

POSTER SESSION

1031 Echo Assessment of the Left Atrium and Interatrial Septum

Sunday, March 18, 2001, Noon-2:00 p.m.
 Orange County Convention Center, Hall A4
 Presentation Hour: Noon-1:00 p.m.

1031-133 Degree of Patent Foramen Ovale Shunting Quantified by Transthoracic Transmitral Doppler Is Associated With Likelihood of Cryptogenic Cerebral Ischemic Events

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Background: Despite a 20 to 30 percent incidence of patent foramen ovale (PFO) in the general population, strokes attributable to paradoxical embolism are uncommon. A non-invasive method to identify those patients at higher risk of stroke due to paradoxical embolism would provide a rational basis for treatment decisions. **Aims:** This study compared the degree of trans-PFO shunting in patients with cerebral ischemia and PFO using transmitral Doppler (TMD), a recently validated transthoracic echo (TTE) method to quantify bubble passage. Patients without additional risk factors other than PFO (cryptogenic events) may have a greater degree of shunting.

Methods: TMD recordings are made at the mitral leaflet tips during saline contrast study at rest and after a maneuver to provoke right-to-left shunt. Bubble transit corresponded to high intensity signals in the velocity envelope of the mitral inflow profile. Bubble transit is quantified by taking the integral of the acoustic power within the maximal mitral envelope during contrast injection, divided by the integral of the acoustic power before contrast for any given patient. Ischemic events were classified as cryptogenic (C) or non-cryptogenic (NC) according to TOAST criteria.

Results: 32 of 101 (32%) consecutive patients referred for TTE TMD saline contrast study after cerebral ischemic events had a PFO detected. Of these 32, 21 (66%) had cryptogenic vs. 11 (33%) had non-cryptogenic events. Bubble passage measured by normalized acoustic power was significantly greater in the C group than in the NC group after the provocative maneuver.

	NC (n=11)	C (n=21)	
Rest	45±86	65±82	P = 0.07
Maneuver	57±86	94±78	P = 0.03

Patients with > 5 bubbles in the maximal beat were more likely to have a cryptogenic stroke, both at rest (OR = 9, p = 0.02), and with maneuver (OR=7.92, p = 0.03).

Conclusions: Because larger shunts detected by transthoracic TMD are associated with otherwise cryptogenic events, the technique may be useful in the decision analysis of PFO closure after cerebral ischemia.

1031-134 Interatrial Septal Aneurysms Predict Larger Shunts Across Patent Foramen Ovale: An Analysis by Transmitral Doppler

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Background: The association of patent foramen ovale with cryptogenic stroke is strongest in patients with larger trans-PFO shunts and those with interatrial septal aneurysms (IASA). We postulate that the potency of IASA as a risk factor for cerebrovascular accidents may relate to the size of the shunt across PFOs associated with IASAs. The size of shunt in PFOs associated with IASAs is unknown.

Purpose: We compared the degree of right to left shunting across PFOs in patients with and patients without IASA using the recently validated transmitral Doppler (TMD) technique.

Methods: Consecutive patients referred for transthoracic saline contrast study were entered. All had transthoracic 2D and TMD contrast studies. TMD recordings were made at the mitral leaflet tips during saline contrast study at rest and after a maneuver to increase right to left shunting. Bubble transit corresponded to high intensity signals in the velocity envelope of the mitral inflow profile. Bubble transit in the maximal mitral profile is reported semi-quantitatively using a 0 to 4 bubble score (0 = no bubbles; 1 = 1 to 5 bubbles; 2 = 6 to 10 bubbles; 3 = >10 bubbles without envelope saturation; 4 = envelope saturation). TMD score has been shown to correlate defect size with the severity of shunt. IASA was present if 1) the base width ≥ 1.5 cm and 2) ≥ 1.1 cm excursion into either the left or the right atrium or a sum of the total excursion into the left or right atrium of ≥ 1.1 cm.

Results: Of 160 consecutive patients 57 had a PFO. Of these, 19 patients had IASAs. Atrial septal motion could not be assessed in three (3) patients due to study quality. Bubble scores were significantly higher (p = 0.0001) among patients with IASAs. Of note, all patients with IASA had bubble scores of ≥ 3.

TMD Bubble Score	IASA (n = 19)	No IASA (n = 35)
0	0	3
1	0	10
2	0	9
3	5	9
4	14	4

Conclusion: Interatrial septum aneurysms are associated with larger right-to-left shunts across PFOs. This observation may have important diagnostic and management implications in patients with unexplained stroke and IASA.

1031-135 Predictors of Left Atrial Appendage Clot: A Transesophageal Echocardiographic Study of Left Atrial Appendage Function in Patients With Severe Mitral Stenosis

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Background: Left atrial appendage (LAA) is the major site of clot formation in severe mitral stenosis (MS). There are not enough studies properly evaluating LAA function in a large number of patients (pts) with isolated severe MS. The purpose of this study was to analyze the LAA function with LAA clot and spontaneous echo contrast (SEC). **Method:** LAA function [LAA-ejection fraction (EF), peak filling and emptying velocities and their velocity time integrals (VTIs)] was prospectively evaluated in 200 consecutive pts (mean age 30.2 ± 9.4 years, 51.5% females) of severe MS by transesophageal echocardiography (TEE). Pts with more than mild mitral regurgitation, significant aortic valve disease, previous valvulotomy and on anticoagulation or antiplatelet therapy were excluded. Twenty normal controls were compared. **Result:** Fifty five (27.5%) were in atrial fibrillation (AF). LAA clot was present in 25% pts and 56.5% had SEC. On univariate analysis the older age, increased duration of symptoms, AF, SEC, larger LA area, depressed LAA function and type II and III-LAA flow pattern correlated significantly (p<0.05) with LAA clot. LAA-EF was significantly less in pts with clot (21.8 ± 12.8% Vs 39.1 ± 13.2%, p<0.0001) and with SEC (30.3 ± 16.2% Vs 40.3 ± 11.3%, p<0.001). LAA filling (18.0 ± 11.7 Vs. 27.6 ± 11.8 cm/s, p<0.001) and emptying (15.4 ± 7.0 Vs 21.5 ± 9.6 cm/s, p<0.001) velocities and filling (1.4 ± 1.0 Vs 2.5 ± 1.4 cm, p<0.0001) and emptying (1.5 ± 1.2 Vs 2.1 ± 1.2 cm, p<0.05) VTIs were also significantly lower in pts with clot. Similarly pts with SEC had significantly lower filling and emptying velocities and VTIs. On multivariate regression analysis, AF and LAA-EF were the only independent predictors of LAA clot formation. Pts with LAA-EF < 25% had 62.5% incidence of clot as compared to 10.4% with LAA-EF >25%. In a subgroup of the pts with sinus rhythm (NSR) the LAA-EF was significantly less in pts with clot (31.2 ± 13.2 Vs 41.2 ± 11.5%, p<0.01) and was the only predictor of clot formation. **Conclusion:** We conclude that in the pts with severe MS, besides AF, a subgroup of pts in NSR with depressed LAA -EF (< 25%) had a higher risk of LAA clot formation and we suggest that these pts should be routinely anticoagulated for prevention of LAA clot.

1031-136 High Grade Left Atrial Spontaneous Echo Contrast Is a Potential Risk for Micro-Emboli in Cerebral Circulation in Patients With Atrial Fibrillation Under Anticoagulants

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Background. Presence of left atrial spontaneous echo contrast detected in patients with atrial fibrillation has been reported as a potential risk factor for cerebral ischemic event. However, whether spontaneous echo contrast in left atrial cavity is the actual source of micro-emboli in cerebral circulation remains to be clarified. **Methods.** Study patients consisted of 24 chronic atrial fibrillation patients, who received anticoagulant therapy (prothrombin time 1.83 ± 0.16 INR). We evaluated spontaneous echo contrast in the left atrial cavity quantitatively as an integrated backscatter intensity using transesophageal echocardiography. Calibrated -left atrial - integrated backscatter was calculated as difference between digital integrated backscatter image sequences of the left atrial cavity and the right atrial cavity under the same gain settings in all patients. Then, we estimated micro-emboli in middle cerebral arteries as the counts of high intensity transient signals during 30 minutes in transcranial Doppler recordings. **Results.** In all patients, integrated backscatter in the left atrial exceeded that in right atrial. Calibrated left atrial - integrated backscatter was closely correlated with high intensity transient signals counts (p<0.0005, r=0.69). **Conclusions.** Atrial fibrillation patients with high grade spontaneous echo contrast in the left atrial have frequent incidence of micro-emboli in middle cerebral arteries, in whom more intensive anticoagulant therapy will be required.

POSTER SESSION

1032 Cardiovascular Magnetic Resonance: Plaque and Lumen

Sunday, March 18, 2001, Noon-2:00 p.m.
 Orange County Convention Center, Hall A4
 Presentation Hour: Noon-1:00 p.m.

1032-137 Feasibility of Using High Resolution MR Imaging of Atherosclerotic Plaque in an Epidemiological Study

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Background: It has been previously shown that magnetic resonance imaging (MRI) is capable of identifying various atherosclerotic plaque tissue types and monitoring the progression of lesions. This study is to demonstrate the feasibility of performing high resolution (HR) carotid MRI of atherosclerotic plaque in an epidemiological study.

Methods: MRI scans were performed on the carotid arteries of 28 (17 female, mean age = 85) members of the Cardiovascular Health Study (CHS) at a participating site using a (HR) imaging protocol on a GE SIGNA scanner. The protocol included 3D time-of-flight (TOF), T1-weighted, and proton density-weighted (T1W and PDW) cross sectional images of bilateral carotid arteries centered at the bifurcation. A specially designed bilateral phase-array carotid coil was used. Flow suppression techniques were applied in T1W and PDW images to highlight soft tissues in the vessel wall. Images were reviewed to evaluate: (1) the image quality (IQ) - based on a scale of 1-5 with 5 being the highest; (2) lesion type - I = normal, II = diffuse thickening, III = eccentric small core, IV = eccentric large core, V = total occlusion; and (3) diameter reduction (DR) based on tracing the luminal and outer wall boundaries. An IQ rating was assigned to each series of images.

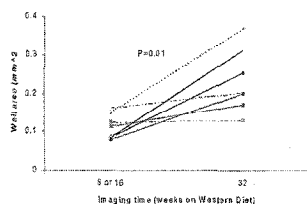
Results: The overall scan time was around 40 minutes (including set up time), and all subjects tolerated the scan. The mean IQ was 3.5 among all subjects and series of images (an IQ of 3 was considered average). Of the 56 arteries available for review (28*2 with three series of images each), all can be reviewed with at least one series of images. Lesion types were as follows: 7 in type I, 7 in II, 20 in III, 22 in IV, and none in V. There were 22 cases with 31-40% DR, 17 cases with 41-50% DR, 1 case with >50% DR, the rest has < 30% DR.

Conclusions: This elderly cohort tolerated the scan with an above average IQ. Preliminary review of the images showed that valuable information on plaque lesion type and distribution may be obtained, in addition to lumen narrowing. This study demonstrated the feasibility of using the HR MRI in an epidemiology study.

1032-138 Serial, Non-invasive, High Resolution Magnetic Resonance Microscopy Measures Progression of Atherosclerosis in Apolipoprotein E Deficient Mice

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Background: Atherosclerosis is under investigation in a large number of genetically engineered mouse models. No technique has been capable of monitoring atherosclerotic lesion size in vivo. We therefore sought to determine the utility of serial magnetic resonance microscopy (MRM) in detecting lesion progression. **Methods and Results:** In vivo MRM was performed with a Bruker 9.4 - Tesla, 89mm-bore system operating at a proton frequency of 400MHz. Thirty two contiguous, 500um thick transverse slices were obtained (100um in-plane resolution, spin echo sequence). For MRM validation experiments, apolipoprotein E knockout (apoEKO) mice (n=16) were derived from studies of atherosclerosis progression and regression. Selection (according to: age; plasma lipoprotein profile and diet) incorporated mice with a wide range of severity of atherosclerosis, and included normal aortas. Selected MRM and perfusion-fixed histological sections (n=43) were aligned using anatomical landmarks and the aortic wall area measured in both. There was a strong correlation ($R^2=0.72$; $P < 0.0001$) between aortic wall area measured by MRM and histopathology. To test the ability of serial MRM to detect lesion progression, three further EKO mice underwent MRM at 8 to 16 weeks and again at 32 weeks after commencement of an atherogenic (Western) diet. Corresponding MRM slices (n=7) from the two scans were aligned. Mean (\pm SD) wall area at the earlier vs later timepoints was 0.114 (\pm 0.034) vs 0.234 (\pm 0.084)mm² ($P=0.01$, paired t test). See figure. **Conclusions:** MRM accurately quantifies aortic wall area when compared to histopathology. Progression of atherosclerosis can be measured in vivo by MRM alone. This technique will enable serial, non-invasive assessment of atherosclerotic plaque in mouse models of progression and regression.



1032-139 Serial In Vivo Magnetic Resonance Imaging of Luminal Narrowing After Carotid Arterial Injury in Apolipoprotein-E Deficient Mice

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Background: Apolipoprotein-E-deficient (apoE^{-/-}) mice experience severe hyper-cholesterolemia and develop atherosclerotic lesions similar in cellular content and vascular localization to those in humans. We have developed a model of carotid artery wire injury in apoE^{-/-} mice which results in accelerated neointimal growth and luminal narrowing. To follow lesion development serially, we developed magnetic resonance imaging (MRI) methods to detect luminal narrowing.

Methods: The right and left carotid arteries of 4 fourteen week-old apoE^{-/-} mice were imaged serially 1 week before (baseline) and 2, 4 and 6 weeks after wire injury of the left carotid artery (LCA). A gated spin-echo sequence was used to collect axial images with a field of view (FOV) of 2x2 cm² with a matrix of 256x256, resulting in a spatial resolution of 78x78x750 μm³. Using the carotid bifurcation as a fiducial marker, carotid artery luminal area was measured along the axial length of each vessel at each of the 4 time points by MRI and at the time of sacrifice by histomorphometry.

Results: Significant luminal area narrowing of the LCA was successfully detected by MRI at 2 weeks (16±26%, p=0.01), 4 weeks (29±26%, p=0.0007), and 6 weeks (30±20%,

p<0.0001) after arterial injury as compared to baseline (pre-injury). No statistically significant luminal narrowing of the non-injured RCA was observed. Luminal area measurements from MR images were successfully correlated with corresponding histological cross sections ($y=1.1x + 75,000$, $R^2=0.32$).

Conclusions: Luminal narrowing after carotid wire injury of apoE^{-/-} mice was successfully detected using serial magnetic resonance imaging and correlated with histologic luminal area. This method provides a powerful and expeditious tool to non-invasively track the natural progression of neointima formation in response to arterial injury in mice.

1032-140 Coronary Magnetic Resonance Angiography Using a Free-Breathing, T2 Weighted, Three-Dimensional Gradient Echo Sequence With Navigator Respiratory and ECG Gating Can Be Used to Detect Coronary Artery Disease

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Background: Coronary magnetic resonance angiography (CMRA) is a promising technique for noninvasive imaging of the coronary artery tree. We sought to assess the feasibility and accuracy of CMRA using a free breathing, T2 weighted, three-dimensional gradient echo (3DGRE) sequence, with navigator respiratory and ECG gating.

Methods: Twenty-five (25) consecutive pts scheduled for coronary angiography (CA) were studied. CMRA was carried out prior to CA. After localization of the heart, imaging slabs were directed to the expected location of the proximal native coronary arteries. Images were obtained using a 3DGRE sequence with navigator respiratory and ECG gating. Lengths of the visualized segments of the left main (LM) trunk, left anterior descending (LAD), left circumflex (LCX) and right coronary (RCA) arteries were measured. Significant coronary artery disease (CAD) was defined as >50% diameter stenosis. The proximal coronary artery tree was defined as LM trunk, LAD segment prior to the first septal perforator and the proximal one third of LCX and RCA arteries. Coronary artery lengths and presence of significant CAD were determined by consensus of three reviewers who were blinded to CA results. Sensitivity and specificity of coronary MRA to detect significant CAD was calculated using CA as the gold standard.

Results: Twenty-three pts (92%) were able to complete the study. Mean age was 60±14 yrs and 44% were females. Mean visible length was 12±6 mm for LM, 52±14 mm for LAD, 39±12 mm for LCX and 86±38 mm for RCA. Sixteen (16) pts (70%) had significant disease on CMRA compared to 12 pts (52%) on CA. The sensitivity and specificity for CMRA to detect significant CAD were 92% and 55% respectively. In the proximal coronary artery tree alone, 10 pts (43%) had significant CAD on both CMRA and CA and the sensitivity and specificity of CMRA were 90% and 92% respectively.

Conclusion: CMRA using a free breathing, T2 weighted, 3DGRE navigator gated technique is highly sensitive for the detection of significant CAD. It is also highly specific for the detection of significant CAD in the proximal coronary artery tree. Large-scale studies are needed to confirm the usefulness of this technique.

1032-141 Coronary Magnetic Resonance Angiography (CMRA): The Gold Standard for Determining the Proximal Course of Anomalous Coronary Arteries

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Background: X-ray cineangiography has been the imaging modality of choice for assessment of the coronary arteries. However, this technique does not reliably delineate the proximal course of anomalous coronary arteries in relation to the aorta or pulmonary trunk. This information is often critical to the management of these patients. Preliminary data indicates that CMRA is an effective tool in defining the proximal course of these arteries. We investigated the value of CMRA in 12 patients with angiographic suspicion of anomalous coronary arteries with uncertain course.

Methods: Each patient was scanned on a 1.5 T magnet (GE Signa; General Electric Medical Systems, Milwaukee, WI.) After scout images were obtained, axial T1-weighted spin echo sequences were used to determine the location of the aortic and pulmonary trunk. This was followed by series of cardiac-gated, segmented fast gradient echo images (TR/TE/Flip Angle = 12/4/20°) with slice thickness = 4mm during breath holding. In addition to axial gradient echo sequences, other sequences were individualized based on the results of the prior images.

Results: MRA correctly delineated the origin and proximal course of the coronary vessels in all 12 patients. Two patients had normal origin and course of the coronaries. In two patients the circumflex originated off of the right coronary artery (RCA) with proximal course posterior to the aorta. In five patients there was slight displacement of the origins of one of the coronary vessels as assessed qualitatively by three readers. One patient had an RCA arise from the left main coronary artery (LMCA) and coursing between the aortic and pulmonary trunk. Another patient had an anomalous origin of the LMCA off of the right coronary ostium with a proximal course between the aortic and pulmonary trunk. One patient had a common ostium of both right and left coronaries behind the pulmonary artery with possible compression.

Conclusion: CMRA is a non-invasive and accurate technique for diagnosis and management of patients with anomalous coronary arteries. In this series, it correctly identified every anomaly. This degree of accuracy qualifies CMRA as the gold standard for assessing coronary anomalies.

POSTER SESSION

1033 Refining Risk Stratification in Patient Subsets

Sunday, March 18, 2001, Noon-2:00 p.m.
Orange County Convention Center, Hall A4
Presentation Hour: Noon-1:00 p.m.

1033-142 Role of Myocardial Perfusion Imaging in Predicting Early and Late Cardiac Events After Renal Transplantation

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Background: Renal transplantation improves morbidity and survival in patients with end stage renal disease (ESRD) but predictors of early and late cardiac events (CE- cardiac events and non-fatal MI) are not well known.

Methods: This study examined the role of stress SPECT myocardial perfusion imaging in predicting peri-operative and late CE. Between 1993-98, 1731 patients received renal transplantation at UAB medical center for ESRD. Of those, 461 patients had pre-operative stress SPECT imaging for risk stratification. There were 290 men and 171 women aged 47.5 ± 1.25 years.

Results: During a mean follow up of 3.8 years, there were 10 peri-operative and 25 late CE. There were 380 patients with normal and 81 patients with abnormal SPECT. Univariate and multivariate predictors of peri-operative, late and total CE are shown in the table. Kaplan-Meier CE free survival was 86% in patients with normal SPECT and 77% in patients with abnormal SPECT. Based on log rank test the survival function for normal and abnormal cohorts are significantly different ($p < 0.01$).

Univariate predictors(OR, p value)

	Peri-operative	late	total
Age	-	+(1.04, 0.04)	+(1.04, 0.01)
SPECT	+(0.13, 0.002)	+(0.3, 0.005)	+(0.27, 0.0007)
History of MI	+(5.2, 0.01)	-	-

Multivariate predictors(OR, p value)

	Peri-operative	late	total
Age	-	-	+(1.04, 0.04)
SPECT	+(0.2, 0.02)	+(0.3, 0.006)	+(0.3, 0.002)

Conclusion: Pre-operative stress SPECT imaging is highly predictive of early and late cardiac events in renal transplant patients.

1033-143 Risk Stratification Using Technetium-99m Sestamibi SPECT Imaging With IV Dobutamine Stress

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Background: Dobutamine stress with myocardial perfusion imaging (MPI) has become a common procedure in risk stratifying patients for cardiac events when they are unable to adequately perform treadmill exercise and have contraindications to vasodilator stress. However, there is a paucity of data regarding the prognostic value of dobutamine stress combined with Tc-99m sestamibi SPECT imaging (DOB-MIBI).

Methods: The joint database acquired by our nuclear laboratories over the past 4 years was screened for patients referred for DOB-MIBI. All patients were clinically referred to evaluate ischemia using graded dobutamine stress (5 to 40mcg/kg/min.). Atropine (0.4 - 1.0 mg.) was given to increase heart rate as required. Perfusion scans were read by 2 experienced readers blinded to clinical data and using a 7 segment model (normal vs. abnormal, normal vs. fixed vs. reversible, normal vs. single vessel vs. multivessel disease). Follow-up was obtained through telephone and mail contact, hospital records, and physician records. The primary endpoint was cardiac death or non-fatal myocardial infarction.

Results: Of 615 patients identified, 6 patients were lost to follow up and 106 patients were revascularized within 3 months of their study. In the remaining 503, the mean age was 66 ± 12.2 years, the mean follow-up time was 16 ± 9 months, and 37 (7.4%) had events. In the group with events, 27 (73%) had abnormal images. The group with no defect had fewer events (10, 3.8%) compared to the group with any defect (27, 11.2%) ($P=0.002$). Patients with multivessel perfusion defects had more events (15.4%) than patients with normal images (3.8%) ($P < 0.001$).

Events versus Extent of Perfusion Abnormality

Group	No Event	Yes Event
Normal	251 (96.2%)	10 (3.8%)
1 vessel disease	133 (91.7%)	12 (8.3%)
Multivessel disease	82 (84.5%)	15 (15.4%)*

* $P < 0.001$ versus Normal

Conclusion: In an unselected clinical population, the presence and extent of perfusion defects on a DOB-MIBI study predicts cardiac death and non-fatal myocardial infarction.

1033-144 Normal PET Myocardial Perfusion Imaging in Women With Chest Pain Predicts a Low Cardiovascular Event Rate and Favorable Long Term Clinical Outcome

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Background: Myocardial perfusion scintigraphy using positron emission tomography (PET) is a non-invasive diagnostic method highly suited for imaging women. By eliminating artifacts due to soft tissue attenuation, PET reportedly achieves a high degree of accuracy in identifying the presence or absence of coronary artery disease (CAD). Whether women with chest pain who are identified by PET as having normal perfusion actually have a low incidence of subsequent cardiac events has not yet been determined.

Methods: We conducted a follow-up study of 301 consecutive women who fulfilled the following criteria: (1) History of chest pain or suspected CAD, (2) pharmacologic stress PET studies showing normal perfusion, and (3) no history of pre-existing coronary artery disease (defined as prior myocardial infarction [MI], percutaneous transluminal coronary angioplasty [PTCA], coronary artery bypass grafting [CABG], or coronary angiography showing $\geq 50\%$ stenosis of ≥ 1 vessel). Follow-up was obtained by structured telephone interviews to patients and/or to their physicians and mailed questionnaires, supplemented by review of medical records and search of mortality registries. Cardiac events were defined as ischemic death, non-fatal MI, PTCA, or CABG. Event rates were determined by the Kaplan-Meier product limit estimate method; follow-up was censored after initial event. Mean follow-up of event-free patients was 2.7 ± 1.1 years. **Results:** Mean age of the population was 63.2 ± 11.9 years. Mean number of cardiac risk factors per patient was 2.1 ± 0.9 . No cardiac events occurred within 1 year of PET. Six cardiac events, comprising 3 nonfatal MIs, 2 PTCA's and 1 CABG, occurred 2.8 ± 1.1 years (range: 1.3 - 3.3 years) post PET. There were no ischemic deaths. Cardiac event rate was 0.74%/yr. **Conclusions:** In women with chest pain, no prior history of coronary disease, and significant cardiac risk factors, a normal stress PET predicts a very low cardiac event rate. Thus, a normal PET imaging study may serve as an important marker of favorable long-term clinical outcome in this patient population.

1033-145 Gated Myocardial Perfusion SPECT Has Incremental Value for Predicting Cardiac Death in Diabetic Patients

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Background: Stress myocardial perfusion SPECT (MPS) effectively risk stratifies diabetic patients (pts) for cardiac events, but the incremental value of ejection fraction (EF) from gated MPS is unknown.

Methods: Of 714 consecutive pts with diabetes who underwent exercise or adenosine gated MPS, 19 pts (2.6%) were lost to follow-up and 118 pts were censored for early revascularization (≤ 60 days post MPS). The remaining 577 pts were followed up 655 ± 229 days (all ≥ 1 year). The mean age was 67.9 ± 10.8 years, 38.3% were woman, and 59.4% underwent adenosine stress. Summed stress (SSS) perfusion scores were calculated by adding 20 visually assessed stress segment scores using a 5-point scale (0=normal and 4=no uptake); previously defined SSS categories were used: normal (0-3), mildly abnormal (4-8), moderately abnormal (9-13), and severely abnormal (>13). EF categories were $\geq 45\%$ and $<45\%$. Risk factors, type of stress, SSS and EF were evaluated by Cox proportional hazards method for predicting cardiac death.

Results: The 16 pts with cardiac death had higher SSS (20.3 vs 8.9, $p < 0.001$) and lower EF (34.2% vs 52.6%, $p < 0.001$) than surviving pts. In addition, EF ($\chi^2 = 4.1$, $p = 0.042$) added incremental value to SSS ($\chi^2 = 5.4$, $p = 0.020$) for the prediction of cardiac death, as pts with left ventricular dysfunction (EF $< 45\%$) had a much higher annual rate of CD (4.2% vs 0.4%, $p < 0.001$).

Annual Rate of CD

EF	Summed Stress Scores				Total
	0-3	4-8	9-13	>13	
$\geq 45\%$	0.2%	0.0%	0.0%	2.1%	0.4%
$< 45\%$	0.0%	2.2%	5.3%	5.2%	4.2%
Total	0.2%	0.5%	1.9%	4.2%	1.5%

Conclusion: Functional data (EF) from gated MPS adds significant incremental value for risk stratification of diabetic patients over perfusion data alone.

1033-146 The Prognostic Value of Stress Technetium-99m Sestamibi Gated Single Photon Emission Computed Tomography in Patients With Dilated Cardiomyopathy

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Background: Dilated Cardiomyopathy (DCM) has a high morbidity and mortality in cardiac failure patients. Studies have tried to identify prognostic parameters, including functional status, left ventricular ejection fraction (LVEF). Few studies have evaluated the use of stress technetium-99m sestamibi Single-Photon Emission Computed Tomography (G-SPECT) as a determinant of the clinical course of DCM. Moreover, there are no data on the ability of a combined assessment of perfusion and function to predict cardiac events in this population.

Methods: One-hundred sixty-three consecutive patients with LVEF $\leq 35\%$ who had cardiac catheterization and stress G-SPECT within 12 weeks were identified. Fifteen patients revascularized within 3 months of stress imaging were excluded. The remaining patients were followed for the occurrence of non-fatal myocardial infarction or sudden cardiac death up to 1 year from G-SPECT. Angiograms were read by a consensus of 2

readers blinded to nuclear data and patients were classified as ischemic (n = 99 [67%]), non-ischemic (n = 25 [17%]), or combined (n = 24 [16%]). G-SPECT images for perfusion and function were read by 3 nuclear cardiologists, by consensus, blinded to catheterization data, using a standard 17-segment model and scoring system. For each image, a summed stress score (SSS), summed rest score (SRS), a summed wall motion score (SWMS), and LVEF were calculated.

Results: Follow-up was obtained in 134 (91%) patients. Of these, 17 (13%) had a cardiac event within 1 year of G-SPECT (11 [65%] ischemic, 2 [12%] non-ischemic, and 4 [24%] combined). Using a combined assessment of perfusion and function in risk stratification, patients with a SSS <7 or a SWMS <34 were classified as *Low Risk* (n = 58 [43%]), whereas patients with a SSS ≥7 and a SWMS ≥34 were classified as *High Risk* (n = 76 [57%]). As shown below, the *High Risk* group had a significantly higher cardiac event rate.

	Low Risk	High Risk	p value
Cardiac Events	3 (5.2%)	14 (18.4%)	0.022
SSS	13.8 ± 9.2	21.5 ± 11	< 0.001
SWMS	27.7 ± 11.8	45 ± 7	<0.001

Conclusion: This is the first study to show that Stress Tc-99m G-SPECT successfully risk stratifies patients with DCM (EF < 35%).

plaque verified the existence of temperature heterogeneity inside the individual plaques. This method can provide significant information on the spatial distribution of temperature in the diseased arterial wall, and probably help us identify vulnerable spots inside the plaque.



1034-149 New Application of Intracardiac Echocardiography With Color and Pulsed Doppler Imaging for Evaluation of Coronary Blood Flow

Masakazu Teragaki, Iku Toda, Keiji Ujino, Ryo Otsuka, Shota Fukuda, Kumiko Hirata, Hiroyuki Watanabe, Takashi Muro, Kazuhide Takeuchi, Junichi Yoshikawa. *Osaka City University, Osaka, Japan*

Background: We evaluated the ability of a newly developed phased-array, multifrequency intracardiac echocardiographic (ICE) imaging catheter with longitudinal scan plane, and with color and pulsed Doppler capability (Acuson Inc. Mountain View, CA) to detect and measure coronary blood flow from a right atrial position. **Methods:** Using seven beagle dogs we investigated Doppler imaging of coronary flow in addition to two-dimensional image. A 10F catheter with phased-array transducer was advanced into the right atrium, from the femoral vein through an 11 Fr sheath. The catheter was manipulated using the 4-way articulation control. When coronary arteries were visualized by two-dimensional image, the coronary flow was detected by color Doppler imaging and the velocity was measured by pulsed Doppler at baseline and during hyperemia (adenosine 5'-triphosphate, bolus injection of 20 mcg/kg). Coronary flow reserve (CFR) from ICE was compared to that from Doppler guidewire examination simultaneously in the left anterior descending artery. **Results:** We visualized 7 left main (100%), 6 left anterior descending (85%), 7 left circumflex (100%), and 5 right (71%) coronary arteries of all 7 animals by two-dimensional and/or color Doppler images. We measured the coronary flow velocity by pulsed Doppler at baseline and during hyperemia (14.1 ± .7 to 34.5 ± 3.0 cm/s, n = 17, p < .0003). The reproducibility of coronary flow measurement was good (measurement 1 vs 2, r = .87, p < .0001). CFR from ICE correlated highly with that from Doppler guidewire examination (r = .94, p < .0001). **Conclusion:** ICE is capable to visualize coronary artery and measure the coronary flow velocity by Doppler imaging. Therefore, ICE can be a useful tool to evaluate coronary circulation.

POSTER SESSION

1034 Intracardiac and Intravascular Ultrasound

Sunday, March 18, 2001, Noon-2:00 p.m.
Orange County Convention Center, Hall A4
Presentation Hour: Noon-1:00 p.m.

1034-147 Segmentation Method Distinguishing Ischemic Nonviable, Ischemic Viable, and Normal Myocardium in a Reperfusion Model

Charles J. Bruce, Xiaohui Hao, Cristina Pislaru, Marek Belohlavek, James F. Greenleaf. *Mayo Clinic and Mayo Foundation, Rochester, MN*

Background: Using high resolution intracardiac echocardiography (ICE) and custom software, tissue texture differences can be quantitated in reperfused myocardium to distinguish ischemic non-viable, ischemic viable, and normal myocardium. We evaluated this semi-automatic system against established staining methods. **Methods:** 5 pigs were studied in an open chest balloon-occlusion myocardial infarction model. Epicardial beads were placed on the anterior wall spanning the area at risk. This area was divided into 3 zones; infarct, zone 1; border, zone 2; and normal, zone 3. The LAD was occluded for 60 minutes followed by 30 min reperfusion. ICE (8.5MHz) of the selected region was performed. The heart was removed and area at risk and infarct determined by Evans Blue and TTC staining. Using the beads as fiducial markers, representative samples from each zone were selected manually for tissue feature analysis. The software analyzed the tissue features from these selected regions and segmented the raw ultrasound image accordingly into 3 zones. The segmented ultrasound (US) images were compared to zoning of the corresponding stained and spatially matched gross specimens. The process was repeated to test the influence of user-defined image sampling for computer driven feature differentiation. **Results:** In all 5 animals there was reproducible visual correlation between the 3 zones in the segmented images and corresponding gross specimens. An example is shown in the graphic below:



Conclusion: Using high resolution intracardiac echocardiographic images, this semi-automatic segmentation technique can reproducibly distinguish ischemic viable and normal reperfused myocardium in a controlled experimental setting.

1034-148 3-D Thermal Reconstruction of the Atherosclerotic Plaque. A New Insight Into Plaque Vulnerability by Means of Thermography and Advanced Computer Algorithms

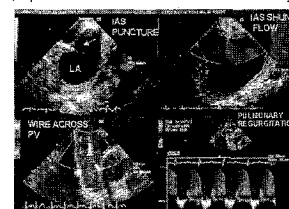
Leonidas D. Diamantopoulos, Glenn Van Langenhove, Pim De Feyter, David Folley, Patrick W. Serruys. *Interventional Cardiology Dept, THORAXCENTER, ROTTERDAM, The Netherlands*

Background: Plaque temperature has been associated with plaque vulnerability. However, the detailed temperature distribution inside the atherosclerotic plaque is still unknown. **Methods:** For the purpose of this study, we studied the aorta of 5 atherosclerotic rabbits. For studying the plaque we used a new catheter-based system that was developed in our laboratory, and has the capability of simultaneous intravascular echogram and temperature sampling at the same place. In each animal, low-speed (0.5mm/sec) retraction of the special catheter was performed and all data were recorded digitally to a computer-based main unit. By means of an image and data analysis software, written in C++ computer language, data was combined and 3-dimensional (3-D) thermal reconstruction of the plaque was performed. The computer coded the individual regional temperatures to colors, based on the Red-Green-Blue code (Flashing Red for 43°C and Dark Blue for 33°C), and built the 3-D thermal image of the area under measurement. **Conclusions:** The 3-D color-coded thermal mapping of the atherosclerotic

1034-150 Non fluoroscopic Guidance of Interventional Procedures Using a Phased-Array Imaging and Hemodynamic Ultrasound Catheter (AcuNav): In vivo Experimental Studies

Peng Li, Ismail Dairywala, Zheng Liu, Biju Mathew, Dana Bowie, Mani Vannan. *University of Michigan Health System, Ann Arbor, MI*

Background: Fluoroscopy (FL) is limited by radiation exposure and provides poor anatomic and hemodynamic information during cardiac interventions. We studied the utility of guiding interventional procedures with intracardiac echocardiography (ICE) without FL, using a new phased-array ultrasound imaging and hemodynamic catheter. **Methods:** In 11 dogs, a 10F ICE catheter (AcuNav, Acuson Corp.) was advanced into the right heart via either a jugular or femoral vein. The IVC, SVC, RA, RV, TV, PV, MV, AV, interatrial septum (IAS) and the ascending aorta (AA) were imaged. Transseptal puncture was done using a guide wire, Mullins sheath and Brockenbrough needle. Balloon mitral and pulmonary valvuloplasties (BMV and BPV) and atrial septostomy were done using a Mansfield balloon dilatation catheter. 2-D echo, color and spectral Doppler of relevant structures were done pre- and post procedure. **Results:** Imaging of the great veins, IAS, valves and AA was successful during all 38 (100%) attempts at optimal positioning of the ICE catheter. Of 29 attempts at IAS puncture, 25 were successful (86%); in 4 attempts optimal needle position was not attained. Balloon IAS septostomy was accomplished in all 9 attempts (100%) with full anatomical and hemodynamic assessment of the resultant interatrial shunt. BMV (4) and BPV (18) was successful in all attempts (100%) followed by visualization of the ruptured chordae, disrupted leaflets and Doppler estimation of valvular regurgitation and transvalvular gradients. There were no major procedural complications. **Conclusions:** ICE as the sole modality to guide cardiac interventions is feasible using this new ultrasound catheter, which provides excellent instantaneous anatomical and hemodynamic information. Further studies are necessary to determine if ICE can obviate the need for FL, optimize interventions and reduce major complications.



POSTER SESSION

1035 Contrast Echocardiography and the Microcirculation

Sunday, March 18, 2001, Noon-2:00 p.m.
Orange County Convention Center, Hall A4
Presentation Hour: Noon-1:00 p.m.

1035-151 Adhesion of P-Selectin-Targeted Microbubbles to Venules: Implications for Imaging Inflammation

Ji Song, Jonathan Christiansen, Alexander L. Klibanov, Klaus Ley, Sanjiv Kaul, Jonathan R. Lindner. *University of Virginia, Charlottesville, VA*

Background. We have previously shown that inflammation can be assessed by ultrasound imaging of microbubbles that attach to activated leukocytes within venules. We hypothesized that microbubble retention within the microcirculation of inflamed tissue could be enhanced by targeting microbubbles to the endothelial adhesion molecule P-selectin.

Methods. P-selectin-targeted microbubbles (MB_p) were made by conjugating a monoclonal antibody against murine P-selectin to a biotinylated lipid microbubble. Microbubbles with isotype control antibody (MB_{iso}) or without antibody (MB) were also made. Flow cytometry with fluorescein-labeled antibodies was used to confirm antibody conjugation to the microbubble shell. The microvascular behavior of these microbubbles was assessed using intravital microscopy of TNF- α -treated (n=5) and control (n=5) cremaster muscles of mice. Twenty optical fields (OF) were observed 5 min following venous injection of 5x10⁶ microbubbles.

Results. Flow cytometry confirmed a mean of >30,000 antibodies conjugated to each microbubble. On intravital microscopy, microbubble retention in control animals was occasionally observed for MB_p (2 \pm 1 per 20 OF) and was rare (<1 per 20 OF) for MB_{iso} and MB. In TNF- α -treated animals, the number of microbubbles retained was greater (p<0.01) for MB_p (16 \pm 4 per 20 OF) compared to MB_{iso} (4 \pm 2 per 20 OF) or to MB (2 \pm 1 per 20 OF). The mechanism for retention of MB_p was both leukocyte and endothelial attachment, whereas retention of MB_{iso} and MB was mediated exclusively by direct leukocyte attachment.

Conclusions. Microbubble retention within the microcirculation of inflamed tissue may be enhanced by targeting microbubbles against specific endothelial adhesion molecules. These results suggest that endothelial inflammatory responses and other phenotypic alterations of the vascular endothelium can be assessed using ultrasound and site-targeted microbubbles.

1035-152 Myocardial Contrast Echocardiography Is a Feasible Method to Evaluate Neovascularization by Autologous Implantation of Bone Marrow Cells

Takashi Nishiue, Hiroshi Kamihata, Hiroaki Matsubara, Soichiro Fujiyama, Yoshiaki Tsutsumi, Mari Tokioka, Toshiji Iwasaka. *Kansai Medical University, Moriguchi, Japan*

Background: Therapeutic angiogenesis is a promising novel approach for treatment of coronary artery disease, while appropriate methods have not yet established to evaluate neovascularization. As pre-clinical studies, we have studied angiogenesis in ischemic myocardium by autologous implantation of bone marrow cells (BMC), which is a natural source of both endothelial progenitor cells and a broad spectrum of angiogenic ligands. We tested whether 1. BMC induce angiogenesis resulting in a beneficial response to infarcted hearts, 2. myocardial contrast echocardiography (MCE) can be used to evaluate the effect of angiogenesis by BMC on microstructure.

Methods: Bone marrow-derived mononuclear cells (10⁷ cells/site x30) obtained from mini-swine ilium or medium alone (control) were injected into the ischemic myocardium due to LAD ligation (n=5, each). MCE (venous infusion of Levovist, intermittent harmonic imaging, short axis slice) were performed, and background-subtracted peak intensity (PI) in the LAD bed and contrast defect (expressed as % of total left ventricular area) were calculated 1 hour and 3 weeks after LAD ligation. Left ventricular (LV) ejection fraction (EF) and end-diastolic LV volume (EDV) were also measured simultaneously. Finally, histologic analyses were performed.

Results: Both BMC and control-injection groups had similar contrast defect (18 \pm 2.6 vs. 17 \pm 2.3%) 1 hour after LAD ligation. After 3 weeks, BMC caused a marked increase in PI (3.0-fold), in good agreement with the increase in capillary vessel densities (2.8-fold) in the border of infarcted myocardium. Interestingly, opacification in BMC-myocardium was observed in the infarct area but not in control; contrast defect (3.1 \pm 1.1%) underestimated the histologically defined size of infarction (21 \pm 1.2%). EF was improved, and the increase in EDV was prevented by BMC.

Conclusions: 1. Autologous BMC enhances microvascular development and perfusion in the border area of infarcted myocardium, leading to the prevention of LV remodeling. 2. MCE is a promising tool for the assessment of neovascularization; however MCE likely overestimates myocardial viability after angiogenic therapy.

1035-153 Bioeffects of Microbubble Destruction by Echocardiography: Implications for Perfusion Imaging and Drug Delivery

Shuyuan Chen, Martin H. Kroll, Ralph V. Shohet, Susan Mayer, Paul A. Grayburn. *UT Southwestern Medical Center, Dallas, TX, VAMC, Dallas, TX*

Background: Microbubble destruction during contrast echo is known to cause capillary leaks and red blood cell extravasation in skeletal muscle. This study was done to evaluate the bioeffects of microbubble destruction on cardiac muscle.

Methods: Contrast echo was performed in 46 rats randomized to either Definity or Optison (0.1mL over 15 min) at a mechanical index (MI) of 1.6, 1.2, or 0.8. LV fractional area shortening was measured at baseline and day 7. Histopathology was assessed at day 7 after euthanasia. In addition, blood samples for troponin T were drawn at baseline and days 1, 4, and 7.

Results: There was no evidence of myocardial damage in terms of LV function or histopathology. However, troponin T increased over time, peaking at day 4 and returning to normal by day 7 (p=0.002). The difference between Definity and Optison was not statistically significant. However, on day 4, troponin T was 40-fold higher at a MI of 1.6 than at 1.2 or 0.8 (p=0.05).

Troponin T Values

	Baseline	Day 1	Day 4	Day 7
MI 1.6	<0.01	0.03 \pm 0.06	0.43 \pm 0.83	<0.01
MI 1.2	<0.01	0.02 \pm 0.03	0.011 \pm 0.002	<0.01
MI 0.8	<0.01	<0.01	<0.01	<0.01

Conclusions: Microbubble destruction at maximal acoustic power causes troponin T elevation in the absence of LV dysfunction or histopathological evidence of myocardial damage. This has important implications regarding high power techniques for myocardial perfusion imaging and drug delivery by contrast echo.

1035-154 Microvessel Injury Induced by Ultrasound Exposure With First Generation Contrast Agent: Dominantly Damaged Venular and Capillary Endothelium

Nobuhiko Kobayashi, Takanori Yasu, Masatoshi Kuroki, Masanobu Kawakami, Muneyasu Saito. *Jichi Medical School Omiya Medical Center, Omiya, Japan*

Background: The safety of contrast echo agents are generally verified in the drug approval process. However, some investigators have reported harmful bioeffects such as intestinal bleeding and hemolysis. We investigated the influence of ultrasound exposure on microvessels during intravenous infusion of Levovist®. **Methods:** A phased-array system transmitted ultrasound to the rat mesentery during intravenous injection of Levovist®. Both higher (30 Hz) and lower frame rate (1 Hz) were applied to four rats. Three kinds of control rats were also prepared as follows: neither Levovist® injection nor ultrasound exposure, only Levovist® without ultrasound and only ultrasound without Levovist®. After the ultrasound exposure, we examined microvessel rupture in the mesentery by optical observation. Subsequently, propidium iodide (PI) was locally applied over the mesentery to evaluate cell injury in microvessels. PI is a fluorescent indicator of cell injury. When a cell is damaged, PI cross the cell membrane and binds to the nuclear DNA. We evaluated the number of PI positive nuclei in microvessel wall compared with the controls. The distribution of PI positive nuclei was also evaluated among 3 portions of microvessels (arteriole, capillary and venule). **Results:** There was only one rupture site in a capillary out of 40 capillaries but not in arterioles (n=38) or venules (n=42) after ultrasound exposure at higher frame rate with Levovist®. Any microvascular rupture was not observed in the other rat group. The number of PI positive cells were not different among the three control rat groups. Ultrasound exposure with Levovist® significantly increased PI positive cells compared with the controls : 1.8 \pm 1.7 (per 100 mm vessel length, mean \pm SD) at 1 Hz, 7.0 \pm 6.1 at 30 Hz ; p<0.01. In the rats exposed to ultrasound at the higher frame rate, PI positive cells were more frequently observed in venules (13.6 \pm 3.4) and capillaries (4.3 \pm 1.9) compared with arterioles (0.7 \pm 1.0). **Conclusion:** Ultrasound exposure with Levovist® potentially causes microvessel injury especially at higher frame rate. In the microcirculation, the adverse bioeffect by contrast echo is dominant in venules and capillaries compared with arterioles.

POSTER SESSION

1036 Stress Echocardiography: Impact on Prognosis

Sunday, March 18, 2001, Noon-2:00 p.m.
Orange County Convention Center, Hall A4
Presentation Hour: Noon-1:00 p.m.

1036-155 Stress Echocardiography for Risk Stratification of Patients With Chest Pain and No Obstructive Coronary Lesion

Alessandro Desideri, Riccardo Bigi, Lauro Cortigiani, Jeroen J. Bax, Carlo Sponzilli, Diego Castini, Cesare Fiorentini. *Cardiovascular Research Foundation, Castelfranco Veneto, Italy, "S. Paolo" Academic Hospital, Milan, Italy*

Background: Stress echocardiography (SE) can provide prognostic assessment of patients with coronary artery disease (CAD). We assessed its prognostic value in patients with chest pain syndrome but no angiographic evidence of obstructive CAD. **Methods:** 125 patients (60 \pm 10 years, 60 F) with known (35 with previous myocardial inf-

arction) or suspected CAD (90) and no angiographical evidence of >70% diameter narrowing in epicardial coronary arteries or their major branches underwent pharmacological (48 dipyridamole and 77 dobutamine)SE. Mean follow-up time was 36±22 months. Target events were: cardiac death, nonfatal infarction and clinically-driven revascularization. The ability of clinical and SE variables to predict outcome was assessed by Cox's proportional hazard model using univariate and stepwise multivariate procedures. A statistically significant increase in global chi-square of the model after the addition of further variables was considered to indicate incremental prognostic value. **Results:** SE was positive in 32 and negative in 93 pts. Seven events occurred: 1 fa-tal, 4 nonfatal infarctions and 2 revascularizations following unstable angina. Hyper-tension, positive SE and peak wall motion score index were multivariate predictors of outcome, but SE provided 87.5% (from 16 to 30) increase in the global chi-square of the model (p<0.001). Patients with positive SE had a significantly lower event-free survival as compared to those with negative SE. **Conclusions:** Functional assessment by SE provides incremental prognostic information in patients with chest pain and no angiographic evidence of obstructive CAD.

1036-156 Chronotropic Incompetence vs. Echocardiographic Ischemia in Prognosis of High Risk Patients With Coronary Artery Disease

Dejan Orlic, Miodrag Ostojic, Branko Beleslin, Goran Stankovic, Ana Djordjevic-Dikic, Ivana Nedeljkovic, Milan Nedeljkovic, Sinisa Stojkovic, Vladan Vukcevic, Jelena Stepanovic. *Institute for CVD, Belgrade, Yugoslavia*

Objectives: The prognostic importance of chronotropic incompetence (CRI) among high risk patients (pts) referred for stress echocardiography (stress-Echo). **Background:** Although CRI has been shown to be predictive of an adverse prognosis in low and medium risk population, it is not well explored in high risk population. **Methods:** Consecutive high risk (electrocardiographic and/or echocardiographic ischemia) pts (102 men and 8 women; mean age 57.7 y) who were not taking beta blockers and were referred for symptom-limited treadmill stress-Echo were followed for a mean of 22 months. Chronotropic incompetence was defined as failure to achieve 85% of the age-predicted maximum heart rate. **Results:** The primary end point comprising of angina, nonfatal myocardial infarction, myocardial revascularisation (either PTCA or CABG) and death occurred in 62 pts. Chronotropic incompetence was found in 37.7% of Echo+ECG+ pts, in 41.7% of Echo+ECG- pts and in 39.4% of Echo-ECG+ pts (p=NS in Echo+ECG- vs. Echo-ECG+ pts) and was not predictive in coronary events in all three subsets of pts (relative risk (RR) 1.17, 95% confidence interval (CI) 0.5 to 2.5, p=NS). Echocardiographic ischemia was predictive of coronary events in Echo+ECG+ pts (RR 10.1, 95% CI 2.9 to 35.3, p=0.0003) and Echo+ECG- pts (RR 5.6, 95% CI 2.2 to 14.7, p=0.0004). **Conclusion:** Chronotropic incompetence was unproductive of coronary events in high risk patients. Echocardiographic ischemia irrespective of ECG findings was associated with increased risk of coronary events.

1036-157 Transient Left Ventricular Cavity Dilatation During Stress Echocardiography Is a Strong Predictor of Cardiovascular Mortality

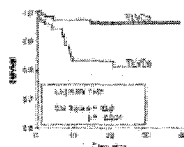
Binoy K. Singh, J. Mahenthiran, Varinder P. Singh, Madhu Jyothinagaram, Manish Undavia, Siu-Sun Yao, Farooq A. Chaudhry. *Columbia University St. Luke's Roosevelt Hospital Center, New York, NY*

Background: We have previously shown that the presence of transient left ventricular cavity dilatation (TLVD) during stress echocardiography (SE) predicts the presence of multivessel coronary artery disease. However, the prognostic significance of TLVD during SE is unknown.

Methods: Two hundred six patients (pts) (145 males (70%), mean age 63 ± 11 years), all of whom demonstrated ischemia during SE, were divided into two groups based on the presence (TLVDp: 91 pts (44.2%)) or absence (TLVDa: 115 pts (55.8%)) of TLVD. TLVD was defined as an increase in end systolic left ventricular dimensions from baseline to peak stress. Mean follow up time was 18 ± 8 months.

Results: Fifteen (16%) cardiovascular deaths occurred in the TLVDp group. Four (3%) cardiovascular deaths occurred in the TLVDa group. TLVDp and TLVDa groups did not differ significantly in demographic or clinical data other than a significant difference in left ventricular ejection fraction (LVEF) (p=0.006; 23%±13 vs. 28%±14, respectively). Using univariate analysis, older age (p=0.006), lower LVEF (p=0.012), and the presence of TLVD (p<0.001) were significant predictors of cardiovascular mortality. Using multivariate analysis, both older age (p=0.012; risk ratio = 1.9 per 10 years; 95%CI 1.1 to 3.1) and the presence of TLVD (p=0.004; risk ratio=5.0; 95%CI=1.6 to 15.1) were significant predictors of cardiovascular mortality.

Conclusion: The presence of TLVD during SE is a significant predictor of cardiovascular mortality.



1036-158 The Effect of Supine Bicycle Exercise on the Change of Right Ventricular Pressure and Function in Children Late After Repair of Tetralogy of Fallot

Manatomo Toyono, Kenji Harada, Masamichi Tamura, Kenji Yasuoka, Goro Takada. *Akita University, Akita, Japan*

Background: Exercise stress test has a possibility of assessing post-operative right ventricular (RV) functional reserve in patients after repair of tetralogy of Fallot (TOF). No quantitative data exists on the change of RV systolic pressure (RVP) and RV function in response to exercise. The aim of this study is to evaluate changes in RVP and RV function using echocardiography combined with tissue Doppler imaging (TDI). **Methods:** We studied 18 patients (11±3 years) who had undergone surgery for TOF at 2-3 years of age and 15 age-matched healthy children. Echocardiography combined with TDI was performed at rest and during supine bicycle submaximal exercise. RVP was estimated at rest and during exercise by maximal tricuspid velocity (V). RV end-diastolic and end-systolic areas were measured from a 4-chamber view, and area shortening fraction (SF) was calculated. TDI of tricuspid annulus movement during systole (Sa) was also obtained from a 4-chamber view. **Results:** At rest, RVP in patients was higher than that in controls (31±7 vs 21±4mmHg, p<0.05). Rv area SF did not show significant differences between the 2 groups (43±6 vs 48±7%). Sa in patients was lower than that in controls (6.4±1.9 vs 8.7±1.2cm/sec, p<0.05). During exercise, the magnitude of exertional RVP augmentation in TOF was 12±4mmHg, which did not differ from controls (11±4mmHg). Although RV area SF in patients did not change during exercise (3±4%), a significant increase was observed in the controls (15±4%). Sa in the 2 groups increased significantly during exercise, however, the magnitude of increases in Sa was significantly less in patients than in controls (43±12 vs 95±23%, p<0.01). **Conclusions:** Echocardiography combined with TDI allows the evaluation of changes in RVP and RV function in response to exercise in TOF patients. An insufficient increase in RV area SF and Sa suggests impaired response to exercise of RV in TOF patients.

POSTER SESSION

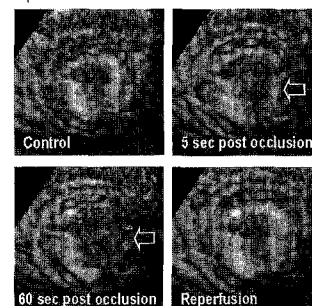
1064 Echo Assessment of Regional and Global Function

Sunday, March 18, 2001, 3:00 p.m.-5:00 p.m.
Orange County Convention Center, Hall A4
Presentation Hour: 3:00 p.m.-4:00 p.m.

1064-133 Echocardiographic Evaluation of Left Ventricular Wall Motion Using Still-Frame Functional Parametric Imaging

Enrico G. Caiani, Roberto M. Lang, Jeanne DeCara, Keith A. Collins, Claudia E. Korcarz, Lynn Weinert, James E. Bednarz, Victor Mor-Avi. *University of Chicago, Chicago, IL*

Assessment of LV wall motion is based on visual interpretation of dynamic 2D images and depends on the reader's ability to integrate spatial and temporal information, which is difficult in patients with poorly visualized endocardium. The aim of this study was to test the feasibility of evaluating wall motion using still-frame functional parametric images obtained in an animal model of ischemia and in patients with poor acoustic windows. **Methods.** In protocol 1, an intracoronary balloon was placed in the proximal LAD in 6 anesthetized pigs. Integrated backscatter images were obtained (Agilent 5500) in the short axis view: 1) under control conditions, 2) 5 sec after complete coronary occlusion, 3) 1 min post occlusion, and 4) during reperfusion. In protocol 2, short-axis and apical 4-chamber images were obtained in 24 patients (15 with wall motion abnormalities; 9 controls) during contrast enhancement (Optison bolus or Definity infusion). Digital images from one cardiac cycle were analyzed off-line. For each pixel, the videointensity over time was fitted with a sinusoidal function, and a parametric image was created by displaying the local amplitude of this function divided by its mean value. **Results.** In all animals, the baseline parametric images showed a bright band around the LV cavity, in the area spanned by the endocardial boundary. Coronary occlusions resulted in a gradual decrease in the thickness and brightness of this band in the LAD territory, concurrent with hypokinesis noted in the dynamic images, which resolved during reperfusion (figure). In 14/15 patients, wall motion abnormalities were visualized in the parametric images, while no abnormalities were noted in control subjects. **Conclusion.** Functional parametric imaging provides an easy still-frame display of regional LV wall motion abnormalities, even in patients who require contrast enhancement to visualize endocardial motion.



