE). We compared DTS and TT CE as cost per event detected by abnormal SPECT and as cost per event detected by intermediate and high DTS, respectively. The variables with a p-value ≤ 0.05 were considered statistically significant.

Results: The percent maximal predicted heart rate achieved was 95 ± 18%. The calculated METs and the heart rate systolic blood pressure product at peak exercise were respectively: 7 ± 2 and 249 ± 6 (bpm x mm Hg). Ischemic changes occurred in 14 (21%) subjects during TT and in 10 (15%) during SPECT and the correlation concordance was 0.63 (p < 0.01). After the 68 ± 11 days of follow-up 6 deaths, 1 CABG and 2 episodes of unstable angina occurred. Univariate variables associated with MACE included: age (83 ± 6 vs 80 ± 4 years; p = 0.08), male gender (78% vs 33%; p = 0.02), ST depression (1 ± 1 vs 0.25 ± 0.6 mm; p = 0.01), intermediate and high DTS (44% vs 2%; p = 0.01) and abnormal SPECT (44% vs 10%; p = 0.02). After adjustment for confounding variables high or intermediate DTS risk and age were the only variables identified as an independent predictor of MACE (HR 8.5, 95% CI 2.35-66.6; p = 0.003 and HR 1.92, CI 0.1-1.4-0.0, p = 0.003, respectively). The CE ratio of applying SPECT in order to predict one event case was $34,440 for low risk, $14,280 for intermediate risk and $2,240 for high risk subjects. The CE ratio of applying TT for the same purpose was $77,295 and $467, respectively.

Conclusion: TT and SPECT are comparable for assessing overall myocardial ischemia in the very elderly. The high and intermediate DTS is superior to predict MACE when compared to SPECT and TT has a lower resource requirement.

A Controlled Exercise Training Trial in Patients With Diastolic Dysfunction

Neil A. Smart, Brian Nakauka, Carole Ritchie, Thomas H. Marwick, University of Queensland, Brisbane, Australia

Background: Exercise training (ExT) improves functional capacity in systolic heart failure, but the role of ExT in diastolic dysfunction patients (DD) is unclear.

Methods: Twenty four DD patients were randomized to ExT or normal treatment. ExT was completed in 15 patients (8 men, 63 ± 14 years, LVEF 55 ± 8%) and 9 DD patients underwent usual treatment (7 men, 58 ± 8 years, LVEF 57 ± 7%). Peak VO2, quality of life QOL, Minnesota Living with Heart Failure (MLWHF) and Hare-Davis (HD) questionnaires and echo measures (EF, systolic [5m] and diastolic tissue velocity [Em] and filling pressure [E/E’]) were performed at baseline and 16 weeks ExT.

Results: Both groups showed similar baseline VO2 (13.2 ± 5.8 vs 16.4 ± 4.4 ml/kg/min, p = 0.16), 5m (5.2 ± 1.2 vs 6.0 ± 0.9 cm, p = 0.10) and E/E’ (21.6 ± 12.2 vs 10.0, p = 0.12) but different Em (3.7 ± 3.8 cm/s vs 6.6 ± 1.6, p = 0.04). Baseline MLWHF and HD scores were similar in both groups. After ExT, the increment in peak VO2 was significantly greater in ExT (27%) versus control group (3%, p = 0.02). Increment in peak VO2 was predicted by baseline E wave velocity (r = 0.77, p < 0.001), but not by changes in echo parameters. The only echo parameter which responded to training was contractile reserve (r = 0.02) versus usual treatment group. At 12 weeks, there was a significant improvement in the total (p = 0.01) and emotional (p = 0.008) dimensions of MLWHF and HD (p = 0.05) scores.

Conclusions: In patients with exercise limitation attributed to DD, there is a significant improvement in peak VO2 and QOL with ExT, in addition to usual medical therapy. This improvement appears unrelated to changes in diastolic function.

Oxygen Uptake Efficiency Slope and Survival in Patients With Systolic Heart Failure

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Background: Peak VO2 and V̇E/VCO2 slope are related to survival in heart failure (HF) patients. Maximal oxygen uptake efficiency slope (OUES) is also related to survival in HF. The purpose of this investigation was to determine if OUES, calculated using four different methods (peak, and submaximal data), is related to survival in HF.