1064-134 Improved Accuracy for Determination of Endocardial Borders and Cavity Volumes with Second Harmonic Echo in Real Time 3-D Echocardiography: In Vitro Studies

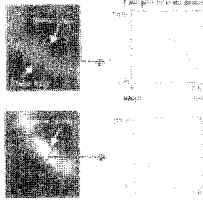
David J. Sahn, Ikuo Hashimoto, Crispin H. Davies. *Oregon Health Sciences University, Portland, OK*

Background: We studied the definition of endocardial borders during real time 3D echocardiography (RT3D) second harmonic imaging (SHI).

Methods: A pear-shaped balloon mimicking LV (with time varying wall thickness averaging 0.25mm) was mounted in a water bath. Pulsatile flow was generated by a flow pump to expand and contract the balloon rhythmically (9 stages, 15-60ml/beat). A 2.5MHz matrix array transducer of the RT3D scanner was placed under the water to image the balloon longitudinally from the apex (fundamental). SHI was acquired using this same array transmitting at 1.6MHz and receiving at 3.2MHz in both C- and B-scan modes. Echo density distributions of the 3D wall segment images were analyzed as grey-scale video plots and compared (for fundamental vs. SHI modes). Reference EDV, ESV and EF were measured directly by displacement and later compared with RT3D in fundamental as well as SHI.

Results: The echo density in SHI was significantly higher than for fundamental imaging (lateral wall: C-scan, 179.1 ± 34.3 vs 126 ± 38.9; B-scan, 160.5 ± 34.2 vs 93.9 ± 22.5; p<0.0001). However, wall thicknesses measured between the enhanced edges observed in SHI, while better defined, were still more than 10 times greater than actual wall thicknesses (lateral wall: C-scan, 2.5 ± 0.8mm; B-scan, 1.8 ± 0.7mm; p<0.0001). By tracing the enhanced edges in SHI, volume measurements of EDV and ESV using RT3D were improved (mean difference: B-scan EDV, 0.0 ± 1.4ml, ESV, -0.4 ± 0.9ml; C-scan EDV, -1.0 ± 1.3ml, ESV, -1.0 ± 1.1ml).

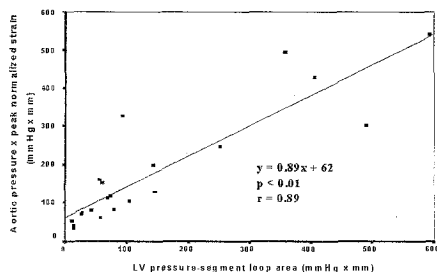
Conclusion: Thus, wall thickness (mass) measurement and chamber volume measurement were both improved by SHI in RT3D echo.



1064-135 Estimation of Regional Myocardial Work by Strain Doppler Echocardiography and Aortic Pressure

Stig Urheim, Thor Edvardsen, Helge Skulstad, Otto A. Smiseth. *Institute for Surgical Research and Dept. of Cardiology, The National Hospital, Oslo, Norway*

Background: In experimental models regional myocardial function can be quantified as the area of the myocardial pressure-segment loop. This measure, which reflects myocardial segment work, can also be calculated as the product of systolic shortening and LV developed pressure. We hypothesized that regional work may be estimated as the product of regional myocardial shortening derived from strain Doppler echocardiography (SDE) and aortic systolic pressure. **Methods:** In 10 anesthetized dogs myocardial longitudinal segment length in the LV anterior wall was measured by sonomicrometry, and aortic and LV pressures by micromanometers. Changes in myocardial function were induced by stepwise reductions in the LAD flow and by IV epinephrine. Area of the myocardial pressure-segment length loop was used as reference method for regional work. Peak systolic strain was calculated in real time with SDE by integrating differences in tissue velocity per unit length (1/sec) from end-diastolic dimensions (EDD). Systolic shortening by SDE and segment length values were normalized to EDD=10 mm. **Results:** As shown in the figure regional work by SDE and aortic pressure correlated well with work by the LV pressure-segment length method (r=0.89, p<0.01). **Conclusions:** Regional myocardial work could be estimated by SDE and aortic pressure. By combining SDE with an indirect measure of aortic pressure it might be possible to estimate regional myocardial work by a completely noninvasive approach.



1064-136 Tissue Tracking: A New Echocardiographic Technique for Evaluating Left Ventricular Myocardial Displacement in Normals and Myocardial Infarction

Jing Ping Sun, Neil L. Greenberg, Marcelo Carneiro, Jill Odabashian, Debbie Agler, Mario J. Garcia, William J. Stewart, James D. Thomas. *The Cleveland Clinic Foundation, Cleveland, OH*

Background: Tissue Tracking (TT) is a new derived ultrasound parameter which calculates and color-codes displacement (the distance the tissue moves) of myocardial tissue over a given time interval, typically systole. Positive (systolic) displacements are mapped into colors, negative displacements are mapped into grayscale.

Method: Using a GE/Vingmed Vivid Five scanner, 30 normal volunteers (15 male, 46 ± 18 years old) and 22 patients (12 male, 59±11 years old) with coronary artery disease (CAD) in different territories (LAD 12, LADprox 12, LCX 8, and RCA 4) were examined. CAD was diagnosed by EKG and cardiac catheterization. TT data was obtained from apical four- and two- chamber views with wall segments placed in the center of the sector to avoid Doppler angle dependencies. Measurements performed in three segments (base, middle and apex) of each wall were averaged over three cardiac cycles using EchoPac. The TT segmental displacement (Seg-Dis) measurements were grouped according to standard coronary perfusion territories for comparison with normal data.

Results: TT measurement of myocardial displacement showed excellent separation of normal versus CAD in the respective territory of the occlude coronary artery.

LV Seg-Dis by TT		LADmid (cm)	LADprox (cm)	LCX (cm)	RCA (cm)
Normal	mean	0.6 ± 0.1	1.1 ± 0.3	0.8 ± 0.2	1.1 ± 0.2
	range	0.4 - 0.8	0.9 - 1.8	0.6 - 1.1	0.9 - 1.4
CAD	mean	0.3 ± 0.1	0.3 ± 0.2	0.4 ± 0.1	0.6 ± 0.1
	range	0.2 - 0.4	0.2 - 0.7	0.1 - 0.5	0.4 - 0.8
p-value		<0.0001	<0.0001	<0.0001	<0.0001

Conclusion: Tissue Tracking is a new echo method to estimate left ventricular segmental wall motion by a quantitative measure of tissue displacement. This new method could be used to estimate segmental systolic function objectively; it requires further validation to determine its use in clinical practice.

POSTER SESSION

1065 Topics in Transesophageal Echo

Sunday, March 18, 2001, 3:00 p.m.-5:00 p.m.
Orange County Convention Center, Hall A4
Presentation Hour: 3:00 p.m.-4:00 p.m.

1065-137 TEE Predicts Poor Outcomes in Infective Endocarditis: 7 Year Follow-Up

Melda S. Dolan, Kamal Riad, Amr El-Shafei, Ravi Chiravuri, George Chahoud, Jeanette St. Vrain, Carrie Totta, Alan R. Maniet, Arthur J. Labovitz. *Saint Louis University School of Medicine, St. Louis, MO*

Despite many advances in the management of infective endocarditis(IE), the overall morbidity and mortality still remains high. We therefore aimed to define clinical and/or echocardiographic parameters which may help to identify high-risk group for embolic events. 128 patients with clinically documented IE and with vegetations that had been detected by transesophageal echocardiography (TEE) were included in the study and followed up to 54 ± 28 months.

The clinical outcome was analyzed by presence or absence of embolic phenomena (central or peripheral), need for surgical intervention and mortality. Echocardiographically detected vegetations were further characterized with morphological properties as maximum length(ML) width (MW), narrowest diameter: neck(N) as well as mobility characteristics as maximal angle of displacement of long axis of vegetation throughout the cardiac cycle (Delta angle).

69% of patients had documented embolic events. No differences with or without embolic event group was observed with respect to age, sex, fever, anemia, significant regurgitant murmur and vegetation site. Comparison of echo characteristics of two groups were as follows:

Embolic Event	ML	MW	Ratio: N/MW	Delta Angle
Yes	1.27 ± 0.3	0.7 ± 0.2	0.44 ± 0.2	70.75 ± 16
No	0.6 ± 0.3	0.4 ± 0.1	0.76 ± 0.2	24.2 ± 10
P	0.005	0.005	0.0001	0.0001

Size and mobility of vegetations as assessed by TEE were significantly different in patients who had embolic events compared to those who did not. Among all patients, multivariate analysis showed the mobility parameters Delta angle (OR: 8.2, p=0.001) and ratio neck/width (OR:4.85, p=0.04) remained significant predictive factors of embolism and mortality.

Conclusion: These findings suggest that mobility of vegetation assessed by transesophageal echocardiography is strong predictor of poor outcome in infective endocarditis. Early examination with transesophageal echocardiography in infective endocarditis patients may help to identify high risk group in whom earlier intervention may be indicated.

1065-138 Predictors of Outcome for Prosthetic Valve Thrombolysis: Results of the International PRO-TEE Registry (Prosthetic Valve Thrombolysis: Role of Trans-Esophageal Echocardiography)

Ann T. Tong, Raymond Roudaut, Mehmet Ozkan, Alex Sagie, Yaron Shapira, Sarah Shimoni, Maie S. A. Shahid, Sergio C. Pontes, Jr., Francesc Carreras, Steve E. Girard, Fletcher A. Miller, Jr., Samir Arnaout, Raymond F. Stainback, J. Kay Dunn, William A. Zoghbi. *on behalf of the PRO-TEE Investigators, Baylor College of Medicine, Houston, TX*

Background: Thrombolytic therapy of prosthetic valve (PV) thrombosis has recently been advocated as an alternative to surgery. Transesophageal echo (TEE) allows evaluation of thrombus burden and may help in risk stratification.

Methods: An international registry of patients with PV obstruction undergoing 2D/Doppler and TEE prior to thrombolysis was established to determine whether clinical, hemodynamic and thrombus characteristics by TEE can help predict complications. All TEE studies were reviewed and quantitated by a single observer, blinded to all data and outcome. Short-term (≤ 1 week) complications were defined as: death, emboli, stroke, intracranial bleed, myocardial infarction, bleeding requiring transfusions.

Results: To date, 88 patients (58 females; age 24-86 yrs) from 14 centers (6 USA) who presented with PV obstruction and underwent TEE followed by thrombolysis from 1985-2000 were identified. The majority of cases involved the mitral valve (65 mitral, 9 aortic, and 14 tricuspid). Overall hemodynamic success rate was 84%: mitral 81%, aortic 78%, and tricuspid 100%. Complications occurred in 18 patients (20%): 17 mitral (26%) and 1 aortic (11%). Univariate analysis of 47 clinical, 2D/Doppler, and TEE parameters revealed the following significant predictors of complications: NYHA class at presentation ($p=0.072$), presence of shock ($p=0.041$), tachycardia ($p=0.03$), previous history of stroke ($p=0.0038$), thrombus extension into the atrium ($p=0.011$), and thrombus area ($p=0.0018$). A multivariate model adjusted for age and gender demonstrated that history of stroke (OR=5.7, CI [1.58-20.79]) and thrombus area (OR=1.5 per cm^2 , CI [1.01-2.23]) were the only two independent predictors of outcome.

Conclusion: Thrombolytic therapy for PV thrombosis is successful in the majority of cases, with a complication rate of 20%. The severity of clinical presentation and previous stroke are associated with adverse outcome. Importantly, the size of thrombus, imaged with TEE, is an additional independent predictor of outcome. TEE is therefore recommended as part of the decision making process in PV thrombolysis.

1065-139 Cardiac Involvement at Initial Presentation of Non-Hodgkin's Lymphoma: Clinical and Echocardiographic Features

Birke Schneider, Ruth Sonnen, Rolf Kuse. *Städt. Krankenhaus Süd, Lübeck, Germany, Allg. Krankenhaus St. Georg, Hamburg, Germany*

Background: Cardiac involvement in non-Hodgkin's-Lymphoma (NHL) is rare and mostly occurs in AIDS patients or during NHL dissemination. This study aimed to assess the intracardiac presentation at initial diagnosis of NHL. **Methods and Results:** Over a 10-year-period, 356 consecutive pts with initial diagnosis of high-grade NHL were evaluated by transthoracic echocardiography. No NHL was AIDS related. Intracardiac involvement was seen in 5 pts (1.4%) presenting with heart failure of recent onset and nonspecific ECG changes. In all pts (4f, 1m, age 49-84 years) predominantly the right heart was affected. A right atrial (RA) myxoma had first been suspected in 4 pts with a large, mobile mass attached to the interatrial septum. Transesophageal echocardiography, however, disclosed additional tumor infiltration of the RA wall ($n=2$), right ventricle ($n=1$), coronary sinus ($n=3$), atrioventricular sulcus ($n=2$) and a fistula between ascending aorta and RA ($n=1$). Diagnosis was confirmed by thoracotomy ($n=1$), transvenous myocardial biopsy under echocardiographic guidance ($n=2$) or peripheral lymph node biopsy ($n=2$). Partial cardiac remission was achieved in 3 pts by polychemotherapy (PCT) alone or combined with radiation therapy (RT); 2 pts had a complete remission by PCT+RT or PCT+surgery. There were no serious cardiac complications, the fistula between aorta and RA closed spontaneously. Three pts died from extracardiac tumor dissemination after 5-24 months, 1 pt with partial cardiac remission refused further PCT and is alive 8 months after diagnosis of cardiac NHL. One pt is in second complete remission after cutaneous relapse (survival > 114 months, the longest reported so far for cardiac NHL). **Conclusion:** Intracardiac presentation of non-AIDS related NHL is rare, predominantly involves the right heart and may be distinguished from RA myxoma by transesophageal echocardiography. Long-lasting cardiac remission may be achieved by combined modality treatment, however, prognosis is determined by extracardiac NHL progression.

1065-140 Unexplained Arterial Embolism in Patients Less Than 55 Years of Age: Role of Primary Cardiac Tumors

Birke Schneider, Eckart Schlemminger, Michael Laß, Mathias Vierbuchen. *Städt. Krankenhaus Süd, Lübeck, Germany, Allg. Krankenhaus St. Georg, Hamburg, Germany*

Background: Primary cardiac tumors represent a rare cause for unexplained arterial embolism (AE). Most commonly they are myxomas attached to the atrial septum and occur in older patients. The prevalence and clinical spectrum of cardiac tumors in a larger group of young patients with AE has not yet been evaluated. **Methods and Results:** Over a 5-year period, 164 patients under 55 years of age were evaluated by echocardiography because of unexplained AE. A left-sided cardiac tumor was detected in 5 of these patients (3%) suffering from stroke ($n=3$), transient ischemic attack ($n=1$), or coronary artery embolism ($n=1$). In 2 patients, transthoracic echocardiography showed a large mass attached to the atrial septum consistent with a left atrial myxoma. In 3 patients, only transesophageal echocardiography was able to detect a small cardiac mass. This was attached to the origin of the left upper pulmonary vein, to the anterior mitral leaflet and to the right coronary cusp of the aortic valve, without compromising valve function. No other cardioembolic source could be identified. In all patients, operative excision of the tumor

was performed without complications. Histologic examination disclosed a myxoma in 4 cases, 2 of which showed an atypical location (mitral valve, left upper pulmonary vein). Papillary fibroelastoma of the aortic valve was diagnosed in the remaining patient. Post-operative course was unremarkable. Follow-up echo showed no valve dysfunction or tumor recurrence. **Conclusion:** Primary cardiac tumors have to be considered as a cardioembolic source even in younger patients. Transesophageal echocardiography is essential for diagnosis since small tumors of atypical location may be missed by transthoracic echocardiography in half of the cases.

1065-141 Comparison of Left Atrial Dimensions by Transthoracic and Transesophageal Echocardiography

Matthew Block, Lisa Hourigan, Wayne H. Bellows, John Reeves, III, Joseph L. Romson, Michael Tran, Darwin Pastor, Nelson Schiller, Jacqueline M. Leung. *California Pacific Medical Center, San Francisco, CA, University of California, San Francisco, San Francisco, CA*

Background: Left atrial (LA) size, as determined by transthoracic echocardiography (TTE), has been shown to predict the risk of atrial fibrillation, success of cardioversion and stroke. Transesophageal echocardiography (TEE) rather than TTE, is increasingly used in these clinical situations. However, measurement of LA size by TEE has not been standardized as it has for TTE. Our study aimed to determine the accuracy of LA measurement by TEE in comparison with TTE and thereby develop reproducible TEE method. **Methods:** In 121 consecutive patients referred for TEE, TTE was performed at the same time to obtain LA measurements using 4 standard views. **Results:** Mean LA size by TTE parasternal long axis was 4.19 ± 0.88 cm (range 2.34 - 6.17 cm). The correlation (r value) between corresponding TTE and TEE views were: parasternal short-axis/TEE 45 degree at aortic valve level - 0.752 ($P < 0.0001$, 95% confidence interval 0.68 - 0.86); parasternal long-axis/TEE 135 degree - 0.719; apical 4-chamber/TEE 0 degree (length, width and area) 0.467, 0.506 & 0.623 respectively; apical 2-chamber/TEE 90 degree (length, width and area) - 0.485, 0.514 & 0.476 respectively. By Bland-Altman bias analysis, only the short axis TTE-TEE views showed good agreement (bias 0.37 ± 1 cm). Complete inclusion of the measurement of interest within the sector scan by TEE was limited in all views except the short axis view, which was obtained in 97% of studies. Compared to TTE, TEE underestimated LA dimensions in all views, largely due to the inability to include the entire LA. The degree of underestimation was least in the short axis view (9%); LA diameter by TTE in this view was 4.23 ± 0.9 cm vs. 3.85 ± 0.97 cm by TEE; $P=0.0048$). **Conclusions:** The short axis view of the LA is the only TEE view in which the entire LA dimension is obtainable in a high percentage of patients (97%). Due to the excellent landmark provided by the aortic valve in cross section, which ensures similar measuring plane as TTE, this view also shows the highest correlation with the corresponding TTE view (parasternal short-axis) though it does underestimate the LA size by approximately 9%. When measuring the LA by TEE, the 45 degree short axis view at the level of the aortic valve should be used.

POSTER SESSION

1066 Assessing Pathophysiology in Ischemic Heart Disease by Positron Emission Tomography

Sunday, March 18, 2001, 3:00 p.m.-5:00 p.m.
Orange County Convention Center, Hall A4
Presentation Hour: 3:00 p.m.-4:00 p.m.

1066-142 Improvement of Resting Myocardial Perfusion Abnormalities After Dipyridamole: A Positron Emission Tomography Finding Associated With Non obstructive Coronary Artery Disease

Stefano Sdringola, Yuko Nakagawa, Keiichi Nakagawa, Abid Assali, Mary Haynie, Nizar Mullani, Neal Parker, Mary Jane Hess, Kenneth L. Gould. *University of Texas Medical School, Houston, TX*

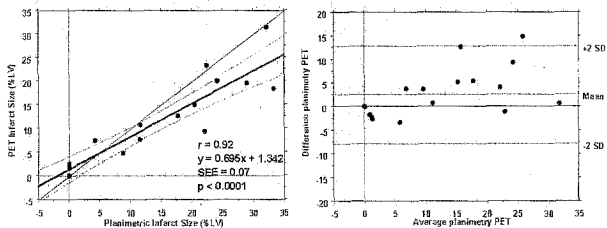
Background. The concepts of coronary flow reserve and stress induced perfusion defects have been so central to myocardial perfusion imaging that resting perfusion defects that improve after pharmacologic stress has not been previously documented. We tested the hypothesis that patients with arteriographic coronary artery disease (CAD) but no significant flow limiting stenoses may have heterogeneous myocardial perfusion defects at rest that improve or disappear after dipyridamole, without the confounding variables of redistribution kinetics or attenuation artifacts, whereas normal control subjects do not show this phenomenon. **Methods.** 1001 patients being evaluated for CAD underwent cardiac positron emission tomography (PET) with N-13 ammonia at rest and after dipyridamole. Of these, 751 had arteriography documenting CAD ranging from mild luminal irregularities to complete occlusion; 250 patients were studied by PET alone to assess potential referral bias related to coronary arteriography. Automated algorithms quantified both the relative decrease and/or increase from rest to dipyridamole images of normalized activity in three dimensional topographic displays of myocardial perfusion, respectively termed the minimum and maximum relative dipyridamole/rest ratio (D/R). **Results.** Of the 1001 patients, 266 had a minimum D/R below two standard deviations (2 SD) of normal controls, indicating significant, severe, localized dipyridamole induced perfusion defects. For the remaining 735 patients, the maximum relative D/R was 1.28 ± 0.165 , significantly greater than 1.118 ± 0.08 in normal controls ($p = 0.02$) indicating improvement after dipyridamole that was significantly greater than normals; 40% of

patients had a maximum relative D/R greater than one standard deviation of controls. **Conclusions:** In patients with CAD without significant dipyridamole induced perfusion abnormalities, resting perfusion defects that improve or disappear after the direct coronary arteriolar vasodilator dipyridamole are common suggesting microvascular endothelial dysfunction.

1066-143 Infarct Size Assessed by Positron Emission Tomography and F-18-Fluoro-Deoxyglucose: A New Absolute Threshold Technique

Panithaya Chareonthaitawee, Klaus Schaefer, Marco Di Terlizzi, Christopher S. R. Baker, Nick Banner, Magdi Yacoub, Robert Bonser, Patricia Iozzo, Paolo G. Camici, Ornella Rimoldi. *MRC Cyclotron Unit, ICSM, London, United Kingdom, Mayo Clinic and Foundation, Rochester, MN*

Background: Infarct size (IS) has been assessed noninvasively with relative thresholds of myocardial tracer uptake. We aimed to validate a new method of utilizing an absolute 18F-deoxyglucose (FDG) threshold in: 1) acute swine experiments 2) normal humans and patients with chronic ischemic cardiomyopathy (ICM). **Methods and Results:** Experiments were performed in 9 anesthetized pigs. Two were sham operated and 7 underwent 90-min occlusion of the mid-circumflex artery. After 4-hour reperfusion, FDG (185 MBq) was injected iv during the steady phase of the hyperinsulinemic euglycemic clamp. Five normal volunteers and 5 patients awaiting cardiac transplantation were also injected with FDG during the steady phase of the clamp. Dynamic images were acquired with positron emission tomography (PET). Postmortem (animals) and post cardiac transplantation (patients), the excised heart was stained with triphenyltetrazolium chloride (TTC) and photographs taken to assess IS by digital planimetry. The photographs and PET images were co-registered. FDG uptake in regions of interest corresponding to infarcted (TTC-negative) tissue was: animals = 0.10 ± 0.04 (control = 0.38 ± 0.11) $\mu\text{mol}/\text{min}/\text{g}$, and humans = 0.19 ± 0.05 (control = 0.69 ± 0.13) $\mu\text{mol}/\text{min}/\text{g}$. Automated software detected endo- and epicardial borders of the left ventricle (LV). Each voxel (size = $2.09 \times 2.09 \times 6.04$ mm) in the final 3-D image expressed an FDG-uptake value (parametric image). Using a threshold of $0.10 \mu\text{mol}/\text{min}/\text{g}$ in animals and $0.19 \mu\text{mol}/\text{min}/\text{g}$ in humans, PET IS was calculated as (number LV voxels < threshold / total LV voxels) x 100%, and was compared to the planimetric IS with excellent agreement by both regression ($r = 0.92$, $p < 0.0001$) and Bland-Altman.



Conclusions: In both a model of acute infarction and in chronic ICM, absolute myocardial FDG uptake can be used for accurate noninvasive IS quantitation.

1066-144 Role of Glycolysis in the Energy Production for the Nonmechanical Myocardial Work in Isolated Pig Hearts

Karim Bendjelid, Emmanuelle Canet, Cendrine Casali, Annie Desenfant, Jean Francois Obadia, Didier Revel, Marc Janier. *CERMEP, Lyon, France, UMR 5515 (CREATIS), Lyon, France*

Background: Dissociation of mechanical from nonmechanical energy utilization can be studied using BDM (2,3-butanedione monoxime) which has been shown to specifically inhibit the actin-myosin interaction such that peak ventricular pressure is zero without inhibition of the Ca^{2+} transients. The objective of the present study was to check if increasing the nonmechanical energy of perfused isolated pig hearts by dobutamine stimulation requires glycolysis with increased exogenous glucose uptake.

Methods: Five isolated pig hearts (CTRL), perfused for 60 minutes (min) at constant flow ($1 \text{ mL} \cdot \text{g}^{-1} \cdot \text{min}^{-1}$) with non-recirculating blood added with 30 mM BDM and ^{18}F FDG (26 MBq/l), were compared to 5 hearts (DOBU) subjected to the same protocol for the first 30 min and then dobutamine ($1.5 \mu\text{M}$) were added respectively for the last 30 min. The blood perfusion contained (in mM) 11 glucose, 2.5 calcium and hematocrit was at 25%. Hearts were paced at $100 \text{ b} \cdot \text{min}^{-1}$. From the sixty one-minute images per slice, acquired with a clinical PET scanner (TTV03, LETI, France), glucose uptake was assessed by estimating ^{18}F FDG uptake using linear regression where the slope α (15-30 min) represented baseline and the slope α' (45-60 min) represented stress. Data were expressed as the mean \pm standard error of the mean. The slopes variations were compared using a global test of coincidence. A $p < 0.05$ was considered statistically significant.

Results: ^{18}F FDG uptake was homogeneous within the whole myocardium and we observed a linear and regular increase in CTRL group as well as in DOBU group (Table).

	α ($\text{nCu} \cdot \text{m}^{-1} \cdot \text{sec}^{-1}$)	α' ($\text{nCu} \cdot \text{m}^{-1} \cdot \text{sec}^{-1}$)	p (α/α')
CTRL (n=5)	3.22 ± 0.23	3.09 ± 0.13	0.94
DOBU (n=5)	2.93 ± 0.09	2.99 ± 0.14	0.96

Conclusion: In blood-perfused isolated pig hearts, exogenous glucose is not necessarily required when nonmechanical energy is increased by dobutamine stimulation. These findings suggest that ATP derived from glycolysis is not necessary to preserve myocardial Ca^{2+} homeostasis during b-adrenergic stimulation.

1066-145 Quantification of Absolute Perfusion Reserve Using 82Rb Positron Emission Tomography Defines Greater Extent of Disease in Three Vessel Coronary Atherosclerosis

Ratika Seth, Robert A. DeKemp, Terry D. Ruddy, Barbara Hart, Agis Kitsikis, May Aung, Natalie Levesque, Deborah Gauthier, Elizabeth Westerman, Robert S. Beanlands. *University of Ottawa Heart Institute, Ottawa, ON, Canada*

Standard perfusion imaging defines disease relative to a maximum region in the myocardium. This may underestimate the extent of disease in three vessel coronary atherosclerosis as the maximum perfusion is below normal. The aim of this study was to determine whether PET quantification of Perfusion Reserve using ^{82}Rb net retention defines a greater extent of disease than a comparison of 'relative' perfusion at stress in patients with three vessel disease and may be preferable for risk stratification.

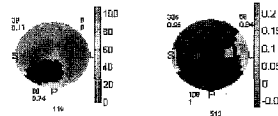
Methods: ^{82}Rb net retention was quantified as a measure of absolute perfusion at rest and with dipyridamole stress using dynamic PET imaging in 18 patients with CAD. Polar maps of 568 sectors were generated and compared to a normal database. The % of myocardium with abnormal segments (>2 SD below normal mean) was determined for the standard approach using stress perfusion relative to the maximum perfusion (STD) and absolute perfusion reserve (APR).

Result: Patients with 3VD served as the primary study population (n=11, 66 ± 10 , 2 female). As a control, a group of patients with a normal zone (1VD) were also studied (n=7, 66 ± 6 , 4 female). APR was compared to STD. (* $p < 0.05$)

	STD Method	APR Method
3VD (% abn LV)	$42 \pm 19\%$	$65 \pm 28\%^*$
1VD (% abn LV)	$24 \pm 19\%$	$14 \pm 14\%$

Absolute retention data also reflected extent and severity of disease on coronary angiography. The figure demonstrates polar maps of a patient with 3 vessel disease. The blue segments are abnormal. The STD method (left) suggests one abnormal region whereas the APR method (right) is abnormal for the entire myocardium.

Conclusion: Quantification of ^{82}Rb net retention to measure absolute perfusion reserve in the myocardium defines a greater extent of disease than the standard approach in patients with triple vessel disease. More accurate measurement of the extent of CAD should facilitate risk stratification and identify more high risk patients for aggressive intervention.



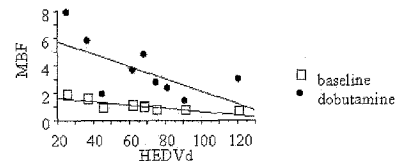
1066-146 Myocardial Blood Flow Magnitude Is Related to Cardiac Catecholamine Uptake-1: A Positron Emission Tomography Study in Anesthetized Dogs

Ornella E. Rimoldi, Angela J. Drake-Holland, Mark I. M. Noble, Mohamed Bentourkia, Paolo G. Camici. *Medical Research Council, London, United Kingdom, Imperial College School of Medicine, London, United Kingdom*

The functional level of sympathetic modulation of myocardial blood flow (MBF) can be characterized noninvasively by means of positron emission tomography.

In 8 α -chloralose anesthetized dogs we carried out simultaneous assessment of sympathetic nerve terminals uptake-1 using [^{11}C]HED, β -adrenoceptor density (βAR) using [^{11}C]GCP and MBF using H_2^{15}O . Hyperemic MBF was measured at rest and during iv dobutamine ($20 \mu\text{g}/\text{kg}/\text{min}$). Volume of distribution (Vd) of [^{11}C]HED ranged from 25 to $117 \text{ mL}/\text{g}$, βAR density from 11 to $24 \text{ pmol}/\text{g}$. Baseline and hyperemic MBF were significantly correlated to [^{11}C]HED Vd ($R=0.83$ and $R=0.65$ respectively). There was a weaker correlation between MBF and rate pressure product at baseline ($R=0.61$) and none ($R=0.308$) during dobutamine infusion. Finally, no significant correlation was found between MBF and βAR density.

The activity of myocardial adrenergic terminals at baseline is inversely related to MBF independently of hemodynamic variables. The hyperemic response to dobutamine is not dependent on βAR density in normal myocardium.



POSTER SESSION

1067 Echocardiographic Assessment of Left Ventricular Mechanics

Sunday, March 18, 2001, 3:00 p.m.-5:00 p.m.
Orange County Convention Center, Hall A4
Presentation Hour: 3:00 p.m.-4:00 p.m.

1067-147 Is Ejection Fraction a Reliable Marker of Left Ventricular Contractility? Comparison With Emax in Chronic Animal Models With Load Alterations

Yong Jin Kim, Michael Jones, Takahiro Shiota, Fabrice Bauer, Jian Xin Qin, Marta Sitges, Hiroyuki Tsujino, Agnese Travaglioli, Lisa A. Cardon, Arthur D. Zetts, Julio A. Panza, James D. Thomas. *The Cleveland Clinic Foundation, Cleveland, OH, National Heart, Lung and Blood Institute of Health, Bethesda, MD*

Aim: To investigate the relationship between left ventricular (LV) ejection fraction (EF) and maximal elastance (Emax) in normal (NL), old myocardial infarction (OMI) and chronic mitral regurgitation (MR) in different loading conditions.

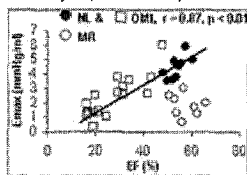
Methods: Thirty-three sheep including 9 NL, 16 OMI and 8 MR (4-6 months after surgical creation of the lesion), were studied. Emax was measured as the slope of the end-systolic pressure-volume relationship during IVC occlusion with a conductance catheter. Mean aortic pressure (MAP) was measured using a Millar catheter and, LV end-diastolic volume (EDV) and EF were measured using epicardial real-time 3D echocardiography. After baseline (B) studies, 500ml of blood (BL), angiotensin II (AT) and nitroprusside (NT) were infused.

Results: OMI showed lower Emax (2.2 ± 1.4 vs 4.4 ± 0.8 mmHg/ml, $p < 0.01$) and lower EF (26 ± 9 vs 54 ± 4 %, $p < 0.01$) than NL. For MR, while EF was similar to NL (56 ± 5 %, $p = \text{NS}$), Emax was lower than NL (1.8 ± 0.7 mmHg/ml, $p < 0.01$). There were linear correlations between EF and Emax in NL ($r = 0.66$, $p = 0.05$) and OMI ($r = 0.83$, $p < 0.01$). In addition, combined data set of NL and OMI showed a better correlation ($r = 0.87$, $p < 0.01$), while the MR sheep showed no correlation between EF and Emax. With BL infusion, MAP, EDV and EF increased. With AT infusion, MAP and EDV increased while EF did not change. However, in the subgroup with EF < 45 % ($n = 16$), EF decreased after AT infusion (27.4 ± 9.7 vs 23.8 ± 10.2 %, $p = 0.05$). With NT infusion, MAP and EDV decreased while EF did not change. Emax did not change under any loading conditions.

	MAP (mmHg)	LVEDV (ml)	EF(%)	Emax (mmHg/ml)
Baseline	79 ± 22	73 ± 27	40.6 ± 15.1	2.3 ± 1.2
Blood	$101 \pm 28^*$	$82 \pm 30^*$	$43.6 \pm 13.7^*$	2.1 ± 1.2
Angiotensin	$121 \pm 31^*$	$86 \pm 32^*$	39.0 ± 17.7	2.3 ± 1.3
Nitroprusside	$59 \pm 20^*$	$63 \pm 25^*$	42.8 ± 14.9	2.2 ± 1.1

* : $p < 0.05$ vs baseline

Conclusions: Though load dependent, EF was well correlated to Emax in NL and OMI. However, in MR Emax was severely depressed despite normal EF.

**1067-148 Atrioventricular Plane Displacement Correlates Closely to Circulatory Dimensions but Not to Ejection Fraction in Normal Subjects**

Carl J. Carlhall, Lena Lindström, Bengt Wranne, Eva Nylander. *Dept. Clinical Physiology, Institution of Medicine and Care, Linköping, Sweden*

Background: Mitral atrioventricular plane displacement (AVPD) contains information about left ventricular systolic function. M-mode of systolic annulus amplitude or tissue Doppler imaging of systolic annulus velocity are the current methods of evaluating AVPD, where the former is the integral of the latter. A correlation to ejection fraction (EF) has been demonstrated in patients with coronary artery disease and left ventricular dysfunction. Our aims were 1) to investigate the mitral AVPD of healthy subjects with different physical work capacity, 2) to further evaluate AVPD as an index of left ventricular systolic function.

Methods: Twenty-eight cardiopulmonary healthy men, mean age 28 years (20-39) were included, endurance trained ($n=10$), strength trained ($n=9$) and non trained ($n=9$). The systolic AVPD at four sites, septal, lateral, anterior and posterior, were recorded with M-mode. Left ventricular volumes were calculated according to Simpson's rule. Maximal oxygen consumption was measured at bicycle ergometry.

Results: Systolic AVPD was higher in endurance trained, 16.9 ± 1.5 mm, than in both strength trained, 13 ± 1.6 ($p < 0.001$) and in non-trained, 14 ± 1.6 ($p < 0.001$). Left ventricular systolic AVPD correlated strongly with end-diastolic volume ($r=0.82$), stroke volume ($r=0.80$) and max. oxygen consumption/body weight ($r=0.72$). The correlation between AVPD and ejection fraction was weak ($r=0.22$).

Conclusion: In the subjects studied, with a range of normal cardiac dimensions, AVPD correlated to stroke volume, end-diastolic volume and max. oxygen consumption/body weight, but not to ejection fraction. On theoretical grounds it is reasonable that a dimen-

sion like AVPD is related to other dimensions and volumes, rather than a fraction like EF. We suggest that previous findings of a correlation between AVPD and ejection fraction in different patient groups, could depend on co-variation between EF and stroke volume in patients with left ventricular dysfunction. AVPD is one useful parameter for evaluation of left ventricular systolic function but is not interchangeable with other measurements as ejection fraction.

1067-149 Relation Between Left Ventricular Sphericity and Errors in M-Mode Mass: Insights From Magnetic Resonance Imaging

Michael L. Chuang, Carol J. Salton, Kraig V. Kissinger, Daniel Levy, Christopher J. O'Donnell, Warren J. Manning. *Beth Israel Deaconess Medical Center, Boston, MA, The NHLBI's Framingham Heart Study, Framingham, MA*

Elevated left ventricular mass (LVM) is an important predictor of cardiovascular morbidity and mortality. The widely used difference-of-cubes Penn formula for measuring LVM by M-mode echocardiography assumes the LV is a prolate ellipsoid with a major axis twice the length of the minor axes. This may lead to errors in M-mode derived LVM. We sought to determine the relationship between ventricular shape and Penn formula error. **Methods:** 280 adults (134 men) without overt cardiovascular disease, from the Framingham Heart Study Offspring Cohort, underwent contiguous multislice breathhold cine MRI to evaluate true LVM (SRLVM) using a summation of disks ("Simpson's rule") method. At a separate time, left ventricular diameter (EDD) and septal (IVS) and posterior wall (PW) thicknesses were measured from a basal slice at end-diastole and used to compute corresponding "echo-equivalent" Penn mass. Mean diastolic long-axis length (LAL) was measured from MRI 2- and 4-chamber views and used to determine Sphericity = EDD/LAL , where a perfectly spherical ventricle would have Sphericity = 1.0. The relation between Sphericity and Error (Penn-SRLVM) and %Error (Error/SRLVM) was assessed by Pearson correlation (r). **Results** (mean \pm SD): SRLVM = 133 ± 35 g. Penn LVM was significantly greater ($p < 0.001$) at 197 ± 59 g. Sphericity = 0.62 ± 0.07 . Error correlated significantly ($r = 0.39$, $p < 0.001$) with Sphericity, as did %Error ($r = 0.47$, $p < 0.001$). **Conclusion:** The M-mode Penn formula overestimates LVM. Penn error increases both absolutely and proportionally as left ventricular shape becomes more spherical (dilated). This source of error should be considered when comparing LVM determined by volumetric methods, such as MRI or 3D echo, against M-mode derived reference values.

1067-150 Inertia of Left Ventricular End-Ejection Flow Speeds the Propagation of Left Ventricular Early Diastolic Filling Flow

Nobuyuki Ohte, Hitomi Narita, Sachie Akita, Kazuyuki Kurokawa, Norio Takada, Junichiro Hayano, Genjiro Kimura. *Nagoya City University Medical School, Nagoya, Japan*

It is known that left ventricular (LV) systolic function affects LV early diastolic filling. However, the mechanism how the LV behavior during systole modifies the LV function during diastole has not been fully understood. Thus, we investigated this issue from a viewpoint of inertia of the blood flowing out of the LV at end-ejection in 48 pts who underwent cardiac catheterization for evaluation of chest pain. The inertia force in each pt was calculated using the method reported by Sugawara et al. (*Cardiovasc Res* 1997;13:433) from a phase loop of LV pressure (dP/dt vs P relation). As an index of LV function during isovolumic relaxation, apically directed intraventricular flow at this phase (IRF) was observed using high frame rate color Doppler echocardiography and as that of early diastolic filling phase, the propagation of peak early filling on color M-mode Doppler tracings was measured as a propagation velocity of early diastolic filling flow (PVE).

Results: LV end-systolic volume index was significantly smaller in pts with the inertia force > 1.0 mm Hg (In+) than in pts without such magnitude of the force (20.6 ± 10.8 vs 42.9 ± 23.9 ml/m², $p < 0.001$) and LV ejection fraction was greater in the former than in the latter (72.8 ± 8.6 vs 54.7 ± 14.0 %, $p < 0.001$). The IRF was observed in 28 of the 48 pts. Twenty-two of those were with In+, while 6 were without. In any pt without IRF, the In+ was not found. The incidence of observable IRF was significantly higher in pts with In+ than in pts without ($p < 0.001$). In all pts with IRF, it was observed between the apex and the tip of papillary muscle, melting into early diastolic filling flow. The PVE was significantly greater in pts with In+ than in pts without (48.7 ± 6.8 vs 33.8 ± 8.5 cm/s, $p < 0.001$). **Conclusions:** These findings suggest that the better LV systolic function produces the inertia and the appearance of IRF strongly depends on the inertia. From the temporal relation between the IRF and LV early diastolic filling flow, the IRF seems enhanced the PVE through the function that works as if it sucks the blood from the base to the apex in the LV. Thus, the role of inertia may be a key in realizing the effects of LV systolic function on LV early diastolic filling.

POSTER SESSION

1068 Echo Assessment of Viability: Predicting Outcome

Sunday, March 18, 2001, 3:00 p.m.-5:00 p.m.
Orange County Convention Center, Hall A4
Presentation Hour: 3:00 p.m.-4:00 p.m.

1068-151 Contractile Reserve During Low-Level Exercise Echocardiography Predicts Long-Term Outcome in Patients With Chronic Ischemic Cardiomyopathy

Jay H. Lee, Monika Kuzminska, Kim Bishop, S. Suave Lobodzinski, Leonard E. Ginzton. Harbor-UCLA Medical Center, Torrance, CA

Background: Identifying myocardial contractile reserve(MCR) during dobutamine stress echocardiography(DSE) has favorable impact on long-term left ventricular(LV) function and survival in patients with chronic coronary artery disease(CAD) and LV dysfunction. The presence of MCR during low-level exercise(LLEX) correlates with DSE, but its long-term prognostic significance is unknown. We tested the hypothesis that MCR during LLEX has the same prognostic value as DSE in predicting long-term outcome(death, recurrent myocardial infarction(MI) and/or congestive heart failure) in patients with chronic CAD and LV dysfunction(LV ejection fraction <40%). **Methods:** All patients referred for stress echocardiography from January 1992 to March 1999 with regional wall motion abnormalities and baseline ejection fraction <40% were identified. The study population was 110 patients(81 LLEX, 29 DSE) for whom at least 12 months(range 12-83) followup data was available. Presence of MCR was defined as improved wall motion in >4/16 LV segments. All studies were read by an experienced echocardiographer blinded to all other data. No attempt was made to influence therapy, but patients' physicians were not blinded to study data. Time to the first end-point(cardiac death(n=5), recurrent MI(n=14) or congestive heart failure hospitalization(n=14)) for LLEX and DSE were used to compute event-free survival using the log-rank test. **Results:** During LLEX MCR was present in 35/81 patients; adverse events occurred in 3 patients with MCR and in 9 without MCR. During DSE MCR was identified in 13/29 patients, and only 1/7 adverse outcomes occurred in patients with MCR. During followup 61 patients were revascularized. Presence of MCR by both tests had a better event-free survival than those without MCR. After 27 months the event-free survival was 97% in patients with MCR and 71% in those without MCR(p=0.05). **Conclusion:** Presence of MCR during LLEX in patients with chronic CAD and LV dysfunction is associated with a better long-term prognosis than patients who do not have MCR. LLEX may be a clinically useful alternative to DSE in long-term risk stratification and choice for possible revascularization in these patients.

1068-152 Revascularization Reduces Remodelling in Patients With Viable Myocardium After Infarction

Vincent Khoury, Danielle Spicer, Richard Lim, Thomas Marwick. UQ Dept of Medicine, Princess Alexandra Hospital, Brisbane, Australia

Background: Revascularization of viable myocardium is associated with improved regional myocardial function. The effect of revascularization and viability on remodelling are less defined. We sought to address this by using three-dimensional echo (3DE) to measure LV volumes. **Methods:** Forty two pts with previous infarction and LV dysfunction were studied with 3DE before and after revascularization. All pts underwent a standard dobutamine echo protocol. Segts were predicted to be viable if they improved or had a biphasic response to dobutamine. Remodelling was defined as >10% increase in LV diastolic volume. The decision to revascularize was made on clinical grounds, independent of the study. Treatment for all pts included standard medical therapy for all pts (eg ACE inhibitors). Differences in %change in volumes were compared using Mann-Whitney test. **Results:** Fifteen patients were revascularized and 27 were treated medically. Patients that were revascularized had a smaller increase in LV end systolic and end diastolic volumes than those treated medically, although the changes in ejection fraction were similar in both groups.

	End-systolic	End-diastolic	EF
Medical	+19%	+18%	-1%
Revascularized	+6%	+10%	-1%
p	<0.01	<0.01	NS

Pts with more viable segments appeared to undergo less remodelling; of those with >25% viability in medical group, end systolic and end diastolic volumes changed 1% and -1% respectively, vs 19% and 21% in pts with <25% viability. Similarly in revascularized pts with >25% viability, increases were 14% and 15%, compared with 7% and 23% in medical pts. **Conclusion:** Restoration of perfusion to viable myocardium reduces remodelling after myocardial infarction.

1068-153 Wall Motion Score Index During Dobutamine Stress Echocardiography Best Predicts Improvement With β -blocker Therapy in Heart Failure Patients?

Susan Mayer, Paul A. Grayburn, Eric J. Eichhorn, Martin St John Sutton, Christopher Appleton, Jonathan Plehn, Jae Oh, Barry Greenberg, Anthony DeMaria, Heidi Krause-Steinrauf, For The BEST Investigators. UT Southwestern Medical Center, Dallas, TX

Background: Dobutamine stress echocardiography (DSE) has been widely used to predict myocardial viability. However, the best predictors of viability have not been determined.

Methods: In a substudy of the Beta-Blocker Evaluation of Survival Trial (BEST), we examined 5 measures of response to DSE in 35 patients randomized to bucindolol: 1) change in LVEF 2) change in velocity time integral (VTI) 3) change in wall motion score index (WMSI) 4) change in left ventricular (LV) power index and 5) number of viable segments. WMSI was determined by the 16 segment model and was calculated as the sum of the scores in each segment divided by the total number of segments visualized. Changes in these 5 measurements in response to dobutamine were compared by linear regression to the change in LV ejection fraction (EF) measured by MUGA after 3 months of β -blocker therapy.

Results:

DSE Measurement	r*	P-value
change in LVEF	0.35	0.041
change in VTI	-0.02	0.93
change in WMSI	-0.72	<0.0001
change in LV power index	0.14	0.48
Number viable segments	0.66	<0.0001

*Pearson's correlation coefficient and associated p-value

Conclusions: WMSI and number of viable segments were stronger predictors of improvement in LVEF in response to β -blockade. This suggests that these measurements may be better measurements of myocardial viability than LVEF or Doppler based indices.

1068-154 Left Ventricular Dilatation Following Uncomplicated Myocardial Infarction in Patients With Inducible Ischemia at Discharge

Claudio Coletta, Augusto Sestili, Riccardo Rambaldi, Fulvia Seccareccia, Roberto Ricci, Marco Renzi, Nadia Aspromonte, Riccardo Bigi, Alfonso Galati, Vincenzo Ceci. S. Spirito Hospital, Rome, Italy, Cardiovascular Research Foundation, Castelfranco Veneto, Italy

Aim of the study was to investigate the relation between pre-discharge inducible ischemia and left ventricular (LV) volume changes at six months in patients (pts) recovering from acute myocardial infarction (MI). **Methods:** 143 consecutive pts with first, uncomplicated MI were considered for the study (Age: 57, M= 127). All pts were referred for pre-discharge dobutamine-atropine stress echocardiography (DSE: 5-40 mcg/kg/m², 3' steps) 8 +/- 4 days from the admission. Inducible ischemia (IS) was considered in case of >= 1 wall motion score increase during DSE, in a 16-segment model of left ventricle and a 1- to 4 segmental wall motion score. Indexed left ventricular end-diastolic and end-systolic volumes (LVEDV, LVESV: mL/m²) were blindly calculated (modified Simpson's rule) from apical 4- and 2-chamber views at baseline DSE and six months following MI. LVEDV and LVESV changes (%) were calculated and compared in relation to the presence/absence of IS during DSE. Moreover, a group of basic clinical parameters, resting echocardiographic data and DSE results were considered in relation to the occurrence of any LVEDV increase at six months in a multivariate stepwise regression model analysis. **Results:** IS was present in 59 pts (41%). All basic clinical variables, LV ejection fraction and ACE-inhibition at discharge were comparable in pts with- and without IS. LVEDV increased at 6 months in pts with IS (+ 14.3 +/- 2.4 %) whereas it was unchanged in pts without IS (+ 0.1 +/- 2.0 %; IS+ vs IS- : p < 0.0001). LVESV increased in pts with IS (+ 8.6 +/- 3.3 %), whereas it decreased in pts without IS (- 2.3 +/- 2.7 %; IS+ vs IS-: p < 0.0001). Among all considered variables in the stepwise regression model, IS during DSE (OR=5.2, 95%CI: 1.4 - 26.2) and pre-discharge LVESV (OR=1.06, 95%CI: 0.99 - 1.13) were independently related to any six-months LVEDV increase. **Conclusions:** The presence of dobutamine-inducible ischemia at discharge identifies pts with both diastolic and systolic LV dilatation following uncomplicated MI.

Noninvasive Imaging

POSTER SESSION

1069 Myocardial Contrast Echocardiography in Acute Myocardial Infarction I

Sunday, March 18, 2001, 3:00 p.m.-5:00 p.m.
Orange County Convention Center, Hall A4
Presentation Hour: 3:00 p.m.-4:00 p.m.

1069-155 Reduced Microvascular and Myocardial Damage in Patients With Acute Myocardial Infarction and Ischemic Preconditioning Due to Preinfarction Angina

Paolo Colonna, Christian Cadeddu, Abdel Hakeem Selem, Roberta Montisci, Lijun Chen, Massimo Ruscazio, Enrico Onnis, Luigi Meloni, Sabino Iliceto. Department of Cardiovascular and Neurological Sciences, University of Cagliari, Cagliari, Italy

Background: After acute myocardial infarction patients with microvascular damage have worse myocardial function and long term prognosis. The presence of ischemic preconditioning due to preinfarction angina has a protective role, guaranteeing limited necrosis and greater myocardial functional recovery. The relationship between preinfarction angina and microvascular reflow is poorly known. We hypothesized that patients with preinfarction angina have a more preserved microvascular integrity at intravenous contrast echocardiography and a better functional recovery. **Methods:** We studied 54 patients with a first acute myocardial infarction by means of intravenous myocardial contrast echocardiography (Levovist rapid infusion), harmonic power Doppler (Agilent Sonos 5500) and ECG triggering 2.9±0.6 days after acute myocardial infarction. The no-reflow

extent was the percentage ratio of segments not opacified to the total segments in the risk area. Typical angina occurring in the 7 days preceding the myocardial infarction, was present in 33 patients and absent in 21 patients. Low dose dobutamine echocardiography was performed 3.8±1.6 days after acute myocardial infarction and follow up echo after 90 days. **Results.** Microvascular no-reflow extent was greater in patients without preinfarction angina (48.3±23.3%) than in patients with preinfarction angina (32.6±22.8%, p<0.05). The functional status of the myocardium, as expressed by wall motion score index in the risk area, was similar at the first echocardiogram in preinfarction and no preinfarction angina patients (2.60 ± 0.28 vs 2.63 ± 0.28; p=ns); conversely, at dobutamine (1.67 ±0.61 vs 2.10 ± 0.43; p<0.005) and at follow-up echocardiogram (1.72 ± 0.56 vs 2.22 ± 0.40; p<0.0001) it was better in preinfarction angina patients. **Conclusion.** The presence of preinfarction angina, because of its preconditioning effect, limits myocardial damage, favoring myocardial viability. This beneficial effect seems to be, at least in part, mediated by the reduction in no-reflow after myocardial infarction. Thus, preconditioning due to preinfarction angina has a protective role not only on the myocardium, but also on microcirculation.

1069-156 Risk Stratification of Patients with Acute Myocardial Infarction from Perfusion Studies With Myocardial Contrast Echocardiography

Ryusuke Kimura, Hiroshi Ito, Katsuomi Iwakura, Yasunori Shintani, Koichi Yamamoto. *Division of Cardiology, Sakurabashi Watanabe Hospital, Osaka, Japan*

Background: Myocardial contrast echocardiography (MCE) is a novel technique for the detection of microvascular integrity which is a surrogate marker of viable myocardium. Accordingly, we examined the potential of MCE at pre-discharge for risk stratification among patients with acute myocardial infarction (AMI).

Methods: Study population was consisted of consecutive 66 patients with AMI. Before the discharge, we performed MCE with bolus (2-3 ml) injection of Levovist (300mg/ml). We recorded intermittent harmonic power Doppler imaging at intervals of 4 cardiac cycles. In apical 2- or 4-chamber view, we divided the left ventricle into 6 segments and evaluated the presence or absence of perfusion defect (PD) in each segment. We performed 2-D echo at day-1 and 1 month later and measured left ventricular end-diastolic dimension (LVDd, mm) and wall motion score (WMS: sum of 17 segment scores of wall motion (0:normal to 3:a/dyskinesis)). 2-D echo was also performed 3-6 months later in 30 patients.

Results: PD was observed in none, 1 and ≥2 segments in 33, 9 and 24 patients, respectively. In those with PD≥2, functional improvement was the worst and LV dilation was observed. Cardiac events (heart failure, reinfarction, cardiac tamponade) was observed in 5 (21%) of 24 patients with PD≥2, while reinfarction was observed only in 1 (2%) of 42 patients with PD=0 or 1.

Conclusion: Thus, intravenous MCE at pre-discharge provides useful information for the risk stratification among patients with AMI.

	WMS-1 day	WMS-1 month	LVDd-1 day	LVDd-1 month
PD=0	14±6	7±6*	51±5	49±6#
PD=1	18±4	11±6*	51±5	52±3
PD≥2	18±7	16±7#	53±6	55±7

*p<0.01 vs. day-1 #p<0.05 vs day-1

1069-157 Influence of Microvascular Damage on Left Ventricular Remodeling After Acute Myocardial Infarction

Luciano Agati, Stefania Funaro, Cristina Volponi, Gabriele Veneroso, Camillo Autore, Fred Kemah. *Dept of Cardiology, La Sapienza University of Rome, Rome, Italy*

Background: Determinants of late left ventricular (LV) remodeling after myocardial infarction are still under discussion. In this study we sought to evaluate the role of microvascular damage on post-infarction LV remodeling. **Methods:** Six-months follow-up was obtained in 22 consecutive patients with a first acute transmural anteroapical myocardial infarction treated with intravenous thrombolysis within 6 hours from symptom onset. All patients underwent coronary revascularization (14 PTCA, 8 CABG) before hospital discharge. The extent of microvascular damage was evaluated on day 1 after thrombolysis by intravenous myocardial contrast echocardiography (IVMCE). IVMCE was performed using Intermittent Harmonic Angio (Hewlett Packard, Sonos 5500, ATL 5000) with Levovist (400mg/ml, IV pump infusion, trigger intervals 1.4-1.8). Myocardial perfusion was assessed in 4-2-chambers apical views, using a 12-segment model. The endocardial length of the residual contrast defect within the infarct area was calculated. To evaluate the extent of LV remodeling, the percent of summed endocardial lengths showing abnormal wall motion (AWML%) was calculated from 3 short axis and 2 apical views (SAVE study method) on day 1, at pre-discharge and at 6 months follow-up. **Results:** At pre-discharge, AWML% was significantly increased from day 1 in 12 patients (from 24±10% to 38±13%, p<.001, Group A), whereas no significant changes were observed in the remaining 10 patients (from 23±13% to 22±13%, ns, Group B). At 6 months follow-up, a further increase in AWML% was observed in Group A (from 38±13% to 40±15%, ns) whereas it significantly decreased in group B (from 22±13% to 11±13%, p<.001). On day 1, no statistical differences were observed between groups as for AWML% (24±10 vs 23±13%), ejection fraction (44±5 vs 42±3%), wall motion score (1.7±0.3 vs 1.8±0.6) and coronary artery disease severity. However, on admission, the endocardial length of contrast defect was significantly higher in remodeling as compared to non-remodeling group (47% vs 16%, respectively, p<.001). **Conclusion:** This study further support the importance of microvascular damage in post-infarction LV remodeling processes.

1069-158 Intravenous Myocardial Contrast Echocardiography Predicts Left Ventricular Remodeling in Patients With Acute Myocardial Infarction

Wolfgang Lepper, Otto Kamp, Jean Louis Vanoverschelde, Andreas Franke, Gert J. Sieswerda, Agnes Pasquet, Paolo Voci, Cees A. Visser, Peter Hanrath, Rainer Hoffmann. *Medical Clinic I University RWTH Aachen, Aachen, Germany, Department of Cardiology University Hospital Amsterdam, Amsterdam, The Netherlands*

Background: Persistent myocardial perfusion defects after recanalization for acute myocardial infarction (AMI) determined by myocardial contrast echocardiography (MCE) may be a predictor of left ventricular remodeling (LVR).

Methods: To determine the ability of MCE to predict LVR, intravenous MCE (Sonazoid, Nycomed-Amersham) was performed immediately after primary percutaneous transluminal coronary angioplasty (PTCA) in 35 patients (pts) with first AMI. The length of the endocardial border corresponding to the part of the myocardium with no or poor opacification measured in the 2- and 4-chamber view defined the size of the perfusion defect. The perfusion defect size divided by the total endocardial border length defined the relative perfusion defect size (in %)(relMCD). Left ventricular volumes and ejection fraction (EF) were assessed directly after PTCA and after 4 weeks with 2D-echocardiography using the area-length method in the 2- and 4-chamber view.

Results: RelMCD after PTCA was 13.6±14.8% for all pts. Two pts, both with a large relMCD, 34 and 38% respectively, died within the 4 week follow-up period. After 4 weeks pts were divided in two groups. Group A, pts with an increase in enddiastolic left ventricular volume (EDV) of at least 15% within the follow-up period and group B pts with less than 15% increase or a decrease in EDV.

	Group A (n=15)	Group B (n=18)	P
EDV after PTCA (ml)	99±22	102±16	0.255
EDV after 4 weeks (ml)	130±31	101±20	0.003
relMCD (%)	20±13	1±12	0.005
EF after PTCA (%)	52±13	55±7	0.568
EF after 4 weeks (%)	48±10	55±11	0.067

Receiver Operating Characteristic (ROC) curve analysis revealed a relMCD of 7% or more after PTCA to predict an increase of EDV within 4 weeks of more than 15% with a sensitivity of 87% and a specificity of 83% (area under the ROC curve = 0.807, standard error = 0.079).

Conclusion: The persistent MCE perfusion defect after revascularisation procedures is highly predictive for left ventricular remodelling during a 4 week follow-up period.

POSTER SESSION

1107 Coronary Artery Doppler

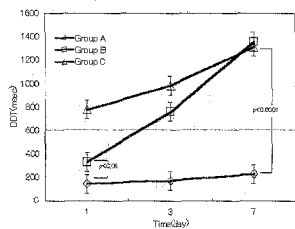
Monday, March 19, 2001, 9:00 a.m.-11:00 a.m.
Orange County Convention Center, Hall A4
Presentation Hour: 9:00 a.m.-10:00 a.m.

1107-133 Time Course of Coronary Blood Flow Velocity Pattern After Coronary Reperfusion in Patients With Acute Myocardial Infarction Using Transthoracic Doppler Echocardiography

Souki Lee, Shinichi Minagoe, Koichi Toyonaga, Masanori Tsurugida, Midori Okamura, Tsuminori Yamashita, Yutaka Otsuji, Shuichi Hamasaki, Chuwa Tei, Hitoshi Toda. *Kagoshima City Hospital, Kagoshima, Japan*

Background Several studies have demonstrated that analysis of coronary blood flow spectrum immediately after direct percutaneous transluminal coronary angioplasty (PTCA) by invasive Doppler guidewire is useful for predicting the damage of the coronary microvasculature (no-reflow pattern) in patients with acute myocardial infarction (AMI). In this study, we examined the time course of coronary blood flow velocity pattern after PTCA using noninvasive transthoracic color and pulsed Doppler echocardiography (TTDE). **Methods** Using TTDE, we assessed the change in coronary blood flow velocity in the left anterior descending artery (LAD) after coronary reperfusion in consecutive 22 patients (pts) with AMI immediately after 3 days, 7 days, 2 weeks, and 1 month after the reperfusion. Good reflow pattern was defined as deceleration time of diastolic flow velocity (DDT) ≥ 600 ms and no reflow pattern ≤ 600ms using TTDE. Anterior wall motion score index (A-WMSI) by echocardiography were evaluated before and 1 month later to the PTCA, and A-WMSI ≤ 2.0 after 1 month was defined as viable myocardium. **Results:** Eight of 22 pts showed good reflow pattern immediately after PTCA (group A), whereas the other 14 pts showed no-reflow pattern, which were divided into 2 groups; viable (group B: n=6) and nonviable (group C: n=8) myocardium by A-WMSI 1 month after PTCA (2.70±0.30 versus 1.54±0.20; p<0.0001). The time course of DDT immediately after, 3 days, 7 days after PTCA in all groups is shown in the figure 1. In group B, decreased DDT improved rapidly within 1 week up to the level of group A (333±107 to 1320±420 ms; p=0.0016), and time course was the same as in group A. **Conclusions** 1),

In patients with microvascular damage after coronary reperfusion in AMI, some of them showed rapid improvement within 1 week. 2) Demonstrating the LAD flow velocity by TTDE is useful for predicting viable myocardium after coronary reperfusion.



1107-134 Noninvasive Assessment of Coronary Artery Diameter by Transthoracic High Resolution Doppler Technique

Nozomi Watanabe, Yasuko Yamaura, Reishi Izumi, Yuji Koyama, Takeshi Sato, Masamichi Oyanagi, Takashi Akasaka, Kiyoshi Yoshida. *Kawasaki Medical School, Kurashiki, Japan, Toshiba Corporation, Tokyo, Japan*

Background: Transthoracic color Doppler echocardiography is useful for evaluating significant coronary artery stenosis. However, conventional color Doppler echocardiography overestimates the actual flow diameter because this technique has poorer axial resolution than tissue reflections. "Dynamic flow" is newly developed technique based on the wide band Doppler with short transmit period. Dynamic flow has high axial resolution as well as the tissue mapping. The aim of this study was to clarify whether dynamic flow can be used to measure coronary artery diameter accurately from transthoracic approach. **Methods:** 1) Vitro study: A set of urethane rubber with internal diameters of 2.0 and 4.0mm were used in a water tank. Polystyrene microspheres were used as a blood substitute at a constant velocity (20cm/sec). The 3.0 MHz transducer (TOSHIBA Inc., Tokyo, Japan) was immersed in the water and was aimed at the tubing. We measured the flow diameter by using conventional color Doppler and dynamic flow. 2) Clinical study: Transthoracic echocardiography was performed in ten patients. We measured the coronary artery diameter by transthoracic color Doppler and dynamic flow, and compared with coronary angiography. **Results:** 1) Vitro study: Flow diameter measured by color Doppler was significantly larger than tubing diameter (4.2±0.4mm for 2.0mm tubing and 6.1±0.3mm for 4mm tubing, P<0.0001). There was no significant difference between the flow diameter measured by dynamic flow and tubing diameter (2.1±0.1mm for 2.0mm tubing, 4.2±0.1mm for 4mm tubing, P=NS). 2) Clinical study: Eighteen sites of coronary arteries (8: left main trunk, 10: left anterior descending coronary artery) were measured in both technique. Coronary artery diameter measured by color Doppler was significantly larger than that measured by angiography (3.6±1.5mm versus 2.5±1.0mm, P<0.0001). There was no significant difference in the coronary artery diameter between dynamic flow and angiography (2.6±1.1mm versus 2.5±1.0mm, P=NS). **Conclusion:** Coronary artery diameter can be measured accurately by using high resolution transthoracic Doppler technique.

1107-135 Persistent Early Systolic Reverse Coronary Flow Predicts Poor Functional Recovery in Acute Myocardial Infarction After Primary Coronary Angioplasty: Serial Assessment With Transthoracic Coronary Doppler Echocardiography

Yuichi Nohtomi, Kazushige Nagasawa, Tohru Yamawaki, Kenji Miyata, Ken-ichi Arimura, Isamu Matsuo, Kouichi Kuwata, Shoichi Kondo, Atsushi Sobashima, Akira Yamada, Shuichi Okamoto. *Iizuka Hospital, Iizuka, Fukuoka, Japan*

Background: Early systolic reverse flow (ESRF) detected by Doppler guide wire in the infarct-related artery after primary coronary angioplasty (PCA) predicts poor recovery of posts ischemic dysfunction in acute myocardial infarction (AMI). However, little is known about its serial changes in acute phase.

Method: Forty-eight consecutive patients with anterior AMI after PCA were studied. Averaged regional wall motion score index of left anterior descending coronary artery (LAD) segments (RWMSI, as ASE recommendation) and distal LAD flow velocity were recorded by two-dimensional echocardiography and transthoracic coronary Doppler echocardiography (TTCDE) (SONOS 5500, Agilent Technologies, using s4 and s12). Data were obtained at immediately after PCA (day 0), 48 hours and 3 weeks after AMI. The ESRF was defined as reverse flow with peak velocity ≥ 10 cm/s and duration ≥ 60 ms. Recovery of the posts ischemic dysfunction was assessed with Δ RWMSI defined as RWMSI at day 0 minus one at 3 weeks.

Result: Serial recording of TTCDE was feasible in 44 patients (92%). 70% of the patients were stented. At day 0, ESRF was not observed in 26 patients (Group 1), and was appeared in 18 patients. Nine patients showed ESRF only at day 0 (Group 2). ESRF was observed persistently until 48 hours after AMI in other 9 patients (Group 3). No patients showed ESRF at 3 weeks. Baseline RWMSIs were not significantly differ among 3 groups (Group 1, 2 and 3: 2.47±0.45, 2.81±0.35 and 2.73±0.18). Δ RWMSI was significantly lower in Group 3 (-0.09±0.25) than Group 1 (0.61±0.44, p<0.0001) and 2 (0.48±0.50, p<0.008), but no significant difference was noted between Group 1 and 2. The sensitivity and specificity of ESRF for predicting irreversible dysfunction (defined as Δ RWMSI<0.22) are 81 and 82% at day 0, 56 and 100% at 48 hours. Sensitivity is not significantly different between the two tests, however the specificity is higher at 48 hours test than day 0 (p<0.02).

Conclusion: In anterior AMI, persistent ESRF until 48 hours after PCA may be more useful marker for accurately identifying irreversible posts ischemic dysfunction than ESRF manifested only at day 0 with TTCDE.

1107-136 Can Coronary Flow Reserve Using Transthoracic Color Doppler Echo in the Left Anterior Descending Artery Predict Restenosis After PTCA? Usefulness of Contrast Enhanced Diastolic Coronary Flow Velocity

Masako Okada, Takahiro Ota, Hiroyuki Okura, Keiji Nagae, Yukio Abe, Hirohito Yoh, Shiro Yanagi, Kazuyoshi Hirota, Hiroyuki Watanabe, Junichi Yoshikawa. *Fuchu Hospital, Izumi city, Japan, Osaka City University Medical School, Osaka city, Japan*

Background: Transthoracic color Doppler echo (TCD) has been reported as a feasible and useful method to assess coronary flow velocity (CFV) and thus coronary flow reserve (CFR) of the left anterior descending coronary artery (LAD). Measurements of distal CFR, defined as maximal hyperemic flow divided by resting flow, using a Doppler guide wire after percutaneous transluminal coronary angioplasty (PTCA) have been demonstrated to provide a predictive value for the short- and long-term outcomes after PTCA. Levovist® (LEV) improves color and spectral Doppler coronary flow signal detection without affecting coronary flow velocity. A good correlation between CFR detected by Doppler guide wire and those by TCD with LEV has been reported. **Objectives:** The aim of this study was to assess feasibility and usefulness of coronary flow velocity (CFV) measurements using TCD with intravenous injection of Levovist® (LEV: 300mg/ml, 1-2 ml) for predicting angiographic restenosis following PTCA. **Methods:** Twenty consecutive patients (mean age 61±10) who were treated with PTCA were enrolled. CFV was assessed at basal and during hyperemic conditions in the LAD with TCD using LEV after angiographically successful PTCA. Coronary angiography were performed at 6 month follow-up. Angiographic restenosis was defined as % diameter stenosis of <50%. Averaged peak velocity (APV), diastolic peak velocity (DPV), and systolic peak velocity (SPV) were measured. CFR was defined as DPV during hyperemia following adenosine triphosphate infusion (0.15 mg/kg/min) divided by DPV at rest. **Results**

	Restenosis (+)	Restenosis (-)	P value
Base DPV	19.0±6.8	16.6±7.7	0.46
Peak DPV	31.5±10.7	42.1±10.8	0.042
CFR	1.67±0.6	2.90±0.9	0.003

Lesions with angiographic restenosis had significantly lower CFR than those without. The sensitivity and specificity of CFR<2.0 for predicting angiographic restenosis at 6 month follow-up were 80 % and 80 %, respectively. **Conclusions:** Transthoracic Doppler echocardiography with intravenous LEV injection is a noninvasive and accurate method to assess residual coronary flow reserve and thereby predict future restenosis following percutaneous coronary intervention.

POSTER SESSION

1108 Cardiovascular Magnetic Resonance: Imaging the Left Ventricle

Monday, March 19, 2001, 9:00 a.m.-11:00 a.m.
Orange County Convention Center, Hall A4
Presentation Hour: 9:00 a.m.-10:00 a.m.

1108-137 Real-Time Magnetic Resonance Image Acquisition During Dobutamine Stress for the Detection of Left Ventricular Wall Motion Abnormalities in Patients With Coronary Artery Disease

Simon Schalla, Eike Nagel, Ingo Paetsch, Axel Bornstedt, Bernhard Schnackenburg, Hans Lehmkühl, Christoph Klein, Eckart Fleck. *German Heart Institute Berlin/ Charité Campus Virchow, Berlin, Germany, Philips Medical Systems, Hamburg, Germany*

Background: Magnetic resonance (MR) imaging has been shown to be superior to dobutamine stress echocardiography for the detection of left ventricular wall motion abnormalities. A shortcoming of magnetic resonance imaging in comparison with echocardiography is the need to acquire images during several cardiac cycles which prohibits the assessment of new onset of wall motion abnormalities in real-time and requires breath holding. Purpose of this study was to compare real-time imaging with standard MR imaging for the detection of wall motion abnormalities.

Methods: In 22 patients with coronary artery disease left ventricular wall motion was examined at rest and during increasing doses of dobutamine (up to 40µg/kg +atropine) using echo planar imaging (TE 5.6ms; TR 1 heartbeat; Flip angle 30; spatial resolution 1.3 x 2.6mm; temporal resolution 30ms) and a new real-time imaging technique (TE 6.8ms; TR 16.5ms; Flip angle 20; spatial resolution 2.2 x 4.4mm; temporal resolution 62ms). Wall motion abnormalities for each perfusion territory were determined visually. Coronary angiography was performed after dobutamine stress MR examinations in all patients.

Results: Sensitivity and specificity for real-time in comparison with breath-hold MR imaging were 100% / 98% at rest and 97% / 97% at maximum dobutamine stress. In comparison with coronary angiography sensitivity and specificity were 87.5 % / 83.3 % for echo planar imaging and 81.3% / 83.3% for real-time MR imaging.

Conclusions: Real-time imaging of left ventricular wall motion is possible under stress conditions and allows an accurate detection of wall motion abnormalities. This technique can be used for an online analysis of wall motion at pharmacological or physical stress.

1108-138 Age-Related Changes in Myocardial Relaxation Using Tagged Magnetic Resonance Imaging

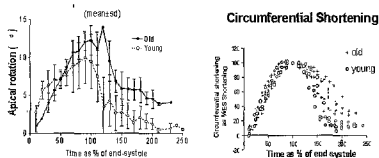
Helen C. Oxenham, Alistair A. Young, Brett R. Cowan, Robert Doughty, Norman Sharpe. University of Auckland, Auckland, New Zealand

Background: Magnetic resonance imaging (MRI) with tagging provides novel information regarding the complex, three-dimensional motion of the heart. Localized radio frequency is used to "tag" specific regions within the myocardium creating a grid pattern, which becomes deformed as the myocardium moves. Analysis of this deformation then allows direct measurement of the movement of the myocardium.

Methods: Tagged MRI images from two groups of normal individuals were analyzed using dedicated computer software. The mean age of the younger group was 24 years (range 20-26 years, n=5) and that of the older group was 65 years (range 60-74 years, n=7); 11 of the 13 subjects were male. Analysis of tagged images provided values for apical rotation (degrees of clockwise rotation from the onset of systole, viewed from the apex) and circumferential shortening through most of the cardiac cycle.

Results: During systole there were no significant differences between the two groups. However, during early diastole (time = 150% of end-systole), mean apical rotation persisting was 6.8° (range 5.1-8.9°) in the older group, compared with 2.6° (range 0.3-6.0°) in the younger group (p<0.002) (figure). Significantly more circumferential shortening persisted in the older group 58.6±15.8% compared to 20.4±5.7% in the younger group (95% CI 24-52%, p<0.0003) (figure)

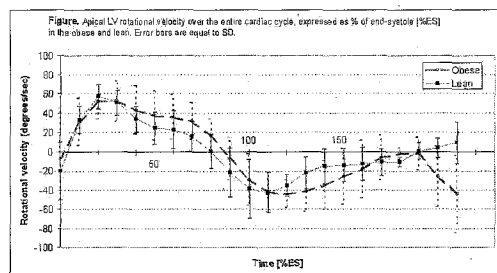
Conclusions: Whilst retaining normal systolic function, significant delay and reduction in myocardial relaxation is observed in older compared to younger normal individuals. Tagged MRI is a unique, non-invasive imaging method that can identify significant changes in myocardial relaxation associated with advancing age.



LV, with an in-plane resolution of 2.3 x 2.3 mm². We acquired 16-20 cardiac phases per RR interval, extending throughout diastole (temporal resolution 35 msec). The apical LV rotational velocity (°/sec) and rotation (°), and LV wall thickness-to-cavity radius ratio (WTCRR) were measured in a blinded fashion.

Results: The twisting and untwisting pattern of the apical LV (Figure) was significantly different between obese and lean individuals (p=0.0007, repeat measures ANOVA). The peak untwisting diastolic velocity of the obese (63±27°/sec) was slightly higher than that of the lean (56±20°/sec, p=0.3). The LV rotation was similar in the obese and lean (p=0.1). The peak LV systolic rotation in the obese (11.4±3.8°) was slightly higher than in the lean (10.2±2.5°, p=0.2) and tended to occur later in relation to end-systole (ES), (88±9 %ES vs. 81±13 %ES, obese vs. lean, respectively, p=0.09). The LV WTCRR was similar in the obese (0.6±0.1) and lean individuals (0.6±0.1, p=0.6).

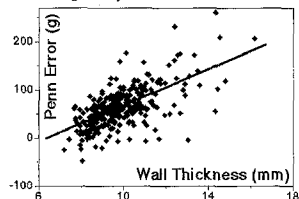
Conclusion: Obesity is associated with an altered apical LV rotation pattern. cMRI tagging offers a unique tool to assess subclinical changes of LV rotation and may be helpful in early evaluation of obese individuals.



1108-139 M-Mode Errors in Determination of Left Ventricular Mass Are Greater With Increasing Cavity Size and Wall Thickness: An MRI Study

Michael L. Chuang, Carol J. Salton, Kraig V. Kissinger, Daniel Levy, Christopher J. O'Donnell, Warren J. Manning. Beth Israel Deaconess Medical Center, Boston, MA, NHLBI's Framingham Heart Study, Framingham, MA

Purpose: M-mode echo formulas for determining LV mass may lead to errors in true mass. We sought to determine the relationship between this error and LV wall thicknesses (PW, IVS) and end-diastolic diameter (EDD). **Methods:** A representative sample of 292 adult participants (150F, 142M) from the Framingham Heart Offspring Study, who were free of symptomatic cardiovascular disease, underwent contiguous multislice breathhold cine cardiac MRI. True mass was determined by Simpson's rule (SR). At a separate time, EDD, IVS and PW were measured from a basal diastolic short-axis MRI image and mass was calculated using original Penn, corrected Penn (cPenn) and Teichholz formulas. M-mode-formula derived mass was compared with SR mass by ANOVA. Relationship between Error (=Mmode-SR) and %Error (=Error/SR mass) and mean wall thickness (WT=(PW+IVS)/2) or EDD was assessed by Pearson correlation (r). **Results:** M-mode formula Penn, cPenn and Teichholz methods all overestimated SR-derived LV mass (64g, 36g and 31g respectively; all p<0.001). Error and %Error correlated significantly with meanWT for all 3 methods (r=0.29 to 0.64, p<0.001, see Figure for Penn error) and with EDD (r=0.33 to 0.61, p<0.001) for Penn and cPenn. Teichholz Error and %Error did not correlate with EDD (p>0.1). **Conclusion:** Using SR MRI as the gold standard, all 3 commonly used M-mode formulas overestimate LV mass, with increasing error associated with progressive wall thickness. For Penn and cPenn formulas, error also increases with EDD. In the general population, M-mode error is both proportionally and absolutely greater with increasing cavity size and wall thickness.



1108-141 Comparison of Interstudy Reproducibility of Cardiovascular Magnetic Resonance and 2D-Echocardiography in a Mixed Study Group and Implications for Clinical Trial Planning

Frank Grothues, Gillian S. Smith, Nick G. Bellenger, Peter Collins, Helmut U. Klein, Dudley J. Pennell. Cardiovascular Magnetic Resonance Unit, Royal Brompton Hospital, London, United Kingdom, Division of Cardiology, Otto-von-Guericke University, Magdeburg, Germany

Background: Cardiovascular Magnetic Resonance (CMR) has produced excellent results for accuracy and interstudy reproducibility in the assessment of left ventricular (LV) volumes, ejection fraction (EF) and mass, that are superior to results achieved with 2D-Echocardiography (Echo). However, a direct comparison of the interstudy reproducibility of both methods in the same subjects has never been performed. **Methods:** A total of 60 subjects (47 male, 20 normal volunteers, 20 patients with heart failure, 20 patients with LV hypertrophy) underwent two CMR and 2 Echo studies with a short interval between each study. For CMR, a stack of contiguous cine gradient echo short axis cines was acquired and analysed for LV mass and volumes. For Echo parasternal short axis and apical 4- and 2-chamber views were obtained. From this LV mass and volumes were calculated using the 5/6 (area x length) and biplane Simpson's rule respectively. **Results:** For all measured parameters, the interstudy percentage variability was significantly lower with CMR compared to Echo (see table below). The smaller standard deviation (SD) of the interstudy variability with CMR results in considerably lower sample sizes required by CMR versus Echo to show a 10 ml change in EDV (10 versus 38) and ESV (6 versus 42), a 3% absolute change in EF (11 versus 87) and a 10 g change in mass (13 versus 132) with a power of 90% and an error of 0.05.

	EDV		ESV		EF		Mass	
	CMR	Echo	CMR	Echo	CMR	Echo	CMR	Echo
Interstudy Variability = SD	0.1±6.7ml	0.9±13.5ml	-0.3±5.3ml	0.9±14.0ml	0.1±2.1%	-0.3±6.1%	-1.0±7.7g	8.7±25.0g
% Variability ± SD	3.2±2.1	5.7±5.2	6.0±4.9	12.2±9.7	3.7±3.2	9.4±9.0	3.0±2.4	10.8±9.2
P value between % Variabilities	< 0.001		< 0.001		< 0.001		< 0.001	

Conclusion: CMR showed excellent interstudy reproducibility in a mixed study group with significantly lower percentage variation, but also lower SD of the differences compared with 2D-Echo (which determines sample size in studies). These results have important implications for longitudinal follow-up in individual patients as well as for the planning of clinical trials, in which serial measurements of LV function and mass are desired, as smaller sample sizes can be used with CMR for the same study power.

1108-140 Obesity is Associated With Altered Apical Left Ventricular Rotation: A Cardiac Magnetic Resonance Tagging Study

Peter G. Danias, Nicholas A. Tritos, Matthias Stuber, Carol J. Salton, Kraig V. Kissinger, Warren J. Manning. Beth Israel Deaconess Medical Center, Boston, MA, Joslin Diabetes Center, Boston, MA

Background: Obesity affects 1/3 of the adult US population and carries increased morbidity and mortality. We used tagging cardiac magnetic resonance imaging (cMRI) to measure apical left ventricular (LV) rotation, a correlate of diastolic LV function, in otherwise healthy obese men.

Methods: We evaluated 41 men (20-40 yr) including 20 obese (body mass index BMI>30 kg/m²) (30±8 yr; BMI 35±3 kg/m²) and 21 lean (BMI 19-25 kg/m²) (29±5 yr; BMI 23±1 kg/m²). cMRI was performed with a 1.5T Gyroscan NT (Philips) system. Breath-hold ECG-gated short-axis tagged cMRI images (slice thickness 8mm) were acquired at the apical

POSTER SESSION

1109 Optimizing Assessment of Ventricular Function: Advances in Radionuclide Techniques

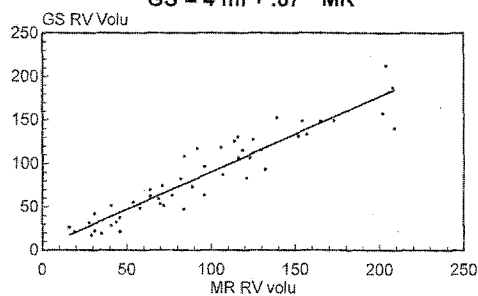
Monday, March 19, 2001, 9:00 a.m.-11:00 a.m.
Orange County Convention Center, Hall A4
Presentation Hour: 9:00 a.m.-10:00 a.m.

1109-142 Accuracy of Gated Blood Pool SPECT Ventricular Function Parameters: Validation by MRI

Kenneth Nichols, Ala'Eldin A. Ababneh, Julia Rheem, Rola Saouaf, Robyn J. Barst, Marlon S. Rosenbaum, Mark W. Groch, Steven R. Bergmann. *Columbia University, New York, NY*

Background: Accurate right ventricle (RV) volume and ejection fraction (EF) measurements have been difficult to quantitate in patients with primary pulmonary hypertension (PPH) and tetralogy of Fallot (TOF) due to the wide range of RV shapes and sizes. Unfortunately, these are the patients for whom accurate RV values are needed in order to assess disease progression. **Methods:** Tc-99m red blood cell gated blood pool SPECT (GS) scans were acquired at 8 frames/R-R, reconstructed and reoriented. End-diastolic (ED) and end-systolic (ES) valve planes determined in 3 mid-RV orthogonal views were used to limit the number and shape of automated short axis (SA) regions within 50% of maximum ED counts per SA section. Volumes were computed from the number of volume elements within these limits, and EF from systolic count changes within these volumes. Volumes were assessed for the left ventricle (LV) and RV at ED and ES in 15 patients with PPH and 11 with TOF (28±14 years; 50% female) who also had cardiac gated gradient-echo cine MRI evaluations using breath-holding protocols. MRI values were derived independently using Simpson's rule from semi-automated SA regions (modified manually to conform to endocardial borders, and to take into account trabeculations in the apical third of the RV). **Results:** GS and MRI values were highly correlated, with linear regression probabilities <0.0001 for volumes and EF (see Graph and Table). GS volumes were statistically significantly (p<0.05) smaller and EF's higher than MR values, most likely due to radiation self-attenuation for the largest volumes. **Conclusion:** GS provides accurate RV volumes and EF, and may prove useful in evaluating therapeutic interventions in the management of patients with PPH and TOF.

**Linear Regression
GS = 4 ml + .87 * MR**



	r	intercept	slope	SEE	GS	MR
RV vol	0.95	4 ml	0.87	16 ml	86±50 ml	96±53 ml
LV vol	0.84	7 ml	0.91	16 ml	64±40 ml	69±41 ml
RVEF	0.80	11%	0.86	9%	44±16%	38±15%
LVEF	0.88	6%	0.92	8%	64±16%	60±16%

1109-143 Angioscintigraphic Assessment of Cardiac Resynchronization by Biventricular Pacing in Heart Failure Patients

Christophe Leclercq, Sr., Gilles Rouault, Sr., Christine Alonso, Sr., Anne Devillers, Claude Daubert, Sr., *Departement de Cardiologie et Maladies Vasculaires CHU, Rennes, France*

Biventricular pacing may significantly improve symptoms and exercise tolerance in patients with chronic left ventricular (LV) systolic dysfunction and intraventricular conduction delay. Biventricular pacing is supposed to decrease ventricular electromechanical discoordination. The aim of the MUSTIC study was to assess the effects of Biventricular pacing on mechanical ventricular synchronization using a phase analysis radionuclide study. **Methods:** In a sub-group of the MUSTIC trial population, results of radionuclide phase analysis study were compared at the end of the two 3 months crossover phases (Biventricular pacing and inactive pacing). The following parameters were measured: LV ejection fraction (LVEF), LV and RV peak contraction time (LV Peak and RV Peak) and

interventricular delay (IVD = LV Peak - RV Peak). **Results:** 23 patients (68±7 years old, mean QRS duration 194±13ms) were included. Clinical and radionuclide data during the two crossover phases are summarized below.

	Inactive Phase	Biv Phase	P
NYHA (class)	2.9 ± 0.5	2.1 ± 0.6	< 0.005
6'Hall Walk (meters)	313 ± 105	351 ± 77	< 0.005
VO2max (ml/kg/min)	14 ± 4	16 ± 3.5	0.005
QRS duration (ms)	194 ± 17	157 ± 18	< 0.001
LVEF (%)	31 ± 11	31 ± 10	NS
LV Peak (°)	143 ± 20	162 ± 26	< 0.01
RV Peak (°)	125 ± 19	159 ± 27	< 0.001
IVD (°)	20 ± 5.5	6 ± 15	< 0.005

A positive correlation between improvement in IVD with Biventricular pacing and baseline QRS duration was observed (r = 0.8, p<0.001). **Conclusion:** Biventricular pacing significantly improves symptoms and exercise tolerance and decreases ventricular discoordination. The magnitude of mechanical ventricular resynchronization is correlated with the degree of baseline electrical asynchrony.

1109-144 Comparison of Rest and Post Stress Left Ventricular Ejection Fraction Using a Counts Based Method of Gated SPECT

Steven A. Unger, Tina M. Sias, Denny D. Watson, George A. Beller. *University of Virginia, Charlottesville, VA*

Background: Previous studies have reported differences in left ventricular ejection fraction (ΔEF) between rest and post-stress gated SPECT, which have been attributed to post-stress stunning. However the incidence of this finding varies widely between reports. The purpose of this study was to assess the ΔEF in a series of unselected patients, comparing those with and without reversible perfusion defects.

Methods: 200 patients referred for stress sestamibi imaging underwent both rest and 30-minute post-stress gated SPECT. Ejection fractions were calculated via a counts-based method.

Results: The mean ΔEF (post-stress - rest) for the total study group was 1.1%, with a standard deviation (SD) of 5.7%. In the 126 patients with no perfusion defects (Group 1), the mean ΔEF was 1.2% (SD 5.5%). In the 35 patients with fixed perfusion defects (Group 2), the mean ΔEF was 2.0% (SD 6.2%), while in the 39 patients with partly or completely reversible perfusion defects (Group 3), the mean ΔEF was 0.2% (SD 5.8%). In all 3 groups, the mean EF was not significantly different between the post-stress and rest studies. The numbers of patients with falls in EF on post-stress images of > 2 SD were 2/126 (1.6%), 0/35 (0%), and 2/39 (5.1%) for Groups 1, 2, and 3 respectively, which do not exceed that expected from entirely statistical variance. The 2 patients in Group 3 with "significant" falls in EF on post-stress images had only small zones of reversibility, implying that the ΔEF in these patients was not due to stunning.

Conclusion: In this series of unselected patients, the observed ΔEF was similar whether reversible perfusion defects were present or not. The incidence of a significant fall in post-stress EF was low, and is explained by statistical variability rather than true stunning. Hence the 30-minute post-stress EF calculated using a counts-based method is a valid measurement of resting EF.†

	N	Stress EF (%)		Rest EF (%)		ΔEF (%)	
		mean	SD	mean	SD	mean	SD
All patients	200	56.3	8.5	55.2	8.2	1.1	5.7
Group 1	126	59.0	6.5	57.8	6.2	1.2	5.5
Group 2	35	50.8	11.3	48.8	10.2	2.0	6.2
Group 3	39	52.7	7.9	52.5	8.3	0.2	5.8

1109-145 Automated Quantitation of Regional Function by Gated Perfusion Tomography: Determination of a Normal Range and Correlation With Echocardiography for Detection of Abnormal Wall Motion

T Chua, C Y. Lee, F Keng, Z P. Ding, Y L. Lim. *National Heart Centre, Singapore, Singapore, Singapore*

Automated quantitation of regional wall motion(WM) and thickening(WT) by gated perfusion tomography (GSPECT) has potential for improving objectivity of visual assessment. We determined normal limits for WM and WT using automated quantitative software (AutoQuant) from 20 patients undergoing rest Tc-99m tetrofosmin GSPECT(Group A) who had normal WM by echocardiography (echo), and tested the accuracy of these normal limits for detecting abnormal WM in 42 patients who had GSPECT and echo (Group B, 30 with abnormal WM), using threshold values for abnormality defined as < 5th% of the normal range. All 62 patients had echo and GSPECT done on the same day, read blinded to each other for the presence of abnormal WM in a 20 segment model. Reproducibility: Mean difference between 2 observers was 0.04±/0.40mm(limits of agreement=±/0.78mm) for WM and 0.06±/2.6% (limits of agreement=±/5%)for WT. There was regional heterogeneity in normal WM and WT values by GSPECT in Group A. There were significant differences between mean GSPECT WM values for normal (6.6±/

2.2mm), hypokinetic(3.7±2.2mm) and akinetic(1.6±1.9mm, p<0.001) segments by echo. Table shows mean values/lower limits for normal WM (from Group A) and accuracy for detection of abnormal WM in Group B using these normal limits:

Segment	Mean Normal WM (mm)	Lower 5%tile Normal WM(mm)	Sensitivity	Specificity
Apex ant	7.7±1.7	4.7	95	86
Apex inf	8.6±1.8	3.4	91	95
Apical ant	8.1±1.8	4.1	95	96
Apical antsept	7.0±1.9	4.2	96	65
Apical infsept	6.9±2.2	3.1	88	72
Apical inf	9.2±2.0	5.5	91	74
Apical inflat	9.4±1.6	7.0	100	61
Apical antlat	8.2±1.5	5.4	95	96
Mid ant	9.5±2.1	5.8	100	85
Mid antsept	7.4±2.0	4.3	95	75
Mid infsept	6.5±2.0	1.9	41	100
Mid Inf	7.8±1.5	4.4	82	90
Mid inflat	9.3±2.6	6.1	83	63
Mid antlat	8.8±1.7	5.9	90	75
Basal ant	10.2±1.9	6.7	75	93
Basal antsept	6.9±1.6	3.3	50	89
Basal infsept	5.5±2.0	1.6	39	91
Basal inf	7.3±1.8	4.3	74	87
Basal inflat	8.4±2.3	4.5	36	94

Using these limits, agreement between echo and GSPECT in Group B was 82%(688/840, kappa=0.63, p<0.0001) for abnormal WM and 82%(692/840, kappa=0.64, p<0.0001) for WT. **Conclusion:** Automated quantitative GSPECT correlates well with echo and has potential for objective detection of abnormal WM.

1109-146 Quantification of Left Ventricular Function by Gated Perfusion Tomography: Testing of a New Fully Automatic Algorithm

Aman Chugh, Edward P. Ficaro, Mauro Moscucci, James N. Kritzman, James R. Corbett. *University of Michigan, Ann Arbor, MI*

Background: LV ejection fraction (EF) is commonly measured using gated SPECT perfusion imaging, but certain common image characteristics have been problematic. The purpose of this study was to test a new algorithm (3D-MSPECT) for measuring EF against contrast ventriculography (CVG) and another available SPECT quantification program (QGS) in patients with widely varying image characteristics. **Methods:** A new LV surface detector using gradient images to determine initial estimates was developed. Weights based on activity, motion and consistency of the endo- and epicardial surface estimates in space and time are assigned. A series of two-dimensional weighted splines are used to refine the surface estimates. Splines insure that the continuity of the surfaces and the natural curvature of the myocardium is preserved even in the presence of large perfusion defects. Threshold values as a function of position are automatically determined and used in conjunction with a morphological operator to create the segmented image of the LV. The spline interpolators are reapplied to refine the surface estimates utilizing contiguity information. The LV wall activity is fitted to a Gaussian function to estimate the mid-wall position and thickness. The volume curve is estimated to determine the end-diastolic and end-systolic frames. The new algorithm was tested in consecutive patients (N=97, Male= 65) with diverse image characteristics. **Results:** The new method was robust in the presence of large infarct-related defects as well as small hyper-contractile hearts. In all cases without user intervention, smooth visually acceptable LV surface estimates were obtained. The correlation between 3D-MSPECT and CVG was very good with a regression line of $y = 0.841x + 8.043$ ($r = 0.873$, $p < 0.001$). In this same population operating in automatic mode, QGS provided a regression line of $y = 0.750x + 7.645$ ($r = 0.841$, $p < 0.001$). **Conclusion:** From these studies, we conclude that this new automatic algorithm is robust in providing accurate measurements of LV function independent of the image characteristics in comparison to CVG and QGS.

POSTER SESSION

1110 Echo Assessment of Right Ventricular Infarction

Monday, March 19, 2001, 9:00 a.m.-11:00 a.m.
Orange County Convention Center, Hall A4
Presentation Hour: 9:00 a.m.-10:00 a.m.

1110-147 Prevalence and Coronary Correlations of the T-Sign in Patients With Inferior Left Ventricular Wall Motion Abnormalities: Clue to Avoid Right Ventricular Neglect

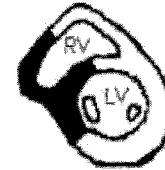
Ronen Beeri, Marcia Leavitt, Igor F. Palacios, Robert A. Levine. *Massachusetts General Hospital, Boston, MA*

Background: Right ventricular wall motion abnormalities (RV WMAs) are often difficult but important to recognize because they can contribute to reduced output and congestive signs. Clinical observations suggest a constellation of LV inferior wall, inferior septal and adjacent RV inferior WMAs, forming a "T", and providing a marker of RV involvement. We therefore tested the hypothesis that RV WMA, forming this "T" pattern, frequently accompanies LV inferior WMAs. We aimed to corroborate this pattern and explore the underlying coronary anatomy.

Methods: Of 116 patients with inferior and not anterior LV WMAs studied by echo over 1 month, we reviewed 43 with coronary angiography. The T sign, if diagnosed in short-axis views at basal-to-apical levels, was confirmed by RV inferior and apical WMAs in RV inflow and 4-chamber views.

Results: The T-sign was present in 34/43 (79%) of patients with LV inferior WMAs. Posterolateral LV extension was present in 20 (47%). In patients with the T-sign and a right-dominant coronary system, 21/26 (81%) had important right coronary artery disease; in left- or co-dominant patients, 6/8 (75%) had left circumflex disease.

Conclusion: The T-sign is observed in the majority of patients with inferior LV WMAs. Inferior and inferoseptal LV involvement therefore mandates attention to RV disease as well. This constellation of RV together with LV abnormalities is given a stronger pathophysiologic basis by its frequent association with disease of the dominant vessel supplying the inferoposterior wall of the LV.



1110-148 The Importance of Using Multiple Windows for the Echocardiographic Identification of Right Ventricular Infarction

Carol Y. Gemayel, Daniel B. Fram, Leigh-Ann A. Fowler, Francis J. Kiernan, Anita M. Kelsey, Linda D. Gillam. *Hartford Hospital, Hartford, CT*

Background: The echocardiographic assessment of left ventricular (LV) function routinely employs a segmental approach, and it is understood that the identification of ischemic dysfunction or infarction requires imaging from multiple windows. The right ventricle (RV) is, however, frequently viewed as responding uniformly to ischemia/infarction and its assessment may be limited to the apical 4 chamber (A4C) view which images only the lateral wall of the RV. Occasionally, this is the only view available. Since RV infarction (RVMI) is an important complication of acute left ventricular inferior wall infarction (LVMI), it is important that there be robust echocardiographic methods for its diagnosis. It is hypothesized that the dysfunction of RVMI may be regional and overlooked if multiple views are not employed.

Methods: Twenty-five patients with acute LVMI complicated by RVMI were prospectively evaluated with complete 2D echocardiographic examinations. RVMI was defined by positive RV ECG leads. Angiography was performed in all pts. Angiograms were reviewed in a blinded fashion and categorized according to whether the obstruction was proximal or distal to the acute RV marginal branch. Echocardiographic views obtained were: parasternal RV inflow, parasternal short axis, A4C, subcostal-4C and subcostal short axis. Segments were scored as normal, hypokinetic(H) or akinetic(A) by an experienced echocardiographer blinded to the ECG and angiographic findings. The presence of H or A RV segments was considered indicative of RVMI by echo.

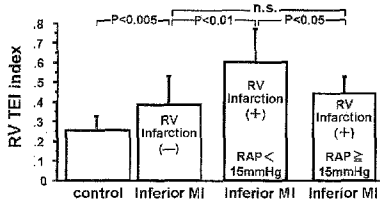
Results: Adequate echocardiographic images were obtained in all pts. When all views were evaluated, RVMI was diagnosed by echo in 25/25 pts. In 5 pts, the RV wall motion abnormality was limited to the inferior (diaphragmatic) wall and not seen in the A4C view. These pts all had RCA occlusion distal to the acute RV marginal artery.

Conclusion: Acute RVMI may be missed echocardiographically if imaging of the RV is limited to an A4C view. Therefore, a segmental approach using multiple echocardiographic windows is essential in patients with suspected right ventricular infarction.

1110-149 Pseudonormalized Doppler Total Ejection Isovolume (TEI) Index in Patients with Severe Right Ventricular Infarction

Shiro Yoshifuku, Yutaka Otsuji, Kunitsugu Takasaki, Toshinori Yuasa, Eiji Kuwahara, Kouichi Toyonaga, Souki Lee, Hitoshi Toda, Toshiro Kumano, Hitoshi Nakashima, Tatsuru Matsuoka, Shinichi Minagoe, Chuwa Tei. *Kagoshima University, Kagoshima, Japan*

Background: It has been reported that Doppler total ejection isovolume (TEI) index, defined as sum of isovolumetric contraction and relaxation time divided by ejection time, is useful to diagnose right ventricular infarction (RVI). However, relationships between TEI index and severity of RVI has not been investigated. **Methods:** Relationships between TEI index and severity of RVI was evaluated in 24 patients with acute inferior myocardial infarction (MI) (13 with and 11 without RVI) and 20 controls. TEI index was measured as (a-b)/b, where a is the interval between cessation and onset of tricuspid flow and b is the pulmonary flow ejection time. RVI was diagnosed when right atrial pressure (RAP)≥10mmHg or RAP/(pulmonary capillary wedge pressure) > 0.8 and it was defined as severe when RAP≥15mmHg. **Results:** 1) RV TEI index was significantly increased in patients with RVI compared to those without it (0.53±0.15 vs 0.38±0.16, P<0.05). 2) However, RV TEI index in patients with severe RVI (RAP≥15mmHg) was significantly smaller (pseudonormalization) compared to those with mild/moderate RVI (RAP<15 mmHg) and had no significant difference to those with MI but without RVI. 3) By setting RV TEI index≥0.47 as the criteria, the diagnosis of RVI had the sensitivity, specificity, and accuracy of 69%, 73%, 71%. However, 5 of 6 patients with severe RVI showed false negative by this criteria. **Conclusion:** RV TEI index is generally increased in patients with RV infarction, however, severe RV infarction can be manifested with limited or no increase in TEI index (pseudonormalization).



1110-150 Assessment of Right Ventricular Function Using a Doppler Index of Combined Ventricular Function in Patients With Inferior Myocardial Infarction

Mi-Seung Shin, Jong-Won Ha, Donghoon Choi, Namsik Chung. *Cardiology Division, Yonsei University College of Medicine, Seoul, South Korea*

Background: Right ventricular (RV) ischemia occurs in 50% of patients (pts) with acute inferior (inf) myocardial infarction (MI), and may result in severe hemodynamic compromise or subclinical RV dysfunction. Unlike left ventricular dysfunction, there is no reliable method to evaluate RV function due to its complicated geometry. Previous studies have shown that a Doppler echocardiographic index (IMP, Index of Myocardial Performance) showing combined systolic and diastolic function is useful in the assessment of cardiac function in normals and pts with dilated cardiomyopathy. The purpose of this study was to investigate whether the diagnosis of RV dysfunction by RV IMP is feasible or not. **Methods:** We analyzed Doppler echocardiographic data in 31 pts with acute inf MI (17 male, mean age 60) and 20 normal controls. Peak early (E) and late (A) diastolic velocities and deceleration time (DT) of transtricuspid inflow were measured. RV IMP was calculated as follows: RV IMP=(ICT+IVRT)/ET=(a-b)/b, ICT; isovolumic contraction time, IVRT; isovolumic relaxation time, ET; ejection time, a; the interval between cessation and onset of transtricuspid Doppler flow, b; the interval of pulmonary ejection flow. **Results:** In inf MI pts, E velocity (44.6 vs 52.4 m/sec, p=0.03) and DT (181 vs 206 msec, p=0.03) were significantly decreased compared with normal controls. RV IMP was significantly increased (0.25 vs 0.11, p=0.01) in pts with inf MI compared with normal controls. **Conclusion:** Analysis of transtricuspid Doppler flow and RV IMP is a simple and noninvasive measure to evaluate RV function in patients with inf MI.

Comparison of echocardiographic data between inferior MI and control groups

Group	E(m/sec)	DT(msec)	a(msec)	b(msec)	RV IMP
Inferior MI	44.6±12.8	181.2±39.9	367.65±40.85	295.35±35.14	0.25±0.19
Control	52.4±10.1	206.0±38.2	362.11±39.38	328.16±33.96	0.11±0.10
p-value	0.03	0.03	0.68	0.005	0.01

POSTER SESSION

1111 Stress Echocardiography: Protocol Refinements

Monday, March 19, 2001, 9:00 a.m.-11:00 a.m.
Orange County Convention Center, Hall A4
Presentation Hour: 9:00 a.m.-10:00 a.m.

1111-151 Target Heart Rate During Dobutamine Stress Echocardiography: Where Should We Draw the Line?

Melda S. Dolan, Amr El-Shafei, Kamal Riad, Hassan Rajjoub, George Chahoud, Denise Sherriff, Wendy Watts, Michelle Bierig, Carrie Totta, Alan R. Maniet, Arthur J. Labovitz. *Saint Louis University School of Medicine, St. Louis, MO*

Over the past years, Dobutamine Stress Echocardiography has emerged as one of the important methods for detection and management of patients with known or suspected coronary artery disease. A limitation of this technique is in the evaluation of patients with inadequate heart rate response. Even though atropine has been adopted to Dobutamine protocols to achieve the target heart rate (85% of age predicted maximal heart rate), the effect of reaching higher heart rates than the target one, on the sensitivity and specificity of Dobutamine Stress Echocardiography has not been studied yet. Accordingly, we designed a study to evaluate the effect of achieving higher heart rates during stress echo on diagnostic accuracy of Dobutamine Stress Echocardiography. Total of 592 patients, 352 male 240 female ranging in age from 38 to 86 had DSE and coronary angiography within 18 ± 14 days. The patients were divided into 2 groups; group(1) included patients reaching 85% or less of age predicted maximal heart rate and group(2) included those reaching more than 85% of target heart rate. Sensitivities and specificities were compared among the 2 groups with respect to extent and location of coronary stenosis. There were not any differences noted between the groups with respect to age, gender, presence of resting wall motion abnormalities, stenosis location and severity and antianginal therapy.

	Group 1 (n=464)	Group II (n=128)	P
Sensitivity	71	79	0.01
Single vessel	68	77	0.01
Multi-vessel	80	86	NS
Specificity	83	77	NS

These data indicate that the achievement of higher heart rates lead to better sensitivities more prominently for single vessel disease.

Conclusion: Achieving higher peak heart rates than the target one during Dobutamine Stress Echocardiography was associated with increased sensitivity with no change in specificity for detecting patients with single vessel disease. Therefore, peak heart rate greater than 85% of age predicted maximal heart rate should be targeted during dobutamine stress echocardiography.

1111-152 Isometric Handgrip Exercise With Dobutamine Stress Echocardiography Reduces Total Study Duration Time and Atropine Use

Siu-Sun Yao, Sonja Moldenhauer, Marc Nolan, Eduardo Chacana, Mark V. Sherrid. *St. Luke's Roosevelt Hospital Center, New York, NY*

Background: Dobutamine stress echocardiography (DSE) is an established test for CAD diagnosis and risk-stratification. Atropine use to attain target heart rate prolongs DSE time. **Methods:** To study impact of isometric handgrip exercise (HGE)(33% maximal voluntary contraction for 4 minutes) on atropine use and DSE study duration, we prospectively evaluated 113 patients (68±15 years, 49% male) undergoing DSE randomized to HGE (even birthdate) or no HGE. Effect of HGE on endpoints: time to target heart rate (85% maximum predicted), recovery time, total time and mean dose atropine used. The effect of current beta-blocker (B-B) medication use on study endpoints was also evaluated.

	DSE Study Time (minutes)			Atropine dose(mg)
	To Target	Recovery	Total	
No B-B medication				
no HGE(39)	10.9±2.9	10.2±6.7	21.1±8.7	0.3±0.5
yes HGE(37)	8.8±3.1*	6.4±4.6*	15.2±6.6*	0.1±0.3†
Yes B-B medication				
no HGE(16)	10.5±3.7	9.1±6.4	19.6±7.9	0.4±0.4
yes HGE(21)	11.2±2.9	7.2±5.0	18.4±7.0	0.4±0.4

*p<0.01 or †p<0.05 versus No B-B, no HGE group.

Results: There was no difference in baseline clinical characteristics or peak blood pressure in patients, with or without HGE. With HGE, DSE time was reduced by 4.3 minutes (16.4±6.9 vs 20.7±8.4, p=0.004) in all patients, and 5.9 minutes (p=0.001) in patients not on B-B. Patients not on B-B, use of HGE decreased all DSE time and atropine endpoints. With or without HGE, there was no difference in endpoints in patients on B-B. **Conclusions:** Use of HGE with DSE in patients not on B-B, significantly decreases time to target heart rate, recovery time, total study time and atropine use. HGE should be routinely incorporated into all DSE protocols, in patients not on B-B medication.

1111-153 Early Administration of Atropine Prevents Symptomatic Paradoxical Sinus Deceleration During Dobutamine Stress Echocardiography

Alessandra Brofferio, Jamshid Alaeddini, Raju Oommen, Thomas DiBitetto, Yaron Shalomoff, Arzu Ilercil, Jamshid Shirani. *Albert Einstein College of Medicine, Bronx, NY*

Background: Reflex paradoxical sinus deceleration (PSD) may occur during dobutamine stress echocardiography (DSE), is associated with unpleasant symptoms, and may prevent achievement of target heart rate. As this reflex likely results from stimulation of parasympathetic activity, we hypothesized that early administration of atropine would prevent PSD during DSE. **Methods:** We prospectively randomized 114 consecutive pts [age 36-91 (66±12) yrs, 66 (58%) women] undergoing DSE, to two protocols. Group A (n=55) received standard DSE protocol, i.e., incremental doses of dobutamine (D) from 5 to 40 mcg/Kg/min at 3-minute intervals and up to 1 mg of atropine, at 0.25 mg doses at 2-minute intervals, if needed, at completion of the 40 mcg/Kg/min dose of D. A 3-minute infusion of D at 50 mcg/Kg/min was given if necessary at peak (n=2). Pts in group B (n=59) underwent the same protocol except for administration of atropine at completion of 10 mcg/Kg/min dose of D with the aim to increase heart rate by 25% before advancing to next dose of D. PSD was defined as a reduction in heart rate of >5 bpm lasting for 3 minutes at D infusion rates of 20 mg/Kg/min or higher. **Results:** PSD occurred in 7 (12.7%) group A and 1 (1.7%) group B pts (p=0.02). Compared to 48 pts without PSD in group A, the 7 pts with PSD were more often women (100%-vs-60%, p=0.03), older (74±9-vs-65±14 yrs, p=0.03), and had smaller body surface areas (1.6±0.1-vs-1.8±0.2 m², p=0.003). In addition, pts with PSD tended to be hypertensive (100%-vs-69%, p=0.08) and had higher LVEF (64.7-vs-59±12%, p=0.07). PSD was associated with symptoms of throat tightness, nausea, and generalized discomfort in group A pts. The one pt with PSD in group B had no symptoms. Twelve (22%) pts in group A did not reach 70% of predicted maximum heart rate at completion of the 40 mg/Kg/min dose of D (compared with none in group B, p<0.01). Average dose of D was significantly lower in B than A group (32±13-vs-35±9 mcg/Kg/min, p=0.01). **Conclusion:** PSD during DSE occurs primarily among small older women with history of hypertension and normal or supranormal LVEF and is associated with unpleasant symptoms. Early administration of atropine can effectively prevent PSD and its accompanying symptomatology.

1111-154 Age Related Changes in Systolic Pulmonary Artery Pressure During Exercise by Doppler Echocardiography

Joseph P. Navarrijo, Mary Callaway, Sue Maisey, Eunice Huxford, Raymond F. Stainback, Susan Wilansky. *St. Luke's Episcopal Hospital/ Texas Heart Institute, Houston, TX*

Background: Doppler echocardiography (DE) can be utilized to determine systolic pulmonary artery pressure (SPAP). The full range of SPAP with exercise over different age groups has not been completely studied. The purpose of this study was to determine systolic pulmonary artery pressure (SPAP) during exercise in normal subjects over a wide age range using DE. **Methods:** Twenty-four normal subjects (mean age 49±10, range 24 to 60 years; 11 males, 13 females) underwent semi-upright bicycle exercise with DE. Agitated saline was injected intravenously to enhance the spectral signal of tricuspid regurgitation velocity (TRV). SPAP was derived by the formula: 4 x TRV squared + 5mmHg. Adequate exercise was defined as ≥ 85% of maximum age predicted heart rate (HR) response or doubling of cardiac output (CO). **Results:** Resting and peak exercise SPAP was significantly higher in subjects ≥ 50 years of age (p=0.017 and 0.003 respectively). There were no significant differences in exercise duration, peak watts achieved, HR or CO response between the two subgroups. There was no gender related differences in SPAP at rest or exercise. **Conclusion:** This study helps determine the physiologic limits of SPAP at rest and exercise in normal subjects over a wide age range. There was a significant difference in SPAP response to exercise in subjects ≥ 50 years of age at similar cardiac workloads.

	SPAP (mmHg)			Peak HR (beats/min)	Peak CO (L/min)
	Rest	Peak Exercise	Recovery		
All Subjects	30±8	49±10	32±8	153±12	10.5±2.0
Age<50yrs (n=11)	26±6	44±8	29±8	156±15	10.3±1.8
Age≥50yrs (n=13)	33±7*	55±8*	35±6*	150±8	10.3±2.3
Male	31±8	48±10	33±8	147±11	10.9±1.6
Female	28±7	49±10	29±8	158±11**	10.2±2.3

* p<0.03 vs. Age<50 years old, 95% confidence interval (CI)

** p=0.016 vs. Male, 95% CI

POSTER SESSION

1112 Myocardial Contrast Echocardiography in Acute Myocardial Infarction II

Monday, March 19, 2001, 9:00 a.m.-11:00 a.m.
Orange County Convention Center, Hall A4
Presentation Hour: 9:00 a.m.-10:00 a.m.