Methods & Results: We identified 338 patients from our prospective database with documented HF (EF < 22%). We determined the peak VO2 and V̇E/VCO2 slope by least-squares linear regression analysis during cardiopulmonary exercise testing (CPX) from the start of the test to the point at which the patient was unable to perform further exercise. Peak VO2 and VO2 at the V̇E/VCO2 slope were used as primary endpoints. The relationship between peak VO2 and V̇E/VCO2 slope and survival was evaluated using Cox regression analysis.

Conclusions: Peak VO2 is a strong predictor of survival in patients with HF. Additionally, several submaximal OUES values also are related to survival. Importantly, these submaximal methods do not require peak exercise effort which is required for peak VO2 and V̇E/VCO2 slope determination. Thus, submaximal OUES provides promise as a method for prognostic assessment in patients with heart failure who do not, or cannot, achieve a physiological maximum on a graded exercise test.

Relationship of Cardiac Hemodynamics and Ventilatory Efficiency, Inefficiency, and Their Mortality Prediction in Patients With Heart Failure

Robert L. Bard, John M. Nicklas, Brenda W. Gillespie, University of Michigan, Ann Arbor, MI

Background: Ventilatory inefficiency (VE/VCO2 slope) during cardiopulmonary exercise testing (CPX) is a strong and independent predictor of mortality in heart failure. Since VE/VCO2 slope is usually lower in patients who die, it is a possible marker of fatal arrhythmias or pulmonary compromise. The purpose of this study was to determine if there is a relationship between VE/VCO2 slope and data obtained from clinical right heart catheterizations (RHC).

Methods & Results: Heart failure patients (n = 92, 70% males, age 52 ± 10 years) underwent RHC after CPX testing and had follow-up for at least 5 years for the testing data. Mean follow-up was 3 ± 1.9 years and there were 28 events (30%, 27 deaths and 1 emergent cardiac transplant). VE/VCO2 slope (36.5 ± 4.9) and peak VO2 (16.7 ± 4.8 ml/kg/min) were significant mortality predictors in a multivariable Cox model that included SBP (113 ± 17 mmHg), EF (19 ± 9%), sex, and HR (82 ± 15 beats/min). No hemodynamic variable, gender, or covariate was predictive of mortality in the multivariable model. Since VE/VCO2 slope reflects underlying cardiac hemodynamic abnormalities, the purpose of this study was to determine if there is a relationship between VE/VCO2 slope and data obtained from clinical right heart catheterizations (RHC). There was no correlation between VE/VCO2 slope and the RHC hemodynamic data.

Conclusions: The superior predictive ability of VE/VCO2 slope was not explained by data obtained from RHC.

A Biphasic Improvement Following Cardiac Resynchronisation Therapy

Ashlyn P. Patwala, Paul Woods, Diane Barker, Khaled Albaouane, David F. Goldspink, Lip-Bun Tan, David J. Wright, The Cardiothoracic Centre, Liverpool, United Kingdom

Background: Cardiac Resynchronisation therapy (CRT) is recognised as a treatment for patients with heart failure and electromechanical dyssynchrony. The studies to date have shown improvements in functional class and peak VO2. Our study was designed to investigate the physiological changes underpinning these improvements.

Methods: 41 patients (mean age 64 ± 38) were assessed pre, 2 weeks, 6 weeks, 3 and 6 months post CRT. At each visit the subjects performed maximal cardiopulmonary exercise testing. Peak VO2, peak and resting cardiac output (CO) via O2 rebreathing, Cardiac Power Output (CPO) and Cardiac Reserve (CR) were measured. Peak Skeletal muscle torque was measured using a Biodesi isokinetic dynamometer. A repeated measures ANOVA was used to look for differences between tests.

Results: 2 weeks Post CRT there was a significant improvement in exercise duration, NYHA class and CPOpeak, CR and peak VO2 were improved at 6 weeks. At 6 months post CRT a further significant improvement had occurred compared to 6 weeks post test (see table, results shown as mean ± SE (SD)).