1112-155 Real-Time Contrast Echocardiography Predicts Contractile Reserve Early After Myocardial Infarction

Jonathan M. A. Swinburn, Avijit Lahiri, Roxy Senior. *Northwick Park Department of Cardiac Research, Harrow, United Kingdom*

Background: Power pulse inversion is a novel technique by which contrast microbubbles can be visualised in real time within the myocardium, enabling simultaneous assessment of myocardial function and perfusion. The presence of contrast microbubbles in the micro-circulation suggests capillary integrity, which is a marker of viability and a pre-requisite for contractile function. We aimed to determine whether power pulse inversion can be used to predict contractile reserve early after myocardial infarction. **Methods:** We studied 19 stable patients 5.1 ± 1.6 days after presentation using low dose dobutamine stress echocardiography and power pulse inversion contrast imaging using bolus intravenous injections of 0.5mls Optison. A 16-segment left ventricular model was used to define baseline wall thickening (1-normal; 2-reduced; 3-absent), wall thickening following low dose dobutamine infusion, and contrast opacification (1-homogeneous; 2-heterogeneous or reduced; 3-absent). The techniques were compared on a segment by segment basis to determine whether homogeneous contrast opacification could predict contractile reserve of segments that were akinetic at rest. **Results:** 94 (31%) of the 304 segments were akinetic at rest, and 22 (23%) of these demonstrated contractile reserve. In 87 (92%) of the resting akinetic segments contrast opacification could be adequately determined, and of these 8 (12%) had a contrast score of 1 and 67 (77%) had a contrast score of 3. A contrast score of 3 had a negative predictive value for detection of contractile reserve of 90% while the positive predictive value of a contrast score of 1 was 88%. A contrast score of 2 however, did not discriminate between the presence or absence of contractile reserve.

Segmental comparison of contrast opacification and contractile reserve

	Contrast Opacification Score		
	1	2	3
Contractile Reserve	1	2	3
Yes	7	6	7
No	1	6	60

Conclusion: Power pulse inversion contrast echocardiography can be used at rest to determine myocardial function and simultaneously to predict contractile reserve of akinetic segments in patients early after myocardial infarction. This technique has the potential to provide a bedside assessment of myocardial viability.

1112-156 Spatial Extent and Magnitude of Myocardial No-, Low- Reflow by Contrast Echocardiography After Reperfusion in Patients With Acute Coronary Syndrome Represent Segmental and Transmural Extent of Infarct

Christian Firschke, Peter Andrassy, Ullrich Schricke, Jens Paliga, Markus Schwaiger, Albert Schoemig. *Deutsches Herzzentrum, Technische Universitaet Muenchen, Muenchen, Germany*

Background: In the experimental setting, venous myocardial contrast echocardiography (VMCE) allows delineation of infarct size after reperfusion, and contractile response during dobutamine stress echo (DSE) correlates with the amount of salvaged myocardium. We hypothesized that there would be concordance between size of no-/low- reflow on VMCE and defect size on sestamibi SPECT imaging (SI) 14 days after reperfusion in patients with acute coronary syndrome (ACS), and that there would be a correlation between the magnitude of contrast effect of initially akinetic (Ia) segments at day 14 and transmural extent of infarct. We defined (1) normokinesia, (2) hypokinesia, (3) akinesia with functional improvement during DSE, and (4) akinesia without functional improvement during DSE as steps of increasing transmural extent of infarction at day 14. **Methods:** In 103 patients (male n=84; median age 60 years) 2-dimensional echocardiography was performed before, and VMCE (Optison, 200 ml/h, intermittent harmonic imaging, digital image processing) and SI 14 days after reperfusion (PTCA n=96, thrombolysis n=7) of ACS. DSE (5µg/kg-40µg/kg) was performed in all but 14 patients at day 14. The number of segments with contrast and sestamibi uptake defect was determined. Magnitude of contrast enhancement on VMCE was given as ratio between videointensity of Ia segment and brightest segment (VI) of the same view. **Results:** At day 14, ACS-related artery had TIMI 3 flow in 95/103 patients, and 76/103 patients showed areas of no-/low- reflow on VMCE. Number of defect segments on VMCE and SI was equal in 49% of patients. In 70%, discordance included no more than 1 segment. VI was 90±14% for (1) segments (n=78), 83±22% for (2) segments (n=81), 80±30% for (3) segments (n=44), and 31±22% for (4) segments (n=97). VI differences between groups were highly significant (p<0.001) except between (2) and (3). **Conclusions:** The size of myocardial no-/low- reflow by VMCE 14 days after reperfusion of ACS represents segmental extent of infarct. Magnitude of contrast enhancement by VMCE of Ia segments represents transmural extent of infarct. Thus, VMCE is a promising tool for accurate assessment of infarct size early after reperfusion of ACS.

1112-157 Early Q Waves Are Clinical Predictors of No-Reflow After Successful Recanalization of the Infarct Related Artery

Leonarda Galiuto, Antonella Lombardo, Antonio G. Rebuzzi, Luca Santoro, Domenico Cianflone, Filippo Crea, Attilio Maseri. *Institute of Cardiology, Catholic University of the Sacred Heart, Rome, Italy*

Background: In patients with acute myocardial infarction (AMI), "no-reflow" phenomenon is associated with an unfavourable prognosis. To search for predictors of no-reflow, clinical, ECG and echo parameters available at the time of hospital admission were analyzed in 20 pts (18 males, 61 ± 9 yrs) with AMI (15 anterior) successfully treated by thrombolysis (n=12) or PTCA (n=8) within 6 hrs from onset. **Methods:** No-reflow was diagnosed by MCE performed within 24 hrs from onset by Harmonic Power Doppler (end-systolic triggering 1:4) and i.v. Levovist (400 mg/ml, 2 ml/min). Each myocardial segment was scored for function (3=akinesia, 2=hypokinesia, 1=normokinesia) and perfusion (3=absent, 2=hypo, 1=normo). A regional wall motion score index (WMSI) and contrast score index (CSI) were calculated within the dysfunctioning myocardium. Power Doppler videointensity (VI) was measured in dB within the risk and control zone and their ratio was calculated. **Results:** Coronary angiography performed following PTCA or 5 ± 2 days after thrombolysis showed successful recanalization of the infarct related artery in all pts (TIMI grade 2.4 ± 0.7). No-reflow at MCE occurred in 11/20 pts (55%). CSI was 2.6 ± 0.6 and VI ratio was 0.4 ± 0.2 in no-reflow and 1.1 ± 0.2 and 0.8 ± 0.2 in reflow pts (p<0.0001 and <0.05, respectively). In the first ECG recorded before coronary recanalization, Q waves were present in 80% of no-reflow pts and in 33% of reflow pts, their number was 2.6 ± 1.7 in no-reflow and 0.8 ± 1.2 in reflow pts (p<0.05). In the prediction of no-reflow, early Q waves showed a sensitivity of 80%, a specificity of 66%, a positive predictive value of 72% and a negative predictive value of 75%. Time from onset of symptoms to reperfusion, treatment by thrombolysis or PTCA, TIMI grade and WMSI were not different between no-reflow and reflow pts. **Conclusions:** The presence and extent of early Q waves is highly predictive of the occurrence of no-reflow, independently from time to and modality of reperfusion. Since this phenomenon is associated with an unfavourable prognosis, such a clinical predictor may be extremely valuable to establish a tailored treatment.

1112-158 Distal Microthromboembolism Contributes to the No Reflow Phenomenon After Primary PTCA in Acute Myocardial Infarction

Tadamichi Sakuma, Kevin Wei, Se-Joong Rim, Howard Leong-Poi, Nick Fisher, Sanjiv Kaul. *University of Virginia, Charlottesville, VA*

Background. Previous canine studies have used coronary ligation to produce acute myocardial infarction (AMI). The no reflow seen under these circumstances after reperfusion has been established has been attributed solely to tissue necrosis. In the clinical setting, AMI occurs from an occlusive thrombus and PTCA might cause microemboli that could also contribute to the no reflow phenomenon. **Aim.** We hypothesized that when PTCA is performed for AMI microthromboemboli contributes toward no-reflow. **Methods.** An occlusive thrombus was attempted to create in the mid-LAD of 5 dogs. It was labeled in-vivo with a 99mTc-labeled glycoprotein 2b/3a-platelet inhibitor (DMP-444, Dupont). Significant amounts of thrombi were detected using coronary angiography. Risk area was measured using myocardial contrast echocardiography (MCE). PTCA was performed at a mean of 150 min later and TIMI grade III flow was confirmed. MCE was repeated 15 and 60 min after during adenosine administration. The heart was sliced for 99mTc-autoradiography (to define region with micro thrombi) and triphenyl-tetrazolium chloride (TTC) staining (to define infarct size). **Results.** Risk area, perfusion defect size 15 and 60 min after recanalization, hot spot size on 99mTc-autoradiography, and infarct size (all as a percent of LV) are shown in the Table. Perfusion defect sizes both 15 minutes and 60 minutes after recanalization during adenosine administration were larger than the final infarct size in the dogs with thrombus. The hot spot on 99mTc-autoradiography corresponded to the risk area. **Conclusions.** Microthromboemboli from the attempted PTCA cause no reflow. This finding may explain why the no reflow region decreases with time as these thrombi dissolve. Interventions aimed at reducing microthromboemboli may benefit patients undergoing primary PTCA for AMI.

	Thrombus	Risk Area	15 min	60 min	Hot Spot	Infarct Size
1	yes	35.2	18.5	14.7	37.3	12.9
2	no	27.0	0	0	11.6	5.3
3	yes	45.0	32.9	29.6	43.4	23.4
4	yes	36.4	27.4	19.6	33.3	16.7
5	no	9.5	5.8	4.6	8.2	4.0

ORAL CONTRIBUTIONS

814 Echocardiographic Assessment of Atrial Fibrillation and Source of Embolus

Monday, March 19, 2001, 9:15 a.m.-10:30 a.m.
Orange County Convention Center, Valencia B

814-1 Doppler Indices of Left Ventricular Filling and Risk of Atrial Fibrillation: The Framingham Heart Study

Ramachandran S. Vasan, Martin G. Larson, Daniel Levy, Maurizio Galderisi, Philip A. Wolf, Emelia J. Benjamin. *NHLBI's Framingham Heart Study, Framingham, MA, Boston University School Of Medicine, Boston, MA*

Background: Select transmitral indices of LV filling (peak A velocity and atrial filling fraction) are indicators of atrial mechanical function. A reduced A wave or a decreased atrial filling fraction have been reported to predict recurrences of atrial fibrillation (AF). The prognostic significance of these Doppler indices in individuals without a history of AF is unknown.

Methods: We evaluated 942 Framingham Heart Study subjects (355 M, 587 F; mean age 75 years) who underwent Doppler echocardiographic evaluation at a routine biennial examination and who did not have a history of AF or significant valve disease. We used Cox proportional hazards regression models to examine the relations of AF incidence with Doppler indices of transmitral filling (ratio of peak early to late diastolic filling velocities: E/A; ratio of the velocity time integrals of E and A waves: VTI E/A; E wave deceleration time: DT; and atrial filling fraction). We adjusted for known covariates, and stratified by sex and prevalent cardiovascular disease.

Results: During follow up (mean 7 years), 86 subjects (44 M, 42 F) developed AF. In multivariable models - adjusting for age, smoking, diabetes, cholesterol, hypertension, heart rate, PR interval, and interim heart failure/myocardial infarction - a 1 SD increment in VTI E/A was associated with a 30% increase in risk of AF (Hazards Ratio [HR] 1.3, 95% CI 1.0-1.6, p=0.02). Although of borderline statistical significance, a 1 SD decrement in atrial filling fraction was associated with a 30% higher risk of AF (HR 1.3, 95% CI 1.0-1.7, p=0.054). E/A and DT were not related to risk of AF.

Conclusion: In our elderly population-based sample, we noted that an increased VTI E/A was a marker of increased risk of AF on follow up. The association of high VTI E/A with increased LV filling pressure may explain this observation.

814-2 Prevalence of Cardiac Sources of Embolism in African Americans With Cryptogenic Cerebrovascular Events

Jorge R. Kizer, Frank E. Silvestry, Michael B. Erwin, Stephen E. Kimmel, Susan E. Wiegers, Scott E. Kasner, Stephanie A. Schwalm, John R. Pollard, Ted Plappert, Martin G. Keane, Martin G. St John Sutton. *University of Pennsylvania Medical Center, Philadelphia, PA*

Background: Although many studies have evaluated the prevalence of transesophageal echocardiography (TEE) findings among caucasians (C) with cerebrovascular events (CVE), little is known about the potential cardiac etiologies among African Americans (AA). We compared the TEE-determined frequency of potential cardiac sources of embolism (CSE) between AAs and Cs with cryptogenic CVE. **Methods:** We reviewed the echocardiography database at our institution to identify pts with CVE (stroke or transient ischemic attack) referred for TEE to assess CSE (1/95-8/00). Pts with known embolic risk factors (a fib, valve surgery, LVEF < 35%, LV aneurysm, congenital heart disease, bacteremia and recent coronary bypass surgery) were excluded. Coupled with physician referring practice, these exclusions yielded pts with predominantly cryptogenic CVE. Potential CSE included interatrial communication (IAC), interatrial septal aneurysm (ISA), spontaneous echo contrast (SEC), mitral valve prolapse (MVP), vegetations (Veg), valvular strands (VS), LA/LV clot and complex aortic atheroma (CAA). LV dysfunction (LVD) was defined as LVEF 36-49%. **Results:** N = 315 pts; median age 56; male 49.8%; C 67.3%, AA 28.5% and other 4.2%. After adjusting for age and sex, AAs had significantly fewer IACs or positive TEEs for other potential CSE (Table). They had less MVP or ISA, but the prevalences of CAA, Veg, VS, LA/LV clot and SEC were not statistically different. (LA/LV clot not shown.) Abnormalities of the LV were more prevalent among AAs, who were 4 and 1.5 times more likely to have hypertrophy (LVH) and LVD, respectively (Table). **Conclusions:** In this population with cryptogenic CVE, TEE-detected CSE were significantly less common in AAs than in Cs. IAC and other potential cardioembolic findings appear to play a less important role in the etiology of cryptogenic CVE among AAs, who have a higher burden of LV hypertrophy and dysfunction.

Relative Prevalence of TEE Findings

	IAC	ISA	SEC	MVP	Veg	VS	CAA	+TEE	LVD	LVH
AA	17.2%	2.3%	3.4%	3.4%	9.0%	5.6%	5.8%	37.1%	21.6%	60.2%
C	34.5%	7.2%	7.6%	3.4%	8.1%	5.2%	6.8%	52.9%	16.3%	30.6%
Adj OR	0.4	0.3	0.4	0.9	1.1	1.0	0.7	0.5	1.5	4.1
95% CI	0.2-0.8	0.1-1.3	0.1-1.5	0.2-3.7	0.5-2.7	0.3-3.0	0.2-2.3	0.3-0.9	0.8-2.8	2.3-7.3

9:45 a.m.
814-3 Safety and Clinical Value of TEE Imaging With Continuous In Situ Probe During Direct Current Cardioversion of Atrial Fibrillation/Flutter

Can Hasdemir, Krishnaswamy Chandrasekaran, Muddasir A. Shah, Suresh Chandrasekaran, Najj E. Karam, Chittur A. Sivaram, Ralph Lazzara. *University of Oklahoma Health Sciences Center, Oklahoma City, OK*

Background: The diagnostic and therapeutic role of Transesophageal Echocardiography (TEE) guided Direct Current Cardioversion (DCCV) in patients (pts) with atrial fibrillation (AF) is well established. The purpose of this study was to determine the safety of in-situ TEE probe during DCCV and to evaluate the clinical information derived. **Methods:** Continuous TEE imaging was performed during DCCV of AF/flutter in 62 pts (age 66±15, 65% male) while keeping the TEE probe in-situ during and after DCCV. Propofol and midazolam were used for sedation and blood pressure, heart rate, O₂ saturations were continuously monitored in all pts. Underlying etiologies for AF were hypertension (52%), coronary artery disease (32%) and valvular disease (21%). Underlying rhythm was AF (71%), atrial flutter (26%) and atrial tachycardia (3%). Arrhythmia duration was ≤ 1week (27%), < 6months (13%), >6months (37%), unknown (23%). **Results:** Mean DCCV energy and number of shocks were, 256±110 Joule, 1.4±1.0 respectively. Mean left ventricular ejection fraction was 49±13%. Mean left atrial appendage (LAA) emptying velocities before DCCV was 33±20 cm/sec. 30 pts (48%) had spontaneous echo contrast (SEC, 22 faint, 8 dense) and 76% of the pts were anticoagulated prior to DCCV. The success rate for DCCV was 84%. Following DCCV, LAA emptying velocities decreased to 24±20cm/sec (p value=.0009). 4 pts developed new dense SEC; in 2 pts faint SEC became dense SEC with early thrombus formation. Hemodynamics and O₂ saturations remained normal in all pts during DCCV with the probe in-situ. There were no immediate pts complications or equipment failure. **Conclusion:** 1) TEE imaging during DCCV with continuous in-situ probe is safe for pts and equipment. 2) It provides additional information about left atrium and LAA function during and after DCCV.

10:00 a.m.
814-4 Effect of Balloon Mitral Valvuloplasty on Left Atrial Appendage Function and Spontaneous Echo Contrast in Patients With Severe Mitral Stenosis: A Transesophageal Echocardiographic Follow-Up Study

Kewal C. Goswami, M. Bhaskararao, Rakesh Yadav, Kewal K. Talwar, Vinay K. Bahl and Subhash C. Manchanda. *Cardiothoracic Sciences Center, All India Institute of Medical Sciences, New Delhi, India*

Background: Left atrial appendage (LAA) function is depressed in patients (pts) with mitral stenosis (MS) and it is associated with increased incidence of LAA clot and spontaneous echo contrast (SEC) formation. **Method:** LAA function [LAA-ejection fraction (EF), filling and emptying velocities, filling and emptying velocity time integrals (VTIs)] was prospectively studied in 100 consecutive pts (mean age - 29.2 ± 8.4 years, 52 males) of severe MS by transesophageal echocardiography (TEE). TEE was done 24 hours before and after BMV, at 3 & 6 months, then at 6 months intervals. **Result:** LAA function in pre, post and during follow-up (FU)-after BMV is shown in table.

	Pre-BMV	Post-BMV	FU-BMV	Controls
Mitral valve area (cm ²)	0.80 ± 0.12	2.2 ± 0.4*	2.1 ± 0.33 #	
LAA max area (cm ²)	5.6 ± 2.0	5.2 ± 3.3	5.1 ± 2.4	2.8 ± 0.8
LAA - EF (%)	41.7 ± 12.1	50.4 ± 13.8*	56.2 ± 12.9 #	61.2 ± 10.2
Peak filling velocity (cm/s)	30.9 ± 11.2	36.7 ± 13.7*	36.1 ± 13.9 #	46.2 ± 21.6
Filling VTI (cm)	2.5 ± 1.2	3.4 ± 1.6*	3.5 ± 2.5 #	4.4 ± 2.1
Peak emptying velocity (cm/s)	22.3 ± 9.2	31.3 ± 12.1*	34.3 ± 14.6 #	46.6 ± 18.3
Emptying VTI (cm)	1.9 ± 0.08	2.7 ± 1.2	2.8 ± 0.8 #	3.4 ± 1.3

p value is significant between pre and post BMV (*), pre and FU-BMV (#) and post and FU-BMV (\$)

There was significant improvement in all the parameters except LAA area and it persisted during FU (mean -12.4 ± 6.1, range 3-24 months). The improvement was more marked in a subgroup of pts who had post-BMV-mitral valve area (MVA) > 1.5 cm², sinus rhythm (NSR) and smaller LAA. However, the improved LAA function was still significantly lower than controls. Before BMV, the SEC in LAA was present in 68% cases. SEC disappeared in 60% and 90% of cases after BMV and during FU respectively and decreased in the rest. **Conclusion:** BMV resulted in a significant improvement in the LAA function and this improvement persisted during FU. The improvement mainly depends on post-BMV-MVA, presence of NSR and size of LAA. In majority of cases SEC disappeared after BMV and during FU. BMV may have favorable clinical effect on the incidence of LAA clot by improving LAA function and by clearing SEC.

10:15 a.m.
814-5 Evaluation of Beat-to-Beat Change in Left Ventricular Diastolic Function During Atrial Fibrillation by Color M-Mode (CMM) Flow Propagation Velocity

Peggy K. Han, Tomotsugu Tabata, Junko Watanabe, Benjamin Cheong, Neil L. Greenberg, Allan L. Klein, James D. Thomas, Richard A. Grimm. *The Cleveland Clinic Foundation, Cleveland, OH*

Background: Preliminary studies have shown that in pts with atrial fibrillation (AF), LV end-diastolic volume determines subsequent peak systolic LV pressure. Prolongation of the cardiac cycle (RR) results in improved diastolic function and normal relaxation time constants. CMM LV inflow propagation velocities (V_p) are known to be determinants of LV

relaxation. Therefore, we evaluated beat-by-beat changes in RR and their subsequent V_p to assess CMM 1) as a determinant of LV diastolic function in AF and 2) a discriminator of pts with normal and impaired systolic function.

Methods: Transthoracic 2D echocardiography was performed in 44 pts in AF (mean age 62±14 yrs), 16 of whom had normal LV function (EF>50%), 19 had left ventricular hypertrophy (LVH) and 9 had low EF. Ten to 30 consecutive RR intervals were studied for each pt and corresponding V_p were measured. Peak and mean V_p were compared to preceding R-R interval. Peak and mean V_p as well as slope of the linear regression lines were compared between groups.

Results: V_p showed a positive correlation with their preceding RR intervals (r=0.65). Peak (maximum) and mean V_p were different among the 3 pt groups (Table). Among pts with LVH, only those under 55 yrs showed significant diastolic dysfunction when compared to normal pts in the same age group, whereas low EF pts demonstrated impaired diastolic function regardless of age. Linear regression analyses indicated similar average graphical slopes among normal and LVH pts and decreased graphical slopes in low EF pts (Table).

Conclusions: Flow propagation velocities in atrial fibrillation depend on preceding RR intervals and vary among normal, LVH, and low EF patients. These results suggest the use of V_p as a determinant of diastolic function in atrial fibrillation.

	Color M-mode Vp vs. Preceding RR Interval			p Values		
	Normal	LVH	Low EF	Normal vs. LVH	Normal vs. Low EF	LVH vs. Low EF
Mean Vp (cm/s)	67.3±7.9	59.4±8.7	44.2±6.3	0.01	0.0001	0.0001
Peak Vp (cm/s)	80.6±10.7	72.2±11.7	53.2±6.3	0.04	0.0001	0.0001
Slope	30.6±6.4	29.8±9.7	17.1±5.7	0.77	0.0001	0.001

ORAL CONTRIBUTIONS

824 Stress Echocardiography: Risk Stratification

Monday, March 19, 2001, 11:00 a.m.-12:15 p.m.
 Orange County Convention Center, Valencia B

11:00 a.m.
824-1 Can Allocation of Risk Be Used to Guide Management in Patients Undergoing Stress Echocardiography?

Colin Case, Susan Allen, Patricia Brennerman, Charles Vasey, Stephen Sawada, Thomas Marwick. *University of Queensland, Brisbane, Australia*

Background: Results of clinical evaluation and stress echo stratify risk of death in pts with known or suspected CAD. However, as these models incorporate factors that are not or are minimally amenable to intervention (age, diabetes), these models might merely predict pts likely to die rather than those whose risk may be ameliorated by intervention. We sought whether revascularization altered outcome in pts with 5 levels of risk predicted by stress echo. **Methods:** Exercise or dobutamine echo was performed at 3 centers in 5864 pts with known or suspected CAD. Clinical, stress and echo parameters were gathered prospectively. For each pt, risk was attributed on the basis of a previously derived logistic regression (which includes age, gender, heart failure, resting LV function, workload during stress and the presence of ischemia); pts were grouped into quintiles of risk. Event rates were recorded for pts treated medically and with revascularization. **Results:** Over follow-up, 590 pts were revascularized and 1146 pts died. Revascularization was associated with lower mortality in each group apart from those at lowest risk.

	n	Expected mortality	Mortality in RVS pts	Mortality in medical Rx	p
Lowest quintile	1163	4.6%	4.3%	4.7%	0.70
Second quintile	1183	9.3%	3.1%	9.8%	0.01
Third quintile	1150	15.6%	4.0%	17.1%	<0.001
Fourth quintile	1203	23.8%	11.2%	25.8%	<0.001
Fifth quintile	1170	43.3%	17.6%	47.9%	<0.001

Comparison of revascularized with medically-treated patients after adjusting for risk showed a relative risk of 2.0 (1.5 - 2.8) associated with non-revascularization. For pts at significant risk (ie. those in quintiles 2-5), there was no difference in age (63 vs 64 yrs, p=0.064) or peak RPP (22.6-23.0 x 1000 p=0.19) for the revascularized and medically treated groups, though heart failure was more prevalent in revascularized pts (despite better outcome). In contrast, pts in the lowest risk category who were revascularized were older than medically treated pts (46 vs 40 yrs p=0.004) and had slightly lower PRPP. **Conclusion:** Allocation of risk at functional testing appears to represent "treatable risk" in that outcome of revascularized pts is better than medically treated pts.

11:15 a.m.
 824-2 **Long-Term Prognostic Value of Exercise Echocardiography in Patients Evaluated for Coronary Artery Disease: The Value of a Risk Index Combining Echocardiographic, Treadmill, and Exercise ECG Parameters**

Wojciech Mazur, A. George Basu, Jose M. Rivera, Gary F. Marks, Miguel A. Quinones, Sherif F. Nagueh, William A. Zoghbi. *Baylor College of Medicine, Houston, TX*

Background: Exercise echo (EE) is an established method for assessing coronary artery disease and provides significant prognostic power, independent of other known predictors of risk. The purpose of this study was to evaluate a risk index incorporating echocardiographic and conventional exercise variables in predicting long term risk.

Methods: Two consecutive, mutually exclusive populations referred for treadmill EE with the Bruce protocol were investigated: hypothesis-generating (388 patients; 268 males; age 55±13yrs) and hypothesis-testing (105 patients; age 54±14 yrs). Patients with left bundle branch block, paced rhythms, hypertrophic cardiomyopathy, or significant valvular lesions were excluded. Cardiac events included death (sudden and proven cardiac), myocardial infarction, late revascularization (>90 days), hospital admission for unstable angina and admission for heart failure. Mean follow up in the hypothesis-generating population was 3.1 years. There were 38 cardiac events. A total of 21 variables were tested including clinical, exercise and echocardiographic parameters. Independent predictors of events by multivariate analysis were: exercise wall motion index (WMSI-Ex; OR= 2.77/ unit; p<0.001), ischemic ST depression ≥ 1mm (OR= 2.84; p=0.002) and treadmill time (OR= 0.87/min; p=0.037). A risk index was generated based on the above as:

Risk Index = 1.02 (WMSI-Ex) + 1.04 (ST Change) - 0.14 (Treadmill Time). The validity of this index was tested in the hypothesis-testing population. Mean follow up was 4.3 years. Event rate in the population, divided into quartiles of risk index were:

Risk/Group Size	Risk Index	Event Rate
Lowest Risk (n=26)	-1.22 to -0.47	0%
Lower Middle Quartile (n=26)	-0.45 to +0.08	19.2%
Upper Middle Quartile (n=26)	+0.08 to +0.64	15.3%
Highest Risk (n=27)	+0.66 to +2.02	29.6%

The Odds Ratio of risk index for events in this population was 2.94 (95% C.I.: 1.4 to 6.2); p=.0043. Thus, echocardiographic and exercise parameters are independent powerful predictors of events after treadmill stress testing. A risk index can be derived with these parameters for a more comprehensive risk stratification with exercise echocardiography.

11:30 a.m.
 824-3 **Dobutamine Echocardiography for Prediction of Sudden Arrhythmic Death in Patients With Ischemic Cardiomyopathy**

Azad Raiesdana, Teri Greco, Jeff Howard, Irmina Gradus-Pizlo, Adam Greene, Judy Foltz, Naomi Fineberg, Harvey Feigenbaum, Stephen Sawada. *Indiana University School of Medicine, Indianapolis, IN*

Background: Patients (pts) with ischemic cardiomyopathy (CADCM) often have extensive infarction and enhanced sympathetic tone, which may predispose them to lethal ventricular tachyarrhythmias. The purpose of this study was to investigate the ability of a death index, comprised of the extent of nonviable myocardium and heart rate, to identify pts at risk for sudden arrhythmic death (SAD). **Methods:** The data from 160 consecutive pts with CADCM who had dobutamine stress echocardiography (DE) for assessment of viable myocardium was reviewed. Ninety-eight pts who were not receiving beta-blockers comprised the study group. Wall motion scores and the extent (%) of ischemic and the extent (%) of nonviable myocardium were calculated. The % of nonviable myocardium was defined as the % of myocardium with akinesis at rest and with low dose (10 ug/kg/min) DE. A sudden death index (SDI) was derived from the product of the heart rate and the extent of nonviable myocardium ([heart rate] x [% nonviable myocardium/100]). Clinical and echocardiographic variables were compared between pts with SAD and survivors. **Results:** Follow-up was obtained (mean 22 months) and 24 pts were identified as having SAD. Thirteen had nonsudden cardiac death and there were 61 survivors. Heart failure class, elevated cholesterol, use of digoxin, use of lasix, wall motion scores at rest, low dose, and peak dose, the extent of nonviable myocardium, and the SDI were univariate predictors of SAD. The SDI was the strongest multivariate predictor of SAD (p<0.001). The SDI was significantly higher in pts with SAD compared to those with nonsudden cardiac death (4079 ± 1632 versus 3045 ± 1175, p=0.052). The SDI was also significantly higher in SAD pts compared to survivors (4079 ± 1632 versus 2041 ± 1317, p<0.001). Excluding pts with nonsudden death, an SDI ≥ 30 had a sensitivity of 79% (19/24) for SAD and a specificity of 77% (47/61) for SAD. The positive predictive value was 46% (19/41) and the negative predictive value was 91% (52/57). Receiver operating characteristic curve analysis showed that the area under the curve for the SDI was 0.83. **Conclusion:** The SDI was a strong multivariate predictor of SAD and had good accuracy for identifying pts at risk for SAD.

11:45 a.m.
 824-4 **Long-Term Survival of Patients With Chest Pain Syndrome and Angiographically Normal or Near Normal Coronary Arteries: The Additional Prognostic Value of Dipyridamole Stress Echocardiography**

Attila Palinkas, Eugenio Picano, Bruno Ghelarducci, Patrizia Landi, Alessandro Pingitore, Albert Varga. *CNR, Institute of Clinical Physiology, Pisa, Italy*

Background: Dipyridamole stress echo has consistently shown an excellent specificity, but it remains to be clarified whether diagnostic "lies" (i.e. false positive responses occurring in <10% of patients) may reflect prognostic "truths" (i.e., they identify trouble-makers in the long run). Aim: to assess the prognostic value, if any, of stress echo results in patients with angiographically normal coronary arteries. **Methods:** The study group was

made of 321 consecutive patients (161 men, mean age 56±10 years) studied in Pisa, Institute of Clinical Physiology between 1983 and 1999 and meeting the following inclusion criteria: history of chest pain; dipyridamole (up to 0.84 mg/kg) stress echo performed before and within 15 days of coronary angiography; coronary angiography showing either absent or insignificant (<50% visually assessed) stenosis in any major vessel. All patients were followed up for a median of 92 (1 to 192) months. **Results:** Resting echo was normal in 274 patients, and showed regional wall motion abnormalities in 47 patients. At study entry, mean wall motion score index (WMSI, from 1=normal to 4=dyskinetic, in a 16 segment model of the left ventricle) of the 321 patients was 1.06±0.20. The stress echocardiogram was positive in 28 patients. During the follow-up, there were 18 all-cause deaths: 6 cardiac and 12 non cardiac deaths. The survival rates were 91.8% and 71.8% for patients with negative and positive stress echo (p<0.001), respectively. At multivariate analysis, hypertension (p=0.012, OR= 3.7, CI 95%=1.7-10.3), left bundle branch block on resting ECG (p=0.0015, OR=13.7, CI 95%= 3.2-58.9), dipyridamole stress echo positivity (p=0.007, OR=7.8 CI 95%=2.6-23.4) and mild or moderate irregularity on coronary arteriogram (p=0.0008, OR=9.1 CI 95%=3.1-26.9) were independent predictors of all cause death. **Conclusion:** Stress echo adds incremental value to the prognostic stratification achieved with clinical, resting electrocardiographic and angiographic data in the subset of patients with normal or near normal coronary arteries. This angiographically identified low risk population can be prognostically heterogeneous, and stress echo positivity identifies a less benign subset.

Noon
 824-5 **Risk Stratification of Patients With Left Ventricular Hypertrophy by Exercise Echocardiography**

Abdoul Elhendy, Bijoy K. Khandheria, Douglas Mahoney, Kelli Burger, James B. Seward, Patricia A. Pellikka. *Mayo Clinic, Rochester, MN*

Background. Left ventricular hypertrophy (LVH) is associated with an increased risk of cardiovascular morbidity and mortality. Exercise ECG has a limited accuracy in the evaluation of coronary artery disease in patients with LVH. This study evaluates the prognostic value of exercise echocardiography in patients with LVH. **Methods.** Exercise echocardiography was performed for evaluation of known or suspected coronary artery disease in 608 patients (age 66 ± 11 years, 356 men) with LVH. Five hundred sixteen (85%) patients had hypertension and 80 (13%) had a previous myocardial infarction. Echocardiographic imaging was performed before and immediately after termination of treadmill exercise. **Results.** During a median follow-up of 3 years, 35 hard cardiac events occurred (11 cardiac death and 24 non-fatal myocardial infarction). The incidence of cardiac events was 3.6% (12/333) in patients with normal wall motion, and 8.4% (23/275) in patients with regional wall motion abnormalities by exercise echocardiogram (p<0.01). The incidence of cardiac events was 7% (19/281) in patients with a negative exercise ECG, 1% (1/115) in patients with ST depression, and 7% (15/212) in patients with non-diagnostic ECG. Clinical and exercise stress test variables associated with an increased risk of cardiac events in a multivariate analysis model were a history of coronary artery disease (Chi2 = 4.6, p<0.05) and a lower rate pressure product (Chi2 = 13.1, p<0.0005). When exercise echocardiographic variables were considered, exercise ejection fraction was the most powerful variable associated with an increased risk of cardiac events, and was incremental to clinical and hemodynamic variables (Chi2 = 18.1, p<0.0001). **Conclusion.** Exercise echocardiography provides incremental data for identification of patients with LVH who are at an increased risk of cardiac death and non-fatal myocardial infarction.

ORAL CONTRIBUTIONS

825 **Cardiovascular Magnetic Resonance: Imaging Plaque, Thrombus, and Ischemia**

Monday, March 19, 2001, 11:00 a.m.-12:15 p.m.
 Orange County Convention Center, Room 414A

11:00 a.m.
 825-1 **Detection of Subendocardial Ischemia in Patients With Coronary Artery Disease by Cardiac Magnetic Resonance**

Nidal Al-Saadi, Eike Nagel, Katharina Ziegenhorn, Axel Bornstedt, Eckardt Fleck. *German Heart Institute & Charit, Humboldt University, Berlin, Germany*

Subendocardial (ENDO) perfusion defects are very sensitive for the detection of myocardial ischemia. In contrast to MR other techniques for the evaluation of myocardial ischemia lack sufficient spatial resolution to detect ENDO ischemia. We therefore evaluated the feasibility of MR for the detection of ENDO perfusion defects in patients with coronary artery disease or arterial hypertension (HTN).

17 patient with single vessel disease (≥75% area reduction, QCA), 10 controls and 5 with HTN were examined (1.5T, Philips, ACS NT). 5 slices per heart beat were acquired during the first pass of 0.025 mmol/kg Gd-DTPA before and during adenosine (140µg/kg) vasodilation. The upslope of the resulting signal intensity (SI) curves of 6 segments per slice was determined and a myocardial perfusion reserve index (MPRI) was calculated from the alterations of the upslope after correction for the input function. ENDO and sub-epicardial (EPI) regions were defined as the inner or outer 50% of each segment. A previously defined ischemic threshold was used to differentiate ischemic and nonischemic segments.

ENDO versus EPI SI upslopes were similar at rest and after adenosine in controls (slope ENDO vs. EPI = 0.98 both). In ischemic segments ENDO versus EPI SI upslope was mildly reduced at rest (slope= 0.88) which was more pronounced after adenosine (slope=

0.61, $p < 0.05$ vs. rest). More ENDO than EPI segments were found to be ischemic ($p < 0.05$). In patients with HTN there was a trend for reduced ENDO MPRI. (Table, p values ENDO vs. EPI).

upslope	control			ischemic			HTN
	rest	adenosine	MPRI	rest	adenosine	MPRI	MPRI
ENDO	10.6±7.9	14.6±7.2	1.73±0.4	8.6±4.4	11.6±4.1	1.07±0.4	1.5±0.4
EPI	11.8±8.2	16.5±8.1	1.86±0.4	9.3±4.3	12.5±6.0	1.2±0.4	1.7±0.8
p value	<0.05	<0.05	ns	<0.05	<0.05	<0.02	ns

The high spatial resolution of MR perfusion measurements allow the detection of small perfusion defects, e.g. within the subendocardium.

11:15 a.m.

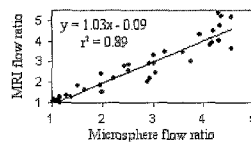
825-2 Detection of Regional Reductions in Coronary Flow Reserve Using First-Pass Magnetic Resonance Perfusion Imaging

Francis J. Klocke, Orlando P. Simonetti, Robert M. Judd, Raymond J. Kim, Stephan Miller, Kathleen R. Harris, Sascha Hedjbeli, David S. Fieno. *Northwestern University Medical School, Chicago, IL*

Background: In principle, magnetic resonance perfusion imaging can detect regional differences in perfusion reserve with improved resolution over radionuclide techniques. However, the minimum regional difference in vasodilated flow which can be detected with MRI has not been defined.

Methods: Graded levels of regional vasodilation were produced by infusing increasing doses of adenosine selectively into the left circumflex artery (LC) of chronically instrumented dogs. First-pass magnetic resonance signal intensity-time curves were obtained following right atrial injection of Gd-HP-DO3A (0.025 mmol/kg) using an inversion recovery true-FISP sequence. The area under the LC intensity-time curve up to its peak was compared to that of a curve from a remote nonvasodilated portion of the left ventricle (LV). Relative regional flows in the LC and remote beds were assessed simultaneously using fluorescent microspheres injected into the left atrium.

Results: The ratio of MR areas in the LC and remote portions of the LV and the ratio of microsphere flows in the LC and remote portions of the LV were highly correlated ($r^2 = 0.89$, $p < 0.001$) and linearly related over a five-fold range of flow differences ($y = 1.03x - 0.09$, SEE 0.45).



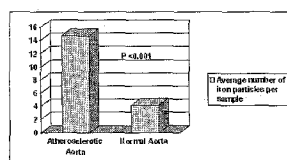
Conclusion: Regional reductions in vasodilated flow of 50% or more (± 2 SEE) can be detected with 95% confidence over the range of 1-5 times resting flow. This suggests that MRI can identify and quantify limitations in perfusion reserve produced by stenoses of 70% or greater.

11:30 a.m.

825-3 Detection of Vulnerable Atherosclerotic Plaques Using Super Paramagnetic Iron Oxide (SPIO), Mice and Rabbit Studies

Mitra Rajabi, Daniel Chen, Mohammed Asif, Michael Quast, Jingna Wei, Mohammad Madjid, Khawar Gul, Ward Casscells, James T. Willerson, Morteza Naghavi. *University of Texas-Houston, Houston, TX, University of Texas-Medical Branch at Galveston, Galveston, TX*

Background: SPIO particles are magnetic resonance (MR) imaging contrast media that have a central core of iron oxide generally coated by a polysaccharide layer. They shorten relaxation time by 10 folds or more. SPIO particles are taken up 10-100 times more by macrophages, than other cells, and macrophages are more apt to phagocytose larger particles (SPIO) than smaller ones (USPIO, Ultra SPIO). We hypothesized that certain features associated with plaques vulnerability (i.e. inflammation, angiogenesis, intra-plaque hemorrhage, and fissured/permeable cap) may cause higher uptake of SPIO by vulnerable atherosclerotic plaques. **Methods:** We used a modified dextran-coated SPIO. After diluting in dextrose solution, we injected SPIO intravenously into 6 Apo E-deficient atherosclerotic mice aged 23-26 months. Four C57BL6 wild mice aged 14 months were taken as control group. We sacrificed the animals at days 1, 2, 3 and 5 after injection. Samples from aorta (valve region, ascending, descending, and abdominal), heart, lung, kidney, liver, spleen and esophagus (as negative controls) were taken and fixed and then stained with H&E, Pearl's, CD68, and Movat. **Results:** The graph below depicts a significant increase in SPIO uptake by atherosclerotic aorta compared to normal aorta ($p < 0.01$). In MRI study of SPIO-injected ApoE deficient mice, a significant reduction of signal intensity in T2 images was observed compared to normal C57BL6 mice.



Conclusion: We found a significantly higher uptake of SPIO particles by aortic atherosclerotic lesions associated with marked reduction in their MRI signal intensity. Our findings may have clinical application in detection of vulnerable plaques using MRI. Plaque-

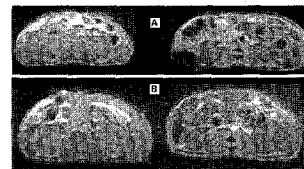
targeted SPIO (i.e. ox-LDL and ICAM-1 antibody-conjugated SPIO, under development in our laboratory) may hold promise for more accurate non-invasive MR imaging of vulnerable plaques.

11:45 a.m.

825-4 MRI Detection of Atherosclerotic Vulnerable Plaque Using Super Paramagnetic Iron Oxide (SPIO) Contrast Media

Mitra Rajabi, Mohammed Asif, Michael Quast, Jingna Wei, Daniel Chen, Mohammad Madjid, Ward Casscells, James T. Willerson, Morteza Naghavi. *University of Texas-Houston, Houston, TX, University of Texas-Medical Branch at Galveston, Galveston, TX*

Background: Because of the important role of inflammation in plaque rupture, finding a technique for imaging plaque inflammation is center of much interest. Super paramagnetic iron oxide (SPIO) particles are magnetic resonance (MR) imaging contrast media that have a central core of iron oxide generally coated by a polysaccharide layer. They shorten the relaxation time, predominantly the T2 relaxation time. We hypothesized that inflamed vulnerable atherosclerotic plaques would preferentially take up these nanoparticles by virtue of macrophage infiltration, leaking vasa vasorum and fissured thin caps. **Methods:** After baseline MR imaging with respiratory gating, we injected 1-3 mmol Fe/kg super paramagnetic iron oxide to six Apo E deficient and two C57bl mice through the tail vein. Post-contrast MR imaging were performed in day 5 with the same parameters ($TR=2.5$, $TE=0.012$, $FOV=6$, slice thickness=2.0mm, flip angle (orient)=trans, and matrices=256 256). We selected the aorta at the level of kidney for comparison of the baseline and post-contrast images. **Results:** We found decreased signal intensity in SPIO injected Apo E deficient mice and no decrease in signal intensity in SPIO injected C57bl mice as depicted in the Figure below. Panel A (top): MR images of abdominal aorta in an Apo E deficient mouse before (left) and 5 day (right) after SPIO injection. Panel B (down): MR images of abdominal aorta of a C57Bl mouse before (left) and 5 day (right) after injection of SPIO.



Conclusion: As we have predicted, MR imaging using SPIO as contrast media can accurately locate atherosclerotic plaques in Apo E deficient mice. Further studies should be carried out to assess the importance of this finding in human clinical settings.

Noon

825-5 In Vivo Resonance Imaging of Thrombosis

Michael T. Johnstone, Alexandra Perez, Robert Stewart, William Quist, James Hamilton, Rene Botnar. *Beth Israel Deaconess Medical Center, Boston, MA*

Background: The process of atherosclerotic plaque disruption has been difficult to monitor because of the limited ability to directly visualize the atheroma and new thrombus in vivo and the lack of an adequate animal model. one animal model in which to study these processes is the modified Constantinides rabbit model in which an atherosclerotic rabbit is pharmacologically triggered, frequently resulting in aortic plaque disruption with an overlying thrombus. **Aim:** Our aim was to validate in vivo magnetic resonance imaging (MRI) as an imaging tool for thrombus detection in the modified Constantinides animal model of plaque disruption. **Methods:** Atherosclerosis was induced in nine New Zealand white male rabbits with endothelial denudation of the aorta followed by 8 weeks of a high(%)cholesterol diet. After a baseline MRI of the aorta, the rabbits were pharmacologically triggered with histamine and Russell's viper venom, followed by another MRI 48 hours later. The animals were then sacrificed. Contiguous cross-sectional T2 weighted Fast.Spin Echo(TSE)images of the abdominal aorta were compared with histopathology. **Results:** Aortic wall thickening was present in all baseline MRI's of all animals. in the MRI performed 48 hours after triggering, a histologically confirmed intraluminal thrombus was visualized in 67% of the animals. MRI data correlated with the histopathology with regards to aortic wall thickness ($R=0.77, P < 0.001$), thrombus size ($R=0.82, p < 0.001$), thrombus length ($R=0.86, P < 0.01$) and anatomic location ($R=0.98, P < 0.001$). **Conclusion:** In vivo MRI reliably identifies the presence, location, and size of thrombus in this animal model of atherosclerosis. The combination of in vivo MRI and the modified Constantinides animal model could be an important research tool for improving our understanding of the pathogenesis of acute, coronary syndromes

POSTER SESSION

1141 Strain-Rate Imaging

Monday, March 19, 2001, Noon-2:00 p.m.
Orange County Convention Center, Hall A4
Presentation Hour: Noon-1:00 p.m.

1141-133 Accurate Measurement of Early Diastolic Transmural Myocardial Velocity Profile Using Tissue Doppler Imaging in Normal Subjects and Patients With Left Ventricular Hypertrophy

Hirotsugu Yamada, Takashi Oki, Ryoichi Kanda, Yasuhiko Abe, Tomio Nabatame. *The University of Tokushima, Tokushima, Japan, Toshiba Medical Systems Research and Development Center, Tochigi, Japan*

Background: Transmural myocardial velocity profile (MVP) measured by color tissue Doppler imaging (TDI) has been reported to reflect the regional myocardial function. However, accurate measurement of the MVP is difficult due to the stochastic nature of ultrasound signal. We developed a new method to obtain the MVP, and applied the method to normal subjects and patients with left ventricular (LV) hypertrophy (LVH). **Method:** We recorded the parasternal LV short-axis color TDI in 10 normal subjects (N) and 15 patients with LVH. From the obtained images, MVP of the LV posterior wall in early diastole was measured using the newly developed prototype software (PowerView, Toshiba Corp., Japan). A region of interest (ROI) was set along the myocardium with the reference point for angle-correction being at the center of LV contraction. The velocities at each point within the ROI were automatically angle-corrected to calculate the velocity component in the radial direction of the LV cavity. To improve the stability and accuracy of the velocity profile measurement, the myocardial velocities were spatially averaged along the circumference of the LV short-axis images. **Results:** The averaged MVP obtained from the new method was more close linear regression than the non-averaged MVP using the conventional method in both the N and LVH groups. The slope of the early diastolic averaged MVP was lower in LVH group than N group. The averaged MVP showed lower inter- and intra-observer variability than the non-averaged MVP. **Conclusion:** A non-isotropic averaging algorithm has been applied for the MVP measurement using color TDI. This new method provides stable measurement without losing the radial resolution for MVP, and may be useful to assess the regional myocardial function with accuracy and high reproducibility.

1141-134 Higher Strain Rate During Isovolumic Relaxation Than During Systole Characterizes Ischemic Myocardium

Cristina Pislaru, Marek Belohlavek, James F. Greenleaf, James B. Seward. *Mayo Clinic, Rochester, MN*

Background: Post-systolic shortening (PSS) is a sensitive marker of ischemia. However, inconsistent patterns of PSS have also been observed in presumed normal myocardium, or normal myocardium adjacent to the ischemic. The heterogeneous wall motion calls for knowledge of the normal range of local systolic deformation for diagnostic purposes. We propose a new method to easily discriminate normal from ischemic PSS using local tissue velocity-derived strain rate parameters measured non-invasively by ultrasound. **Methods:** Seven pigs were used in an open-chest model of myocardial ischemia. Digital cine loops of tissue velocity data were collected from 3 apical views, before and after LAD occlusion (5-90min). Regions were selected in the ischemic and adjacent normally-perfused region (both parallel with the ultrasound beam), based on the anatomic location of the area at risk in the same cross sections through the stained cardiac specimens. Local peak strain rate values were measured during systole (S), isovolumic relaxation (IVR), rapid filling (E), late filling (A) phases. **Results:** S and E were significantly lower in ischemic than normal regions (S: -0.51 ± 0.21 vs -1.08 ± 0.22 ; E: 0.59 ± 0.38 vs 1.13 ± 0.64 s⁻¹, respectively; $p < 0.05$ for both). At baseline, 3 animals had negative IVR and 4 positive IVR. During ischemia, peak IVR became consistently negative or higher negative only in the affected region (-1.08 ± 0.43 vs 0.07 ± 0.44 s⁻¹, ischemia vs baseline, respectively; $p < 0.01$). Individual baseline IVR/S ratio were < 1 in both regions. With ischemia, IVR/S ratio were consistently > 1 in ischemic but not in normal regions (2.51 ± 1.60 vs. -0.43 ± 0.52 , respectively; $p < 0.0001$). There were no differences in SR parameters at baseline between the 2 tested regions. **Conclusions:** Higher strain rates during isovolumic relaxation than during systole characterizes ischemic myocardium. This new finding best differentiated normal from ischemic myocardium.

1141-135 The Utility of Strain Rate Imaging for Regional Myocardial Function: Results From A Clinical Model of Septal Ablation

Theodore P. Abraham, Rick A. Nishimura, David Holmes, Jr., Marek Belohlavek, James B. Seward. *Mayo Clinic, Rochester, MN*

Background: Tissue Doppler (DTI) and strain rate imaging (SRI) are novel echocardiographic techniques that may enable quantification of regional contractile function. SRI is less influenced by translation, tethering and damping and should be superior to DTI in the assessment of regional pathology. Assessment of the accuracy of these techniques requires a model of a discrete area of infarction which does not cause global changes in hemodynamics. **Methods:** DTI and SRI (using a GE Vingmed System FiVe) was performed in 10 patients (6 males) with hypertrophic cardiomyopathy during alcohol induced septal ablation. **Results:** All patients underwent successful basal septal ablation, documented by occlusion of the septal artery on angiography. Except for a trend towards higher mean aortic pressure post ablation, invasive hemodynamics were similar pre and post ablation. The infarct area was delineated prior to the ablation by intracoronary con-

trast injection into the septal perforator artery during simultaneous two-dimensional echocardiography. Comparison of pre and post ablation strain rate and velocity profiles in the infarct zone demonstrated that SRI accurately depicted loss of systolic strain rate in infarct areas while DTI did not show a loss of myocardial motion. Similarly, on color M mode display SRI showed either no compressive pattern (8pts) or a peak strain rate of < 0.2 s⁻¹ (2pts) in the infarct segment while DTI incorrectly displayed contraction pattern in the infarct area in all patients.

n=10	Mean BP(mmHg)	LVEDP (mmHg)	dp/dt(max)	Tau	Infarct zone peak systolic strain rate (s ⁻¹)
Pre-ablation	89	22	1677	0.064	1.2
Post-ablation	100	19	1333	0.066	0.2
p-value	0.05	0.6	0.2	0.8	<0.0001

Conclusion: In a clinical model of a small discrete infarct without significant change in invasive hemodynamic indicators of systolic and diastolic function, SRI but not DTI accurately depicted regional systolic function in both color and velocity modes.

1141-136 Temporal and Spatial Systolic Analysis of Myocardial Velocities in Ischaemic Heart Disease: Role of the Different Myocardial Layers

Pedro Marcos-Alberca, Miguel A. García-Fernández, Manuel Desco, María J. Ledesma, Andrés Santos, Mar Moreno, Javier Bermejo, Norberto Malpica, José C. Antoranz. *Hospital Gregorio Marañón, Madrid, Spain*

Damage of contractility and impairment of systolic function is the most important event in ischaemic heart disease (IHD). Through the analysis of myocardial velocities, Doppler Tissue Imaging (DTI) has emerged as a powerful tool to study systolic myocardial function, but little is known about the temporal and spatial behavior of the different myocardial layers (L) in systole in IHD. 32 patients (P), 20 healthy volunteers as control group and 12 with IHD (age 66.2 ± 3.2 yo, 83% male), were studied. All P with IHD had severe dysinergia of posterobasal segment in parasternal long-axis view. Color M Mode DTI of posterobasal segment (Acuson™ Sequoia System) was performed. Acquired images were processed with own software. Myocardium was divided in three equal thickness L (endocardium, mesocardium and epicardium) and velocities in the main systolic times (protosystole, mesosystole and telesystole) were calculated. Results are shown in Table.

	Protosystole			Mesosystole			Telesystole		
	End	Mes	Epi	End	Mes	Epi	End	Mes	Epi
Control	3.91 ± 0.32	3.88 ± 0.33	2.97 ± 0.25	4.48 ± 0.30	4.40 ± 0.31	3.03 ± 0.24	3.06 ± 0.22	3.14 ± 0.22	2.05 ± 0.16
IHD	3.24 ± 0.39	3.21 ± 0.37	2.67 ± 0.36	3.33 ± 0.37	3.35 ± 0.36	2.54 ± 0.32	2.59 ± 0.31	2.40 ± 0.29	1.95 ± 0.22
p	NS	0.02	NS	0.02	0.02	NS	NS	0.01	NS

Systolic velocities were lower in P with IHD. There were intramyocardial and temporal differences in the magnitude of this decrease. Velocities diminished more in mesocardium than other layers in all the systole, but more in mesosystole than the other two systolic times. This event suggest a prominent damage of this layer produced by ischaemia and point out mesosystole as the moment which this damage are more marked. In conclusion, there is a spatial and temporal heterogeneous distribution of myocardial velocity decrease in IHD. This fact can help to detect earliest the myocardial damage produced by ischaemia.

POSTER SESSION

1142 Stress Perfusion Imaging Following Percutaneous Intervention and Acute Coronary Syndromes

Monday, March 19, 2001, Noon-2:00 p.m.
Orange County Convention Center, Hall A4
Presentation Hour: Noon-1:00 p.m.

1142-137 A Comparison of Stress Radionuclide Myocardial Perfusion Imaging and Stress Echocardiography Following Acute Myocardial Infarction

Kenneth B. Harris, Macduff Sheehy, Michele Nanna, V. S. Srinivas, Alexander DelVecchio, Gareth M. Gordon, David G. DiMattia, Kimberly D. Weltman, Mark I. Travin. *MONTEFIORE MEDICAL CENTER, BRONX, NY, ALBERT EINSTEIN COLLEGE OF MEDICINE, BRONX, NY*

Background: Stress radionuclide myocardial perfusion imaging and stress echocardiography are both commonly used to assess patients (pts) in the immediate post myocardial infarction (MI) period. However, the relative value of these techniques in identifying post MI ischemia remains unclear. **Methods:** Eighteen pts underwent both dipyridamol radionuclide perfusion imaging and dobutamine stress echocardiography on either the same day or on consecutive days, 3-7 days following uncomplicated AMI. Pts who had undergone an acute PTCA were excluded. Images were reviewed with clinical information available, but blinded to the opposing modality, for perfusion defects, wall motion abnormalities, and evidence of ischemia (reversible defect(s) on perfusion imaging, worsening wall motion abnormalities on stress echocardiography). Of the 18 pts, 12 subsequently underwent cardiac catheterization. **Results:** In the 18 pts, perfusion imaging identified defects in 16 (89%), of which 15 (83%) were found to be ischemic. Stress echocardiography identified a fixed wall motion abnormality in 17 (94%) and ischemia in 8 (44%, $p < 0.05$ compared with perfusion imaging ischemia). Among the 12 pts who

underwent catheterization, perfusion imaging identified ischemia in the territory of an obstructed ($\geq 70\%$) vessel in all 12 pts, while stress echocardiography identified ischemia in 8 (67%). **Conclusion:** In the immediate post infarction period, stress radionuclide myocardial perfusion imaging appears to be better able to identify ischemia than stress echocardiography. It may be that post-MI myocardium is stunned for a variable duration and is thus poorly responsive to a dobutamine challenge, explaining the decreased sensitivity of dobutamine stress echocardiography for identifying ischemia.

1142-138 Incomplete Risk Stratification in the Non Invasive Arm of the Fast Revascularization During Instability in Coronary Artery Disease (FRISC-II) Compared to the Veterans Affairs Non-Q-Wave Infarction Strategies in Hospital (VANQWISH) Trials: A Potential Factor to Explain the Difference in Trial Outcomes

Abhinav Goyal, Frederick F. Samaha, William E. Boden, Michael J. Wade, Stephen E. Kimmel. *University of Pennsylvania School of Medicine, Philadelphia, PA, Hartford Hospital, Hartford, CT*

Background: The FRISC-II Trial demonstrated improved clinical outcomes among patients (pts) with acute coronary syndromes randomized to an invasive strategy (cardiac catheterization [CATH] followed by revascularization), whereas the VANQWISH Trial of non-Q-wave myocardial infarction did not. However, there were differences in the non-invasive (NI) arms of both studies that triggered CATH: VANQWISH used exercise stress testing [EST] with ≥ 2 mm ST-segment depression [STD] and thallium myocardial perfusion imaging (MPI) results or dipyridamole MPI (D-MPI) in pts who could not exercise. FRISC-II employed only EST (≥ 3 mm STD required for CATH) and did not use MPI or pharmacologic testing. We sought to evaluate whether differences in the results could be due to incomplete identification of surgical coronary disease in FRISC-II NI pts. **Methods:** Using VANQWISH data, we divided the NI pts who met CATH criteria into 3 groups based on stress test results: "CATH-FRISC" (met both VANQWISH & FRISC-II EST CATH criteria), "no-CATH-FRISC" (met VANQWISH but not FRISC-II EST CATH criteria), and "D-MPI Positive (+)" results. These groups were correlated with pre-discharge CATH results. **Results:** Of 259 VANQWISH NI pts who underwent EST, 66 (25%) were "no-CATH-FRISC"; of 154 NI pts who underwent D-MPI, 47 (31%) were "D-MPI +." VANQWISH pts had significantly more co-morbidity than FRISC-II pts. Pts with EST or MPI findings that did not meet CATH criteria in FRISC-II had a similar proportion of 3 vessel/left main disease (3VLM) or Class I indication for coronary bypass (CABG) as those who did meet FRISC-II CATH criteria (table). **Conclusions:** The unusually stringent risk stratification protocol for NI arm pts in FRISC-II could have missed almost as many pts with surgical disease as it identified. Other differences between studies may have accounted for the disparate results. However, this study suggests that a lower threshold for CATH in FRISC-II NI pts might have improved outcomes in this group and therefore diminished the putative benefit of an invasive strategy.

Predischarge CATH results

	"CATH-FRISC"	"no-CATH-FRISC"	"D-MPI +"
Number of pts	47	21	14
3VLM or Class I CABG indication - n (%) *	25 (53)	12 (57)	6 (43)

* All comparisons: $p > 0.4$

1142-139 Myocardial Stress Perfusion Imaging 1 Day After Percutaneous Coronary Intervention in the Modern Era

Sherif S. Iskander, John J. Mahmarian, Neil S. Kleiman, Albert E. Raizner, Mario S. Verani. *Baylor College of Medicine/The Methodist Hospital, Houston, TX*

Background: Percutaneous coronary interventions (PCI) relieves ischemia in patients (pts) with significant coronary artery disease (CAD), but whether myocardial perfusion detected by SPECT is normal early after PCI is controversial. Older studies suggested that perfusion defects are common after PCI and disappear over time. **Methods:** Pts (n=65) with 1, 2, or 3 vessel CAD $\geq 70\%$ luminal stenosis, evidence of myocardial ischemia by abnormal stress test or typical angina who received successful, complete revascularization by PCI, without any additional lesion $>50\%$, underwent adenosine tetrofosmin SPECT on day 1 after PCI. Pts with prior myocardial infarction, coronary bypass grafting or ejection fraction $<40\%$ were excluded. **Results:** Complete revascularization was achieved in all 65 pts (83 vessels), 89% of whom received stents. A history of angina was present in 96% of pts (stable: 69%; unstable: 27%) and 77% had abnormal stress testing before PCI. Mean % stenosis was reduced from $84 \pm 10\%$ before PCI to $2.4 \pm 7\%$ after PCI ($p < 0.0001$). All but 2 pts had normal SPECT results after PCI by qualitative and quantitative analysis. Both pts with small ($<5\%$), residual defects had side-branch occlusion during PCI. **Conclusion:** Nearly all pts with evidence of myocardial ischemia and who underwent successful and complete revascularization using current PCI, had a normal SPECT on the day after the intervention. The early normalization of myocardial perfusion, in contrast with data from older reports, may be due to liberal use of stents and complete revascularization achieved in these pts.

1142-140 Does the Timing of Myocardial Perfusion Imaging After Intracoronary Stent Placement Impact on the Detection of Restenosis?

Indu G. Poornima, David O. Hodge, Todd D. Miller, Raymond J. Gibbons, Timothy F. Christian. *Mayo Clinic, Rochester, MN*

Background: Coronary flow reserve has been shown to normalize earlier after stenting compared to conventional PTCA. This may have implications for the accuracy of noninvasive detection of restenosis early. The purpose of this study was to determine the accu-

racy of myocardial perfusion imaging (MPI) for detecting restenosis following PTCA with stent placement, as a function of elapsed time from the procedure. **Methods:** 136 patients who had stress MPI (exercise=90, pharmacological=46) within 1 year following stenting and subsequently underwent repeat coronary angiography within 3 months following MPI were included in the study. Patients who had intervening MI or revascularization were excluded. Patients were prospectively subdivided into 3 time categories: 0-2 weeks, 2-8 weeks and >8 weeks, to test the impact of elapsed time. A reversible or fixed defect in the region of prior stent implantation was considered as SPECT evidence of restenosis. Obstruction of $\geq 50\%$ on follow-up angiography represented restenosis. **Results:**

Performance of MPI following stenting

Elapsed time	0-2 weeks (n=20)	2-8 weeks (n=22)	>8 weeks (n=94)
Restenosis rate (%)	35	64	65
Sensitivity (%)	86	71	89
Specificity (%)	54	50	51
False-positive rate (%)	30	18	17

The rate of restenosis was lower in the 0-2 week range ($p=0.04$, see table). Sensitivity and specificity for predicting restenosis did not change as a function of time. There was an insignificant trend ($p=0.15$) towards a higher false-positive scan rate when performed early after stent implantation. **Conclusions:** The performance characteristics of MPI do not change with time following stent placement in contrast to prior studies examining conventional PTCA. The observed trend towards greater false-positive studies early may in part be due to the lower prevalence of restenosis during the first 2 weeks. The high sensitivity and low specificity likely reflect the effects of referral bias.

1142-141 High Incidence of Repeat Catheterization and Revascularization in Patients With Normal Stress Myocardial Perfusion SPECT Early After PCI

Sean W. Hayes, Howard C. Lewin, Enrique F. Schisterman, Ishac Cohen, Raluca D. Agafitei, John D. Friedman, Daniel S. Berman. *Cedars-Sinai Medical Center, Los Angeles, CA*

Background: Although normal myocardial perfusion SPECT (MPS) is generally associated with a benign prognosis, the relationship between normal (nl) MPS early following percutaneous coronary intervention (PCI) and subsequent hard and soft events is unknown.

Methods: We identified 2155 consecutive patients with previous PCI who underwent rest ^{201}Tl /stress $^{99\text{m}}\text{Tc}$ -sestamibi dual-isotope MPS. Of 720 patients with nl MPS, 22 pts (3.1%) were lost to follow-up and 51 pts (7.1%) were excluded due to unknown PCI date. The remaining 647 pts were followed for 23.2 ± 7.7 months (all ≥ 1 year). The mean age was 65.7 ± 11.7 , 67.1% were male and 27.4% had adenosine stress. Summed stress perfusion scores (SSS) were calculated by adding 20 visually assessed segment scores using a 5-point scale (0=normal to 4=no uptake) with SSS < 4 categorized as normal. Nonfatal MI or cardiac death were classified as hard events. Revascularizations by repeat PCI or bypass surgery were considered soft events. Using multiple logistic regression to control for baseline risk factors, differences in event rates in pts with nl MPS early (<60 days) vs late (>60 days) after PCI were assessed.

Results: Compared to pts tested late after PCI, those with nl stress MPS early post PCI had increased incidence of repeat cardiac catheterization (RR=5.2, $\chi^2=36.7$) as well as revascularization (RR=11.0, $\chi^2=43.1$) within 180 days after MPS (See Table). There was no significant difference in the hard event rates.

Cardiac Event Rates in Patients with Normal MPS after PCI

	Normal MPS <60 days post PCI (n=124)	Normal MPS >60 days post PCI (n=523)	p
MI or CD (annual risk)	2.2%	1.5%	NS
Revasc within 180 d.	21.0%	2.5%	<0.001
Cath within 180 d.	26.6%	6.7%	<0.001

Conclusion: NI stress MPS early after PCI is associated with a high incidence of catheterization and revascularization within 180 days of testing, but low incidence with nl MPS late after PCI. The findings suggest that nl MPS early post PCI does not predict a low incidence of restenosis.

POSTER SESSION

1143 Three-Dimensional Imaging of Valvular Heart Disease

Monday, March 19, 2001, Noon-2:00 p.m.
Orange County Convention Center, Hall A4
Presentation Hour: Noon-1:00 p.m.

1143-142 3-D Echocardiography of the Aortic Valve Is Superior to 2-D Echocardiography When Compared to Operative Anatomy

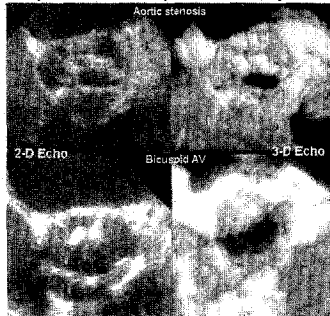
Zheng Liu, Wei Lau, Thippeswamy H. Murthy, Peng Li, Farzan Rajput, William Armstrong, Mani Vannan. *University of Michigan Health System, Ann Arbor, MI*

Background: 2-D multiplane transesophageal echocardiography (MPTEE) can accurately define aortic valve (AV) anatomy. The purpose of this study was to investigate whether 3-D Echo has incremental value over 2-D MPTEE in evaluating AV anatomy

when compared to direct inspection at operation. **Methods:** Reconstructed 3-D Echo of AV with normal 2-D and Doppler hemodynamic examination from 35 patients undergoing TEE for non-valvular indications constituted the cohort of normal AV. 33 patients having pre-operative TEE for AV surgery formed the abnormal AV cohort. A blinded reader viewed longitudinal, sagittal and surgical transverse 3-D projections of the normal and abnormal AV to assess leaflet thickness and mobility, cusp symmetry and calcification, commissural fusion, and leaflet anatomy. **Results:** Of 35 normal aortic valves by 2-D MPTEE, all had normal morphology on 3-D Echo(100%): 18 had a triangular orifice and 17 a nearly-circular orifice. 2-D and 3-D echo, and operative findings for the 33 abnormal valves are shown below: (*p<0.05 and **p<0.01 3-D Echo versus 2-D Echo)

	2-D Echo	3-D Echo	Operative Findings(100%)
Thickened Cusps	18(64.3%)	25*(89.3%)	28
Cusp Calcification	16(72.7%)	13(59.1%)	22
Cusp Restriction (Stenosis)	20(87%)	18(78.3%)	23
Commissural Fusion	11(68.8%)	17*(93.8%)	19
Asymmetric Cusps	5(33.3%)	14***(93.3%)	15
Bicuspid Anatomy	8(53.3%)	12(80%)	15

Conclusions: 1) 3-D Echo is able to depict normal AV anatomy as well as current 2-D MPTEE and 2) 3-D Echo is superior to 2-D MPTEE in defining abnormal AV morphology when compared to directly visualized intraoperative anatomy.



1143-143 Measurement of Mitral Valve Orifice Area by Real-Time Three-Dimensional Ultrasound System Without Reconstruction Process

Makoto Matsumura, Ryozo Omoto, Shunei Kyo, Chigiru Kanoh, Tsuyoshi Mochizuki, Mutsuhiro Akahane. *Saitama Medical School, Moroyama, Japan*

Background: It is thought that three-dimensional (3-D) echocardiography is more effective than two-dimensional (2-D) echocardiography for measurement of the anatomical mitral valve orifice area because the valve orifice is not flat. However, conventional 3-D ultrasound system has several problems. From data acquisition to 3-D display is cumbersome and its processing is time intensive. These problems limit quantitative application of 3-D echocardiography in practical use. The purpose of this study was to evaluate the feasibility of the mitral valve orifice area measurement by real-time 3-D ultrasound system without reconstruction process. **Methods:** Subjects are 30 patients with mitral valve disease (16 mitral regurgitation and 14 mitral stenosis) who are examined by routine echocardiography. Echo images of mitral valve were obtained from parasternal and apical approach, and the maximum valve orifice area at early diastole was measured by 2-D image and 3-D image manually. In this study, we used the newly developed 3-D ultrasound system (Aloka SSD-5500 prototype). This system can acquire volumetric data from mechanical scanning (15 times/sec) of the phased array transducer (3.5MHz) and promptly display the 3-D volume rendered images of the objects without reconstruction process. **Results:** The mitral valve orifice area was able to be measured by this system in 25 of 30 patients (83%). There are no significant difference in mean value of maximum mitral valve orifice area between 2-D and 3-D measurement in patients with mitral regurgitation. Mean value of the mitral valve orifice area was larger in 3-D measurement in patients with mitral stenosis (2.0±0.7 vs 1.5±0.3cm²), and not significant different in patients with mitral regurgitation. Although there was no significant correlation between both method in patients with mitral regurgitation, the valve orifice area measured by 3-D image well correlated with that by 2-D image in patients with mitral stenosis (r=0.705, p<0.05). **Conclusion:** The 3-D ultrasound system with reconstruction process provides not only spatial anatomy of the mitral valve in real-time but also quantitative assessment of the valve orifice area in mitral stenosis.

1143-144 Feasibility of Real-Time 3D Echocardiography for Measuring Mitral Valve Orifice Area in Normal Subjects and in Patients With Mitral Stenosis

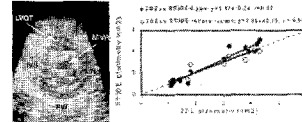
Fabrice Bauer, Takahiro Shiota, Jian Xin Qin, Marta Sitges, Yong Jin Kim, James D. Thomas. *The Cleveland Clinic Foundation, Cleveland, OH*

Background: Mitral valve orifice area (MVA) determined by 2D cross-sectional planimetry is strongly correlated with the anatomic orifice size. However, inappropriate transducer angle resulting in oblique views of the mitral valve can overestimate the true MVA in patients with mitral stenosis (MS). Real-time 3D echocardiography (RT3DE) has the ability to display a C-plane (3D-CP) anywhere in the space and reconstructed 3D images (3D-R) of the mitral valve might overcome this limitation. The aim of the study was to test the feasibility and accuracy of 3D-CP and 3D-R planimetry for measuring MVA in normal subjects and in patients with MS.

Methods: 8 normal subjects and 7 patients with MS were studied. From the RT3DE parasternal long axis view, 3D-CP was moved in 3D space to identify the tip of the mitral valve. Apical 4-chamber window was used to image the mitral valve and 3D-R was performed using TomTec software. The 3D-CP and 3D-R area of the maximal leaflet distension during the diastole were planimeted (picture). These measurements were compared to conventional 2D short-axis planimetry.

Results: RT3DE reconstruction method demonstrated localized abnormalities of MV apparatus, including valve calcification. MVA was 2.6 ± 1.6cm² by 2D planimetry, 2.7 ± 1.3cm² by 3D-CP planimetry and 2.9 ± 1.6cm² by 3D-R planimetry. Excellent linear relationship between 2D echocardiography and RT3DE method were found for MVA determination (graph).

Conclusion: RT3DE C-plane and reconstruction method are new and unique for measuring MV area. RT3DE could be a superior technique when conventional 2D fails to obtain a true perpendicular parasternal short-axis view.



1143-145 Incremental Value of Longitudinal Plane Three-Dimensional Reconstruction for Assessment of Mitral Valve Morphology

Anita Bhattacharya, Paul Atkinson, Nick Jenkins, Simon G. Ray. *Wythenshawe Hospital, Manchester, United Kingdom*

Background: Three dimensional (3D) echocardiography may improve the assessment of regurgitant mitral valves. Volume rendered reconstruction of the left atrial en-face view (surgeons eye view) is commonly used to assess leaflet anatomy but may miss important abnormalities. This could have an impact on decisions regarding suitability of valve repair and therefore timing of surgery. We compared this atrial view with serial longitudinal reconstructions to determine whether these might add additional information on valve structure.

Methods: 56 patients with non-rheumatic mitral valve regurgitation (43 due to degenerative valve disease, 9 functional and 4 endocarditis) underwent transoesophageal echocardiography (TOE) followed by 3D acquisition and mitral valve reconstruction. The valves were initially reconstructed from the atrial view. Guided by this view, 5 longitudinal cut planes were reconstructed through lateral, middle, medial zones of both leaflets as well as both commissural zones. Each zone was scored for visualisation (0=inadequate for analysis, 1=adequate and 2=good). Total scores for each valve from atrial and longitudinal views were compared. Furthermore, the ability to identify significant pathology seen on TOE was also recorded for each view using a "yes" or "no" score. 10 randomly selected studies were assessed by two independent operators to determine inter-observer variability.

Results: Visualisation scores were significantly better for longitudinal reconstruction (mean (SD)12.59 (3.14) versus 10.05 (4.94); P<0.001). Moreover, atrial views failed to identify significant pathology in 27/56 valves compared to 7/56 valves for longitudinal views (P<0.001). In particular, the atrial view missed tethering of leaflets in all 9 valves with functional regurgitation. In the 10 randomly selected mitral studies there was wider variability between the observers for the atrial view than the longitudinal view (mean SD 3.77 versus 1.77).

Conclusion: Atrial reconstruction alone is inadequate for the identification of leaflet pathology and serial longitudinal reconstructions are necessary to ensure a full description of valve leaflet morphology to guide surgical repair.

1143-146 Mitral Leaflet 3-D Kinematics During Valve Closure

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Purpose: Effective mitral valve closure requires precise coordination of the 3-D motion of the mitral apparatus. Because echo cannot track motion of discrete loci, little is known about precise leaflet motion; therefore, we studied 3-D leaflet kinematics during valve closure.

Methods: Markers were sutured to the LV, MA, and central meridian of anterior (AML) and posterior (PML) mitral leaflets in 12 sheep. After 7-10 days, the animals underwent biplane videofluoroscopy to determine exact 3-D mitral annular and leaflet marker positions throughout the cardiac cycle. Leaflet edge angular displacement (θ) was calculated at peak of the E-wave (E) and A-wave (A), and at valve closure (C) as the angle in 3-D space formed by the two markers on the mid-anterior and mid-posterior annulus with respect to the leaflet edge marker. Leaflet angular velocity (V) was determined during E-wave descent (EF), atrial contraction (FA), and valve closure (AC). Valve closure was defined as the minimum distance in 3-D space between the two leaflet edge markers after end-diastole (ED, t= 0), and leaflet length as the distance between the respective leaflet edge and annular markers.

Results: Leaflet motion in all animals displayed distinct E and A-wave motion. Valve closure occurred at 42 ± 21 ms from ED, with $52 \pm 33\%$ of closure occurring prior to onset of LV systole. Both leaflets started their final motion toward closure at the same time (33 ± 18 vs. 33 ± 20 ms prior to ED, $P = NS$), and total angular excursion from A to C was similar (32 ± 8 vs. $29 \pm 4^\circ$, $p = NS$)

	AML	PML	p-value
Length (cm)	1.92 ± 0.05	1.13 ± 0.04	.0001
-E ($^\circ$)	76.5 ± 8.2	87.3 ± 6.9	.004
-A ($^\circ$)	63.5 ± 6.0	81.8 ± 8.0	.0001
-C ($^\circ$)	31.8 ± 5.5	53.0 ± 9.2	.0001
V_{EF} ($^\circ$ /ms)	0.26 ± 0.06	0.20 ± 0.06	.03
V_{FA} ($^\circ$ /ms)	0.28 ± 0.14	0.26 ± 0.12	NS
V_{AC} ($^\circ$ /ms)	0.55 ± 0.21	0.37 ± 0.13	.03

Conclusion: PML was displaced farther than AML from the trans-annular septal-lateral chord at all times. Although motion toward closure occurred simultaneously in both leaflets, angular closing velocity of AML was greater. These differences in individual leaflet kinematics should be considered when performing leaflet-altering mitral repair techniques.

POSTER SESSION

1144 Echo Doppler Assessment of Vascular Disease

Monday, March 19, 2001, Noon-2:00 p.m.
Orange County Convention Center, Hall A4
Presentation Hour: Noon-1:00 p.m.

1144-147 Arteriosclerosis of Thoracic Aorta Influences on Renal Arterial Blood Flow in Diastole

Aiko Muro, Akira Matsumoto, Hiromitsu Miyamoto, Katsunori Osada, Naoki Oka. *Kurume University School of Medicine, Kurume, Japan*

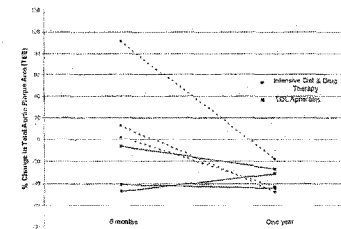
Background: The aorta has an important function as a distensible reservoir (Windkessel function), which plays an active role in the peripheral circulation during the diastole. However, little information is available on the effects of the arteriosclerotic change of the aorta on the peripheral circulation. **Methods:** In this study, we examined the relation between stiffness of the thoracic aorta and the renal arterial blood flow in 33 subjects (17 males and 16 females, mean 49 ± 18 years old). All subjects had normal cardiac and renal function with no renal artery stenosis. We calculated the stiffness S of the thoracic aorta as a parameter of arteriosclerosis by transesophageal echocardiography ($S = \ln[SBP/DBP] / [D_{max} - D_{min}] / D_{min}$). SBP: the systolic arterial blood pressure, DBP: the diastolic blood pressure, D_{max} : the maximum aortic dimension during the ejection period, and D_{min} : the minimum aortic dimension during the pre-ejection period). Furthermore, we measured the renal arterial blood flow velocity by pulsed Doppler echocardiography, and calculated systolic and diastolic peak flow velocity (V_s and V_d), end-diastolic flow velocity (V_{ed}), systolic and diastolic time velocity integral (TVI $_s$ and TVI $_d$), and diastolic pressure half time (PHT). **Results:** There was a significant positive correlation between stiffness S of the thoracic aorta and aging ($r = 0.845$, $p < 0.001$). The stiffness S of the thoracic aorta showed significant correlation with V_{ed} ($r = -0.50$, $p < 0.01$), TVI $_d$ ($r = -0.44$, $p < 0.05$) and PHT ($r = -0.82$, $p < 0.001$), respectively. However, the stiffness S of the thoracic aorta did not correlate with any systolic parameters of renal arterial blood flow velocity. **Conclusion:** Thus, our findings suggest that the stiffness of the thoracic aorta influences on the renal arterial blood flow in diastole, which may be due to the impairment of Windkessel function.

1144-148 Reduction in Aortic Plaque Burden in Patients With Familial Hyperlipidemia as Assessed by Transesophageal Echocardiography

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Aortic atherosclerosis as assessed by transesophageal echocardiography (TEE) has been shown to correlate with coronary artery disease (CAD). Detection of plaque progression/regression in high risk patients, such as patients with familial hyperlipidemia (FH), may be important as a guide to aggressiveness of lipid lowering. **Methods:** Patients with FH with low density lipoprotein (LDL) > 200 mg/dL (with CAD), or LDL > 300 mg/dL (without CAD) despite being on maximum diet and drug therapy were enrolled in the study. 3 patients underwent LDL apheresis while 3 were referred to a lipid specialist for intensification of diet and drug therapy. TEE was performed at baseline and every 6 months of follow-up. The thoracic aorta (20 segments) was digitized and analyzed off-line using computer-assisted videodensitometry. Plaque area was determined by subtracting the internal luminal area from the area bounded by the media. Total plaque burden described the sum of all lesions visualized in the thoracic aorta. Data were analyzed using the paired t-test. **Results:** Further LDL lowering was achieved by an intensification of diet and drug therapy with (-57.2%) or without LDL apheresis (-7.2%). At 6 months of treatment, only the LDL apheresis group demonstrated plaque regression (-31.2%), whereas the drug therapy group demonstrated continued plaque progression (+35.8%). At one year of follow-up, there was a decrease in total aortic plaque burden ($p = 0.013$,

95% CI 1.35-7.05) with a -34.0% reduction in the LDL apheresis group and a -36.0% decrease in the drug arm. There were no clinical events (myocardial infarction or revascularization) observed.



Conclusion: Intensive therapy of high risk patients results in further LDL lowering, with demonstrable plaque regression as assessed by TEE. TEE can be a useful tool to screen and follow these high risk patients to determine who may need more aggressive lipid management prior to clinical events.

1144-149 Activation of Coagulation and Hyperfibrinolysis in Patients With Aortic Arch Atheromatosis (AAA) as a Risk Factor for Cerebral Ischemia

Hans-Joachim G. Siemens, Wladimir Mirau, Sabine Brueckner, Juergen Jahn, Abdolhamid Sheikzadeh. *Department of Internal Medicine II, Luebeck, Germany*

Background: In patients (pats) with cerebral ischemia, a frequent finding are atherosclerotic plaques in the ascending aorta and the aortic arch which are considered a separate risk factor. Since we were able to demonstrate that patients (pats) with atrial fibrillation have an increased procoagulatory activity (Thromb. Haemost. 75: 219-23, 1996), we wanted to evaluate a potential systemic activation of the coagulatory system in patients with AAA. **Methods:** In 101 consecutive pats (62 males, 36-88 years of age, mean 66.3 years) with cerebral ischemia, we determined several parameters of the procoagulatory and fibrinolytic systems as well as several thrombophilia risk factors and compared the results with 207 aged-matched controls (99 males, age range 36-95 years of age, mean 64.6) without any thromboembolic disease. **Results:** In 63 of the 101 pats, the transthoracic echocardiography showed AAA (A+), and in the remaining 28 patients, there were no aortic findings (A-). 12 pats had to be excluded due to additional thrombotic findings. There were no sex differences. Both groups significantly differed in age (A+ 69.2 years vs. A- 58.9, $p < 0.002$) but also concerning the concentration of plasminogen-anti-plasminogen-complexes PAP (500 ± 218 vs. 410 ± 232 $\mu\text{mol/L}$, $p < 0.05$), a parameter to determine the intensity of fibrinolysis. When the AAA patients are further divided into 5 subgroups of different severity (grade 0: no plaques; grade 1: plaques < 2 mm, grade 2: plaques < 5 mm, grade 3: plaques > 5 mm, grade 4: mobile plaques), we found significant differences for the concentrations of fibrinogen ($p < 0.05$), D-dimers ($p < 0.03$) and prothrombin fragments F1+2 ($p < 0.02$). The grade-4 group displayed highest values in comparison to all other groups. **Conclusion:** The pathological finding of AAA as such is a risk factor for cerebral ischemia and also seems to cause a systematically detectable activation of coagulation which substantially exceeds the values for age-matched controls. This observation is in accordance with our findings in patients with atrial fibrillation.

1144-150 Echocardiographic Predictors of Abdominal Aortic Aneurysm: The Cardiovascular Health Study

Jonathan F. Plehn, Ellen O' Meara, Anne B. Newman, Joseph Polak, Teri A. Manolio, John S. Gottdiener. *St. Francis Hospital, Roslyn, NY, National Heart, Lung and Blood Institute, Bethesda, MD*

Background: Detection of abdominal aortic aneurysm (AAA) can lead to surgical repair and improved survival. Echocardiography may identify patients at elevated risk for AAA who could benefit from abdominal aortic imaging at the time of echo. We hypothesized that echo features related to hypertension and coronary artery disease, both risk factors for AAA, might predict aneurysm prevalence in the Cardiovascular Health Study (CHS) of free-living subjects over the age of 65. **Methods:** We assessed two dimensionally-derived M-mode echo (adjusted for height) and Doppler parameters and other non-echo risk factors in 4,735 subjects (1,953 males, 2,782 females, mean age = 75) at the year 2 CHS examination as predictors of either: a) AAA prevalence at year 5 abdominal ultrasound exam or b) interim AAA repair. **Results:** Surgical grade AAA (maximum diameter > 4 cm) was detected or interim repair occurred in 69 (1.5%) subjects. Significant echocardiographic predictors of AAA in univariate analysis (odds ratios, 95% confidence intervals) included Doppler early/late (E/A) transmitral peak velocity ratio $< 0.6 = 4.36$ (2.31, 8.22), regional LV wall motion abnormalities = 2.41 (1.12, 5.22), left ventricular (LV) diastolic dimension (per cm) = 1.65 (1.04, 2.61), aortic root dimension (per 2 mm) = 1.29 (1.14, 1.46), LV mass (per 10 grams) = 1.10 (1.04, 1.16), left atrial dimension (per 2 mm) = 1.09 (1.01, 1.18) and LV outflow time velocity integral = 0.71 (0.51-0.98). LV radius/thickness ratio, ejection fraction and estimated aortic compliance had no predictive value. When entered in a stepwise, logistic regression model which included age, sex, history of coronary artery disease, smoking and hypertension, Doppler E/A ratio < 0.6 remained a strong predictor of AAA = 3.68 (1.89, 7.16) while aortic root dimension = 1.22 (1.08, 1.39) and left atrial dimension = 1.11 (1.02, 1.20) provided minimal additional value. AAA was detected in 5% of subjects with Doppler E/A < 0.6 . **Conclusion:** Doppler E/A ratio, which is affected by both coronary artery disease and systemic hypertension, can predict AAA in an elderly population. When E/A < 0.6 , concomitant screening for AAA with abdominal ultrasonic imaging should be considered.

POSTER SESSION

1145 Pharmacologic and Contrast Stress Echo

Monday, March 19, 2001, Noon-2:00 p.m.
Orange County Convention Center, Hall A4
Presentation Hour: Noon-1:00 p.m.

1145-151 Detection of Coronary Stenoses During the Early Stages of Dobutamine Stress Testing Using Intravenous Ultrasound Contrast and Pulse Inversion Doppler

Thomas R. Porter, Feng Xie, Danielle Noll, David Kricsfeld, Mary Silver, Edward O'Leary, University of Nebraska Medical Center, Omaha, NE

Low mechanical index Pulse Inversion Doppler (PID) has made the real time identification of myocardial contrast defects (MCD) possible with intravenous (IV) contrast. During dobutamine stress echo (DSE), MCD may antedate the onset of wall motion (WM) abnormalities, and potentially could be detected at an earlier stage in the test. Accordingly, we analyzed regional and coronary artery territory (CAT) myocardial contrast enhancement (MCE) following IV Optison (0.3 milliliters) at rest, during an intermediate dobutamine infusion stage (70% predicted maximum heart rate, or PMHR-70%) and at peak stress (>85% predicted maximum, or PMHR>85%) in 38 patients with a 50% pre-test probability of coronary artery disease. Real time PID was performed using a 2000 hertz pulse repetition frequency, mechanical index of 0.16-0.26, and a frame rate >25 hertz. Regional and CAT MCE were compared with WM and quantitative angiography. **Results:** Contrast defects were identifiable at >85% PMHR in 41 regions. These contrast defects were visually evident at PMHR-70% in 31 regions (76%; See Example). WM was abnormal at 70% PMHR in only 15 of the 31 regions with contrast defects at PMHR-70%, but 28 of the 41 regions (68%) with contrast defects at PMHR>85%. Even though MCE at >85% PMHR detected more contrast defects, agreement on a CAT basis with quantitative angiography was equivalent for MCE at 70%PMHR (kappa 0.64; IOA 82%) when compared to MCE at >85%PMHR (kappa 0.57; IOA 79%) because of a higher specificity of MCE at 70%PMHR. **Conclusions:** MCD observed with PID in real time antedate the onset of WM abnormalities and occur at lower heart rates. The sensitivity and specificity of perfusion imaging at this earlier stage of the DSE is equivalent to both MCE and WM at >85% PMHR. DSE could potentially be made safer and quicker without affecting accuracy if perfusion was also analyzed with low mechanical index PID.

**1145-152 Detection of Significant Coronary Stenoses With a Six Minute Adenosine Stress Echo and Real Time Pulse Inversion Doppler**

Danielle R. Noll, Feng Xie, Lisa Gobar, David Kricsfeld, Mary Silver, Edward O'Leary, Thomas R. Porter, University of Nebraska Medical Center, Omaha, NE

Intravenous adenosine infusions have been utilized to detect myocardial blood flow (MBF) abnormalities with incremental intermittent harmonic imaging and a continuous infusion (CI) of microbubbles (MB). Low mechanical index (MI) Pulse Inversion Doppler (PID) is a non-destructive imaging modality that has made the real time quantification of MBF more rapid. In order to test the feasibility of PID during an adenosine stress test (AST), we analyzed regional myocardial contrast enhancement (MCE) and contrast replenishment (MCR) with low MI PID (MI 0.2, frame rate 23 hertz) and brief high MI tone bursts during an intravenous CI of the undiluted liposome encapsulated MB (Definity). Measurements were made before and during a six minute 140 u/kilogram/minute adenosine infusion in 14 patients with intermediate probability of coronary artery disease. Myocardial perfusion was also measured the same day with single photon emission computed tomography (SPECT). Both SPECT and MCR were also compared with quantitative angiography (QA). **Results:** The CI of Definity produced bright MCE in 12 of 14 patients, allowing rapid real time acquisition of MCR following microbubble destruction. MBF abnormalities due to >50% diameter stenoses were evident visually during adenosine by a delayed MCR (9.0±3.2 seconds versus 2.2±0.8 seconds in normal regions; p<0.001; see Figure). Of the 72 regions compared between SPECT and MCR, SPECT identified nine defects during the AST (five fixed, four inducible), while delayed MCR with PID was detected in 13 (four fixed, nine inducible). The regional agreement between low MI PID and SPECT was 95% (kappa 0.81), while it was 94% (kappa 0.76) in the 18 regions compared with QA.



We conclude that a six minute AST with real time low MI PID is feasible, and could permit rapid detection and quantification of MBF abnormalities due to functionally significant coronary stenoses.

1145-153 Potential of Dobutamine Echocardiography and Different Myocardial Contrast Echocardiography Perfusion Patterns in Identifying Dysfunctional Viable Myocardial Segments After Acute Myocardial Infarction

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Background: After acute myocardial infarction microvasculature preservation is a prerequisite for myocardial viability. The diagnostic potential of early intravenous contrast echocardiography in identifying myocardial functional recovery after acute myocardial infarction is still unknown. Therefore, we tested the accuracy of different contrast echocardiography perfusion patterns and of dobutamine echocardiography to detect functional recovery after acute myocardial infarction. **Methods:** Fifty-five consecutive patients with first acute myocardial infarction underwent an echocardiogram on the first day of acute myocardial infarction, an intravenous myocardial contrast echocardiography with harmonic power Doppler 2.9±0.6 days after acute myocardial infarction, a low dose dobutamine echocardiography 3.8±1.6 days after acute myocardial infarction, and an echocardiogram at 3 months follow-up. A patient was considered as having adequate reflow if ≥50% of segments within the risk area was fully opacified (contrast pattern A), or fully/patchy opacified (contrast pattern B) at contrast echocardiography. **Results:** Functional recovery at follow-up was observed in 158 of 191 myocardial segments considered viable at dobutamine echocardiography and in only 27 of the 140 not viable. Among the 182 segments showing normal perfusion at contrast echocardiography (contrast pattern A), 133 improved in wall motion score at 3 months follow-up, whereas 49 did not. Of the 129 segments showing absent or partial perfusion, 36 improved in wall motion score at follow-up, whereas 93 did not. Sensitivity, specificity and predictive values of dobutamine echocardiography and different contrast patterns in predicting functional recovery of individual myocardial segments are shown in the Table.

	Sensitivity	Specificity	PP value	NP value	Accuracy
Dobutamine echo	85	77	83	81	82
Contrast pattern A	79	65	73	72	73
Contrast pattern B	91	43	65	79	69

Conclusion: Due to the low specificity and high sensitivity, microvascular preservation demonstrated with intravenous contrast echocardiography is a prerequisite for myocardial functional recovery after acute myocardial infarction.

1145-154 Basis for Inducible Wall Motion Abnormalities During Dipyridamole Stress. Could it Really Work After All?

Jian-Ping Bin, Elizabeth Le, Robert A. Pelberg, Matthew P. Coggins, Kevin Wei, Sanjiv Kaul, University of Virginia, Charlottesville, VA

Background: Although dipyridamole stress echocardiography (DPSE) is widely used for the detection of coronary artery disease (CAD), the pathophysiologic basis for the induced wall motion abnormalities (WMA) during dipyridamole-stress remains controversial. We hypothesized that a reduction in endocardial myocardial blood flow (MBF) reserve is responsible for WMA induced during dipyridamole stress.

Methods: 15 dogs were studied 7-10 days after placement of ameroid constrictors around the proximal LAD and LCX. MBF determined by radiolabeled microspheres and percent wall thickening (%WT) determined by 2-D echocardiography were measured at rest and following 0.56mg/kg of intravenous dipyridamole. MBF reserve was defined as the ratio of MBF during dipyridamole compared to that at rest.

Results: The rate-pressure product increased slightly (p<0.05) after dipyridamole. In the 110 myocardial segments analyzed, %WT in those with endocardial MBF reserve of 1.5 to 2.5 did not change after dipyridamole (31.5±1.9% vs 32.8±2.5%), while it decreased significantly in segments with endocardial MBF reserve of <1.5 (25.8±3.4% vs 20.6±2.7%, p<0.05) and increased significantly in those with endocardial MBF reserve of >2.5 (33.9±2.1% vs 38.6±3.4%, p<0.05). Using a decrease in %WT of >5% (> 2 SD of normal %WT at rest) as the criterion for inducible WMA, 80% of segments with endocardial MBF reserve of < 1.5 and 14.3% with endocardial MBF reserve of 1.5 to 2.5, showed inducible WMA after dipyridamole, while none of the segments with endocardial MBF reserve of >2.5 showed WMA. In contrast, the endocardial/epicardial MBF ratio during hyperemia was a poor predictor of inducible WMA. Only 35% of the segments with a ratio of <0.8 (normal -2 SD) showed inducible WMA.

Conclusions: During dipyridamole stress a significant reduction in endocardial MBF reserve in myocardial beds supplied by a stenosed coronary artery may be the main pathophysiologic basis of induced WMA rather than just a reversal in the endocardial/epicardial ratio. Although DPSE may not identify stenoses of low or moderate severity, it may be effective in identifying clinically significant coronary stenoses.

POSTER SESSION

1146 New Insights Into the Microcirculation Using Contrast Echocardiography

Monday, March 19, 2001, Noon-2:00 p.m.
Orange County Convention Center, Hall A4
Presentation Hour: Noon-1:00 p.m.

1146-155 Cerebral Blood Flow Can Be Accurately Measured Using Contrast Enhanced Ultrasound Imaging

Se-Joong Rim, Howard Leong-Poi, Jian-Ping Bin, Jonathan R. Lindner, Daniel Couture, Dilantha Ellegala, Holland Mason, Marcel Durieux, Sanjiv Kaul. *University of Virginia, Charlottesville, VA*

Background. There is currently no non-invasive technique for monitoring cerebral blood flow (CBF) in the acute care setting. We hypothesized that changes in cerebral perfusion could be accurately measured using contrast-enhanced ultrasound (CEU) imaging.

Methods. In 5 anesthetized dogs, cerebral perfusion was assessed at baseline and during hypercapnia and hypocapnia while maintaining normoxia. At each stage, CEU was performed through a partial craniectomy using power pulse-inversion imaging during a continuous infusion of microbubbles. Cerebral microvascular blood volume (A), blood velocity (β), and blood flow (A β) were calculated from time-intensity curves following a high-power pulse sequence. A values were normalized to baseline for each dog due to differences in volume of distribution. CBF was also measured using radiolabeled microspheres.

Results. Illustrated in the table, hypercapnia and hypocapnia significantly increased and decreased cerebral blood flow, respectively, compared to baseline. CEU data demonstrated that these changes in blood flow were mediated by changes in both A and β . A good correlation was found between CBF measured by radiolabeled microspheres and that by derived from CEU ($r^2=0.88$, $p<0.001$).

	PaCO ₂ (mmHg)	CBF(mL.G ⁻¹ .min ⁻¹)	A(normalized)	β (sec ⁻¹)	A β
Baseline	36 \pm 3	0.84 \pm 0.13	1	0.59 \pm 0.19	0.59 \pm 0.19
Hypercapnia	83 \pm 11*	2.11 \pm 0.88*	1.37 \pm 0.76*	0.89 \pm 0.39*	1.19 \pm 0.46*
Hypocapnia	29 \pm 3*	0.60 \pm 0.23*	0.60 \pm 0.16*	0.49 \pm 0.26	0.27 \pm 0.13*

* p<0.05, compared to baseline

Conclusions. Changes in CBF, which are mediated by changes in both capillary blood volume and velocity, can be accurately assessed non-invasively with CEU. These results suggest that CEU may provide very valuable information at the bedside for monitoring CBF in patients with acute cerebrovascular disorders.

1146-156 Hemodynamic Effects of Intravenous PESDA Microbubbles During Acute Myocardial Ischemia

Thomas R. Porter, Feng Xie, David Kricsfeld, John Lof. *University of Nebraska Medical Center, Omaha, NE*

It has been demonstrated that intravenous (IV) microbubbles carrying a high molecular weight gas (mechanical stabilizer) are capable of delivering oxygen to ischemic myocardium independent of hemoglobin. We hypothesized that this may be beneficial in unstable angina, where IV perfluorocarbon containing microbubbles (PESDA) could potentially deliver oxygen from the lungs to myocardium during repetitive episodes of myocardial ischemia (MI) and prevent reductions in regional and global systolic function. In order to test this hypothesis, mean arterial pressure (MAP), regional wall thickening (RWT), coronary sinus oxygen saturation (CSO₂sat), and cardiac output (CO) were measured before, during, and after repetitive bouts of left circumflex or left anterior descending ischemia (six minutes duration followed by nine minutes reperfusion) in five dogs. IV PESDA or IV saline in the presence of 100% inhaled oxygen were given during each six minute period of MI. This six minute ischemic period was repeated up to four times for each group (MI-1 through MI-4). Percent (%) changes in CO, MAP, CSO₂sat, and RWT were measured before, at 4 minutes of MI, and 2 minutes following coronary reperfusion. Results are shown (*p<0.05 compared to IV saline with 100% oxygen).

Hemodynamic Effects of IV PESDA

Treatment During Ischemia	% Change in CO- MI 1	% Change in CO MI2-4	% Improvement in RWT Following Reperfusion MI2-4
IV PESDA + 100% Oxygen	-43 \pm 10	-12 \pm 24*	31 \pm 4*
IV Saline + 100% Oxygen	-34 \pm 11	-36 \pm 9	20 \pm 10

There were no differences in % MAP during MI between groups, but IV PESDA attenuated decreases in CSO₂ sat following MI (p=0.05 compared to saline +100% oxygen). Conclusion: IV PESDA in the presence of inhaled oxygen prevents reductions in CO that occur during repetitive bouts of MI, and may reduce the stunning that results from repetitive ischemic episodes. We conclude that IV PESDA may be useful in preventing hemodynamic and myocardial compromise in acute coronary syndromes.

1146-157 Does Microbubble Destruction by Intermittent Power Doppler Imaging Alter the Systemic Contrast Agent Concentration and Influence the Myocardial Replenishment Function in Perfusion Studies?

Jens-Uwe Voigt, Andrej Schmidt, Gerald Wasmeier, Dierk Werner, Uwe Nixdorff, Frank A. Flachskampf, Werner G. Daniel. *University Erlangen, Erlangen, Germany*

Background: Currently, the quantification of myocardial perfusion is attempted by measuring contrast agent (CA) replenishment within the myocardium after its complete destruction by high power ultrasound (HPU) imaging. However, this approach relies on a constant blood pool concentration (CONC) of the CA independent of the interval between two HPU images. This study was designed to test whether the frequency of HPU images will significantly alter the systemic CA CONC which could result in a wrong estimation of myocardial perfusion. **Methods:** In 5 volunteers, the CA Levovist was infused at an individual constant rate (2-3ml/min). For measuring blood pool CA CONC, the common femoral artery (CFA) was imaged with a TEE probe in Second Harmonic Mode (2.8/5.6MHz). ECG-triggered imaging (1:1) and a moderate mechanical index (MI=0.8) were used to minimize CA destruction. The mean SI within the CFA which was measured off-line from our digitally stored data was used as a marker of systemic CA CONC. An ATL HDI 5000 System (Power Doppler Mode, MI=1.3) was used for constant and ECG-triggered HPU cardiac imaging with TIs of 1:1, 1:2, 1:4 and 1:8 (30s each). In between, the system was switched to freeze for another 30s to allow CA CONC to stabilize. **Results:** During CA infusion, blood pool SI within the CFA increased significantly by 4.2 \pm 2.4dB. Continuous HPU cardiac imaging resulted in an immediate remarkable SI reduction (-2.0 \pm 1.5dB, p<0.05). With a TI of 1:1, a SI reduction was still measurable (-0.4 \pm 0.3dB, p<0.05). Longer TIs did not significantly alter blood pool SI. **Conclusion:** Continuous HPU cardiac imaging and a TI of 1:1 significantly reduce the systemic blood pool CONC of a constantly infused CA. In triggered imaging mode, this may result in an overestimation of the myocardial perfusion if the exponential replenishment function is derived from too few measurements at different TIs. In real time imaging, the measurements may be altered if the HPU flash is used too frequently.

1146-158 Temporal Changes of Microvascular Obstruction After Acute Reperfused Myocardial Infarction

Leonarda Galiuto, Antonella Lombardo, Antonio G. Rebuzzi, Luca Santoro, Domenico Cianflone, Filippo Crea, Attilio Maseri. *Institute of Cardiology, Catholic University of the Sacred Heart, Rome, Italy*

Background: Although the causes of no-reflow in humans are still unknown, lack of reperfusion may be the result of either anatomic or functional obstruction of coronary microvasculature. Therefore, we hypothesized that, according to the prevalent pathogenetic mechanism, no-reflow could be either a stable or dynamic phenomenon. **Methods:** Fifteen pts with first acute myocardial infarction (AMI) (14 males, 61 \pm 10 yrs, anterior in 12) were studied by myocardial contrast echo (MCE) within 24 hrs from onset and at 1.5 \pm 1 month follow-up. Pts were treated within 8 hrs from onset by i.v. rt-PA (n=9) or by primary PTCA (n=6). MCE was performed by Harmonic Power Doppler (end-systolic triggering 1:4) and i.v. Levovist(400 mg/ml, 2 ml/min). Each myocardial segment was scored for microvascular perfusion (3=absent, 2=hypo, 1=normo) and a regional contrast score index (CSI) was calculated within the dysfunctioning myocardium. Power Doppler videointensity (VI) was measured in dB within the risk and control areas and their ratio was calculated. **Results:** The infarct related artery was successfully recanalized in all pts (TIMI grade 2.4 \pm 0.7). In the first MCE, 9 of the 15 pts (60%) showed at least one non-perfused segment (mean 3.2 \pm 1.1) (no-reflow), their CSI was 2.6 \pm 0.6 and VI ratio was 0.4 \pm 0.2. The remaining 6 pts had a complete reflow with a CSI of 1.1 \pm 0.2 and a VI ratio of 0.8 \pm 0.2 (p<0.05 vs no-reflow pts). At follow-up, reflow pts maintained their perfusion (CSI of 1, VI ratio of 0.9 \pm 0.3, p=ns vs first MCE). In 4 of the 9 no-reflow pts, the number of segments not perfused, the CSI and VI ratio remained unchanged, while in the remaining 5 pts, the number of non-perfused segments was reduced from 3.6 \pm 1.3 to 0.4 \pm 0.9, the CSI was reduced from 2.5 \pm 0.5 to 1.3 \pm 0.3 and VI ratio of segments with recovered perfusion improved from 0.4 \pm 0.2 to 0.9 \pm 0.3 (p<0.05 vs first MCE). **Conclusions:** After AMI, microvascular obstruction may remain stable or improve over time, possibly because of the occurrence of different pathogenetic mechanisms in different patients. Although further investigation is needed, these data provide the first evidence of the clinical heterogeneity of the no-reflow phenomenon.

ORAL CONTRIBUTIONS

833 Myocardial Contrast Echocardiography: New DevelopmentsMonday, March 19, 2001, 2:00 p.m.-3:30 p.m.
Orange County Convention Center, Valencia B**833-1 Decrease in Myocardial Blood Flow Reserve With Hyperlipidemia is Secondary to Increases in Blood Viscosity and Not Endothelial Dysfunction**Se-Joong Rim, Howard Leong-Poi, Tadamichi Sakuma, Kevin Wei, Ranjith Jayaweera, Sanjiv Kaul. *University of Virginia, Charlottesville, VA*

It is generally thought that decreased coronary blood flow (CBF) reserve during hyperlipidemia (HL) is caused by endothelial dysfunction. We have recently shown that when coronary arterioles and venules are maximally dilated by adenosine, capillaries limit the increase in hyperemic CBF. Unlike larger vessels, where for any pressure gradient, luminal size determines CBF, in the capillaries CBF is primarily determined by blood viscosity. We, therefore, hypothesized that the decreased CBF reserve during HL is secondary to increased blood viscosity rather than due to endothelial dysfunction. We studied 8 open chest dogs during maximal hyperemia induced by intracoronary adenosine. Various doses of IV Intralipid® were administered along with 2 mM of CaCl₂ (to prevent direct vasodilatory effect of free fatty acids secondary to increased Ca²⁺ sequestration). CBF (ultrasonic flow probes), myocardial blood flow (MBF) (radiolabeled microspheres), and coronary driving pressure (CDP) were measured. Myocardial vascular resistance (MVR) was calculated as CDP/CBF. MCE was performed for both coronary blood volume (CBV) measured using transit time estimates from intracoronary injections of microbubbles, and myocardial blood volume (MBV), measured from pulsing interval vs video intensity curves obtained during a continuous IV infusion of microbubbles. Intralipid resulted in a 43±35% increase in MVR (p<0.005) with no significant changes in total CBV and a 16±33% decrease in MBV (p<0.05). Decreases in both CBF by 24±16% (p<0.001) and MBF by 28±13% (p<0.001) were observed. Serum triglyceride levels (ranging from 47 to 2407 mg·dL⁻¹) and whole blood viscosity (ranging from a 24% to 119% increase) correlated significantly with reductions in hyperemic MBF (R=-0.55, p<0.05; R=-0.88, p<0.005 respectively). We conclude that biophysical properties at the capillary level (hyperviscosity) rather than impaired endothelial function is responsible for reduced CBF reserve during HL. These novel findings not only provide new pathophysiological insights into the microcirculatory control of CBF, but also provide an opportunity to develop new therapeutic strategies towards altering blood viscosity.

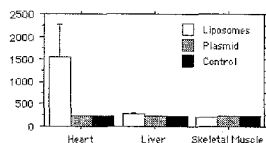
2:00 p.m.

833-2 Successful Expression of Plasmid DNA in Rat Myocardium by Ultrasound-Targeted Microbubble DestructionShuyuan Chen, Ralph V. Shohet, Peter Frenkel, Susan Mayer, Roger H. Unger, Paul A. Grayburn. *UT Southwestern Medical Center, Dallas, TX*

Background: We have previously shown successful expression of adenoviral reporter genes in the myocardium after ultrasound-targeted microbubble destruction (UTMD). Because adenoviral vectors are limited by liver uptake and a profound immune response, we attempted to deliver plasmid DNA by UTMD.

Methods: Plasmid DNA encoding a firefly luciferase reporter gene under a CMV promoter was attached to the phospholipid shell of perfluoropropane-filled liposomes and infused into the jugular vein of 9 rats. After 7 days, the rats were killed and the heart, liver, and hindlimb skeletal muscle were analyzed for luciferase activity. Control groups included infusions of plasmid DNA and microbubbles. All infusions were done during echocardiography. At sacrifice, heart, liver, and hindlimb skeletal muscle were harvested and assayed for luciferase activity. A blank control was also assayed.

Results: Results are depicted in the figure. Luciferase activity was over 7-fold higher in the hearts treated with UTMD than in control hearts. Moreover, UTMD resulted in no significant luciferase activity in the liver. Liver and skeletal muscle activity were no different than a blank control.



Conclusions: Expression of plasmid DNA can be targeted to the heart by UTMD without significant liver uptake. This offers a tremendous advantage over adenoviral vectors for gene therapy.

833-3 Dissolution of Intracranial Thrombi With Transcranial Low Frequency Ultrasound and Perfluorocarbon Exposed Sonicated Dextrose Albumin MicrobubblesFeng Xie, David Kricsfeld, William C. Culp, Thomas R. Porter. *University of Nebraska Medical Center, Omaha, NE*

The mechanical shear forces generated by cavitation of intravenous perfluorocarbon containing microbubbles (PESDA) in the presence of transcutaneous low frequency ultrasound (US) can be utilized to dissolve intraarterial thrombi in animals without the need of

2:30 p.m.

fibrinolytic agents. We hypothesized that two facets of this technique would make it optimal for treating intracerebral thromboemboli: (1) it can be performed at low frequencies which may not attenuate across the skull, and (2) the thrombus dissolution is not accompanied by a systemic lytic state. To test the hypothesis, we performed transtemporal US with two different frequencies (40 kilohertz (KHz) and 1 megahertz (MHz)) across a human skull which contained a thrombosed vessel (TV) made from the clotted blood of five healthy volunteers. The depth of the TV underneath the skull was five centimeters. Ultrasound penetration across the temporal bone and through the tissue mimicking phantom was measured with calibrated hydrophones at the same depth as the TV. Each TV was perfused with saline at 37° Celsius at a flow rate of 20-25 milliliters per minute. Intravascular pressure was 35-40 mm Hg. Thrombi were randomly exposed to the 40 KHz versus 1 MHz US frequencies at duty cycles of either 20% (PW) or 100% (CW) for 10 minutes while PESDA or saline (0.2 milliliter bolus) was injected proximal to the TV. **Results:** The attenuation in intracerebral peak negative pressure with 1 MHz US was 17 kilopascals (KPa), while it was 11 KPa for 40 KHz US.

Transcranial Thrombolysis with Microbubbles

Treatment Group	% Clot Dissolution Without PESDA	% Clot Dissolution With PESDA
1 MHz US PW	12±25	24±20
1 MHz US CW	1±7	25±25
40 KHz US PW	7±5	32±16*
40 KHz US CW	1±8	19±15

Despite transcranial attenuation, 40 KHz PW in the presence of PESDA produced significant thrombus dissolution (up to 60% thrombus dissolution in 10 minutes; *p<0.05 compared to 40 KHz US alone; ANOVA). These data indicate that transcranial pulsed wave US combined with intravenous PESDA may be the best method of achieving localized thrombolysis in acute stroke.

833-4 Influence of Shell Characteristics on Low-Power Contrast Ultrasound ImagingHoward Leong-Poi, Ji Song, Se-Joong Rim, Edward Gertz, Sanjiv Kaul, Jonathan R. Lindner. *University of Virginia Health Sciences Center, Charlottesville, VA, Point Biomedical Corp, San Carlos, CA*

Background. Real time perfusion imaging with myocardial contrast echocardiography (MCE) currently relies on the detection of signals produced by microbubble oscillation at low acoustic powers that produce minimal microbubble destruction. We hypothesized that the optimal acoustic power for producing ultrasound signal without destruction would differ for microbubbles with different shell elastic and damping characteristics.

Methods. Three microbubble agents with varying shell stiffness according to their shell polymer composition were studied. The acoustic lability of these microbubbles was characterized by direct microscopic visualization of microbubble destruction during repeated single pulses of ultrasound (1.8 MHz) at peak negative acoustic pressures of 0.1, 0.3, 0.6, and 1 MPa. The ultrasound signal generated by the microbubbles at these acoustic pressures was determined in an in vitro flow system using pulse-inversion imaging at varying pulsing intervals.