Conclusion: Post CRT a biphasic improvement is seen. There is an initial improvement due to improved CPOpeak and Peak VO2 A second improvement occurs between 6 weeks and 6 months, which coincides with an improvement in Peak Skeletal muscle torque during extension. This improvement, which can be explained by the chronic muscular deconditioning seen in heart failure, may explain the secondary improvement in functional capacity seen in this study.
ABSTRACTS - Diagnostic Testing

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Exercise Training in Addition to Cardiac Resynchronization Therapy to Maximize Patient Benefit

Ashish V. Patwaria, Paul Woods, Diane Barker, Simon G. Williams, David F. Goldspink, Lip-Bun Tan, David J. Wright, Cardiothoracic Centre, Liverpool, United Kingdom

Background: Cardiac Resynchronization Therapy (CRT) is a recognized treatment for suitable patients with heart failure. The effect of exercise training in addition to CRT has not been investigated.

Method: 20 patients referred for CRT were recruited. Patients were randomised to either a control or an exercise group. Patients were tested pre, 3 and 6 months post CRT. At each visit the subjects performed maximal cardiopulmonary exercise testing. Peak lower limb skew was measured using a Bodex isokinetic dynamometer. Between the 3 and 6 month test the exercise group underwent supervised exercise training 3 times a week, performing 20 min of walking and 10min of cycling at 80 % maximal heart rate. Paired t tests were used to look for statistical significance.

Results: At baseline there was no significant difference in any measure between the control and exercise group. At 3 months post both groups showed increases in NYHA class, Exercise Duration, Peak VO2, CPO2, CR, and Skeletal muscle mass were unchanged. After exercise training there was a further increase in NYHA class. Exercise Duration, Peak VO2, CPO2, CR and peak lower limb torque during extension. In the control group no significant changes occurred in any measure (see table, results shown as mean (SE)).

Conclusion: Exercise training after successful CRT leads to a further improvement in haemodynamic measures and skeletal muscle strength. We feel exercise rehabilitation should be offered to all patients following CRT.

1017-29

Ventricular Efficiency for Monitoring CHF Therapy: A Need for Method Standardization

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Background: Ventilation efficiency (VE), the linear relation between ventilation and CO2 output has been shown to provide the most powerful, independent predictor of CHF survival. Discrepancy exists as to whether sub-max (SM) vs. max exercise is more appropriate for clinical application of VE. It is hypothesized that VE standardization is of clinical importance to assess CHF patient risk status and response to therapy.

Methods: Ninety two subjects, 53 males/39 females of mean age 64±17 yrs, were exercised using CPX treadmill testing. Data was analyzed retrospectively as three subgroups: normal, heart disease/pacemaker (HD/PM) and CHF. A CRAA system (St. Paul, MN) was used to measure and standardize VE. Linear regression slope calculations. The VE slopes were analyzed with partitioning of 3 exercise phases: (A) rest to peak exercise (B) phases of CPX and (C) RCP-PK.

Results: VE slopes showed significant improvements (range 32.7 to 38.5 %) in the VE slope during (C), as compared to (B) phases of exercise, CHF pts. having the greatest increase. The VE slope throughout phase A yielded significant increases, as compared to phase B, ranging from 12 to 13.7 %.

Conclusion: VE should be standardized using SM exercise. SM testing permits easier, more tolerable testing representative of daily activity. SM levels of VE may provide more appropriate and accurate risk stratification for monitoring of CHF therapy.

VENTILATION EFFICIENCY DATA

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<th>Subject Type</th>
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1017-30

Relationship Between Cardiopulmonary Exercise Testing and Pulmonary Pressures in Hypertrophic Cardiomyopathy

Ross Arena, David S. Owens, Kevin Smith, Said A. Mohiddin, Dorothy MacAreeay, Karen L. Usifenu, Lameh Fananapaziri, Jonathan F. Pehr, NIH/NHLBI Cardiovacular Branch, Bethesda, MD, Virginia Commonwealth University, Richmond, VA

Introduction: Cardiopulmonary exercise testing (CPX) reflects resting hemodynamics in patients with dilated cardiomyopathy and primary pulmonary hypertension. The relationship has not, however, been reported in patients with hypertrophic cardiomyopathy (HCM) and intact systolic function.