Results. On microscopy, minimal destruction was seen at 0.1 MPa for any of the microbubble agents. Incrementally greater rates of microbubble destruction were seen with increases of acoustic power. The rates of destruction at 0.3 and 0.6 MPa were significantly (p<0.05) different for the 3 microbubble agents according to the predicted shell "stiffness". At 1.0 MPa, essentially all microbubbles were destroyed by the first 1 or 2 ultrasound pulses. Ultrasound imaging at varying pulsing intervals confirmed different degrees of destruction for the 3 microbubble agents. The optimal power for achieving high video intensity with minimal destruction was different for the 3 agents and increased with predicted shell "stiffness".

Conclusions. Unlike high power imaging, where bubbles behave similarly, the acoustic power for maximizing acoustic signal without destroying microbubbles during 'real-time' imaging varies according to shell characteristics. These findings have major implications for optimizing 'real-time' perfusion imaging.

833-5 Effect of Different Insonifying Frequencies on the Coronary Vascular Uptake of Drugs Bound to Albumin Coated MicrobubblesDavid Kricsfeld, Feng Xie, Carr Everbach, Thomas R. Porter. *University of Nebraska Medical Center, Omaha, NE*

A wide range of transthoracic ultrasound frequencies (20 KHz to 2 MHz) have been utilized to target the delivery of therapeutic drugs bound to microbubbles into the heart. However, the frequency which is optimal for targeted drug delivery remains unclear, as are other potentially important parameters such as peak negative pressure (PNP) and duty cycle. Accordingly, a tissue phantom with an attenuation of 0.49 decibels/cm/MHz was constructed. Twenty-five coronary vessels (22 normal, 3 atherosclerotic) were obtained fresh and unfixed after autopsy and placed at a depth of 6 centimeters within the phantom. The bis-azo compound Evans Blue was bound to perfluorocarbon exposed sonicated dextrose albumin (PESDA) microbubbles and then injected proximal to the vessel. Ultrasound at different frequencies (20 KHz - 1 MHz), different peak negative pressures (PNP up to 32 kilopascals) and different duty cycles (20-100%) was applied through the phantom following each injection. Evans Blue was given either bound or unbound to PESDA. Uptake in the vessel was measured with color spectrophotometry. Results are shown in the Table.

	PNP	Uptake (moles x 10 ⁻⁹)
20-80 KHz plus PESDA	17 kilopascals	15.2±3.9*
1 MHz plus PESDA	32 kilopascals	13.7±5.6

Control

8.8±3.2

*p<0.05 versus Control

These data indicate that a wide range of ultrasound frequencies is effective in targeting the coronary vascular uptake of drugs bound to albumin coated microbubbles.

3:15 p.m.

833-6

BR-14: A Novel Ultrasound Contrast Agent Demonstrating Redistribution After a Single Venous Injection: Implications for Detection of Coronary Stenosis and Myocardial Viability

Nick G. Fisher, Ranjith A. Jayaweera, Jiang-Pin Bin, Howard Leong-Poi, Tadamichi Sakuma, Sanjiv Kaul. *University of Virginia, Charlottesville, VA*

Background Most current ultrasound contrast agents are not retained in the myocardium. BR-14 is a novel microbubble that is retained within the myocardium after a bolus injection given at peak exercise, allowing perfusion images to be obtained both during and following exercise. However, its *in vivo* kinetics are not known. The aim of our study was to define the *in vivo* kinetics of BR-14, in infarcted myocardium and that supplied by a non-critical stenosis, compared with a normal bed.

Method We studied 6 open chest dogs, with varying degrees of non-critical coronary stenosis on a single artery. In 3 dogs complete occlusion was created to produce infarction. Minimally destructive power pulse inversion harmonic imaging was performed for 10 min after a single bolus injection of 2 mL of BR-14 during maximal hyperemia. TTC staining of myocardium was used to separate infarcted from viable myocardium.

Results The kinetics of most contrast agents can be described by a lagged normal density function where the input (bolus venous injection) resembles a Gaussian function, and can be obtained by solving the differential equation $dc/dt = \kappa(G - C)$, where G is the Gaussian function, C is the concentration of contrast which is proportional to the video intensity, κ is a rate constant, and t is time. BR-14's kinetics and its persistence in viable myocardium can be described by a combination of the lagged normal density and sigmoid functions with the form: $y = A/[1 + e^{-\lambda(t-t_0)}]$, where A is the steady state VI obtained at the late phase and I and t_0 are constants. Normal myocardium could be separated from that supplied by a non-critical stenosis early after injection by a significantly higher (3.3 fold) VI. When myocardium distal to the stenosis was viable, the VI in that bed became equal to that of the normal bed at 10 min (ratio of 1.06) indicating redistribution. When there was necrosis, the abnormal bed showed significantly lower (average of one-third) VI at 10 min compared to the normal bed.

Conclusions BR-14 is a novel ultrasound contrast agent that demonstrates redistribution. Therefore, similar to ^{201}Tl , it can be used to detect both coronary stenosis and myocardial viability after a single injection performed during stress.

MODERATED POSTER SESSION

1006 New Doppler Techniques I

Monday, March 19, 2001, 3:00 p.m.-5:00 p.m.
Orange County Convention Center, Hall A4

3:00 p.m.

1006-201 Left Ventricular Inflow Propagation Determined by Real-Time 3D Color Doppler Echocardiography

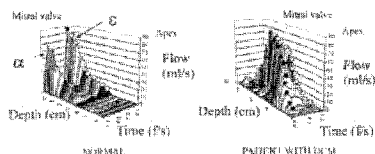
Fabrice Bauer, Takahiro Shiota, Marta Sitges, Jian Xin Qin, Yong Jin Kim, Hiroyuki Tsujino, James D. Thomas. *The Cleveland Clinic Foundation, Cleveland, OH*

Background: Since left ventricular (LV) inflow propagation occurs in 3D space, conventional pulsed Doppler and color M-mode method are insufficient to analyze such a phenomenon. To date, real-time 3D color Doppler echocardiography (RT3DC) is the only potential tool to characterize 3D flow structure. The purpose of this study was to investigate LV flow propagation using RT3DC.

Methods: Twelve patients [6 normal and 6 patients with dilated cardiomyopathies (DCM)] in sinus rhythm with a low heart rate (mean heart rate, 58 ± 6 b/min) were imaged by RT3DC from an apical 4-chamber view. After acquiring LV inflow with RT3DC, data were transferred to a TomTec-equipped workstation for off-line analysis. Using the C-mode display, LV inflow was sliced every 5-mm from the mitral valve to the apex, during one cardiac cycle. The colored boundary of each slice was traced and the mean flow rate was automatically provided by the software.

Results: LV EF was significantly lower in patients with DCM as compared to the normal ($24 \pm 5\%$ vs. $64 \pm 7\%$, $p < 0.01$). LV inflow consisted of 2 waves: The first wave ϵ occurs in the early diastole and the second wave α corresponds to the atrial contraction. Maximum flows of both ϵ and α occurred close to the mitral valve leaflet tip and decreased gradually and exponentially towards the apex (white dots on figure). Maximum mean flow of ϵ was significantly higher in normals than in patients with DCM ($107 \pm 14 \text{ ml} \cdot \text{s}^{-1}$ vs. $86 \pm 18 \text{ ml} \cdot \text{s}^{-1}$, $p < 0.05$). In normals, ϵ filled the LV almost instantly. In contrast, ϵ propagated much slower in patients with DCM (black dots on figure).

Conclusion: Difference in LV inflow propagation pattern between normals and DCM was found by RT3DC, suggesting its potential value for elucidating mechanisms of diastolic dysfunction.



1006-202

Three-Dimensional Computations of Digital Flow Profiles for Assessing Flow Volumes Through the Main Pulmonary Artery and Its Branches: An In Vitro Physiological Porcine Pulmonary Artery Model

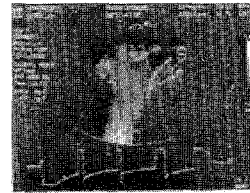
David J. Sahn, Mathew C. Strehlow, Petra S. Mehwald, Thomas Z. Totonchy. *Oregon Health Sciences University, Portland*

Background: Two-dimensional pulsed Doppler methods for assessing pulmonary artery (PA) blood flow are not robust since they require geometric assumptions on flow area and flow profiles that may be difficult to estimate in the curved geometry of the PA. The aim of our study was to test a digital 3D color Doppler method (DCD) for PA flow calculations.

Methods: Main PAs and their branches were surgically excised from 3 pigs (weight 105-127kg) and connected to a pulsatile pump attached to a reference flow meter. Twelve different pulsatile flow volumes (25-55 ml/beat) were generated through the model. An ATL HDI5000 echocardiography system with a multiplane transesophageal transducer, imaging in a water tank, was used to acquire 3D data sets in 180° rotations covering the main PA and the left and right branches. The images were reconstructed from scanline data containing raw digital velocities using an SGI workstation with newly developed software to obtain flow volume estimations by integrating velocity, flow profile, flow area and time over a curved plane selected from 3D space perpendicular to the area of the PA or branches for which flow was to be computed.

Results: Flow volumes in the main PA derived by the 3D method correlated well with reference data ($r = 0.98$, mean difference = 0.36 ml/beat). The combined flow volumes in the right and left PA branches also agreed well with those in the main PA ($r = 0.96$, mean difference = 0.17 ml/beat).

Conclusion: Our 3D DCD method can provide accurate estimations of flow volumes in a physiological pulsatile model of the central main and peripheral PAs and should be applicable in a clinical setting.



3:24 p.m.

1006-203

Feasibility of Calculating Energy Loss Across Stenotic Orifices from 3-D Digital Color Doppler: An In Vitro Model Study

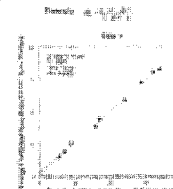
Daniel Dreier, Xiaokui Li, Crispin H. Davies, Xiang-Ning Li, David J. Sahn. *Oregon Health Sciences University, Portland*

Background: Energy loss may be a better predictor of patient outcome in valvular aortic stenosis than effective orifice area (EOA) in isolation. Energy loss is related to the effective orifice area (EOA), flow rate and the area of the receiving volume (the aorta). We have investigated the feasibility of calculating energy loss using flow information derived from digital 3D color Doppler assessment of the vena contracta without the need to assess flow area volume or use the continuity equation.

Methods: An experimental model was designed to measure the energy loss (E_L) units using a fixed orifice (0.5 cm^2) and compliant aortic receiving chambers of diameters (A_d) of 1.8cm and 1.2 cm. A 7-4 MHz multiplane TEE probe was used to perform the 180° 3D rotational scan in 9° increments. Nine pulsatile flows (15-55 ml/beat) were generated through the stenotic orifice. Instantaneous flow rate was determined using an ultrasonic flowmeter. Reconstruction of vena contracta EOA from the raw scanline data was performed with custom software. Energy loss was calculated from the formula (see Formula) and results compared with those obtained from computation of EOA as flow/CW Doppler velocity.

Results: Energy loss was higher when the aorta was larger. There was excellent correlation between the energy loss calculated from the 3D method and that calculated by the standard ($A_d = 1.2 \text{ cm}$, $r = 0.99$, $P = 0.0001$, SEE 0.53 and $A_d = 1.8 \text{ cm}$, $r = 0.99$, $P = 0.001$, SEE 1.02). Energy loss was proportional to the diameter of the chamber receiving the jet.

Conclusions: Calculation of energy loss is feasible using 3D digital color measurement of flow. The technique may be of value in the assessment of aortic stenosis without the need to separately estimate flow rate.



3:36 p.m.

1006-204 Combining CW Doppler with a Digital Semiautomatic Method for Analysis of Digital Color M-Mode Images Provides a Dynamic Measurement of Effective Orifice Area: An In Vitro Validation Study with a Physiologic Mitral Regurgitation Phantom

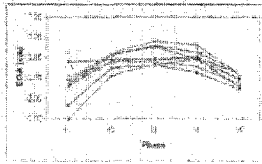
Xiang-Ning Li, Xiaokui Li, Paul R. Detmer, David J. Sahn. *Oregon Health Sciences University, Portland, OR*

Background: Our newly developed interaliasing distance (IAD) automated method from color M-mode offers a simple way for quantifying regurgitant flow with high temporal sample rate. This study investigated the potential of combining the IAD method with CW Doppler to estimate the dynamic changes of the effective orifice area (EOA).

Methods: We used a dynamic regurgitant orifice model in which both orifice area and its location in space varied cyclically. Eleven pulsatile flow conditions (regurgitant volumes, 13-35 ml/sec) were applied to the flow model with the instantaneous flow rate recorded from an ultrasonic flow meter. Digital color M-mode images through the flow convergence zone were acquired with an ATL HD15000 ultrasound system and transferred as scanline data to a PC computer. Instantaneous regurgitant flow rates were measured with a custom HDILab program by the user placing an outline over the first aliasing zone in the flow convergence region. Multiple velocity distance measurements were then computed automatically by the program. CW Doppler was used to derive the velocity (V) at the orifice and EOA was then calculated from 5 pairs of measurements obtained over sampling intervals in "systole" using the equation, $EOA = Q/V$, where Q is instantaneous flow rate from the IAD flow rate, with results compared to those derived from the flow meter divided by CW Doppler.

Results: The mean EOA derived from our method overestimated (by 16%), but correlated well with the reference functional EOA ($r = 0.88$; $p < 0.05$).

Conclusion: This flow field computation method is fast and accurate and should be applicable for clinical studies.



3:48 p.m.

1006-205 Load Dependence of Diastolic but Not Systolic Tissue Doppler Velocities in Patients With Heart Failure

Alessandra Frigiola, Nicola Payne, Andrew Broadley, Alan G. Fraser. *Wales Heart Research Institute, University of Wales College of Medicine, Cardiff, United Kingdom*

Background: Detailed echocardiographic studies in patients with heart failure are important for both diagnosis and monitoring. It has been suggested that LV filling pressures can be estimated by formulae including mitral annular tissue velocities, but these may be load-dependent. We therefore assessed the load-dependence of both systolic and diastolic velocities, of long- and short-axis function.

Methods: 14 patients with treated heart failure (12 NYHA class II, 2 NYHA class III; aged 48-65 years, 13M) underwent echocardiography at rest. We assessed global systolic function from planimetry of apical 4- and 2-chamber views and from M-mode fractional shortening, global diastolic function from pulsed Doppler profiles of mitral and pulmonary venous flow, and regional myocardial systolic and diastolic (early E, atrial A, regional isovolumic relaxation time (IVRT) function from off-line tissue Doppler on stored digital loops. All measurements were repeated during lower body negative pressure (LBNP, -30 mmHg, for >2 minutes).

Results: Myocardial systolic velocities did not change during LBNP (mean of 4 basal segments $4.4(\text{sd } 1.5)$ at rest vs $4.2(1.7)$ cm/s during LBNP), whereas myocardial E velocity decreased both in the longitudinal axis (by 20%, mean E $-4.6(2.0)$ to $-3.7(1.7)$ cm/s, $p=0.03$) and in the transverse axis (by 38% in the mid posterior segment, from $-5.2(3.6)$ to $-3.2(2.4)$ cm/s, $p<0.001$). Myocardial A velocity and myocardial E/A ratio were unchanged during LBNP. There was a non-significant trend for decrease in systolic velocity during LBNP to be greater in patients with worse systolic fractional shortening ($r = 0.42$, $p=0.13$), but change in systolic velocity did not correlate with severity of heart failure judged by mitral E deceleration time, suggesting no evidence of ventricular interaction in these patients; no patient had restrictive filling by standard Doppler criteria.

Conclusion: In patients with heart failure, myocardial velocities during early filling are load-dependent, and unloading exaggerates the pattern of impaired myocardial relaxation. Echocardiographic indices which incorporate tissue Doppler velocities should be interpreted with caution when loading is variable.

4:00 p.m.

1006-206 Quantitation of Aortic (Ao) Regurgitation in a Chronic Animal Model Using an Automated Color M-Mode Interaliasing Distance Flow Convergence Region Method

Ghada O. M. El-Sedfy, Crispin H. Davies, Michael Jones, Xiang-Ning Li, David J. Sahn. *Oregon Health Sciences University, Portland, OR*

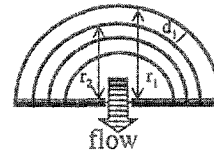
Background: We studied regurgitant flow quantification using the distance between adjacent aliasing boundaries (interaliasing distance = IAD) of the flow convergence region (FCR) in a chronic animal model of Ao regurgitation (AR).

Methods: The Ao valve was partially resected in 4 juvenile sheep 6 months prior to the study. Simultaneous hemodynamic and echo measurements were made on open-chest animals with AR flow derived from the difference between Ao and PA electromagnetic

(EM) flow meters balanced against each other. Volume loading, sodium nitroprusside and angiotensin produced a total of 15 different hemodynamic states. An ATL HD15000 system was used to obtain color M-mode records of AR flow with a 7.4MHz probe placed epicardially and system Nyquist limits (V) set at 33.4-67.3cm/sec. Digital scanline data were transferred into ATL HDILab with our new custom program.

Results: Using digital velocity range and zero shift features to process color M-mode images, the average distances (d) between aliasing points were measured automatically at 5 isovelocity combinations for 3-5 cardiac cycles. Regurgitant flow (Q) was calculated by deriving the area of the two FCR hemispheres ($2Br^2$) and multiplying this by the velocity difference (V) according to the simplified equation: $Q = 72.5 \cdot d^2 \cdot V$, at 6-8 points in diastole. There was an excellent correlation between the regurgitant stroke volumes calculated from the IAD ($r = 0.985$; $y = 0.50x + 0.126$; $SEE = 0.66\text{cc}$), and by EM flow meters.

Conclusion: Our new method is fast, accurate and semiautomatic; it is easy to use, and it should facilitate use of flow field acceleration methods in clinical echocardiography



4:12 p.m.

1006-207 Mechanism of Abnormal Diastolic Filling in Diabetic Rats Characterized with a Parametrized Diastolic Filling Formalism: Abnormal Viscoelastic Recoil

Catherine L. Dent, Andrew W. Bowman, Michael J. Scott, John S. Allen, Jennifer B. Lisauskas, Samuel A. Wickline, Sandor J. Kovacs. *Washington University School of Medicine, St. Louis, MO*

Background: Abnormalities of diastolic function precede systolic dysfunction in diabetic cardiomyopathy. Transmitral Doppler flow analysis is the primary method for noninvasive assessment of diastolic function but provides limited information. The parametrized diastolic filling (PDF) formalism is both a quantitative and a mechanistic method for assessment of diastolic function and has been shown to be of prognostic value in patients with heart failure. In the present study, we sought to elucidate and quantify the mechanism of impaired diastolic filling in diabetes by applying the PDF method to Doppler flow velocity data obtained from nonketotic diabetic rats.

Methods: Diabetes was induced in 30 rats by streptozotocin injection. Eight age-matched rats served as controls. After six months, the surviving diabetic (n=18) and the control rats underwent echocardiography. Traditional Doppler indices and PDF parameters, c, k, and x_0 , were generated. These parameters uniquely characterize the rate of decay, frequency, and amplitude, respectively, of the E-wave contour. E/A ratio, isovolumic relaxation time (IVRT), deceleration time, and shortening fractions were measured. Hearts were analyzed for morphology and myocardial collagen content.

Results: Compared with control rats, diabetic rats had smaller peak E/A ratios (1.33 ± 0.03 vs. 1.67 ± 0.34 , $p < 0.05$), and longer IVRT (46 ± 7 ms vs. 33 ± 5 ms, $p < 0.05$). By the PDF formalism, diabetic rats had an increased value for c (70.7 ± 27.1 g/s vs. 47.4 ± 12.9 g/s, $p < 0.05$). There were no significant intergroup differences in shortening fraction, deceleration time, myocardial collagen content, or the parameters x_0 and k.

Conclusions: These results delineate quantifiable difference in diastolic function between normal and diabetic rats. Specifically, alterations in c (i.e. chamber viscoelasticity) and IVRT without significant alterations in k (i.e. chamber stiffness) or deceleration time, suggest that diabetic hearts manifest decreased rates of active actin-myosin cross bridge cycling. Changes in passive chamber stiffness (collagen content) are not required to explain the E-wave contour differences (i.e. diastolic dysfunction) in this model.

4:24 p.m.

1006-208 Evaluation of Left Ventricular Relaxation during Atrial Fibrillation Using the Color M-mode Doppler Propagation Velocity of Mitral Inflow

Junko Watanabe, Tomotsugu Tabata, Neil L. Greenberg, Don W. Wallick, Deborah A. Agler, Yong-jin Kim, Kent A. Mowrey, Shaowei Zhuang, Youhua Zhang, Mario J. Garcia, Todor N. Mazgalev, James D. Thomas, Richard A. Grimm. *The Cleveland Clinic Foundation, Cleveland, OH*

Background: Standard pulsed Doppler indices are inadequate for the assessment of LV relaxation in patients with atrial fibrillation (AF). Color M-mode Doppler (CMM) propagation velocity of mitral inflow (Vp) has been reported as a reliable determinant of LV relaxation in patients with sinus rhythm (SR).

Purpose: The aim of this study was to assess whether CMM could accurately evaluate LV diastolic function during AF in subjects.

Methods: Rapid AF was induced by rapid atrial stimulation in 8 healthy open chest mongrel dogs. Vagal nerve stimulation (PGVS) was subsequently applied for the slowing of ventricular rate during AF. Epicardial echocardiography was performed to obtain Vp from the CMM method. The time constant (Tau) of LV relaxation was calculated from the recording of LV pressure curve obtained by a Millar catheter. Data were analyzed as an average of 30 consecutive cardiac cycles.

Results: Vp decreased ($p < 0.001$) and Tau ($p < 0.001$) increased during AF compared to during sinus rhythm. Vp increased ($p < 0.001$) and Tau decreased ($p < 0.001$) following application of PGVS during AF.

Conclusion: 1) Vp of color M-mode can accurately evaluate the change in LV diastolic function during atrial fibrillation. 2) LV diastolic function was worsened following induction of rapid atrial fibrillation and improved by slowing of the ventricular rate using PGVS.

	Baseline-SR	Baseline-AF	Baseline-PGVS
Tau (msec)	30.6+/-3.9	46.1+/-8.9	43.9+/-5.2
Vp (cm/sec)	62.0+/-11.8	42.0+/-15.7	61.8+/-18.8

4:36 p.m.

1006-209 Repetitive Myocardial Ischaemia at Intervals Associated With Stunning Can Be Detected by Diastolic but Not Systolic Parameters Measured by Tissue Doppler

R. Ian Williams, Navroz D. Masani, Alan G. Fraser. *Wales Heart Research Institute, University Hospital of Wales, Heath Park, Cardiff, United Kingdom*

Background: Stunned myocardium demonstrates systolic and diastolic dysfunction, but non-invasive diagnosis is difficult. Characteristic tissue Doppler changes have been described during ischemia, but it is not yet known if there are distinctive changes in stunned myocardium.

Methods: 15 subjects (14M; age 57±9 years) underwent 2 maximal symptom-limited exercise tests (Bruce protocol) 1 hour apart (Ex1, Ex2); this sequence has been shown to cause prolonged dysfunction after the second test. All subjects had significant coronary disease (>75% area stenosis in ≥2 major epicardial vessels, with ≥2mm ST segment depression on prior testing); none had a history of MI. Each patient underwent serial transthoracic echocardiography (Vingmed System V) at baseline, immediately post exercise, every 15 minutes for 1 hour, then every 30 mins for 3 hours. Digital loops were stored, and 11 myocardial segments were analysed off-line for peak systolic velocity (V), time to V (TP), tissue E and A velocities, and isovolumetric relaxation time (IVRT).

Results: Chest pain and ischemia limited both exercise tests in all patients. The duration of the second test was longer (469±141 vs 421±164 s, p<0.025) but peak double product was similar (28.7±4.4 vs 27.5±5.6 x10³mmHg/min, ns). The second test caused more ST segment depression (-2.6±1.1 vs -2.2±1.0 mm, p<0.05). Peak systolic velocity increased immediately after each test in basal segments (p<0.05) (e.g. Basal Septum, Table); all systolic indices were normal within 15 mins after each test. Basal myocardial E-wave velocity fell and remained low for 60 mins. Regional IVRT prolonged after ischemia and remained abnormal for 60 mins.

	Rest	Peak Ex1	Ex1 15 min	Ex1 60 min	Peak Ex2	Ex2 15 min	Ex2 60 min
V(cm/s)	6.0	9.3*	6.1	5.3*	10.1**	5.8	5.7
TTP(ms)	139.8	102.2*	128.5	128.6	97.5**	124.8	133.0
IVRT(ms)	118.8	115.6	120.8	131.8*	129.2	154.3*	146.1
E(cm/s)	-5.7	-5.5	-4.4*	-4.2*	-6.0**	-4.4*	-4.7
A(cm/s)	-8.1	-9.7	-6.2*	-5.7	-9.9*	-6.6	-7.3
E/A	.81	.59*	.75	.57	.64**	.84	.66

*p<0.05 of rest, **p<0.05 of 60 min

Conclusion: Repetitive myocardial ischemia causes persistent changes in regional diastolic but not systolic function, which can be quantified by tissue Doppler echocardiography.

4:48 p.m.

1006-210 Simultaneous Display of Tissue Velocity and Strain: A Fast Option in Evaluation of Myocardial Function

Lars-Ake Brodin, Mohsen Gaballa, Jan van der Linden, Christofer Madler, Bjorn Olstad. *Karolinska Institute, Stockholm, Sweden, Norwegian institute of technology, Trondheim, Norway*

Introduction: Off-line analysis of tissue velocity curves can be performed from any myocardial localisation from color Doppler images. This concept has shown to be a robust tool in quantitative stress echo. An additional feature is, when myocardial velocity gradients are measured between discrete localisations and divided by respective distances, myocardial strain rate= SRI. The integral of SRI represents strain i.e. percent deformation. Both tools are time consuming to use despite their potential value. Simplified concepts are therefore necessary. **Methods:** Tissue color Doppler recordings (TVI) acquired with a Vingmed S V, analysis was done off-line. The apical parts have almost zero velocity with increasing velocities towards the AV-plane. The strain is constant along the walls in apical views during normal conditions. Simultaneous information about TVI and SRI can be achieved by applying a colour-scale with contrasting colour effects, depending on the amplitude of the velocity integral. The normal amplitude of the AV-plane (14±2 mm) can be colour scaled. The colour of the basal myocardial wall at the AV-plane will then differentiate a normal TVI from a disturbed global movement. The calculated strain is then displayed so velocities resulting in a movement of 10-12 mm should have similar width of the colour band as parts that move 8-10 mm. In the normal apical view a standardised normal colour should be seen at the AV-plane. The rest of the walls should then have a uniform pattern with colour bands of similar widths, with congruent pattern in contra-lateral walls. The concept was tested in 10 normal subjects and in 16 patients with myocardial infarction and during dobutamine stress echo in 10 normals and 16 patients with single vessel disease. **Results:** The concept separated the healthy from the diseased and also very fast localised the wall motion abnormality in one single image of systolic motion. The concept was also very robust during stress echo and reduced the evaluation time from 20 minutes to 3 minutes. **Conclusion:** Fusion information about SRI and TVI in form of parametric velocity integral images using contrasting colour coding makes quantitative stress echo diagnostics very fast.

1174 Contrast Echocardiography

Monday, March 19, 2001, 3:00 p.m.-5:00 p.m.
Orange County Convention Center, Hall A4
Presentation Hour: 3:00 p.m.-4:00 p.m.

1174-133 Intravenous Myocardial Contrast Echocardiography Early After Acute Myocardial Infarction Predicts Myocardial Contractile Reserve and Functional Recovery at Follow-Up

Paolo Colonna, Christian Caddeu, Roberta Montisci, Lijun Chen, Massimo Ruscazio, Luigi Meloni, Sabino Ilceto. *Department of Cardiovascular and Neurological Sciences, University of Cagliari, Cagliari, Italy*

Background: Intracoronary myocardial contrast echocardiography pattern after acute myocardial infarction reflects the extent of microvascular damage. We hypothesized that intravenous myocardial contrast echocardiography in conjunction with harmonic power Doppler is capable of predicting myocardial contractile reserve and functional recovery after acute myocardial infarction. **Methods:** Fifty-five patients with acute myocardial infarction (20 anterior, 8 lateral and 27 inferior) underwent: 1) an intravenous myocardial contrast echocardiography of Levovist and harmonic power Doppler (Agilent Sonos 5500) in intermittent imaging mode 2.9±0.6 days after acute myocardial infarction, 2) a low dose dobutamine echocardiogram 3.8±1.6 days after the infarction and 3) a follow-up echocardiogram 3 months later. Patients were considered to have no-reflow at contrast echocardiography if the ratio between segments with perfusion defect and the total number of segments in the dyssynergic area was >0.5. Regional wall motion score index (RWMSI) in the risk area was calculated at first day, at dobutamine and at follow-up echocardiography. Functional recovery at dobutamine and/or at follow-up echocardiogram was considered present if the patient showed wall motion improvement in at least two contiguous dysfunctioning segments. **Results:** During myocardial contrast echocardiography, 308 (93%) myocardial segments in the acutely dysfunctioning risk area were analyzable and 128 (38.6%) showed a perfusion defect.

	RWMSI at base-line echo	Patients with viability at dobutamine echocardiogram	RWMSI at dobutamine echocardiogram	Patients with recovery at follow-up	RWMSI at follow-up
Reflow (37 pts)	2.6±0.3	32 (86.5%)	1.6±0.5	33 (89.2%)	1.7±0.5
No-reflow (18 pts)	2.7±0.2	5 (27.8%)*	2.3±0.4*	3 (16.7%)*	2.3±0.4*

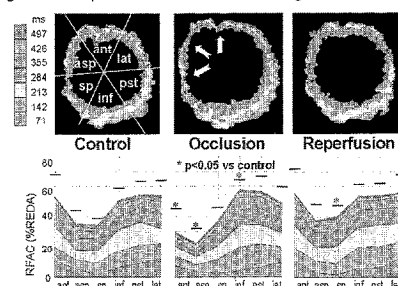
*p<0.005, **p<0.001 vs reflow patients.

Conclusion: Intravenous myocardial contrast echocardiography in conjunction with harmonic power Doppler has the potential of identifying patients with myocardial viability. The presence of microvascular perfusion as assessed by myocardial contrast echocardiography is an indicator of myocardial functional recovery at follow-up.

1174-134 Objective Assessment of Left Ventricular Wall Motion Based on Contrast Enhanced Echocardiographic Images

Enrico G. Caiani, Victor Mor-Avi, Jeanne DeCara, Claudia E. Korcarz, Keith A. Collins, James E. Bednarz, Lynn Weinert, Roberto M. Lang. *University of Chicago, Chicago, IL*

None of the existing methods for objective evaluation of LV function is applicable to contrast-enhanced images. We tested the feasibility of objective evaluation of regional LV function in an animal model of ischemia and in patients with wall motion abnormalities using power modulation imaging, a new technique that provides selective enhancement of microbubble-generated reflections. **Methods:** In protocol 1, an intracoronary balloon was placed in the proximal LAD in 8 anesthetized pigs. Short axis images (Agilent 5500) were obtained: 1) under control conditions, 2) 1 min post occlusion, and 3) during reperfusion. In protocol 2, apical 4-chamber images were obtained in 20 patients (14 with wall motion abnormalities; 6 controls) at end-expiration during contrast enhancement (Optison, iv bolus or Definity infusion). In both protocols, digital images from one cardiac cycle were analyzed off-line. Frame-by-frame semi-automatic endocardial border detection was followed by logical operations, which were applied to each pair of consecutive frames to track endocardial motion. These data were used to create color-coded images of systolic and diastolic wall motion. Apical views were corrected for translation. The LV was divided into segments, and regional fractional area change was computed and displayed as stacked color histograms. **Results:** In all animals, coronary occlusions resulted in hypokinesis in the LAD-related segments, confirmed by a decrease in the corresponding fractional area changes (figure), which was reversed during reperfusion. In 14/14 patients, wall motion abnormalities were visualized in the color-coded images and quantitatively confirmed by the histograms, while no abnormalities were noted in control subjects. **Conclusion:** Color-coding of endocardial motion from contrast-enhanced power modulation images allows quantitative assessment of regional LV function.



1174-135 Myocardial Contrast Echocardiography in Conjunction With Dipyridamole Thallium SPECT in Assessing Myocardial Perfusion in Patients With Suspected Coronary Artery Disease

Miguel Zabalgoitia, John Erikson, Mohamed A. Oraby, Albert Delgado. *University of Texas Health Science Center, San Antonio, TX, Audie L. Murphy Memorial Veterans Hospital, San Antonio, TX*

Background: Dipyridamole thallium (DT) SPECT is commonly used for assessing myocardial perfusion in patients with suspected coronary artery disease (CAD). However, radionuclide images need to be acquired within 6 min after thallium injection, limiting the use of concomitant myocardial contrast echocardiography (MCE) for comparison. To address this problem, we developed a 5-min protocol of segmental wall motion and myocardial perfusion in conjunction with DT. The aim of this study was to assess the safety and tolerance of this novel protocol in the clinical setting. **Methods:** 86 male pts, mean age 60 years (range 40 to 78) with known or suspected CAD underwent a 5-min continuous infusion of Optison (30 to 60 ml/min) before and 2 minutes after dipyridamole (0.56 mg/kg) IV infusion and thallium IV injection. The protocol included a 3-beat capture with 2nd harmonic grey-scale technology, followed by single and dual gating using Power Doppler software (Power Contrast Imaging, Acuson Corp.) with a fixed 1:4 triggering capture mode from the apical 4-, 2-, and 3-chamber views. Focus was set at the upper one-third of the sector. **Results:** MCE results were compared to SPECT findings. Of the 86 pts, good quality MCE images were available in 78 pts. There were no serious side-effects using Optison plus DT. All segments from each apical 6-segment model were suitable for analysis. The "destruction" (2nd frame of the dual gating format resulted in complete clearance of the myocardial contrast at the 2 apical segments, but incomplete contrast clearance of the mid and basal segments offering little advantage over the single gating format for microvascular interpretation of opacification. There was excellent correlation between SPECT perfusion and MCE perfusion. The concordance between the 2 test was 86%. **Conclusion:** This novel protocol allows segmental wall motion analysis representing all 3 major coronary arteries, and myocardial perfusion with both, microspheres and thallium, before and after coronary vasodilation in the same setting. The use of Optison in conjunction with DT is safe. MCE using Optison infusion correlates very well with thallium SPECT images.

1174-136 Correlation Between Myocardial Video-Intensity and Velocity Gradients Assessed by Myocardial Contrast Echocardiography and Tissue Doppler Imaging in a Porcine Model of Non-Transmural Myocardial Infarction

Philippe Garot, Olivier Pascal, Marc Simon, Saleh el Amine, Sophie Benacerraf, Jean-Luc Dubois-Randé, Luc Hittinger, Emmanuel Teiger, Pascal Guéret. *Hopital Henri Mondor, Creteil, France*

Background: The relation between transmural perfusion and contraction after partial coronary occlusion leading to non transmural MI is unclear. **Methods:** 12 closed-chest anesthetized pigs underwent partial occlusion of the right coronary artery (until distal flow measured by intracoronary Doppler guide wire fell by 80%) using a 90-minute balloon inflation followed by reflow. Myocardial contrast echocardiography (MCE) was performed with the intracoronary injection of sonicated microbubbles. MCE images were analyzed with the use of the NIH software package. A region of interest was assessed in the ischemic wall and a video-intensity gradient (VIG) was measured from the subendo- to the subepicardium. The myocardial velocity gradient (MVG) was determined in the posterior wall by M-mode color tissue Doppler imaging (short axis view). The extent of MI was assessed by TTC staining after animal sacrifice. **Results:** Partial coronary occlusion provided an increase of the VIG with a decrease of the MVG. The VIG and the MVG highly and linearly correlated before and during ischemia. Although the restoration of the VIG was not associated with the recovery of basal MVG (indicating post-ischemic myocardial dysfunction), the correlation was far less significant when post-reflow data were included. **Conclusion:** The transmural perfusion and contraction gradients strongly correlated during myocardial ischemia achieved by partial coronary occlusion. A combination of MCE and TDI may differentiate ischemia- from reperfusion-induced myocardial wall dysfunction.

POSTER SESSION

1175 Nuclear Cardiology: Advances in Stress Agents, Tracers, and Techniques

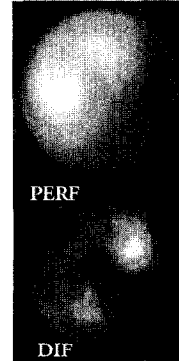
Monday, March 19, 2001, 3:00 p.m.-5:00 p.m.
Orange County Convention Center, Hall A4
Presentation Hour: 3:00 p.m.-4:00 p.m.

1175-137 Correction for Torque Improves Myocardial Perfusion Quantitation

Kenneth Nichols, Mohammed Kamran, C. David Cooke, Tracy L. Faber, Ernest V. Garcia, E. Gordon DePuey. *Columbia University, New York, NY*

Background: Polar maps of myocardial perfusion obtained by radionuclide imaging generally are formed by summing 8 separate maps, each corresponding to 1/8th of the R-R interval. By failing to account for the twisting component of cardiac motion (torque), this summation process artifactually decreases contrast and blurs the edges of perfusion defects. **Methods:** Tc-99m sestamibi gated SPECT data were examined retrospectively

for 14 patients categorized as exhibiting normal perfusion, and 10 patients with perfusion defects, on the basis of visual examination of short axis tomograms. Perfusion maps of maximum myocardial counts at each 3D location, derived from these tomograms, were enhanced using median spatial filtering and Fourier time filtering to normalize the contrast of all inferior wall right ventricular insertion points to the same constant value of 50%, from apex to base and for each of the 8 segments of the R-R interval. Relative torque angles at each tomographic slice were detected from these 8 contrast normalized maps, and perfusion data were then forcibly moved so as to align all torque angles to be the same throughout the heart cycle as the right ventricular angles observed at diastole. Perfusion maps (PERF) of these torque-corrected radioactive distributions were compared to uncorrected maps constructed in the usual manner. **Results:** Maximum % count differences (DIF) were 20±8% between torque-corrected versus uncorrected maps, significantly greater (p<0.0001) than processing errors of 5±1%, with the locations of the greatest DIF values occurring at maximum perfusion gradients in abnormal patients (see graphic). DIF magnitudes were similar in normal and abnormal patient groups (p=NS). **Conclusion:** Correcting for torque sharpens perfusion defect edges and enhances contrast, and will likely result in greater quantitative accuracy.



1175-138 Motion Correction Improves Specificity of Myocardial Perfusion SPECT

Naoya Matsumoto, Daniel S. Berman, Paul B. Kavanagh, Raluca D. Agafitei, James Gerlach, Sean W. Hayes, Howard C. Lewin, John D. Friedman, Guido Germano. *Cedars-Sinai Medical Center, Los Angeles, CA*

Background: Patient motion during myocardial perfusion SPECT (MPS) may cause artificial perfusion defects (PD). We have developed an automatic motion correction (MC) program based on minimization of vertical and horizontal motion offset errors for each projection with respect to its corresponding reprojection. The effects of MC on sensitivity (sens) and specificity (spec) of MPS are unknown. **Method:** We simulated both vertical and horizontal motion via 2-pixel shifting (1-pixel=6.4mm) of projection images in 38 patients (pts) with coronary angiography within 60 days of MPS and 40 pts with <5% pre-scanned likelihood of coronary artery disease (CAD). Pts with prior CABG or cardiomyopathy were excluded. MPS was scored using a 20-segment, 5 point semiquantitative scoring system. **Results:** The sens and spec on overall CAD (≥70% stenosis) and CAD in each coronary artery are shown in the table. With MC there was a significant improvement in spec for overall CAD and for each vessel, without a loss in sens.

	Vertical motion		Horizontal motion	
	Sensitivity	Specificity	Sensitivity	Specificity
Overall before MC	100%	33%	96%	50%
Overall after MC	100%	79%**	100%	75%**
LAD before MC	73%	71%	73%	67%
LAD after MC	73%	87%**	73%	83%**
LCX before MC	79%	66%	79%	72%
LCX after MC	79%	94%*	79%	92%
RCA before MC	92%	58%	85%	85%
RCA after MC	92%	89%**	85%	92%*

*: significant p<0.05 between before and after, **: p<0.01

Conclusions: MC successfully corrects artifactual motion defects.

1175-139 In Vivo Determination of Cell Death Within the Area at Risk in Patients With Acute Myocardial Infarction

Leonard Hofstra, Paul W. L. Thimister, Jan Van Asseldonk, Frans Wackers, Hendrikus H. Boersma, Pieter A. Doevendans, Hein J. J. Wellens, Guido A. Heidendal, Chris P. M. Reutelingsperger. *University Hospital Maastricht, Maastricht, The Netherlands, Yale University, New Haven, CT*

Background: Recently, we showed that visualisation of cell death in the heart of patients with acute myocardial infarction (AMI) is feasible, using technetium labeled Annexin-V and nuclear imaging (Lancet 2000;356:209-212). Annexin-V is a plasmaprotein binding to cells undergoing programmed cell death. However, to test the effect of cell death blocking therapies, quantification of cell death is essential. The goal of this study was to study cell death in the heart in patients with AMI in relation to the area at risk.

Patients and methods: Seven patients with AMI, admitted within 6 hours after the onset of symptoms, received Sestamibi in the acute phase before reperfusion. After reperfusion had been achieved (thrombolysis or PTCA) single photon emission computed tomography (SPECT) was performed. The perfusion defect as observed on the Sestamibi

SPECT was considered to reflect the area at risk. The Sestambi SPECT was followed by intravenous injection of Tc-99m-AnnexinV (mean 400 MBq). SPECT images of Tc-99m-AnnexinV were made 15 hours after injection.

Results. In all patients a perfusion defect was observed in the infarct area on Sestambi SPECT, reflecting the area at risk. On Tc-99m-AnnexinV SPECT imaging, distinct uptake of Tc-99m-AnnexinV was observed in parts of the area at risk, mostly in the central zone. The ghost image of Sestambi as seen on the Tc-99m-AnnexinV SPECT was helpful to reconstruct both images in a similar fashion.

Conclusions. These data suggest that programmed cell death of cardiomyocytes occurs in parts of the area at risk, particularly in the central zone. In addition, our imaging data suggest that quantification of cell death in the heart in relation to the area at risk is possible, which may be a useful approach to test cell death blocking drugs in patients with AMI.

1175-140 Myocardial Distribution of 99mTcN-NOET Following Occlusion and Reperfusion With Residual Ischemia and Necrosis

Zhonglin Liu, Gerald Johnson, III, Curtis L. Hart, Michael W. Eaton, Roberto Pasqualini, Robert D. Okada. *University of Oklahoma, Tulsa, OK, Schering-Cis bio internationale, Gif-sur-Yvette, France*

Background: The purpose of this study was to determine the myocardial distribution of 99mTcN-NOET (NOET) in an open-chest canine model of occlusion with reperfusion and residual ischemia producing infarct. **Methods:** Canines (n=7) underwent surgical preparation, hemodynamic monitoring and four hours imaging in vivo. Hemodynamic monitoring consisted of heart rate, mean arterial pressure, left atrial pressure, left ventricular (LV) pressure, LV \pm dP/dt, left circumflex coronary artery (LCx) flow and wall thickening. The experimental protocol consisted of a twenty minute baseline followed by 1.5 hours LCx occlusion and 4.5 hours reperfusion with 10% baseline LCx flow. The radiotracer (15 mCi; 555 MBq NOET) was injected 30 minutes post-reperfusion. Microspheres were injected at baseline, during occlusion, reperfusion (co-injected with radiotracer) and end to determine tissue flow. Flow and tissue activities in viable (V), mixed (M) and nonviable (NV) tissues were determined by gamma well counting. Infarct size was determined by triphenyltetrazolium chloride staining. **Results:** Mean infarct size was 15.9 \pm 2.6 (mean \pm sem). Normalized end flow (ml/min/gm) in V = 0.81 \pm 0.08 was significantly greater (p<0.05) than M = 0.38 \pm 0.03 and NV = 0.12 \pm 0.02, which were significantly different from each other (p<0.05). End activity (%ID/gm) in V = 0.0060 \pm 0.001 was significantly greater (p<0.05) than NV = 0.003 \pm 0.001, but neither group was significantly different from M = 0.005 \pm 0.001 (p=NS). End flow ratio for M/V=0.48 \pm 0.03 was greater than NV/V=0.15 \pm 0.02; p<0.05. End activity ratio for M/V=0.83 \pm 0.03 was greater than NV/V=0.58 \pm 0.05; p<0.05. Comparison of end activity ratio to end flow ratio revealed significantly higher activity than flow for both M and NV (p<0.05). Serial planar images demonstrated defect fill-in over time. Kinetics from scans indicate redistribution due to differential clearance. **Conclusion:** Thus, normalized end myocardial NOET activity in NV and M tissues significantly overestimated normalized end flow indicative of differential uptake and washout in these tissues. NOET appears to redistribute into ischemic-viable tissue, as does Thallium, albeit by a different mechanism.

1175-141 Selective A2A Adenosine Receptor Agonist, for Pharmacological Stress Test During Myocardial Perfusion Imaging

Jean-Noel Trochu, Gong Zhao, Xiaobin Xu, Luiz Belardinelli, Francis L. Belloni, Thomas H. Hintze. *New York Medical College, Valhalla, NY, CVTherapeutics, Palo Alto, CA*

Background: The use of adenosine in a pharmacological stress test during myocardial imaging is limited by side effects, mediated by A₁ and A_{2B} adenosine receptors. Its ultra-short duration of action makes adenosine a less-than-ideal agent for pharmacological stress test because it precludes its administration by single peripheral intravenous injection. The aim of this study was to demonstrate the advantages of a selective, potent, but low affinity A_{2A} adenosine receptor agonist, CVT-3146 (2-(N-pyrazolyl)Ado derivative), for potential clinical use in pharmacological stress test.

Methods: CVT-3146 (0.1-5 μ g/kg) and Adenosine (13-267 μ g/kg) were given as peripheral intravenous injections in 10 awake dogs instrumented for measurement of coronary blood flow.

Results: CVT-3146 caused a dose-dependent increase of coronary blood flow (ED₅₀=0.34 \pm 0.08 μ g/kg, maximal increase=221 \pm 18%, n=6). Adenosine was less potent (ED₅₀=51 \pm 15 μ g/kg, p<0.05) but equipotent (maximal increase in coronary blood flow=227 \pm 11%). The increase in coronary blood flow caused by 2.5 μ g/kg CVT-3146 reached 84 \pm 5% of the maximal reactive hyperemia following 20-seconds coronary occlusion (n=4). After a 10-seconds injection of CVT-3146 (2.5 μ g/kg) the peak coronary blood flow was attained at 17 \pm 2 seconds and remained at least 2-fold above baseline for 97 \pm 14 sec, whereas for 267 μ g/kg Adenosine, the peak effect was reached at 16 \pm 2 seconds and the 2-fold increase in coronary blood flow lasted 24 \pm 2 seconds (p<0.01, n=6). A 30-seconds injection of 2.5 μ g/kg CVT-3146 prolonged the 2-fold increases in coronary blood flow up to 221 \pm 20 seconds. No tachyphylaxis was found up to 3 consecutive 1 μ g/kg injections of CVT-3146. No atrioventricular block was noted (n=10). At 2.5 μ g/kg the peak effect of CVT-3146 on coronary blood flow was associated with a transient (20 \pm 6 seconds) increase in heart rate (81 \pm 15%) and a 12 \pm 4 mmHg (p<0.05, n=6) decrease in mean arterial blood pressure.

Conclusion: CVT-3146 is a potent coronary vasodilator. Its short duration of action, minimal systemic hemodynamic effects and ease of administration make this agonist suitable for pharmacological stress during myocardial perfusion imaging.

1176 Electron-Beam Computed Tomography: Coronary Calcification--Gender, Genetics, and Pretest Likelihood

Monday, March 19, 2001, 3:00 p.m.-5:00 p.m.

Orange County Convention Center, Hall A4

Presentation Hour: 3:00 p.m.-4:00 p.m.

1176-142 A Cross-Sectional Analysis of the Relationship Between Hormone Replacement Therapy and Coronary Artery Calcification

Amy M. Gallagher, Enrique F. Schisterman, Howard C. Lewin, Sean W. Hayes, John D. Friedman, Romalisa S. Miranda, Arlene Ledesma, Daniel S. Berman. *Cedars-Sinai Medical Center, Los Angeles, CA*

Background: There is evidence that estrogen affects the vascular wall, independent of modifications to plasma lipoproteins, by accelerating reendothelialization of damaged blood vessels and by inhibiting smooth muscle cell proliferation. Therefore, we intended to investigate the relationship between hormone replacement therapy use and prevalence of coronary calcium in postmenopausal women. **Methods:** Cardiac electron beam computed tomography (EBCT) was performed on 793 postmenopausal women participating in the Cedars-Sinai Cardiovascular Observational Study. At the time of their EBCT, 509 women were receiving HRT and 284 were not receiving HRT. The total coronary calcium score was determined using the Agatston method. A self-report of HRT use was assessed in all participants, as well as measurements of other known cardiovascular risk factors. **Results:** Independent sample t-tests identified the means of the following variables as significantly different between the two groups of women: age, LDL, HDL, and body mass index(BMI). Self-reports of hypertension, smoking, exercise, and diet were similar between the two groups. Analysis of variance, controlling for confounders (age, LDL, HDL and BMI), showed a significant difference between the means of the two HRT use groups of women for total coronary calcium score, total number of calcified lesions, and total volume of calcium. **Conclusions:** Total coronary calcium score, total lesions, and total volume were found to be significantly lower in postmenopausal women receiving HRT than for postmenopausal women not receiving HRT. These findings support the hypothesis that hormone replacement therapy is associated with a lower prevalence of coronary calcium in postmenopausal women, which may be due to the independent effects of estrogen on coronary vessel walls.

	HRT mean (sd)	No HRT mean (sd)	p-value
Total Score	96.40 (\pm 256.39)	150.97 (\pm 362.54)	< .001
Total Lesions	2.16 (\pm 3.37)	3.36 (\pm 4.75)	< .001
Total Volume	0.078 (\pm 0.20)	0.122 (\pm 0.29)	< .001

1176-143 Association of Coronary Calcium With the GNB3 Polymorphism in Early Coronary Artery Disease

Achim Guttersohn, Peter Huhndorf, Axel Schmemmund, Winfried Siffert, Raimund Erbel. *University of Essen, Essen, Germany*

Electron beam computed tomography (EBCT) is the standard method for assessment of coronary artery calcium (CAS), a marker of coronary arteriosclerosis. There are several polymorphisms associated with the development of coronary arteriosclerosis. C825T GNB3 polymorphism has been associated with risk factors such as hypertension and obesity and with an increased risk of myocardial infarction. It was our aim to elucidate if the GNB3 polymorphism is associated with CAS in patients with recent onset of symptoms or suspected CAD. 84 male patients (50 - 70 years; mean 61 \pm 2.1), with no history of prior myocardial infarction were included. CAS was measured using EBCT and the Agatston criteria. Genotyping for the GNB3 polymorphism was performed. Genotyping revealed CC (wildtype), TC and TT genotypes, with the 825T representing the mutated allele. Mean CAS score was 370. T-allele (n=34) carriers had a significantly increased score compared against carriers of the CC genotype (570 \pm 75 vs. 188 \pm 55) p< 0.05). All T-allele carriers had scores above the 75th percentile with respect to their age and sex. Risk factors like smoking and cholesterol levels were similar in both groups. Genotyping for the 825T allele in symptomatic patients identifies those with increased amounts of coronary arteriosclerosis and will therefore identify patients of higher risk.

1176-144 Exclusion of Coronary Calcium With Electron Beam Tomography: An Effective Filter Prior to Cardiac Catheterization in Symptomatic Patients

Ralph Haberl, Alexander Becker, Andreas Knez, Christine Lang, Christoph Becker. *Medical Hospital I, University of Munich, Munich, Germany, Department of Radiology, Munich, Germany*

There is a substantial number of cardiac catheterizations (up to 50%) without therapeutic consequences, if the indication is based on the patient's history and non invasive testing only. We tested, if exclusion of coronary calcium with electron beam computed tomography (EBCT) in symptomatic patients referred for coronary angiography identifies a subset of low risk patients without significant stenoses, not requiring interventions. For this, we performed calcium screening with EBCT (Agatston score, 40 slices, scan time 100 ms) and coronary angiography within four days in 1764 symptomatic patients. 454 men and 165 women had significant coronary stenoses in angiography (>70%) necessitating intervention. Only two men (0.4%) and no single woman (0.0%) with stenoses

>70% did not reveal coronary calcium. 822 patients did not have significant stenoses in coronary angiography. 261 of these patients (29.4%) did not show any coronary calcium. In younger age (<60 years), we could exclude coronary calcium in 31.9% of men and 55.8% of women without stenoses. Thus, even in this group of symptomatic patients with a high pre-test likelihood of significant coronary artery disease, exclusion of coronary calcium with EBCT identifies a substantial subgroup of patients who run an extremely low risk of significant stenoses requiring intervention. Exclusion of coronary calcium may therefore be used as an effective filter prior to invasive diagnostic procedures. This is especially true in younger patients below the age of 60 years.

1176-145 A Fifteen-Year Gender Gap in the Development of Coronary Artery Disease: A Study of 29,680 Asymptomatic Individuals

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Background: Electron beam tomography (EBT) is a non-invasive method for quantifying coronary artery calcification (CAC), an indicator of atherosclerotic plaque burden and coronary artery disease (CAD). Past studies have established that gender differences in CAD pathogenesis exist, and have proposed that females develop disease equivalent to men ten years younger. This study investigated gender-related differences in atherosclerosis, as measured by EBT, in a large sample of asymptomatic subjects. **Methods:** Between 1993 and 1998, 29,680 asymptomatic subjects between 30 and 94 years of age self-referred for EBT screening. Prior to screening, subjects completed a questionnaire soliciting demographic and risk factor information. EBT screening was performed with an Imatron scanner and scored with the Agatston method. Subjects were stratified into gender-specific age groups spanning five years. Multiple pair-wise nonparametric tests were used to compare the gender/age strata. **Results:** The sample included 22,631 males (76%) and 7,107 females (24%). Caucasians comprised 96% of the sample; African Americans, 1.7%; Hispanics, 1.2%; and Other ethnicity, 3.8%. As determined by self-report, prevalence of elevated cholesterol was 35%; hypertension, 16%; diabetes, 2.4%; cigarette use, 38%; and family history of CAD, 52%. 69% of females were post-menopausal, 39% of who used estrogen. Median CAC scores in all male strata (M) were significantly different from all female age strata (F) with the exceptions of M<40 & F50-54 ($p=0.67$), M40-44 & F55-59 ($p=0.31$), M45-49 & F60-64 ($p=0.38$), M50-54 & F65-69 ($p=0.80$), and M55-59 & F>69 ($p=0.71$). **Conclusion:** In this study, males consistently demonstrated CAC scores equal to females fifteen years their elder. These results suggest that females may benefit from a fifteen-year atherosclerotic "advantage", in contrast to the ten-year gender difference proposed previously.

1176-146 Does Electron Beam Computed Tomography Add Incremental Value to Pretest Likelihood in Predicting Abnormal Myocardial Perfusion Single Photon Emission Computed Tomography (SPECT) in Asymptomatic Patients?

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Background: Coronary calcium score (CCS) by electron beam computed tomography (EBCT) has been shown to have important predictive value for future coronary events. However, its incremental ability to predict the likelihood (LK) of abnormal nuclear scans over standard clinical assessment is unclear. **Methods:** We studied 355 consecutive asymptomatic patients (pts) (male=80.3±2.1%, age=58.9±0.53) who had both EBCT and myocardial perfusion SPECT (MPS) imaging at our institution. EBCT and MPS were performed within 180 days with a mean of 30.0±2.1 days between tests. CCS was calculated from EBCT by the Agatston scoring technique. Rest thallium-201 with stress (87.3% exercise, 12.7% pharmacological) gated Tc-99m sestamibi MPS images were interpreted by semi-quantitative visual analysis and categorized for overall interpretation as normal or abnormal. Pretest LK for coronary artery disease was used as a comprehensive clinical index and was calculated based on age, sex, and other cardiac risk factors. **Results:** Pts were divided into two groups: normal MPS pts (n=329) and abnormal MPS pts (n=26). Using logistic regression analysis, abnormal MPS pts had significantly higher pretest LK ($p<0.05$) and significantly higher CCS ($p<0.001$). Incremental value of CCS over pretest LK in predicting abnormal MPS was significant (chi square=12.04, $p<0.001$). The area under the ROC curve was 0.650 for pretest LK alone and 0.771 for pretest LK and CCS combined ($p<0.01$). **Conclusion:** EBCT provides incremental information over pretest LK of coronary artery disease in predicting LK of abnormal MPS and may thus provide a better discrimination of the necessity for further testing than standard clinical assessment.

POSTER SESSION

1177 Echo Assessment of the Left Atrium

Monday, March 19, 2001, 3:00 p.m.-5:00 p.m.
Orange County Convention Center, Hall A4
Presentation Hour: 3:00 p.m.-4:00 p.m.

1177-147 Underestimation of Left Atrial Dilation in Older Patients with New Onset Atrial Fibrillation by Use of Standard Echocardiographic Criteria

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Background/Purpose: Echocardiography is commonly performed in the patient with new onset atrial fibrillation (AF) to define LV systolic function, diagnose underlying valvular disease, and to investigate left atrial (LA) size. We have observed that in some older patients, dilation of the LA is encountered in the longitudinal plane even in the absence of dilation in the anteroposterior plane, i.e. the atrium "elongates" preferentially. To investigate the frequency of such asymmetric LA dilation in AF, we investigated LA dimensions in 41 consecutive older patients (age 66±16) undergoing echocardiography to investigate new onset AF; we measured LA linear dimension at end ventricular systole in both the parasternal long axis (PLA-anteroposterior axis) and along the long axis (apical 4 chamber-A4C). LA dilation was defined as ≥ 40 mm in the PLA view; we used the previously published partition value of ≥ 53 mm for longitudinal plane (A4C) dilation. At the time of the study 16 of 41 patients had reverted to normal sinus rhythm. **Results:** Of the 41 patients studied, 9 (21%) had normal LA size in both planes, 16 (39%) had LA dilation in both planes, and 16 (39%) had dilation only in the longitudinal plane. No patient had dilation in the PLA plane only. The three groups did not differ significantly by age; however patients with longitudinal dilation only had significantly higher ejection fraction (59 ± 7 versus 52 ± 10 , $p<0.05$ by t-test) than those with dilation in the anteroposterior plane only. Presence or absence of atrial fibrillation at the time of the study did not influence those results. **Conclusion:** Most older patients with new onset AF have LA dilation, with an equal distribution of symmetric and asymmetric dilation. Preferential dilation in the longitudinal plane in these patients is common, while dilation in the anteroposterior plane is rare. Thus the conventional anteroposterior criteria, obtained from the PLA, may substantially underdiagnose LA dilation. The clinical correlates and implications of asymmetric LA dilation require further study.

1177-148 Left Atrial Volume as a Morpho-Physiologic Measure of Comprehensive Diastolic Function Assessment: A Prospective Study

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Background: Various echo-Doppler methods have been developed for assessment of diastolic function. However, distinguishing normal from pseudonormal filling remains a challenge. Whether left atrial volume can be used as surrogate for overall diastolic function assessment is unknown.

Methods: Patients referred for echocardiography who were in sinus rhythm, and without history of valvular or congenital heart disease were enrolled. Meticulous diastolic function assessment, including mitral inflow (with and without Valsalva and leg-raising maneuver), pulmonary venous flow, tissue Doppler E/E', and left atrial size (biplane area-length left atrial volume and M-mode left atrial dimension) was performed. Diastolic function grade (normal, 0; relaxation abnormalities, 1; pseudonormal, 2; and restrictive, 3) was based on published criteria. Simple and multiple linear regression was used to assess relationships between diastolic function grade (X) and various parameters.

Results: A total of 93 patients (51 male, 42 female), mean age 60 ± 18 years, participated. The linear regression equations were as follows:

Left atrial volume indexed to body surface area = $21.3 + 9.7(X)$, $r=.74$, $p<0.0001$.

Absolute left atrial volume = $39.5 + 20(X)$, $r=.70$, $p<0.0001$.

M-mode left atrial dimension = $37.6 + 4.1(X)$, $r=.48$, $p<0.0001$.

Mitral E/A = $0.97 + 0.17(X)$, $r=.26$, $p=.015$.

E/E' = $8.64 + 1.48(X)$, $r=.23$, $p=.046$.

Pseudonormal filling was distinguished from normal at indexed left atrial volume ≥ 27 mL/m² (91% sensitivity, 83% specificity), or at indexed left atrial volume ≥ 28 mL/m² (84% sensitivity, 92% specificity). Sex was not related to left atrial volume once indexed to body surface area. In multiple regression analysis, indexed left atrial volume remained strongly associated with diastolic function grade after controlling for age and gender. In this model, age did not make a significant independent contribution to prediction of diastolic function grade.

Conclusions: In this study, indexed left atrial volume appeared to be a simple morpho-physiologic surrogate of diastolic function, and was useful in differentiating normal from pseudonormal diastolic filling. Larger studies are needed to confirm these findings.

1177-149 The Utility of Tissue Doppler Imaging in the Measurement of Left Atrial Systolic Function

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Background: Conventional modalities used to measure left atrial (LA) systolic function are inadequate or tedious. Tissue Doppler imaging (TDI) has been validated as an accurate tool in the measurement of systolic and diastolic left ventricular function. The utility of TDI in measuring LA systolic function has not been studied. This study was conducted to

determine if TDI of the LA can accurately measure LA systolic function. **Methods:** TDI velocities of the LA were measured in 22 normals (NL) and in 9 patients with heart disease (HD). TDI measurements were obtained in the parasternal long (PL) view immediately above the mitral valve annulus where atrial contraction was readily visible. Measurements were also made from the parasternal short (PS) axis view at the level of the aortic valve and in the subcostal (SC) view. TDI in these views demonstrated a distinct, reproducible, laminar atrial contraction wave (A') immediately preceding the MV closure click and following the electrocardiographic P wave. The peak A' wave was measured in each of the three views and the mean \pm one standard deviation (SD) was obtained. Measurements were made by 3 independent, blinded cardiologists (IA, JC, HT) to determine interobserver variability. A single observer (IA) also measured the same 10 A' waves a week later to determine intraobserver variability. The highest peak A' wave obtained from any view was compared to LA ejection fraction (EF) calculated using Simpson's method. **Results:** There was excellent agreement between observers (% error 2.7 \pm 13.0, 4.5 \pm 18.3, and 14.3 \pm 18.6 in the PL, PS, SC, respectively) and excellent intraobserver repeatability (% error 3.0 \pm 6.9, 14.8 \pm 52.5, and .10 \pm 9.7 in the PL, PS, SC, respectively). The mean of peak value of A' in normals differed ($p=.017$) from those in patients with HD (.09 \pm .01 vs. .07 \pm .03, $n=22$, $n=9$) respectively. LA EF in normals also differed ($p=.016$) from patients with HD (.66.8 \pm 6.4 vs. 57.5 \pm 14.). Peak TDI correlated with LA EF ($r=.61$ for all and $r=.66$ for HD). **Conclusions:** This is the first report of TDI as an application in the measurement of LA systolic function. Based on our results, we have demonstrated that TDI is an accurate modality in the measurement of LA systolic function.

1177-150 Frequency of the Echocardiographic Embolic Risk Markers in Paroxysmal Atrial Tachycardia Compared With Permanent Atrial Fibrillation? Implication for Anticoagulant Treatment

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Paroxysmal atrial tachycardia (PAT) has been associated with a lower risk of thromboembolism (TE) than permanent atrial fibrillation (AF). We aimed at comparing transthoracic (TTE) and transesophageal echocardiographic (TEE) markers of TE in AF and PAT.

Methods: We prospectively evaluated the echocardiographic embolic risk markers in 118 consecutive Patients (Pts) with permanent AF and in 90 consecutive Pts within the 48 hours of spontaneous cardioversion of any PAT (AF in 78 Pts, other PAT in 12 Pts). The following parameters were evaluated by averaging 3 consecutive cycles: left (LA) and right atrial (RA) areas, left (LAA) and right atrial appendage (RAA) areas, spontaneous echo contrast (SEC), end diastolic emptying velocities (vel.) and thrombus (Thr).

Results: There were no difference in the 2 groups with regard to age (70 \pm 12 and 66 \pm 15 years) and cardiovascular risk factors. Valvular disease was more frequent in Pts with permanent AF (31% vs 9%, $p<0.001$). Warfarin treatment was more frequent in Pts with permanent AF (38% vs 12%, $p<0.001$). History of TE was equally frequent (13% vs 12%). No RAA Thr was found. The main results are summarized in the table.

	AF (n=118)	PAT (n=90)	p
RA area (cm ²)	18.6 \pm 5.6	13.9 \pm 3.5	0.0001
LA area (cm ²)	24.5 \pm 6.4	19.2 \pm 5.3	0.0001
RAA area (cm ²)	3.49 \pm 1.52	2.79 \pm 1.22	0.0007
RAA SEC (n,%)	16 (14)	3 (3)	0.007
RAA vel. (cm/s)	26 \pm 9	28 \pm 11	0.420
LAA area (cm ²)	5.71 \pm 2.04	4.77 \pm 1.65	0.006
LAA SEC (n,%)	68 (58)	15 (17)	0.0001
LAA vel. (cm/s)	33 \pm 18	37 \pm 21	0.288
LAA Thr (n,%)	5 (4)	3 (3)	0.728

Conclusion: TTE and TEE-detected markers of TE are present in Pts with PAT although to a lesser extent than in permanent AF. The presence of LAA Thr in PAT suggests the need for the anticoagulant treatment as in Pts with chronic AF.

POSTER SESSION

1178 Identifying Viable Myocardium With Echocardiography

Monday, March 19, 2001, 3:00 p.m.-5:00 p.m.
Orange County Convention Center, Hall A4
Presentation Hour: 3:00 p.m.-4:00 p.m.

1178-151 Myocardial Viability in Chronic Ischemic Left Ventricular Dysfunction: A Prospective Study Comparing Intracoronary Myocardial Contrast Echocardiography, Low Dose Dobutamine Echocardiography and Rest-Redistribution Thallium Imaging

Liang H. Ling, Timothy F. Christian, Sharon L. Mulvagh, Mary F. Hauser, Rick A. Nishimura, Patricia A. Pellikka. *Mayo Foundation, Rochester, MN*

Background: An intact coronary microvasculature demonstrable by myocardial contrast echocardiography (MCE) is an important determinant of myocardial integrity. However, the role of MCE in defining myocardial viability in the setting of chronic ischemic LV dys-

function is not well substantiated. **Methods:** MCE using intracoronary Alunex[®], low dose dobutamine echocardiography (LDDE) and rest-24-hour redistribution SPECT-thallium (RRST) were performed in 32 patients (age 72 \pm 8 yrs) with ischemic LV dysfunction, 24 of whom were ultimately revascularized (21 had CABG, 3 PTCA). All revascularized patients also had pre- and 3-month post-procedural radionuclide ejection fraction (EF) quantitation and resting echocardiography. Viability was deemed present in myocardial segments which opacified during MCE, showed thickening at rest or augmented wall motion during LDDE, and demonstrated moderate or lesser degrees of reduced thallium uptake or a \geq 1 grade increase in uptake at 24 hrs during RRST. Following revascularization, LV segments were considered viable if echocardiography demonstrated systolic thickening. **Results:** In the 32 patients, 464 of 491 LV segments (95%) were hypokinetic. Resting wall motion score index was 2.60 \pm 0.26 and mean EF 30 \pm 9%. Concordance between MCE and RRST for the presence or absence of viable myocardium was observed in 402 LV segments (82%, kappa coefficient 0.31), and that for LDDE and RRST in 347 segments (71%, kappa 0.69). In the 24 revascularized patients who had an EF increase of 6 \pm 10%, the utility of various tests for prediction of functional recovery in 368 evaluable segments were:

	MCE	RRST	LDDE
Sensitivity (%)	90	95	86
Specificity (%)	30	33	71
Positive predictive value (%)	73	75	86
Negative predictive value (%)	59	76	71

Conclusions: MCE has very high sensitivity but poorer specificity than LDDE for predicting improvement in regional myocardial function after revascularization. These findings and the concordance of segmental MCE opacification with RRST uptake suggest that MCE has a comparable role to nuclear methods in defining myocyte functional integrity in chronic ischemic LV dysfunction.

1178-152 Glucose Insulin Potassium Infusion Improves Systolic Function in Patients With Chronic Ischemic Cardiomyopathy

Yves Cottin, Laurent Gilson, Isabelle L'Huillier, Marianne Zeller, Christine Toulouse, Luc Rochette, Claude Girard, Jean-Eric Wolf. *Cardiology Department, Dijon, France, Anaesthesiology Department, Dijon, France*

Objective: To assess the effects of Glucose Insulin Potassium (GIK) infusion by echocardiography in stable patients with severe LV ischemic dysfunction. **Patients and methods:** 12 non-diabetic male patients (age: 58 \pm 12 years) with stable coronary disease and ejection fraction (EF) less than 45% were studied. Echocardiographic parameters were: EF and wall motion score index (WMSI) for the systolic function. GIK solution consisted of glucose 30% with 300 insulin units and 6 g/l of KCl at an infusion rate of 1 ml/kg/h over 20 minutes. Hemodynamic and echocardiographic measurements were recorded at rest (T0), at the end (20 min) of GIK infusion (T+20), 20 and 40 min after the end of the infusion (T+40 and T+60). **Results:** During GIK perfusion and follow up period, no serious adverse symptoms were observed in echocardiography, and in particular, no arrhythmia or severe hypotension. No significant hemodynamic changes were observed during GIK infusion and follow-up period. At T+20, a significant decrease of WMSI was observed compared to T0 (2.16 \pm 0.14 vs 2.30 \pm 0.16; $p<0.05$). A significant increase of the EF was reported at T+40 and T+60 compared to T0 (44.1 \pm 7.8 % and 53.3 \pm 11.6 % versus 35.6 \pm 4.5 % respectively; $p<0.01$). In addition, a significant decrease in the WMSI was observed at T+40 and T+60 compared to rest (2.02 \pm 0.17 and 1.93 \pm 0.11 versus 2.30 \pm 0.16 respectively; $p<0.01$). **Conclusion:** Our present work suggests that GIK infusion improves LV systolic function in patients with chronic ischemic cardiomyopathy. Further studies are needed to determine if short GIK infusion could be useful for therapeutic or diagnostic strategies in patients with chronic ischemic coronary diseases.

1178-153 Restrictive Left Ventricular Diastolic Filling Pattern Identifies Patients Without Viable Myocardium After First Acute Myocardial Infarction

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Determination of the presence and extent of dysfunctional but viable myocardium (VM) has become an important component of the diagnostic assessment of patients with coronary artery disease. The objective of this study was to examine the hypothesis that there is a relation between the presence of VM in patients (pts.) after first acute myocardial infarction (AMI) and the filling pattern of the left ventricle (LV). **Methods:** 158 consecutive pts with first AMI (mean age: 59 \pm 9, M=136, F=22) underwent echo-Doppler examination 8-10 days after hospital admission. The following parameters were considered: 1) E and A waves peak velocities, 2) E/A ratio, 3) E deceleration time (Edt), 4) LV isovolumic relaxation time (IVRT), 5) LV ejection fraction (EF, modified Simpson's rule: %), 6) Wall motion score index (WMSI), using standard 16-segment model of the left ventricle and a 1-4 scoring system. In the same day, an echo-dobutamine stress test to identify viable myocardium was performed at incremental doses (5 to 20 micrograms/Kg/min) in 3 min-steps. VM was defined as any contractile improvement in \geq 2 LV dysfunctioning segments during dobutamine stimulation. Finally pts have been divided in two groups based on LV filling pattern: Group 1 (restrictive: 21 pts, E/A $>$ 2 or E/A $>$ 1 + Edt $<$ 140 msec); Group 2 (non-restrictive: 137 pts, E/A $<$ 1 or E/A $>$ 1 + Edt $>$ 140 msec). **Results:** Comparison between the two groups revealed that Group 1 pts., (restrictive), had larger infarct size (peak of creatine kinase: 4116 \pm 2417 vs 1993 \pm 1596 U/l, $p<0.0001$), higher WMSI (1.8 \pm 0.21 vs 1.52 \pm 0.25, $p<0.0001$), lower EF (34.1 \pm 3.5% vs 46.4 \pm 6.9%, $p<0.0001$) than Group 2 pts., (non restrictive). All other demographic and clinical variables were comparable among the two groups. Moreover, viable myocardium during echo-dobutamine stress test was found in only 4 pts. of the Group 1 and in 67 pts. of the

Group 2 (19% vs 49%, p<0.01). **Conclusions:** This study shows that pts with restrictive LV diastolic filling pattern after AMI are lacking in VM. Same pts. have larger MI size and worse LV regional and global function than pts without restrictive LV filling pattern.

1178-154 Improved Identification of Viable Myocardium Using Second Harmonic Imaging During Dobutamine Stress Testing: Comparison With Fluorine-18 Fluorodeoxyglucose SPECT

Fabiola B. Sozzi, Don Poldermans, Jeroen J. Bax, Eleni C. Vourvouri, Wim B. Vlietter, Alberico Borghetti, Diego Ardissino, Arend Schinkel, Jos R. T. C. Roelandt. *Thoraxcenter, Rotterdam, The Netherlands, Parma University, Parma, Italy*

Objective: The aim of this study was to find whether second harmonic imaging (SHI) can improve the accuracy of dobutamine stress echocardiography (DSE) for identification of viable myocardium. **Patients and Methods:** We studied 30 patients with chronic left ventricular dysfunction (mean age 60 ± 8; 22 male) by DSE (up to 40 µg/kg/min). Imaging was acquired at rest and during DSE using both fundamental imaging (FI) and SHI. All patients underwent dual-isotope simultaneous acquisition single photon emission computerized tomography (DISA-SPECT) with technetium-99m tetrofosmin/18-fluorodeoxyglucose (FDG) on a separate day. Myocardial segments with akinesia or severe hypokinesia at baseline were considered viable by DSE if these demonstrated a biphasic response, sustained improvement or ischemia. Myocardial viability was considered by DISA in the presence of mildly reduced perfusion or severe perfusion/metabolism mismatch. **Results:** The number of severe hypokinetic/akinetic segments at baseline was 329 by FI and 294 by SHI. 44% of the dyssynergic segments were considered viable by FI and 62% were considered viable by SHI (p = 0.02). The agreement between DSE and DISA was significantly higher with SHI (87%, kappa = 0.73) than with FI (78%, kappa = 0.56, p = 0.005). When DISA was regarded as a standard for myocardial viability, SHI had higher sensitivity (87% vs. 73%, p = 0.001) and accuracy (88% vs. 78% p = 0.005) whereas specificity was not different (86% vs. 85%, p = ns). **Conclusion:** SHI improves the accuracy of DSE for identification of viable myocardium as compared to FI. The agreement between DSE and DISA-SPECT is higher by the use of SHI.

POSTER SESSION

1179 Myocardial Contrast Echocardiography for Coronary Stenosis Detection

Monday, March 19, 2001, 3:00 p.m.-5:00 p.m.
Orange County Convention Center, Hall A4
Presentation Hour: 3:00 p.m.-4:00 p.m.

1179-155 Quantification of Coronary Stenosis Severity and Transmural Perfusion Gradient by Myocardial Contrast Echo: Comparison of Real-Time to Intermittent Triggered Approaches

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Background The present study compared the ability of myocardial contrast echo (MCE) by real-time and ECG gated intermittent triggered techniques to quantify reduced myocardial blood flow (MBF) and impaired transmural distribution of MBF produced by graded coronary stenoses. **Methods** In 8 open-chest dogs, we created 4 graded anterior descending (LAD) stenoses which consisted of 3 levels of non-flow-limiting stenosis and 1 grade of flow-limiting stenosis at rest. The 3 levels of non-flow-limiting stenosis decreased adenosine-induced coronary hyperemia by 30% (mild), 50% (moderate), and 90% (severe), respectively. Real-time MCE was performed with SonoVue (Bracco) infusion using low energy power pulse inversion (PPI) imaging (ATL), while ECG gated intermittent triggered imaging employed the same PPI at pulsing intervals from 1:1 to 1:10. LAD signal intensity (SI) was plotted versus time by real-time MCE and versus pulsing intervals by intermittent triggered MCE and was fitted to an exponential function: $y=A(1-exp^{-bt})$, where A is the plateau SI, b is the rate of SI rise. **Results** The ability of real-time and intermittent triggered MCE to visually detect decreased opacification produced by graded stenoses was similar and included 100% of 90% (severe) and flow-limiting lesions. With both imaging modalities, A and b were progressively decreased with greater level of stenosis. The fluorescent microsphere-derived MBF ratio in LAD/LCx correlated closely with the ratio of b (r=0.79) and Axb (r=0.81) obtained by real-time imaging, findings similar to those with intermittent triggered imaging (b; r=0.78, Axb; r=0.80). However, the endocardial/epicardial ratio of MBF in the LAD bed demonstrated closer correlation with the endocardial/epicardial ratios of b (r=0.71) and Axb (r=0.67) obtained by real-time imaging than those by intermittent triggered imaging (b; r=0.42, Axb; r=0.52). **Conclusion** Real-time and intermittent triggered MCE are equivalent in the ability to identify coronary stenosis and quantify altered MBF, although real-time MCE may have advantages in depicting the transmural distribution of myocardial perfusion in the stenosed bed.

1179-156 Intravenous Myocardial Contrast Echocardiography: Accuracy of Detecting Myocardial Perfusion Using Intravenous Levovist Versus Intracoronary Contrast Injection With Validation of Quantitative Thallium-201 SPECT

Takahiro Ota, Masako Okada, Yukio Abe, Shiro Yanagi, Kazuyoshi Hirota, Keiji Nagae, Junichi Yoshikawa. *Fuchu Hospital, Izumi-city, Japan, Osaka City University Medical School, Osaka, Japan*

The assessment of myocardial perfusion abnormality by intravenous (IV) myocardial contrast echo (MCE) has reported to be limited because of low specificity for the perfusion abnormality. To investigate the diagnostic value of IV MCE using harmonic B-mode (HB) and harmonic power Doppler (HPD) with Levovist® (LEV), both IV and intracoronary (IC) contrast injections were performed and both methods were validated by the quantitative Thallium 201 SPECT. **Methods:** Twenty six pts; 22 myocardial infarction (MI), 4 cardiomyopathy (mean age 66), underwent IV-MCE using HB and HPD injecting LEV (300 mg/ml, 2 ml bolus or infusion, trigger 1:4) and IC-MCE injecting sonicated lopamidole® (bolus 6 ml). Myocardial enhancement was scored as none(0) to good(3) applying a segmental model (4 and 2 chamber views). Perfusion defect (PD) area was calculated as the ratio (PDR) of total length of endocardium of LV to those of PD. A wall motion was graded in the corresponding segments. Mean radionuclide activities (TI count) of SPECT were measured at each segments of LV and normalized to the value of the segment with the maximum TI count (uptake ratio). **Results:** Of a total 240 segment, 95% of IC-MCE and 85% of HB, 88% of HPD of IV-MCE was analyzed. In 22 MI pts, IC-MCE showed PD in 30/192 segments (15.6%), whereas HB in 14.4% and HPD in 6.5% with a concordance of 74% and 34% respectively for the detection of PD segment. There was a fair correlation between TI uptake ratio at delayed image and visual score of IC-MCE (r=0.68, p<0.01) and those of HB of IV-MCE (r=0.64, p<0.01), no correlation in HPD. For diagnosing PD using TI uptake ratio <0.4 as a cut-off value, HB and HPD of IV-MCE had a sensitivity of 71%, 43% and specificity of 86%, 92% respectively. 12 of 22 MI pts, PDR was significantly smaller by HB than IC-MCE (p<0.001). In akinetic segments, a score of myocardial enhancement of IC-MCE (0.8±0.3) was significantly lower than in those IV-MCE (HB; 1.6±1.0, HPD; 2.2±0.7, p<0.01). **Conclusions:** Comparing the quantitative TI count, HB of IV-MCE with LEV can be used to identify perfusion abnormality including PD in the clinical setting, however, visual estimation of IV-MCE tend to underestimate the extent of perfusion abnormality, especially using HPD.

1179-157 Detection of Coronary Stenosis by Real-Time Contrast Echocardiography: Systolic Versus Diastolic Frame Analysis

Stephane I. Lafitte, Hisashi Masugata, Barry Peters, Mario Togni, Monet Strachan, Anthony N. DeMaria. *University of California at San Diego, San Diego, CA*

Although myocardial contrast echo (MCE) can assess myocardial blood flow from refilling time-intensity curves after high energy bubble destruction, motion artifacts in images derived throughout the cardiac cycle can introduce significant error and/or variability. Therefore, this study was performed to determine whether a single cardiac phase (diastolic frames (DF) vs systolic frames (SF) or multiframe analysis (MF) was most accurate in the detection of coronary stenosis. **Methods:** In vivo recordings with 4 grades of LAD stenosis during adenosine hyperemia (30, 50, 70, 90% reduction) were compared to flow probe and microspheres measurements in 6 open chest dogs using real-time imaging and SonoVue (30 ml/l) infusion. Following bubble destruction, time-intensity data were fitted to an exponential function and the rate of intensity increase (b) and peak plateau intensity (A) were derived from refilling curves. Risk area obtained from DF, SF and MF were compared in term of A and b parameters, defect size, and reproducibility of measurements. **Results:** SF and DF analysis reduced the number of analyzed frames from 70±11 (MF) to 12±3 per sequence. By qualitative analysis, MF and DF allowed the same level of the defect detection (30% to 50% of no flow limiting stenosis) with high contrast between risk and control area while SF were less sensitive. Correlations between A and b parameters and coronary flow were significantly closer with MF and DF than SF (Table). Size of risk area from DF but not from SF was well correlated with blue dye analysis: (r=0.82 and .48 respectively). Finally, variability of measurements was significantly lower with MF and DF than with SF both for A and b parameters (A:15.2%, 16.4% and 22.1%, p<0.05, b:11.2%, 13.8% and 25.9%, p<0.05, respectively). **Conclusion:** In this model, real-time myocardial contrast echocardiography is better applied for stenosis detection by analyzing all frames or diastolic frames than systolic frames.

Coronary Flow: MBF vs MCE

	A parameter	b parameter
MF	y = 1.4 x + 1.2, r = 0.61	y = 0.5 x + 0.6, r = 0.89
DF	y = 1.6 x + 1.3, r = 0.56	y = 0.4 x + 0.9, r = 0.85
SF	y = 4.3 x + 2.8, r = 0.21	y = 1.1 x + 1.3, r = 0.53

1179-158 Detection of Coronary Restenosis After Successful Coronary Angioplasty by Contrast Enhanced Transthoracic Doppler Monitoring of Coronary Flow Reserve

Massimo Ruseazio, Roberta Montisci, Gabriele Marongiu, Carlo Caiati, Raimondo Pirisi, Mauro Cadaddu, Giorgio Lai, Paolo Colonna, Lijun Chen, Luigi Meloni, Sabino Illiceto. *Department of Cardiovascular and Neurological Science, University of Cagliari, Cagliari, Italy*

Background: Restenosis is the most important limitation of percutaneous coronary angioplasty. Previous studies have shown that invasive coronary flow reserve at the moment of coronary angioplasty can predict restenosis in the follow up. The aim of this study was to evaluate the potential of a noninvasive method for coronary flow reserve monitoring

Noninvasive Imaging

(contrast enhanced transthoracic echo Doppler during adenosine infusion) in detecting restenosis after successful coronary angioplasty. **Methods:** We followed up 44 patients after coronary angioplasty in the left descending coronary artery (24 elective and 20 primary with optimal reflow) for 1 to 12 months (5±2.6). Coronary flow reserve in the left descending coronary artery was noninvasively monitored through follow up (1, 3, 6, 12 months). Pulsed wave Doppler of blood flow velocity was recorded in the left descending coronary artery at rest and after maximal vasodilation by adenosine infusion (140 mg/kg in 5 minutes). Coronary angiography was performed at the end of the planned follow up, or before, in case of new symptoms of angina or evidence of ischemia at non invasive cardiac imaging tests. **Results:** Coronary angiography showed restenosis (defined as more than 50% stenosis at follow up angiography) in 20 patients (group A), and no coronary restenosis in 24 patients (group B). Before coronary angiography, coronary flow reserve was significantly reduced in group A compared to group B (1.4±0.4 vs 3.0±0.7, p<0.001). A severe impairment of coronary flow reserve (< 2) was found in most patients of group A (19/20, 95%), but only in two patients of group B (2/22, 9%, p<0.001). Thus, sensitivity, specificity, positive and negative diagnostic accuracy of non invasive monitoring of coronary flow reserve in detecting coronary restenosis were 95%, 91%, 90% and 95% respectively. **Conclusion:** Non invasive monitoring of coronary flow reserve by contrast enhanced transthoracic echo Doppler is an accurate new method for detecting restenosis after coronary artery angioplasty in the left descending coronary artery and can be useful in the follow up of these patients.

and analyzed using linear regression, considering both the full contrast range and low concentration (up to 16.6 µL/mL, 1200 bubbles/mL). **Results:** Over the full range of C_C, all modalities showed poor linearity (r² < 0.50), especially at MI > 0.7, due to signal saturation and attenuation. The relationship between C_C and intensity was highly linear (r² > 0.90) at either low C_C or low MIs, as shown in the table.

Table 1. r-squared (A / B) values for intensity vs. CC, A=0-133 µL/mL and B=0-16.6 µL/mL.

Imaging Modality	Mechanical Index			
	0.25	0.5	0.7	0.9
Contrast Harmonics	0.91 / 0.99	0.52 / 0.96	0.06 / 0.85	0.06 / 0.94
Pulse Inversion	0.98 / 0.98*	0.52 / 0.95†	0.27 / 0.92	0.34 / 0.97
Ultraharmonics	0.88 / 0.94††	0.90 / 0.97	0.48 / 0.80	0.00 / 0.98†

* p > 0.05 for A vs. B

† (A) values are not significantly different than Contrast Harmonics (p > 0.05)

†† (A) values are not significantly different than Contrast Harmonics (p > 0.05). **Conclusions:** The novel imaging processing modalities tested provided excellent linearity particularly at low MI or low C_C. These modalities may thus provide better quantification of myocardial perfusion *in vivo*.

4:30 p.m.

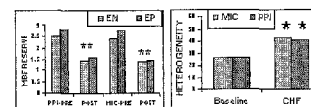
840-3 Myocardial Microcirculation Dysfunction in Pacing-Induced Heart Failure Dogs: Evaluation With Neutron Activated Microspheres and Power Pulse Inversion Imaging

Leng Jiang, Xuedong Shen, Zhu Guoqing, Banthit Khankirawatana, Wei Wang. *University of Nebraska Medical Center, Omaha, NE*

Conflicting data exist on myocardial microcirculation in congestive heart failure, largely for lack of a precise tool to detect small differences in myocardial blood flow (MBF). We have recently validated the accuracy of power pulse inversion imaging (PPI) with emission power of 0.09 in quantifying MBF *in vivo*. To further evaluate microcirculation function in CHF, we studied 7 dogs with PPI and neutron activated microspheres (mic) pre- and post-3 week rapid ventricular pacing. The left ventricle was assigned to 13 segments (base 6, mid 6, apex 1) with a total of 26 subendo(EN)- and subepi(EP)-cardial regions. Pre- and post-pacing MBF were measured, MBF reserve, EN/EP flow ratio, and heterogeneity (SD/mean MBF*100%) were calculated. PPI was performed on the short axis view at mid ventricular level (6 segments and 12 EN/EP regions) with constant perfluorocarbon microbubble infusion; PPI-MBF was calculated by multiplying the rate of replenishment and the plateau of myocardial acoustic density, and compared with corresponding mic-MBF.

Results: Both mic and PPI showed: 1) no significant differences in resting MBF between pre- and post-pacing (1.64 ± 1.2 vs 1.62 ± 1.13 ml/min/g for mic; 16.17 ± 11.97 vs 15.7 ± 10.87 for PPI)(p>0.05); 2) post-pacing, MBF reserve decreased (p<0.01) and heterogeneity increased (p<0.05) significantly (fig); 3) no significant changes in EN/EP flow ratio. PPI-MBF correlated well with mic-MBF (y=0.10x+0.06, r=0.95, SEE=0.19, p<0.0001).

Conclusion: Myocardial microcirculation dysfunction is evident by significantly decreased MBF reserve and increased heterogeneity in dogs with pacing-induced CHF, despite preserved resting MBF. PPI can accurately assess MBF *in vivo*, providing a powerful non-invasive tool for serial evaluation of myocardial microcirculation function.



4:45 p.m.

840-4 Dual Frequency Spectra Analysis of Perfusion Distribution: A Novel Technique for Diagnostic Performance Improvement in Contrast Echocardiography

Toshihiko Asanuma, Marek Belohlavek, Kjetil Viggen, James B. Seward. *Mayo Clinic, Rochester, MN*

Background: Conventional contrast echocardiography is prone to ultrasound signal attenuation. Radio frequency dual spectra analysis allows detection of microbubbles from the harmonic frequency component and estimation of attenuation from the fundamental frequency component. Therefore, Harmonic-to-Fundamental frequency Ratio peak (HFRp) should be less sensitive to attenuation. The purpose of this study was to evaluate sensitivity and specificity of HFRp for the assessment of myocardial perfusion distribution under incremental levels of signal attenuation. **Methods:** Broadband radio frequency data were obtained using apical long axis scans in 6 open-chest pigs during continuous infusion of Sonazoid (Nycomed Amersham) after LAD occlusion. Silicone pads, producing 5, 10, and 15 dB attenuation, were interposed between the transducer and the heart to simulate thoracic wall attenuation. Samples of image data from perfused (n = 72) and nonperfused (n = 49) segments of myocardium were collected and values using HFRp and gray-scale (GS) techniques were calculated. Five cut-off points were used to generate Receiver Operating Characteristic plots for each technique. Specimen staining was used for reference determination of perfused and nonperfused myocardial regions. **Results:** At all attenuation levels, the average HFRp and GS values of the perfused myocardium were significantly higher than those of the nonperfused myocardium (HFRp: -23.7 ± 3.8 dB vs -31.8 ± 2.9 dB; p < 0.0001, GS: -46.9 ± 9.2 dB vs -59.0 ± 7.1 dB; p < 0.0001). However, HFRp showed smaller variance and demonstrated higher sensitivity and specificity for differentiation between the perfused and nonperfused myocardium as

ORAL CONTRIBUTIONS

840 Contrast Echocardiography: New Developments

Monday, March 19, 2001, 4:00 p.m.-5:30 p.m.
Orange County Convention Center, Valencia B

4:00 p.m.

840-1 Ultrasound Enhanced In Vivo Transfection of Canine Myocardium With a Novel Cationic Microbubble Linked Plasmid

Sanjay Rajagopalan, Peng Li, Zhenguo Han, Dana Bowie, Thomas McCreery, Mani Vannan. *University of Michigan, Ann Arbor, MI*

Background: Targeted microbubble destruction through focused ultrasound has the potential of enhancing gene and protein delivery in tissue. We investigated the feasibility of using cationic liposomes filled with a perfluorobutane gas (MRX225, ImaRx Therapeutics, Inc) to enhance plasmid mediated gene delivery.

Methods: In 5 closed-chest dogs, the apical 4-C view was imaged using a 1.3/3.6 MHz transducer. MRX225 was mixed with plasmid encoding for chloramphenicol acetyl transferase (pCMV-CAT) in a 5:1 ratio and the mixture injected intravenously. The imaged myocardium was insonated every 4th cardiac cycle in end-systole at mechanical index > 1.1. After 48 hours, the dogs were sacrificed and hearts sectioned for analysis of CAT expression by ELISA and histochemistry.

Results: As expected, we saw expression in the liver (284±ng/g of tissue). In response to ultrasound, there was ≥ 1.1 fold induction of CAT in the myocardium when expressed as a ratio of non-isonated liver (T/L ratio, see table 1). Histochemical analysis with a CAT stain demonstrated diffuse staining in insonated areas.

Location	Conc (ng/g) of tissue	T/L Ratio
Septum	452±67	1.6
Lateral Wall	519±155	1.8
Apex	336±59	1.2
Anterior Wall	318±5	1.1
Posterior Wall	538±96	1.7

Conclusion: These data suggest that ultrasound mediated destruction of gas filled cationic liposomes admixed with a CAT plasmid may enhance expression of the reporter gene in the myocardium. This may have implications for plasmid-based gene therapy strategies.

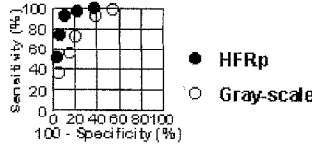
4:15 p.m.

840-2 Myocardial Contrast Echocardiography: In Vitro Assessment of Imaging Modalities

Kasturi K. Ghia, Brian B. Ghoshhajra, Neil L. Greenberg, Mario J. Garcia, James D. Thomas. *The Cleveland Clinic Foundation, Cleveland, Ohio, OH*

Quantification of myocardial perfusion with echocardiographic contrast agents requires a predictable relationship between contrast concentration (C_C) and measured ultrasound intensity. Ultrasound equipment manufacturers have recently designed new imaging modalities intended to better visualize contrast agents, but their quantitative performance with specific agents is ill-defined. We sought to compare three imaging modalities to determine the linearity of the relationship between C_C and echocardiographic image intensity. **Methods:** Varying amounts of contrast agent (Sonazoid, Nycomed Imaging AS) were injected into a uniformly stirred *in vitro* tank to produce a range of C_C (0 - 133 µL bubbles/mL solution, approximately 10,000 bubbles/mL). These experiments were performed over a range of mechanical index (MI) values (0.1 - 1.1). Triggered images were acquired using ATL HDI5000 and Agilent Sonos 5500 scanners, standard contrast harmonics, Pulse Inversion (ATI), and Ultraharmonics (Agilent) whereby imaging is performed at a frequency beyond the usual 2nd harmonic frequency (1.3 MHz transmit, 3.6 MHz receive). Linear-acoustic intensity values were obtained using HDILab software

compared to GS analysis (Figure).



Conclusion: For clinically relevant levels of ultrasound signal attenuation, the HFRp method is more consistent, and provides better diagnostic performance than the conventional GS analysis.

5:00 p.m.

840-5 Assessment of Myocardial Perfusion by Harmonic Power Doppler Myocardial Contrast Echocardiography at Rest and During ATP Stress: Comparison With Coronary Flow Velocity Reserve in the Left Anterior Descending Coronary Artery

Masaaki Takeuchi, Chinami Miyazaki, Hideohshi Yoshitani, Shinichiro Otani, Kazuo Sakamoto, Junichi Yoshikawa. *Tane General Hospital, Osaka, Japan, Graduate School of Medicine, Osaka City University, Osaka, Japan*

Although harmonic power Doppler myocardial contrast echocardiography (HPDMCE) can reliably detect myocardial perfusion during pharmacological stress, whether stress induced myocardial perfusion defect (PD) relates to coronary flow velocity reserve (CFVR) has not been determined. To explore this, HPDMCE and coronary flow velocity (CFV) measurement by transthoracic Doppler echocardiography in the left anterior descending coronary artery (LAD) territory were performed on 53 patients with known or suspected coronary artery disease. After continuous infusion of Levovist, dual-flame triggered apical 4-chamber HPDMCE image (HP5500, S4 probe) and CFV in the distal LAD (S12 probe) were obtained at baseline and during ATP infusion (140 mcg/kg/min). The persistence of PD between rest and ATP or stress induced PD in the LAD territory was defined as abnormal. CFVR was calculated as diastolic average peak velocity during ATP infusion divided by baseline flow velocity. **Results:** Adequate quality of both HPDMCE image and CFV recordings were successfully obtained in 52 patients (feasibility: 98%), and 23 patients showed abnormal findings by HPDMCE (persistent PDs in 6 and reversible defects in 17). CFVR was significantly lower in patients with abnormal HPDMCE than those with normal findings (1.43±0.44 vs. 2.60±0.84, p<0.001). If we set cut-off value of CFVR<1.95, sensitivity and specificity for predicting PD was 87% (20/23) and 83% (24/29), respectively. **Conclusion:** myocardial perfusion abnormality by HPDMCE during ATP stress was closely correlated to CFVR, and may reflect functional significance of coronary artery stenosis or microvascular damage in the LAD territory.

5:15 p.m.

840-6 Quantitative Myocardial Contrast Echocardiography Demonstrates Decreased Myocardial Blood Flow in Ischemic Coronary Artery Disease Patients

Thippeswamy H. Murthy, Peng Li, Bettina Kuersten, Scott Stewart, Elizabeth Locricchio, Mani Vannan. *University of Michigan, Ann Arbor, MI*

Background: Myocardial blood flow (MBF) as assessed by quantitative, intravenous myocardial contrast echocardiography (MCE) has been shown in experimental studies to correlate with radiolabeled microsphere blood flow and to discriminate varying degrees of coronary stenosis. Previously we have demonstrated the feasibility of real time MCE (rt-MCE) in assessing MBF in normal human volunteers. We hypothesized that quantitative, rt-MCE would demonstrate abnormal MBF reserve (MFR) in CAD patients as compared to normal volunteers.

Methods: 27 subjects selected for good apical 4C windows were studied. All of the CAD patients (n=13) either had significant CAD (by coronary angiography) and/or significant inducible ischemia by adenosine sestamibi SPECT. All subjects underwent rt-MCE (Power Modulation™, Agilent) pre and post dipyridamole (0.52 mg/kg) using a continuous infusion of DMP-115 (5.850 mg). Optimal loops were analyzed using previously described techniques and curve fit to: $V_i = A(1 - e^{-\beta t})$ [V_i=video intensity, A=myocardial blood volume, β=microbubble velocity, t=time, and Aβ=MBF]. MFR was defined as the Aβ reserve for the region of interest corresponding to each of the coronary territories.

Results: Of the 81 available coronary artery territories, 9 were not analyzed due to excessive motion or attenuation artifacts. The mean MFR's were markedly and significantly decreased in the CAD patients, with the decrease being due to a decrease in β reserve (shown below) and myocardial blood volume (NS, not shown).

	MFR			β Reserve		
	LAD	LCx	RCA	LAD	LCx	RCA
Normals	4.1±0.6	5.0±1.6	4.0±0.4	2.8±0.3	4.7±0.6	4.1±0.7
CAD Patients	1.2±0.3	1.1±0.4	1.2±0.3	0.8±0.1	1.4±0.8	1.2±0.2
P value	0.00003	0.0003	0.0007	0.00002	0.10	0.0009

Values shown as Mean ± SEM

Conclusions: (1) Quantitative, real time MCE demonstrates a markedly diminished mean myocardial blood flow reserve (MFR) in all coronary territories in CAD patients vs. healthy volunteers. (2) The dipyridamole induced decrease in MFR is attributable to both a decrease in myocardial blood volume and myocardial capillary velocity.

849 Echo-Doppler Indices of Ventricular, Valvular, and Vascular Function

Tuesday, March 20, 2001, 8:30 a.m.-10:00 a.m.
Orange County Convention Center, Valencia B

8:30 a.m.

849-1 Left Ventricular Outflow Tract Mean Systolic Acceleration as a Surrogate of the Slope of the Left Ventricular End-Systolic Pressure-Volume Relationship

Fabrice Bauer, Michael Jones, Takahiro Shiota, Michael Firstenberg, Jian Xin Qin, Hiroyuki Tsujino, Yong Jin Kim, Marta Sitges, Lisa Cardon, Arthur D. Zetts, James D. Thomas. *The Cleveland Clinic Foundation, Cleveland, OH, The National Institutes of Health, Bethesda, MD*

Background: Most indices used to quantify left ventricular (LV) systolic function, such as LV ejection fraction and cardiac output are dependent on loading conditions. To overcome this limitation, LV outflow tract systolic acceleration (LVOT_{Acc}) was analyzed and explored during alterations in LV contractility and LV filling.

Methods: In 18 sheep (4 normal, 6 aortic regurgitation and 8 old myocardial infarction), blood flow velocities through the LVOT were recorded using conventional pulsed Doppler. LVOT_{Acc} was calculated as the LVOT peak velocity divided by the time to peak flow. LVOT_{Acc} was compared to LV maximal elastance (LV E_m) acquired by a conductance catheter under different loading conditions including volume and pressure overload and during an acute coronary occlusion (n=10). In addition, a clinically validated lumped-parameter numerical model of the cardiovascular system was used to validate our animal findings.

Results: LV E_m and LVOT_{Acc} decreased during ischemia (1.67±0.67 mmHg/ml before vs. 0.94±0.41 mmHg/ml during coronary occlusion, p<0.05 and 7.9±3.1 m.s⁻² before vs. 4.4±1.0 m.s⁻² during coronary occlusion, p<0.05, respectively). LVOT_{Acc} showed a strong linear correlation with LV E_m (y=3.84x+1.87, r=0.85, p<0.001, Figure). Similar findings were obtained with the numerical modeling, which demonstrated a strong correlation between predicted E_m and actual E_m [Predicted=0.98(actual)+0.21]. By ANOVA, there was no statistically significant difference in LVOT_{Acc} and LV E_m under different loading conditions.

Conclusion: For a variety of hemodynamic conditions, LVOT_{Acc} was linearly related to the LV contractility index LV E_m and was independent of loading conditions. These findings were consistent with numerical modeling. Thus, this Doppler index may serve as a good non-invasive index of LV contractility.

8:45 a.m.

849-2 Passive Smoking Reduces Coronary Flow Velocity Reserve in Nonsmokers

Ryo Otsuka, Hiroyuki Watanabe, Kenji Shimada, Kumiko Hirata, Kotaro Tokai, Keiji Ujino, Takashi Muro, Kazuhide Takeuchi, Junichi Yoshikawa. *First Department of Internal Medicine Osaka City University Medical School, Osaka, Japan*

Background: Passive smoking is associated with endothelial dysfunction of the vessels. Coronary flow velocity reserve (CFVR) reflects endothelial function in coronary microcirculation, which can be assessed noninvasively by transthoracic Doppler echocardiography (TTDE). The purpose of this study was to determine the effects of passive smoking on coronary microcirculation using CFVR measurement by TTDE. **Methods:**

We studied 15 healthy non-smokers (27±3 years, all are men) who had no history of hypertension, diabetes mellitus, and hyperlipidemia. Coronary flow velocity in the left anterior descending coronary artery was measured by TTDE, and CFVR was calculated as the ratio of hyperemic to basal coronary flow velocity induced by intravenous infusion of adenosine triphosphate (ATP) (140mcg/kg/min). CFVR was measured twice in each subject before and after spending 30 minutes in a smoking room. **Results:** In all subjects, CFVR were measured successfully before and after passive smoking. The response of heart rate and blood pressure to ATP infusion was not affected by passive smoking. Although passive smoking had no effect on basal coronary flow velocity (26.0±8.4 vs. 26.6±8.0 cm/s; N.S.), it reduced hyperemic coronary flow velocity (105.4±31.2 vs. 88.3±27.1 cm/s; p<0.01). Consequently, CFVR was reduced significantly by passive smoking (before vs. after passive smoking, 4.2±1.1 vs. 3.4±0.6; p<0.0001).

Conclusions: Passive smoking reduced CFVR in healthy non-smokers. This result provides direct evidence that passive smoking causes endothelial dysfunction in human coronary microcirculation.

9:00 a.m.

849-3 Changes in Pressure Half-Time With Acute Alterations of Preload and Afterload in Chronic Aortic Regurgitation

Yong Jin Kim, Michael Jones, Takahiro Shiota, Fabrice Bauer, Jian Xin Qin, Marta Sitges, Hiroyuki Tsujino, Lisa A. Cardon, Arthur D. Zetts, James D. Thomas. *The Cleveland Cleveland Foundation, Cleveland, OH, National Heart, Lung and Blood Institute of Health, Bethesda, MD*

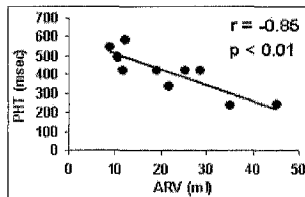
Background: Pressure half-time (PHT) has been used as a marker of severity in aortic regurgitation (AR). However, previous reports have indicated the confounding effects of systemic vascular resistance and left ventricular compliance on this parameter. This study was, therefore, performed to evaluate the relevance of PHT as a marker of severity with acute alterations of preload and afterload in chronic AR.

Noninvasive Imaging

Methods: Ten sheep were studied 8 to 16 weeks after the surgical creation of AR. After baseline (B) studies, 500 ml of blood (BL), angiotensin II (AT) and nitroprusside (NT) were infused to change the loading conditions. Electromagnetic flowmeters were used as reference standards to determine stroke volume, regurgitant volume (ARV) and regurgitant fraction (RF). CW Doppler was performed at each stage to obtain PHT.

Results: Baseline ARV varied from 5.4 ml (RF: 21%) to 45.0 ml (RF: 72%). A significant negative correlation was observed between ARV and PHT ($r = -0.85$, $p < 0.01$) at baseline. With BL infusion, ARV was increased (21 ± 12 vs 26 ± 11 ml, $p < 0.05$) which was associated with PHT shortening (433 ± 110 vs 379 ± 109 msec, $p < 0.05$). However, with AT infusion despite of the increase in ARV (21 ± 12 vs 28 ± 11 ml, $p < 0.05$), PHT was did not change (408 ± 84 msec, $p = NS$ vs B). 40% (4/10) of animals showed a paradoxical increase of PHT during AT infusion. With NT infusion, while ARV decreased (21 ± 12 vs 16 ± 6 ml, $p < 0.05$), PHT was shortened (433 ± 110 vs 326 ± 106 msec, $p < 0.01$).

Conclusion: PHT decreased with increase in ARV by preload augmentation. However, PHT was not a reliable marker of AR severity when afterload changed.

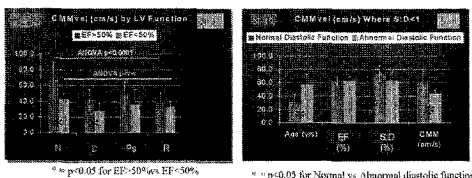


9:15 a.m.

849-4 Clinical Utility of Color Doppler M-Mode in the Routine Assessment of Diastolic Function

Gregory M. Scalia, Ruth E. Melville, Darryl J. Burstow. *The Prince Charles Hospital, Brisbane, Australia, Queensland Heart Clinic, Brisbane, Australia*

Background: Traditional Doppler indices of cardiac diastolic function are confounded by the effects of volume loading conditions. Color M-Mode assessment of mitral inflow is emerging as an investigational tool in this study is compared with standard Doppler grading of diastolic function. **Methods:** Complete Doppler assessment of diastolic function was obtained in 143 pts - transmitral and pulmonary vein Doppler and IVRT. Pts were divided into "normal", "delayed relaxation", "pseudonormal" and "restrictive" filling patterns by standard criteria. The transmitral color M-mode E-wave flow propagation velocity (CMMvel) was compared between groups, across ages and stratified for LV systolic function. **Results:** CMMvel was significantly slower in all grades of diastolic dysfunction than in normals (ANOVA $p < 0.001$). This relationship held in pts with normal and reduced systolic function. CMMvel < 50 cm/s reliably detected pts with all grades of diastolic dysfunction (Sensitivity 0.86, Specificity 0.79). CMMvel did not decrease with age in pts with normal systolic function. In patients with systolic pulmonary venous blunting ($S:D < 1$), CMMvel clearly differentiated young normal subjects from pts in the pseudonormal group. **Conclusions:** Color M-Mode assessment of mitral filling reliably detects pts with all grades of diastolic dysfunction regardless of systolic function. It clearly separates normal from "pseudonormal" cases. It should be considered as a routine component of the complete echo assessment of cardiac diastolic function.



9:30 a.m.

849-5 Characteristics of Left Ventricular Aneurysm by Color M-Mode Echocardiography: A Chronic Animal Study

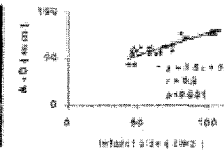
Junko Watanabe, Michael Johns, Takahiro Shiota, Hiroyuki Tsujino, Arthur D. Zetts, Jian Xin Qin, Lisa A. Cardon, Marta Sitges, Fabrice Bauer, Yong-Jin Kim, Mario J. Garcia, James D. Thomas. *The Cleveland Clinic Foundation, Cleveland, OH, National Institutes of Health, Bethesda, MD*

Aim: To investigate the usefulness of color M-mode Doppler echocardiography (CMM) for assessing the existence and size of left ventricular (LV) aneurysms in a chronic animal model.

Methods: A total of 70 different hemodynamic conditions in 15 sheep, 5 normal and 10 with surgically created myocardial infarctions and LV aneurysms by occluding the left anterior descending coronary artery (LAD) ($n = 4$) or the left circumflex artery (LCX) ($n = 6$), were examined by CMM. First, we determined the existence of an abrupt decrease in LV inflow velocity propagation (Vp) detected by CMM (figure 1, arrow), which was obtained from an apical 4-chamber view. In animals which had an abrupt decrease in Vp, we measured the distance from the apex to that point (A-D). After necropsy, the endocardial area of the LV aneurysm was measured by planimetry.

Results: The existence of an abrupt decrease in Vp showed 83% sensitivity, 84% specificity, 89% positive predictive value, 75% negative predictive value for determining the existence of an LV aneurysm. The distance (A-D) showed an excellent correlation with the post-mortem size of the LV aneurysm ($y = 1.6x - 32$, $r = 0.9$, $p < 0.01$, figure 2).

Conclusions: Left ventricular aneurysms can be detected and their size quantitated by color M-mode echocardiography.



9:45 a.m.

849-6 Noninvasive Prediction of Complication With Anteroseptal Acute Myocardial Infarction by Doppler Total Ejection Isovolume (TEI) Index

Toshinori Yuasa, Yutaka Otsuji, Eiji Kuwahara, Kunisugu Takasaki, Shiro Yoshifuku, Keiko Matsukida, Kouichi Toyonaga, Souki Lee, Hitoshi Toda, Toshiro Kumano, Hitoshi Nakashima, Tatsuru Matsuoka, Akira Kisanuki, Shinichi Minagoe, Chuwa Tei. *Kagoshima University, Kagoshima, Japan, Kagoshima CCU Network, Kagoshima, Japan*

Background: Doppler total ejection isovolume (TEI) index, defined as the sum of isovolumetric contraction and relaxation time divided by ejection time, has been proposed as a noninvasive and simple index which enables evaluation of global left ventricular function and prediction of the patients' prognosis. However, its utility to predict later complications with acute myocardial infarction is not fully investigated. Therefore, the purpose of this study is to investigate whether prediction of later complications with acute myocardial infarction by TEI index is feasible or not. **Methods:** Subjects consisted of consecutive 43 patients with anteroseptal acute myocardial infarction. TEI index was measured at the time of admission as (a-b)/b, where a is the interval between cessation and onset of mitral Doppler flow and b is the aortic flow ejection time. Complications including cardiac death, shock, congestive heart failure, ventricular tachycardia/fibrillation, paroxysmal atrial fibrillation, pericardial effusion, and left ventricle aneurysm were prospectively evaluated and compared to the previous TEI index at admission. **Results:** 1) Eighteen of 43 (42%) patients developed complications. 2) Compared to those without complications, TEI index was significantly increased in patients with complications (0.46 ± 0.07 vs 0.68 ± 0.21 , $p < 0.0001$). 3) When the TEI index ≥ 0.55 was used for the criteria, the sensitivity, specificity, and overall accuracy to predict later complications were 78%, 88%, and 84%, respectively. **Conclusion:** TEI index at early After onset allows noninvasive prediction of later complications in patients with anteroseptal acute myocardial infarction.