Methods: We reviewed CPX and right heart catherizations performed during a single admission to the NIH Clinical Center in a series of 87 subjects (54 male/33 female, mean age = 39 ±10 years, NYHA I-III mean = 1.7) with non-obstructive HCM, normal left ventricular ejection fraction and absence of valvular heart disease. Peak oxygen consumption (VO2) in ml kg^-1 min^-1, minute ventilation (VE) and carbon dioxide production (VCO2) were measured by CPX and compared to systolic pulmonary artery pressure (PAP) and mean pulmonary capillary wedge pressure (PCWP) at rest. The mean time between CPX and right heart catherization was 3.4 days (± 8.9). To account for multiple testing, a significance level of p<0.01 was used.

Results: Resting PCWP correlated with RCP (r = 0.80, p<0.001), Systolic PAP correlated with RCP (r = 0.59, p<0.001), PAP < 30 mmHg (sensitivity/specificity = 75%/75%), PAP > 30 mmHg (sensitivity/specificity = 59%/85%) and PAP > 40 mmHg (sensitivity/specificity = 75%/75%).

Conclusion: CPX correlates with invasively-determined resting hemodynamics in patients with non-obstructive HCM with a PCWP of 35 at peak exercise effectively discriminating between normal and elevated PAP and, to a lesser extent, PCWP Assessment of VE/VCO2 at peak exercise may be useful in the routine evaluation of patients with non-obstructive HCM.

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Exercise Capacity but Not BMI is Associated With Mortality in Patients Referred for Exercise Myocardial Perfusion Imaging

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Background: While the inverse correlation between exercise capacity and mortality is well established, the relationship between body mass index (BMI) and mortality is less clear. We examined the influence of BMI and exercise capacity on mortality in a retrospective analysis of patients referred for exercise myocardial perfusion imaging (MPI) in our nuclear cardiology laboratory.

Methods: 3,025 patients underwent exercise MPI from 1995 to 1999. BMI, Bruce protocol exercise time, presence of known CAD, average number of CAD risk factors (diabetes mellitus, hypertension, dyslipidemia, family history, smoking), age, sex, and summed stress score (SSS, a measure of the extent and severity of perfusion defects from a 20 segment model of the left ventricle) were recorded. Mortality outcomes were obtained from the Social Security Administration Death Master File.

Results: There were 262 deaths (8.7%) over an average of 7.5 years of follow-up. Mortality decreased with increasing BMI and increasing exercise time. However, higher BMI patients were younger, more likely female, and had less known CAD. The following variables were significantly associated with mortality (p<0.05) in a Cox proportional hazards model: exercise time (inverse), age, male sex, and known CAD (all direct).

Conclusion: The effect of exercise capacity on mortality is more important than BMI in our population. BMI was inversely related to mortality but was not statistically significant after other variables were taken into account.
Right Ventricular Injury and Dysfunction During Endurance Sports

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BACKGROUND Convincing associations between cardiac dysfunction and biochemical evidence of injury after endurance sports are lacking. We have previously suggested an association between right ventricular (RV) dysfunction and increased serum troponin after participation in endurance sports among younger athletes. We aimed to establish whether there was a similar association among an older cohort of participants.

METHODS 25 senior non-competitive marathon participants were screened with echocardiography and serum troponin T (cTnT) pre and post the 2005 Boston Marathon. Echocardiography included conventional measures as well as tissue Doppler (TD) derived peak endocardial systolic velocities ($V_{ENDO}$), strain ($\varepsilon$) and strain rate (SR) imaging.

RESULTS Our cohort had an average age of 50±6 years, a corrected LV mass of 109±9 g/m$^2$ and a finish time of 4 hr 14 ± 24 mins. Compared to pre-race screening, 60% of participants had a significant rise in cTnT. On imaging there were significant decreases in RV $V_{ENDO}$ and $\varepsilon$ without a concomitant increase in RV area or dimensions. RV systolic pressure increased. Serum cTnT increases correlated with the reduction in RV $V_{ENDO}$ ($r = 0.7, p < 0.001; r = 0.7, p = 0.001; base and mid$) and RV $\varepsilon$ ($r = 0.7, p < 0.001; r = 0.9, p < 0.001; base and mid$).

CONCLUSIONS Marathon running is associated with biochemical evidence of myocardial damage and correlative echocardiographic signs of subtle RV dysfunction. This relationship suggests the possibility of right heart stress during endurance sports.