	Complications (-)	Complications (+)
TEI index < 0.55	22	4
TEI index ≥ 0.55	3	14

POSTER SESSION

1206 Echocardiography: Miscellaneous

Tuesday, March 20, 2001, 9:00 a.m.-11:00 a.m.
Orange County Convention Center, Hall A4
Presentation Hour: 9:00 a.m.-10:00 a.m.

1206-133 Prediction of Maintenance of Sinus Rhythm After Electrical Cardioversion of Chronic Nonvalvular Atrial Fibrillation Using Pulsed Tissue Doppler Imaging

Masami Nishino, Shiro Hoshida, Masayuki Taniike, Yasuyuki Egami, Toshihiro Takeda, Wataru Furumoto, Masayoshi Kawabata, Eiichiro Tsujimura, Junji Kato, Hideo Tanahashi, Jun Tanouchi, Yoshio Yamada. *Division of Cardiology, Osaka Rosai Hospital, Sakai, Osaka, Japan*

Background: In chronic atrial fibrillation (AF), even if the patients had successful cardioversion, high recurrence of AF occurs. Thus, it is clinically important to predict the maintenance of sinus rhythm after cardioversion. In this study, we investigated whether echo and Doppler parameters, including pulsed tissue Doppler imaging (TDI) parameters, can predict the maintenance of sinus rhythm after cardioversion in the patients with chronic AF. **Methods:** Fifty-two patients (57 ± 12 yo) with chronic non-valvular AF (duration of AF > 6 months) who underwent electrical cardioversion and maintained sinus rhythm for > 24 hours were included in this study. We divided our patients into two groups; success (sinus rhythm persisted > 6 months) and failure group. Echocardiography was performed at 4 and 24 hours after cardioversion to obtain left atrial dimension (LAD), mitral early diastolic (E) and atrial flow velocity (A), systolic/diastolic flow velocity in pulmonary venous flow (S/D), and early diastolic (Ea) and atrial velocity (Aa) of mitral annulus obtained with pulsed TDI. The ratio of each Doppler parameter after 4 hours to that after 24 hours was also calculated. **Results:** After 6 months, 37 patients (71%) reverted to AF (failure group). An Aa ratio in the success group was significantly higher than that in the failure group, while there were no significant differences of all the parameters at 4 hours

and the other ratios (table). Using an Aa ratio: 1.4, the sensitivity and specificity of prediction for maintenance of sinus rhythm after cardioversion were 71% and 87%, respectively.

	Success (n=15)	Failure (n=37)	P value
LAD(cm)	48 ± 8	49 ± 7	NS
E(4hr)(cm/sec)	69 ± 15	65 ± 19	NS
A(4hr)(cm/sec)	17 ± 10	19 ± 9	NS
S/D(4hr)(cm/sec)	1.16 ± 0.11	1.11 ± 0.18	NS
Ea(4hr)(cm/sec)	16.2 ± 3.5	17.5 ± 5.2	NS
Aa(4hr)(cm/sec)	7.8 ± 2.0	7.2 ± 1.7	NS
E ratio	0.82 ± 0.11	0.90 ± 0.10	NS
A ratio	2.01 ± 0.64	1.57 ± 0.62	NS
S/D ratio	1.13 ± 0.11	1.14 ± 0.14	NS
Ea ratio	0.84 ± 0.13	0.89 ± 0.16	NS
Aa ratio	1.51 ± 0.33	1.26 ± 0.21	P < 0.05

Conclusions: A pulsed TDI parameter, Aa, can predict maintenance of sinus rhythm after cardioversion in the patients with chronic non-valvular AF.

1206-134 Echo Directed Pericardiocentesis Using an Electronic Computerized Needle Guide

Lawrence J. Sinak, Dov Gal. *Mayo Clinic, Rochester, MN*

A new electronic computerized device designed to assist in sonographically guided needle placement was evaluated with regard to its utility in performing echo directed pericardiocentesis. The UltraGuide 1000 was used to provide real time images with 3-D location of the needle tip while pericardiocentesis was being done. We performed 21 pericardiocentesis procedures using this device. Pericardial effusion size ranged from 10 ml to 1320 ml. The surface location of needle entry was para-apical in 9 cases, left parasternal in 5 cases, and right parasternal in 7 cases. Successful access to the pericardial space was achieved in all cases. The UltraGuide device was felt to be of added benefit in 8 cases (7 with size 325 ml or less), compared to standard technique. There were no complications. We conclude that the UltraGuide can be of added benefit in performing pericardiocentesis, with the most benefit in when the pericardial effusion is small, and that it may help reduce the rate of complications.

1206-135 Ultrasonic Myocardial Tissue Characterization in Patients With Primary Amyloidosis

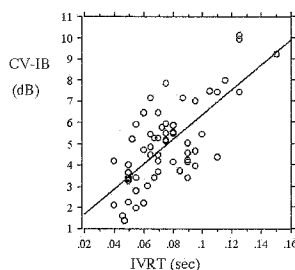
Jun Koyama, Patricia A. Ray, Rodney H. Falk. *Boston Medical Center, Boston, MA*

Background: Cardiac cycle-dependent variation of ultrasonic myocardial tissue characterization with integrated backscatter (CV-IB) is an objective method that is relatively independent of gain setting. This study was performed to clarify the clinical value of ultrasonic tissue characterization with CV-IB in patients with AL amyloidosis.

Methods: We examined 60 biopsy-proven patients. The magnitude of CV-IB was analyzed at the center of interventricular septum (IVS) and LV posterior wall (PW). Doppler analyses of transmitral flow, pulmonary venous flow and LV isovolumic relaxation time (IVRT) were also performed.

Results: The mean thickness of the LV was 16.1±3.3mm (range 12.0 to 24.4) at the IVS, and 14.4±2.3mm (range 11.0 to 19.7) at the PW. Fractional shortening was 33.0%. Compared to 24 normal subjects, the septal and posterior wall CV-IB were significantly decreased (IVS 3.8±2.2dB in amyloidosis versus 5.5±2.9dB in normal (p=0.006); PW 4.7±1.8dB in amyloidosis versus 6.2±1.8dB in normal: p=0.03). Stepwise logistic regression analysis to determine whether wall thickness or systolic/diastolic factors correlated with decreased CV-IB demonstrated that IVRT was the only correlate with CV-IB of the PW (r=0.718; p<0.0001).

Conclusion: In AL amyloid, cycle-dependent variation of ultrasonic myocardial tissue characterization with integrated backscatter is impaired compared to normal. This impairment appears unrelated to either the magnitude of wall thickness or systolic function but is associated with a short IVRT, a marker of elevated pulmonary capillary wedge pressure. Since greater degree of cardiac amyloid causes greater diastolic dysfunction, it is likely that the diminished value of CV-IB reflects the degree of myocardial amyloid deposition.



1206-136 An Innovative Technique to Detect the Single Leg Separation (SLS) in the Bjork-Shiley Convexo-Concave (BSCC) Mechanical Heart Valves

Edmond Rambod, Mostafa Fatemi, James F. Greenleaf. *California Institute of Technology, Pasadena, CA, MAYO Clinic, Rochester, MN*

Background: Occurrence of SLS in the BSCC mitral mechanical heart valves may cause the fracture of outlet strut and total valvular failure. If SLS is detected early, it is possible to prophylactically replace the valve. Past efforts aimed at detecting SLS by radiography and passive listening to the closure/opening sound of the valve. Neither method has been successful in practice. The aim of this study was to utilize Vibro-Acoustic Spectrography (VAS) to differentiate the SLS from the Intact Outlet Strut (IOS) in the BSCC valves. **Methods:** VAS utilizes the radiation force of ultrasound to actively vibrate the object at a range of kHz frequencies, and records the resulting vibrations with a sensitive detector. The data are then used to determine the mechanical frequency response of the object by the Fourier transform of the recorded data. The stress field produced by this technique is highly localized, allowing one to target only the strut and thus avoid interference from vibrations of other structures. Five 29 mm BSCC mitral valves were selected for these studies: three intact valves, one valve with mechanically induced SLS and one explanted valve with SLS. The mechanically induced SLS valve had a fracture at the welding site of the outlet strut leg and the flange. The explanted valve had a fracture about 1.5 mm from the flange. The ultrasound frequency of the vibro-acoustic spectrography system was 3 MHz, and the radiation force frequency was 1-15 kHz. **Results:** It has been demonstrated that defective valves consistently exhibited different resonance frequencies than those of the intact valves. The outlet strut of the intact valves showed a dominant resonance frequency of about 7.4 kHz. The corresponding frequency in the mechanically induced SLS and explanted SLS valves exhibited no resonance frequencies above 6 kHz. Hence, this frequency can be used as a threshold to differentiate SLS from IOS. **Conclusions:** Vibro-Acoustic Spectrography can be effectively used as an active probing method for remote detection of SLS in the BSCC mechanical heart valves. It obtains the frequency response of BSCC struts without interference from surrounding structures. This method shows potential for in-vivo use.

POSTER SESSION

1207 Perfusion, Metabolism, and Neural Function in Ischemic and Other Cardiomyopathies: Radionuclide Techniques

Tuesday, March 20, 2001, 9:00 a.m.-11:00 a.m.
Orange County Convention Center, Hall A4
Presentation Hour: 9:00 a.m.-10:00 a.m.

1207-137 Evidence of Stress-Induced Subendocardial Hypoperfusion in Patients With Aortic Stenosis Demonstrated by Positron Emission Tomography

Kim Rajappan, Ornella Rimoldi, Klaus P. Schafers, Dudley J. Pennell, Desmond J. Sheridan, Paolo G. Camici. *MRC Clinical Sciences Centre, Hammersmith Hospital, Du Cane Road, London, United Kingdom, Imperial College of Medicine and NHLI, London, United Kingdom*

Background: Patients with left ventricular hypertrophy (LVH) and aortic stenosis (AS) have abnormal coronary vasodilator reserve (CVR) with electrocardiographic signs of subendocardial ischemia, despite angiographically normal coronary arteries. The aim of this study was to measure subepicardial and subendocardial myocardial blood flow (MBF) and CVR in these patients using a high sensitivity, high resolution positron emission tomography (PET) scanner. **Methods:** Fifteen patients (age 70 ± 9 years) with severe AS (peak ECHO Doppler gradient 97 ± 13 mmHg), LVH (LV mass index [MRI] 137 ± 32 g/m²), and angiographically normal coronaries were enrolled. Subendocardial, subepicardial and total transmural MBF were measured at rest and during hyperemia (i.v. dipyridamole 0.56mg/kg) using an EXACT 3D PET camera (4.6mm resolution Full-Width Half-Maximum) and oxygen-15 labeled water. CVR was calculated as hyperemic MBF/resting MBF after correcting the latter for resting rate-pressure product (RPP).

	RESTING MBF (ml/min/g)	HYPEREMIC MBF (ml/min/g)	CVR
Heart Rate (beats/min)	64.7 ± 8.6	80.1 ± 9.9 **	
RPP	8539 ± 1307	9927 ± 2365 **	
Diastolic Blood Pressure (mmHg)	72.7 ± 10.4	70.8 ± 12.3 ns	
Transmural	1.24 ± 0.30	1.76 ± 0.51 **	1.54 ± 0.35
Subendocardial	1.28 ± 0.29	1.62 ± 0.49 *	1.30 ± 0.37
Subepicardial	1.14 ± 0.29	1.78 ± 0.58 **	1.58 ± 0.35 ***
Endo MBF/Epi MBF Ratio	1.15 ± 0.18	0.94 ± 0.18 **	

All values mean ± SD; * p<0.01 Hyperemic vs Resting; ** p<0.001 Hyperemic vs Resting; *** p<0.01 Subepicardial vs Subendocardial; ns non significant

Conclusions: Our results demonstrate that in AS patients: 1- CVR is more severely blunted in the subendocardium; 2- the subendocardial/subepicardial MBF ratio is significantly reduced during hyperemia. We postulate that relative subendocardial hypoperfusion might lead to selective ischemia in this LV layer and contribute to anginal symptoms in patients with AS.

1207-138 Increased Right Ventricular Thallium Uptake in Chronic Ischemic Left Ventricular Dysfunction: Evidence for Improvement After Coronary Artery Revascularization

Maung M. Khin, Anastasia N. Kitsiou, Joann Carson, Stephen L. Bacharach, Vasken Dilisizian. *National Institutes of Health, Bethesda, MD*

Background: In patients with chronic coronary artery disease (CAD), progressive deterioration of left ventricular (LV) function results in increased pulmonary artery pressure and right ventricular (RV) hypertrophy. Increased RV tracer uptake in myocardial perfusion studies is thought to represent RV hypertrophy. In this study, we determined whether improvement in LV function (LVEF) after revascularization is associated with improvement in RV thallium uptake.

Methods: To this end, 17 patients with chronic CAD and LV dysfunction (LVEF=30±9%) underwent pre- and post-revascularization stress-redistribution-reinjection thallium SPECT and radionuclide angiography. From matched pre- and post-revascularization mid-ventricular transaxial tomograms, the region with the highest thallium uptake in the RV and LV (posterolateral free wall) on stress was used for computing RV/LV ratios. Mean RV/LV uptake ratios from pre- and post-revascularization studies were compared with 17 age-matched control subjects without history of CAD.

Results: Mean RV/LV ratio was significantly higher in patients with chronic CAD compared to the controls (0.69±0.26 versus 0.42±0.06, p<0.001). After revascularization, mean RV/LV ratio decreased from 0.69±0.26 to 0.52±0.20 (p=0.007), approaching the mean RV/LV ratio of controls (0.42±0.06, p=NS). Mean LVEF at rest increased from 30±9% to 36±14% after revascularization (p<0.001). Improvement in LVEF from pre- to post-revascularization correlated inversely with improvement in RV/LV ratio (r=-0.5, slope=-1.42, p=0.06).

Conclusion: These findings suggest that in patients with CAD, a consequence of chronic LV dysfunction is increased RV thallium uptake. However, this increased RV thallium uptake is reversible after coronary artery revascularization.

1207-139 Effect of 6 Months Carvedilol Treatment on Cardiac Sympathetic Activity in Patients With Chronic Heart Failure

Alain Cohen-Solal, Pascal Merlet, Nicolas Delahaye, Dominique Le Guledec, Alain Berdeaux, Jean Yves Le Heuzey, Damien Logeart, on behalf of the SYMPOXYDEX Study Group. *Cardiology, Beaujon Hospital, Clichy, France*

Background: Carvedilol treatment has beneficial effects on ventricular function and morbi-mortality in chronic heart failure (CHF) patients, but its effects on cardiac sympathetic activity remain controversial.

Methods: In the current study, we measured the cardiac norepinephrine (NE) re-uptake by the metaiodobenzylguanidine (MIBG) scintigraphy technique (calculation of the late (4h) heart/mediastinum activity ratio (H/M) on a planar image) in 50 CHF patients (LVEF < 40%) in NYHA class II (78%) and III (22%) in a 6 months randomized, double-blind, placebo-controlled (n=22 placebo, n=28 carvedilol), multicenter study (SYMPOXYDEX trial). In addition, heart rate variability (HRV) (24h holter, SDNN and rMSSD) and plasma NE and epinephrine (E) were measured. Results (mean ±SD) are summarized in the table.

	LVEF (%)	MIBG H/M	SDNN (msec)	rMSSD (msec)	NE (pg/ml)	E (pg/ml)
placebo (baseline)	27±12	1.46±0.24	109±40	33±20	541±284	58±23
placebo (6 months)	29±12	1.43±0.24	103±41	38±42	492±380	50±26
carvedilol (baseline)	25±11	1.42±0.18	110±36	39±37	411±181	60±35
carvedilol (6 months)	34±12*	1.50±0.22*	131±47*	68±65*	439±268	68±69

* p<0.01 vs corresponding placebo value

Results: Plasma catecholamines did not change despite a clear enhancement of cardiac re-uptake of NE.

Conclusion: This suggests a limited value of NE changes under carvedilol treatment, which decrease both NE stimulation and clearance. Improvement in cardiac sympathetic function was associated with an improvement in HRV. MIBG scintigraphy and HRV are better than NE to assess the effects of carvedilol of sympathetic tone.

1207-140 Early Myocardial BMIPP Uptake Is Enhanced Relative to Perfusion in a Canine Model of Reperfused, Viable Myocardium

Kazuya Takehana, Mirta Ruiz, Laurent M. Riou, Toshiji Iwasaka, Denny D. Watson, George A. Beller, David K. Glover. *University of Virginia, Charlottesville, VA, Kansai Medical University, Osaka, Japan*

Background: ¹²³I-betamethylodophenylpentadecanoic acid (BMIPP) is used clinically to assess myocardial fatty acid metabolism. In many of these studies, a "mismatch" pattern with normal perfusion and reduced BMIPP uptake has been observed 5-7 days following reperfusion of severe ischemia. To better understand this phenomenon, we sought to compare the uptake pattern of BMIPP with ²⁰¹Tl in the early stage after reperfusion.

Methods: Accordingly, 10 open-chest dogs underwent total left anterior descending coronary occlusion for 30 minutes followed by either full (Group 1, n=5) or partial reperfusion with a severe residual stenosis which reduced resting flow by ~50% (Group 2, n=5). Sixty minutes after reflow, when net lactate production had ceased, ²⁰¹Tl and BMIPP were injected and 10 minutes later the dogs were killed. Myocardial ²⁰¹Tl and BMIPP

activities were quantified by gamma-well counting. Myocardial segments were grouped according to flow during the occlusion into ischemic (flow < 0.3 ml/min/g) and normal (flow ≥ 0.3 ml/min/g) zones.

Results: In both groups, transmural ²⁰¹Tl uptake in the ischemic zone (Group 1: 0.72±0.02; Group 2: 0.67±0.02) was identical to injection flow (Group 1: 0.76±0.03; Group 2: 0.63±0.04), indicating substantial preservation of myocardial viability. Interestingly, ischemic zone BMIPP uptake (Group 1: 0.87±0.08; Group 2: 0.79±0.04) was significantly higher than both ²⁰¹Tl and injection flow (p<0.01) whereas normal zone segments had similar uptake of both tracers (Groups 1&2: 0.99±0.01 vs. 0.98±0.01).

Conclusion: Unlike the mismatch pattern observed clinically, early after reperfusion fatty acid uptake in viable myocardium may actually be enhanced relative to perfusion and ²⁰¹Tl uptake. For viability assessment early after reflow, in the presence of a residual infarct-vessel stenosis, BMIPP imaging may be more sensitive than ²⁰¹Tl.

1207-141 The Impairments of Myocardial Sympathetic Activity May Reflect the Progression of Myocardial Damage in Hypertrophic Cardiomyopathy

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Background: Abnormalities of myocardial sympathetic nerve function were reported in hypertrophic cardiomyopathy. However, the mechanism of such abnormalities remains unknown. In part, the high plasma level of B-type natriuretic peptide reportedly reflects myocardial damage in addition to a hemodynamic disorder. **Methods:** To assess myocardial sympathetic nerve function, we obtained metaiodobenzylguanidine (MIBG) images 15 and 180 min after the injection of I-123 MIBG at a dose of 111 MBq and calculated the ratio of heart/mediastinum count (H/M) and the washout rates in 56 consecutive patients with hypertrophic cardiomyopathy [non-obstructive: n=33, obstructive: n=4, apical hypertrophy: n=10, dilated phase: n=9] and age-matched normal controls (n=23). The plasma levels of atrial natriuretic peptide, B-type natriuretic peptide, norepinephrine were measured. The left ventricular mass index and ejection fraction were measured. **Results:** H/M ratio was significantly lower in hypertrophic cardiomyopathy (2.1±0.3) than in controls (2.6±0.4) (p<0.01). The washout rates was higher in hypertrophic cardiomyopathy (36±6) than in controls (28±3) (p<0.01). H/M had a significant negative correlation with ejection fraction, the left ventricular mass index, atrial natriuretic peptide, B-type natriuretic peptide and norepinephrine. The washout rates also had a significant positive relation with the plasma levels of norepinephrine and B-type natriuretic peptide. To identify the independent predictors of H/M and the washout rates, stepwise multivariate regression analysis was used with 5 variables (the ejection fraction, the left ventricular mass index, atrial natriuretic peptide, B-type natriuretic peptide, and norepinephrine). The B-type natriuretic peptide (p=0.0001) and the left ventricular mass index (p=0.0009) were independent and significant predictors of H/M. And norepinephrine was an independent and significant predictor of the washout rates (p=0.0018). **Conclusion:** These findings indicate that impairments of myocardial sympathetic function should reflect the progression of myocardial damage in hypertrophic cardiomyopathy.

POSTER SESSION

1208 Three-Dimensional Echocardiography in Nonvalvular Heart Disease

Tuesday, March 20, 2001, 9:00 a.m.-11:00 a.m.
Orange County Convention Center, Hall A4
Presentation Hour: 9:00 a.m.-10:00 a.m.

1208-142 Reliability and Accurate Quantification of Left Ventricular Size and Function by Ultrafast (Freehand) Three-Dimensional Echocardiography in Patients With Normal and Abnormal Left Ventricles: Comparison With Magnetic Resonance Imaging

Stefano De Castro, Antonio Pelliccia, Laura Vitali Serdoz, Marcello De Santis, Rachele Adorisio, Federica Papetti, Cristian Di Russo, Francesco Fedele, Natesa Pandian. *Department of Cardiovascular and Respiratory Sciences, "La Sapienza" University, Rome, Italy, NEMC, Tufts University, Boston, MA*

Three-dimensional (3-D) freehand ultrasound is a new imaging technique that is rapidly finding clinical application. Existing methods of 3D imaging have shown the potential of this modality, but each suffers from inherent restrictions which limit its pliability in clinical scenario. Aim of our study was to validate the ultrafast 3D method (freehand technology) in patients with normal and abnormal left ventricles in comparison with magnetic resonance imaging (MRI). To assess this, we performed transthoracic magnetic freehand 3DE using a harmonic imaging system, with and without IV contrast agent, in 33 patients (age 18 to 76 yrs) with normal and abnormal left ventricular shape. All patients were in sinus rhythm.

Results: Dynamic freehand 3DE images of the Left Ventricle (LV) facilitated qualitative assessment of LV size, geometry, morphology and function. Quantitative data were (mean ± SD): MRI (x) vs 3DE (y) EDV in ml: 129. 8 ± 30. 44 (range 89.3- 179.4) vs 106 ± 34.7 (range 77.5- 155.9); correlation: y = .95 x -17.8, r = .83, p < .01. ESV in ml: 77.1 ± 32.1 (range 30.3-133.7) vs 63.9 ± 29.7 (range 35.3-109.1); correlation: y = .8x - .02, r = .89, p < .003. %EF: 42 ± 13 (range 25-66) vs 42 ± 9 (range 30-55); correlation: y = .6x + 15.3, r .92, p < .002.

We concluded that, freehand technology offers several advantages over existing methods of 3DE in analysis of LV volumes in patients with different shape and global or regional abnormalities.

1208-143 Three-Dimensional Echocardiographic Acquisition at 8 Degree Rotational Intervals Allows Rapid Volume Rendered Reconstruction of Atrial Septal Defects With Adequate Morphological and Accurate Quantitative Assessment

Youssef F. M. Nosir, Anita Dall'Agata; Ron T van Domburg, Ad JJC Bogers and Jos RTC Roelandt. *Heartcenter, Erasmus University, Rotterdam, The Netherlands, Cardiology Department, Al-Azhar University, Cairo, Egypt*

Background: Prolonged three-dimensional echocardiographic (3DE) acquisition time currently limits its routine use in clinical practice particularly for perioperative assessment of patients undergoing cardiac surgery. Our aim was to define the optimal three-dimensional echocardiographic (3DE) rotational acquisition interval that allows rapid qualitative and accurate quantitative assessment of patients with atrial septal defects (ASD).

Methods. 12 patients with ASD underwent 3DE with 2° rotational acquisition intervals. Images were processed to create data sets containing images at 2°, 4°, 8° and 16° intervals. The volume rendered ASD enface view was reconstructed and its suitability for the morphological assessment (location, shape, and structure) was scored by two experienced observers. The frame with the largest ASD size was selected and the defect area, anterior-posterior (L1) and superior-inferior (L2) diameters were measured. Measurements obtained at 4°, 8° and 16° were compared with values obtained at 2°. The correlation (r), p value, limits of agreement (Agr.) and the interobserver variability (SEE) were calculated (table).

Results. Volume rendered ASD enface views obtained from 3DE data sets up to 8° interpolation intervals were of adequate quality for morphological assessment. At 16° intervals, 5 data sets were not interpretable. The mean±SD of ASD area measurement were (4.9±5, 4.9±5, 5.1±5.2 and 6.4±7.2), of L1 were (2.2±1 2.2±1, 2.2±1 and 2.3±1.4) and of L2 were (2.5±1.5, 2.5±1.6, 2.6±1.6 and 2.9±1.2), for data sets obtained at 2°, 4°, 8° and 16° intervals respectively.

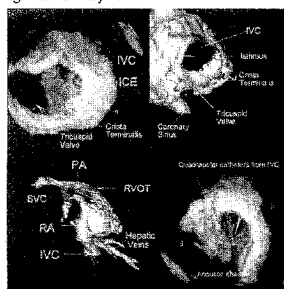
	2°			4°			8°			16°		
	Area	L1	L2	Area	L1	L2	Area	L1	L2	Area	L1	L2
P	-	-	-	0.3	0.7	0.4	0.1	0.6	0.1	0.4	0.7	0.1
Agr.	-	-	-	±0.6	±0.2	0.2	±0.4	±0.2	±0.4	±2	±0.6	±0.8
r	-	-	-	0.99	0.98	0.99	0.99	0.99	0.99	0.99	0.98	0.98
SEE	0.04	0.02	0.02	0.05	0.04	0.04	0.05	0.04	0.03	0.3	0.03	0.05

Conclusions. 3DE data sets obtained with rotational interpolation intervals up to 8° allows the reconstruction of ASD enface volume rendering view with adequate quality for qualitative and quantitative analysis.

1208-144 Four-Dimensional Reconstruction of the Right Atrium-a Comparison of Intracardiac Echocardiography With Magnetic Resonance Imaging

Ron D. B. Simon, Reza Rezavi, Marc Miquel, Artur Baszko, Edward J. Baker, Jaswinder S. Gill. *Guy's and St Thomas' Hospitals, London, United Kingdom*

Background: Increasingly, the ablation of arrhythmias requires visualisation of intra cardiac anatomy, particularly when creating lines of block between anatomical non-conducting obstacles. The aim of this paper was to assess two methods of generating 4D reconstructions of the right atrium: intracardiac echocardiography (ICE) and magnetic resonance imaging (MRI). **Methods:** We studied 7 patients, aged 18 to 68 (median 39) with SVT. ICE images (9F, 9MHz, 360 degree; Boston Sci.) were acquired with ECG and respiratory gating during electrophysiological study/ablation. MRI scans with breath holding (1 Tesla magnet Siemens Imapct Expert) using a phased array body coil were performed later. Off line 4-D reconstructions of the right atrium were created (Tomtec for ICE, Visualisation Tool Kit for MRI) and images and measurements were compared. **Results:** With both techniques we could identify major anatomical structures. For more detailed visualisation of endocardial surface anatomy, ICE appeared to be better. Acquisition and reconstruction times were faster with ICE (ICE: 5mins, 5mins, MRI: 30mins, 60mins). Orientation was easier with MRI as whole heart images presented clearer anatomical reference points. The measured distances between IVC, SVC, coronary sinus (CS) and tricuspid valve (TV) and diameters of SVC, IVC, CS and TV agreed closely (Bland/Altman limits of agreement +/- 1cm). Inter-observer differences were smaller for MRI (+/-0.5cm) than for ICE (+/-1cm). ICE allowed the identification of the lie of catheters. Figure: Top; short axis views from SVC to IVC by ICE and MRI showing the isthmus area. Bottom; right lateral view of the right atrium and ventricle by 3D MRI, quadrapolar catheters in the right atrium by ICE.



Conclusion: 4-D imaging allows understanding of individual anatomy, which helps anatomical linear ablation. ICE allows 4-D imaging during intervention which helps with catheter placement.

1208-145 New Observations in Contrast Enhanced Real-Time 3D Dobutamine Stress Echocardiography in Assessment of Ischemia

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Background: We have reported the feasibility and efficacy of real-time 3D echocardiography (RT-3D VOLUMETRICS) in detection of ischemia during Dobutamine stress echocardiography (DSE), however LV visualization (LVV) may be suboptimal in some patients (pts). To improve LVV and wall motion assessment (WM), contrast enhanced RT-3D images were obtained during DSE.

Methods: A total of 120 pts (mean age 58.6± 12.7 yrs, 48.3% males) were studied. RT-3D images were obtained with and without contrast (0.75 mg intravenous bolus of OPTISON) in the fundamental mode in 74 pts and in the second harmonic mode in 46 pts. All images were evaluated by 2 observers for LVV and for WM. LVV was graded as 1 for no LVV, 2 for partial LVV and 3 for full LVV. WM was graded according to the standard ASE criteria.

Results: Mean LVV scores at baseline were 2.38± 0.56 pre contrast and 2.73± 0.53 post contrast (P<0.0001). At peak DSE, the scores were 2.42± 0.50 pre contrast and 2.80± 0.49 post contrast (P<0.0001). There were no significant differences in post contrast LVV scores between the fundamental and the second harmonic modes. The interobserver agreements for LVV at baseline were 70.3% pre contrast and 88% post contrast and at peak DSE were 67.2% pre contrast and 91.1% post contrast (P<0.0001). Mean WM scores at baseline were 1.08± 0.16 pre contrast and 1.09± 0.19 post contrast and at peak were 1.18± 0.27 pre contrast and 1.22± 0.4 post contrast. The interobserver agreements for WM at baseline were 79.2% pre contrast and 89.2% post contrast (P<0.05). At peak DSE, the agreements were 65.8% pre contrast and 77.5% post contrast (P<0.05). In 39 pts with coronary angiograms, pre contrast RT-3D had a sensitivity of 87.1% and post contrast sensitivity was 90.3%.

Conclusions: 1) Contrast enhancement of RT-3D images improved LV visualization and resulted in superior interobserver agreement. 2) There were no significant differences in the contrast enhancement between the fundamental and second harmonic modes. 3) Although pre and post contrast sensitivity levels in detection of coronary artery disease were similar, the observers felt more confident in interpreting the contrast-enhanced images.

1208-146 Left Ventricular Volume-Time Curves Generated by Real-Time 3D Echocardiography: A New Quantitative Approach for Detecting Diastolic Dysfunction

Ziad Zeidan, Thomas Buck, Joerg Barkhausen, Thomas Bartel, Joerg Debatin, Raimund Erbel. *Department of Cardiology, University of Essen, Essen, Germany, Dept. of Radiology, University of Essen, Essen, Germany*

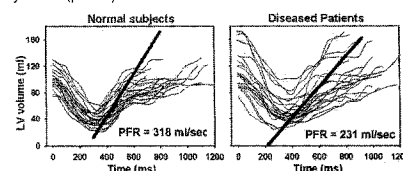
Background: Left ventricular volume-time curves (VTC) providing rapid filling rate have been described as a diagnostic approach to detect LV diastolic dysfunction. However, existing techniques providing VTCs like magnetic resonance imaging (MRI) and radionuclide ventriculography are either expensive, time consuming or inaccurate. We therefore tested whether VTCs can be generated by real-time 3D echocardiography (RT3DE) and if they allow to discriminate between subjects with and without diastolic dysfunction.

Methods: VTCs were generated from absolute LV volumes (18-24/s) of 30 normal subjects and 26 patients (5 dilated cardiomyopathy, 8 hypertensive, 10 coronary, 3 valvular heart disease) by transthoracic RT3DE (Volumetrics) and of 11/30 normal subjects by MRI (Sonata, Siemens). Volumes were traced manually and calculated by disc method. From VTCs we determined enddiastolic and endsystolic LV volume indexes (EDVI; ESVI), peak ejection and peak early filling rates (PER; PFR) and time to PER and PFR (PER(t); PFR(t)).

Results: In normal subjects parameters agreed well between RT3DE and MRI (p=NS, t-test). PFR and PFR normalized to EDV were significantly reduced (p<.001; p<.00001) and PFR(t) was significantly elongated (p<.001) indicating diastolic dysfunction in patients compared to normals.

	3DE Normals	3DE Diseased	MRI Normals
EDVI ml/m ²	60+/-11	62+/-14*	63+/-14*
ESVI ml/m ²	23+/-7	26+/-10*	27+/-8*
PER ml/sec	359+/-84	336+/-87*	414+/-108*
PFR ml/sec	318+/-89	231+/-88§	370+/-157*
PER(t) msec	131+/-40	140+/-44*	119+/-26*
PFR(t) msec	132+/-29	170+/-48§	141+/-38*

* NS, §< 0.001 by t-test (p<.05) vs 3DE Normals



Conclusion: VTCs can be generated by RT3DE providing quantitative analysis of diastolic filling pattern. Thus, VTCs by RT3DE are a promising diagnostic approach rapidly providing rapid filling rate for early identification of LV diastolic dysfunction.

POSTER SESSION

1209 Echo Assessment of Novel Surgical Devices

Tuesday, March 20, 2001, 9:00 a.m.-11:00 a.m.
Orange County Convention Center, Hall A4
Presentation Hour: 9:00 a.m.-10:00 a.m.

1209-147 Port-Access Aortic Valve Replacement: Echocardiographic and Clinical Results

Smadar Kort, Robert M. Applebaum, Eugene A. Grossi, Stephen B. Colvin, Aubrey C. Galloway, Greg H. Ribakove, F. Gregory Baumann, Bryan Piedad, Paul A. Tunick, Itzhak Kronzon. *NYU School of Medicine, New York, NY*

Background: Port-Access (PA) cardiac surgery via mini-thoracotomy incisions has been used for coronary bypass and mitral surgery. The echocardiographic and clinical outcomes for PA aortic valve replacement (AVR) have not been described. **Methods:** Between 1996-99, 153 PA AVR were performed at our institution. Mean age was 63 (16-91 yrs); 58% males. New York Heart Association Class was a mean of III, and 18% were Class IV. 13% had diabetes, 41% hypertension, 7% prior TIA or stroke, 7% lung disease, 3% renal failure, 10% AF, and 13% were reoperations. Echoes were obtained post-PA AVR in 125 pts (96 intraoperative transesophageal and 97 postop transthoracic echoes, a mean of 5 months postop (range 1 day - 31 months)). **Results:** Clinical: Median hospital length of stay was 8 days. There were no intraoperative deaths; 10 pts (6.5%) died within 30 days. Stroke occurred in 4 pts (2.6%), sepsis in 5 (3.3%), renal failure in 5 (3.3%), pneumonia in 3 (2%), and chest wound infection in 1 (0.7%). Reoperation for bleeding was necessary in 14 pts (9.3%). Echo: Tissue AVR was present in 83 pts, and mechanical AVR in 42. No or trace regurgitation (AR) was seen on 94 of 96 (98%) intraoperative echoes, and mild AR on 2. On follow-up echo, moderate to severe AR was seen in 1 of 97 pts (1%), moderate AR was seen in 4 (4.1%), mild-to-moderate in 2 (2.1%), mild in 19 (19.6%) and no or trace in 71 pts (73.2%). Of 26 pts with > trace AR, it was paravalvular in 8 pts (30.8%). On follow-up, vegetations and abscess were seen in 2 pts each. **Conclusion:** Minimally invasive AVR with a PA approach is technically feasible, even in high risk pts. Small incisions, a low infection rate, and short length of stay are attainable. However the complications associated with traditional AVR still occur. Echocardiography is valuable both for intraoperative monitoring and follow-up of this new procedure.

1209-148 Doppler Echocardiographic Diagnosis of Inlet and Outlet Conduit Dysfunction in Patients With the TCI Heartmate Vented Electric Left Ventricular Assist Device

Mihai Croitoru, Raymond F. Stainback, Antonieta Hernandez, Oscar H Frazier, Branislav Radovancevic, Timothy Myers, Susan Wilansky. *St. Luke's Episcopal Hospital/Texas Heart Institute, Houston, TX*

Background: Limited data is available on the role of echo Doppler in detecting left ventricular assist device (LVAD) conduit/valve dysfunction. **Methods:** All 37 patients that underwent implantation of a TCI Heartmate, Vented Electric LVAD in our institution between 3/98 and 9/99 were evaluated by serial transthoracic echo for the duration of assistance (1-15 months). Complete echo exams included continuous wave Doppler scans across inlet conduits (IC) and outlet conduits (OC). Thirty studies performed in 16 clinically stable patients served as controls. Normal flow velocity was <3.0 m/s in the IC and <2.4 m/s in the OC. Conduit dysfunction was defined as a valve tear or perforation or severe conduit deformation seen at the time of surgical removal. **Results:** We identified 9 patients with LVAD conduit dysfunction: one had severe OC angulation (confirmed angiographically) and the other 8 had torn IC valve leaflets, frequently associated with vegetations or severe calcification. We could not assess IC flow in one patient. In the first week after implantation, two patients with reversible causes of hemodynamic compromise had transiently elevated OC velocities. At baseline (7-14 days after implantation), conduit velocities in all 9 patients were normal ($p=0.5$ for comparison with controls): mean IC velocity 2.2 ± 0.5 m/s (1.7-3.0 m/s) and mean OC velocity 1.8 ± 0.2 m/s (1.7-2.2 m/s). Serial Doppler echo identified abnormalities in 7 patients with dysfunctional IC valves, as well as in the patient with OC angulation. IC velocities had increased to 3.4 ± 0.6 m/s (range 3.1-4.2 m/s), a mean increase of 1.3 m/s (range 0.8-1.7 m/s), compared to the same patients at baseline. This was significantly higher when compared to the same patients at baseline ($p=0.0003$, 2-tail paired t-test) or to the control patients ($p=0.0001$, 2-tail t-test). OC velocity was 5.5 m/s in the patient with the deformed OC. Abnormal biphasic IC flow was seen in 5 patients and its occurrence frequently heralded hemodynamic decompensation. Overall echo Doppler sensitivity for LVAD conduit dysfunction was 88%. **Conclusion:** Echo Doppler features of LVAD conduit dysfunction include high conduit velocities and biphasic conduit flow.

1209-149 Echocardiographic Evaluation of the Jarvik 2000 Axial Flow Pump

Mihai Croitoru, Oscar H Frazier, Robert Jarvik, Branislav Radovancevic, Antonieta Hernandez, Sue Maissey, Timothy Myers, Tehreen Khan, Igor D Gregoric, Raymond F Stainback. *St. Luke's Episcopal Hospital/Texas Heart Institute, Houston, TX*

Background: Left ventricular assist devices (LVAD) are now used as "bridge to transplantation" therapy. Axial flow pumps offer advantages over the current systems (small size; simple, valveless construction; less extensive surgery) and are likely to be the next generation of clinically applied LVAD. We report the echocardiographic evaluation of 4 end-stage cardiomyopathy (CMP) patients post Jarvik 2000 axial flow pump implantation

at our institution. **Methods:** We analyzed 16 complete echo exams in 4 pts, 1-38 days after implantation. Twelve studies included 5 incremental pump speed settings (8000-12000 rpm), and in 9 cases the pump was temporarily turned off. We measured aortic valve opening time and calculated flow through the LV outflow tract (LVOT), the RV outflow tract (RVOT) and the pump outflow graft. **Results:** Good quality images were obtained in all studies, even those performed the day after surgery. Aortic valve opening time decreased as pump speed increased. Frequently the valve did not open above a certain pump speed. When the pump was on, significant artifact affected Doppler imaging, but did not prevent adequate evaluation. Output through the RVOT progressively increased and flow through the LVOT progressively decreased as the pump was operated at higher speeds. Mean cardiac index increased from 2.1 ± 0.3 L/min/m² with the pump off to 3.1 ± 0.5 L/min/m² at 12,000 rpm ($p=0.001$, 2-tail paired t-test). We were able to visualize the Doppler flow signal in the outflow graft in 3 patients. When the pump was off, there was systolic antegrade flow (into the aorta) and mild diastolic retrograde flow (into the ventricle) in the outflow graft. When the pump was on we observed continuous antegrade systolic dominant outflow graft flow. The systolic/diastolic flow ratio decreased as pump speed increased. Concomitantly, mean blood pressure progressively increased and pulse pressure decreased. **Summary:** The Jarvik 2000 LVAD generates outputs within physiological range in CMP patients. Less extensive surgery may explain good postoperative echo windows. During pump operation, blood flow remains phasic. Echo appears useful for evaluation and management of this device that has no flow sensor mechanism.

1209-150 Estimation of Mitral Bioprosthetic Area by Proximal Flow Convergence Velocities

John Jue, Salima Shariff, W R. E. Jamieson. *Vancouver Hospital, University of British Columbia, Vancouver, BC, Canada*

Background: The proximal flow convergence method appears promising in the evaluation of the mitral bioprosthetic effective orifice area but it assumes that the velocity isotach is hemispheric and the use of just a single measurement of the axial distance to the isotach may underestimate flow and hence the area. A non-hemispheric model of flow convergence which measures not only the axial dimension but also the lateral width has been advocated. The purpose of this study was to evaluate these 2 methods to estimate the mitral bioprosthetic area.

Methods: The effective orifice area of the Medtronic Mosaic bioprosthesis in the mitral position was estimated by the hemispheric model of proximal flow convergence using just a single axial dimension and by the non-hemispheric model using both the axial and lateral dimensions. The pressure half-time of the Doppler transmitral flow was also used. These were compared to the areas obtained by the continuity equation.

Results: 36 (15 males, 21 females) patients were studied with an average age of 71 ± 12 . Valve sizes ranged from 25 to 31 mm.

	Continuity Equation	Flow Convergence Non-hemispheric	Flow Convergence Hemispheric	Pressure Half-time
Valve Area cm ²	1.85 ± 0.46	1.81 ± 0.42	1.20 ± 0.35	2.40 ± 0.60
Correlation to Continuity Eq'n	0.80	0.66	0.34	

The hemispheric flow convergence method underestimated the effective orifice area as compared to that obtained by the continuity equation whereas pressure half-time overestimated the area. The best correlation and estimation of effective orifice area was by the non-hemispheric flow convergence method.

Conclusion: The non-hemispheric flow convergence method whereby the axial length and the lateral width of the velocity isotach is measured is superior to the hemispheric flow convergence method and Doppler derived pressure half-time in estimating mitral bioprosthetic effective orifice area.

POSTER SESSION

1210 Detection of Myocardial Viability

Tuesday, March 20, 2001, 9:00 a.m.-11:00 a.m.
Orange County Convention Center, Hall A4
Presentation Hour: 9:00 a.m.-10:00 a.m.

1210-151 Adenosine Stress Echocardiography in Detection of Viable Myocardium in Postinfarcted Regions

Ana D. Djordjevic-Dikic, II, Miodrag C. Ostojic, Branko D. Beleslin, Ivana Nedeljkovic, Jelena Stepanovic, Sinisa Stojkovic, Milan Nedeljkovic, Jovica Saponjski. *Institute for Cardiovascular Diseases, Belgrade, Yugoslavia*

Background: Adenosine (Ado) as a potent vasodilator and cardioprotective agent can provoke functional improvement in dyssynergic myocardial regions. Objective: The aim of this study was to assess the potential of adenosine to improve the function of severely damaged myocardial tissue. **Methods:** Fifteen patients with resting dyssynergy, due to previous myocardial infarction (>3 months), underwent low-dose Ado (80, 100, 110 mcg/kg/min in 3 minutes intervals) stress echo test. A criterion for myocardial viability was improvement in systolic thickening of ≥ 1 grade in akinetic segments. In all patients, resting echo follow-up was obtained >3 months after revascularization procedure (5 ± 1 month). **Results:** Of 43 akinetic segments, 19 showed functional improvement during adenosine infusion. No patient developed echo or ECG signs of ischemia during low-dose Ado test. Wall motion score index (WMSI) improved significantly from rest 1.54 ± 0.33 to 1.24 ± 0.28 ($p<0.01$) at peak Ado infusion. Follow-up WMSI was 1.23 ± 0.30

($p < 0.05$ vs. rest). After revascularization, at follow up, 13 previously akinetic segments showed improvement of ≥ 1 grade (11 of them correctly identified by Ado stress echo test, sensitivity 84%, positive predictive value 57%). Lack of positive functional response on adenosine was a good predictor of non-viable tissue, reaching specificity of 73% and negative predictive value of 91%. **Conclusion:** In the akinetic infarcted regions, adenosine could provoke functional response, enabling identification of magnitude of preserved tissue that will recover after revascularization. Negative response on adenosine infusion is highly indicative of irreversible damage.

1210-152 Detection of Myocardial Viability by Hyperbaric Oxygen Treatment and Echocardiography After Thrombolysis for Acute Myocardial Infarction

Milica N. Dekleva, Velibor Obradovic, Ana D. Djordjevic-Dikic, Aleksandar Neskovic, Nenad Dikic, Biljana Pencic, Miodrag C. Ostojic. *Clinical Hospital Zemun, Belgrade, Yugoslavia*

Background: It has been proposed that hyperbaric oxygen treatment (HBO) is capable of transiently reversing hypoxia in myocardium during acute phase of myocardial infarction (MI). Objective: In order to evaluate whether early HBO (within 24 hours) can identify viable segments after acute MI, improvement of regional wall motion (RWM) after HBO was analyzed and compared to dobutamine stress echocardiography (DSE) performed in the third week and to follow up echocardiography (FUE) performed in 6th week after MI. **Method:** Thirty one consecutive pts with first acute MI treated with thrombolysis received 100% oxygen at 2 ATA for 60 minutes in a monoplace hyperbaric chamber within 24h after the onset of pain. All pts underwent 2D echocardiography immediately before and after HBO, DSE in third week and FUE in sixth week after MI. RWM analysis was performed using 16-segment model. Improvement in RWM of dyskinetic segments for ≥ 1 grade during low DSE was considered as sign of viability. Comparison of HBO echo and follow-up studies after six weeks for the detection of viability has been made using DSE as the gold standard. **Results:** There were 229 dyskinetic segments before HBO (RWM 1.83 ± 0.23). Improvement in RWM was noted in 86 segments after HBO, in 90 during DSE and in 83 after 6 weeks. Comparing HBO and DSE there were no significant difference in number of detected viable segments ($p=0.386$) and in RWM differences ($p=0.098$). The number of responding segments was time related, the shorter the time was to onset of chest pain, the more responding segments were, ($p < 0.005$). The sensitivity, specificity and positive and negative predictive value of HBO to detect recovery of viable segments are 87%, 91%, 84% and 93% respectively. **Conclusion:** Our data indicate that HBO may identify viable myocardium as early as day first after MI, and has high and comparable diagnostic value to DSE.

1210-153 Stress Induced QRS Broadening and Septal Long Axis Incoordination in Patients With Coronary Disease and Left Ventricular Dysfunction

Alison M. Duncan, Christine A. O'Sullivan, Derek G. Gibson, Michael Y. Henein. *Royal Brompton Hospital, London, United Kingdom*

Background: Stress-induced ischemia is associated with broadening of the QRS and suppression of long axis amplitude. Aim: To determine the consequences of stress-induced ischemia on ventricular electromechanical function. **Methods:** 17 controls (aged 58 ± 11) were compared with 22 patients (aged 63 ± 10) with normal left ventricular (LV) size and fractional shortening (FS $> 35\%$) and 25 patients (aged 63 ± 10 years) with ischemic LV dysfunction (FS $< 20\%$) and a restrictive filling pattern (E wave deceleration time < 120 ms). In 16/25 patients, activation was normal, and 9 had left bundle branch block (LBBB). Transthoracic echograms of septal LV long axis function at rest and at peak dobutamine stress were made with concurrent 12 lead ECG analysis. The time from the Q wave to the onset of septal long axis shortening (electromechanical EM delay) and post-ejection shortening (PES) were measured. **Results:** At rest, in controls, QRS and EM delay were 91 ± 9 ms and 81 ± 10 ms respectively, and PES was absent. In patients with normal LV function, QRS was not different from controls, (93 ± 14 ms) but EM delay was prolonged (101 ± 21 ms, $p < 0.001$), and PES was present (0.4 ± 0.8 mm, $p < 0.001$). With dilated LV, restrictive filling and normal activation, QRS was not different from controls (96 ± 13 ms) but EM delay was longer (119 ± 29 ms, $p < 0.001$), and PES was present (0.8 ± 1.2 mm, $p < 0.001$). In patients with LBBB, QRS was 150 ± 14 ms, EM delay was prolonged (203 ± 62 ms), and PES was present (1.7 ± 1.4 mm, all $p < 0.001$ compared with controls). Response to stress. The normal correlation ($r = 0.7$, $p < 0.001$) between QRS and septal EM delay was lost at all degrees of left ventricular dysfunction. **Conclusion:** In contrast to normals, stress-induced ischemic dysfunction includes broadening of the QRS, increased electromechanical delay, and exaggerated post-ejection shortening. These may be of particular value in assessing patients with ischemic cardiomyopathy before revascularization.

Variables	Controls	Normal LV cavity	Dilated LV, QRS < 120 ms	Dilated LV, LBBB
QRS (ms)	$-4 \pm 2^{**}$	$+9 \pm 3^{**}$	$+5 \pm ^*$	$+2 \pm 8$
EM delay (ms)	$-47 \pm 6^{**}$	$+8 \pm 5^{**}$	$+15 \pm 6^{**}$	-13 ± 12
PES (mm)	0	$+1.1 \pm 0.4^{**}$	$+1.0 \pm 0.4^{**}$	$+0.7 \pm 0.7$

1210-154 Myocardial Doppler Velocities During Low Level Exercise Echocardiography: Off-Line Quantitative Assessment of Myocardial Viability Early After Myocardial Infarction

Patrizio Lancellotti, Evdokia Petropoulou, Ali R. Bilge, Luc A. Pierard. *University hospital cardiology department, Liege, Belgium*

Background: Assessment of myocardial velocities by Doppler tissue imaging (DTI) is gaining importance and may offer a quantitative approach of stress echocardiography. However, its feasibility during exercise echocardiography to detect myocardial viability early after myocardial infarction is unknown. **Methods:** 30 consecutive patients (pts)

underwent exercise echocardiography 3 days after primary coronary angioplasty of the infarct related artery. Semi-supine exercise test was performed at 25 W for 6 minutes. Peak systolic velocity (PSV) was measured off-line at rest and at low charge. Functional recovery was assessed by follow up echocardiogram 1 month after the acute event. **Results:** 68 out of 320 segments analyzed were dyssynergic at rest. Contractile reserve was visually detected in 43 segments (63%). A significant increase in PSV was observed at low charge in segments with contractile reserve (CR). In contrast, PSV didn't change in segments without CR. Functional recovery occurred in 40 segments (59%). PSV at rest increased significantly from early to follow-up echocardiogram in segments that recovered. No significant change was observed in segments without functional recovery. **Conclusion:** Measurement of PSV during low-level exercise echocardiography is feasible and accurate for the identification of viable myocardium that can recover early after myocardial infarction.

PSV (cm/sec)	Rest	Low charge	Follow-up	P value
Viability	3.14 ± 1.79	6.12 ± 1.65	5.21 ± 1.53	0.004
No viability	2.14 ± 0.96	1.82 ± 0.53	1.63 ± 0.31	NS
p value	NS	< 0.0001	< 0.001	

POSTER SESSION

1211 Myocardial Contrast Echocardiography for Assessing Blood Flow Reserve

Tuesday, March 20, 2001, 9:00 a.m.-11:00 a.m.
Orange County Convention Center, Hall A4
Presentation Hour: 9:00 a.m.-10:00 a.m.

1211-155 Detection of Coronary Steal Phenomenon During Pharmacological Hyperemia by Harmonic Power Doppler Employing a Simple Pulsing Sequence in Patients With Coronary Stenosis

Yuichiro Takagi, Koji Ohmori, Akira Oshita, Yu Yang, Yoshihiro Wada, Kazushi Yukiiri, Hiroto Takeuchi, Shiro Nozaki, Katsufumi Mizushige, Masakazu Kohno. *Second Department of Internal Medicine, Kagawa Medical University, Kagawa, Japan*

Background: The relation of ultrasound pulsing interval (PI) to contrast intensity (CI) has been used to quantitate myocardial perfusion during iv myocardial contrast echo (ivMCE). We have shown in vitro and animal studies that CI difference between long and short PIs well correlates with microbubble transit velocity through the imaging field, while CI with long PI is known to represent myocardial vascular volume. We tested if the alteration of CI with harmonic power Doppler (HPD) during a simple pulsing sequence, in which the long PI was switched to the short PI, could identify coronary stenosis in patients. **Methods:** In 21 patients, who had undergone CAG, we performed ivMCE by HPD using a SONOS 5500 and 1.8/3.6 MHz transducer. Levovist[®] was infused at 1g/min. Apical images were digitally recorded while the long PI with 10:1 end-systolic ECG trigger was shortened to 1:1. Recordings were obtained at baseline and during hyperemia by 150 mg/kg/min adenosine tri-phosphate (ATP). CI was measured in 256 scale with NIH image at the regions of interest encompassing the anterior or posterior wall. **Results:** 15 normal ($< 50\%$: NML) and 12 stenosed ($> 90\%$: STN) coronary territories were free from artifacts and were analyzed. CI was constant at any territories during the long PI (10:1) but exhibited a decay to a constant value after the PI shortening (1:1) and well fit a function: $CI = a \text{Exp}(-b \text{ frame No.}) + g$, where a is the magnitude of the decay, or the difference in CI between the long and short PIs. CI during the long PI was given as a+g. At baseline, there was no difference in a or a+g between NML and STN. During hyperemia by ATP a decreased in NML (41 ± 19 to 22 ± 12 , $p < 0.001$), which confirmed that the less CI decay after the PI reduction represents the higher myocardial flow velocity in humans. In contrast, in STN, ATP increased a (32 ± 15 to 82 ± 28 , $p < 0.05$), which implied a decrease in myocardial flow velocity. Moreover, a+g was decreased by ATP in STN (189 ± 26 to 153 ± 39 , $p < 0.05$), which suggested that vascular volume, and therefore, the volumetric flow decreased during ATP in STN. **Conclusion:** CI decay following PI shortening may be useful to detect coronary stenosis by evidencing coronary blood steal phenomenon induced by ATP in patients.

1211-156 Assessment of Regional Myocardial Blood Flow and Coronary Flow Reserve Using Myocardial Contrast Echocardiography With Power Pulse Imaging: Comparison With Neutron Activated Microsphere

Banthit Khankirawatana, Suwanee Khankirawatana, John Lof, Jodie Hallgren-Golka, Thomas R. Porter, Leng Jiang. *University of Nebraska Medical Center, Omaha, NE*

Quantification of regional myocardial blood flow (MBF) and myocardial flow reserve (MFR) are important in assessing severity of coronary artery disease. Myocardial contrast echo with power pulse inversion technique (PPI) allows real-time MBF imaging at a low emission power and background subtraction of tissue signal. Regional MBF can be quantitated from the product of MBF velocity, which is the rate of myocardial microbubble replenishment after an ultrasound pulse destruction at a high mechanical index, and myocardial blood volume. To assess the accuracy and feasibility of PPI in assessing regional MBF and MFR, 8 open chest dogs were studied. Left ventricle (LV) was assigned to 13 segments (base 6, mid 6, apex 1). Myocardial contrast echo-PPI was performed at baseline and during hyperemia. Regional MBF at each stage was determined by neutron activated microsphere. MFR was calculated as the ratio of hyperemic and

baseline MBF.

Results: MBF derived from PPI (PPI-MBF) correlated well with neutron activated microspheres for mid and apical LV. PPI had limited accuracy in quantitating MBF and MFR of basal LV segments. The feasibility of basal LV segments was also significantly lower than mid and apical LV segments (66% vs 89% for mid LV; and 100% for apex; $p < .001$).

	Baseline PPI-MBF	r	Hyperemic PPI-MBF	r	MFR	r
Basal LV	6.7±2.2	.50*	19.1±9.3	.51**	2.8±0.8	.50*
Mid LV	9.7±3.5	.82**	19.9±11.2	.71**	2.8±0.9	.70**
Apical LV	8.3±2.2	.94**	23.6±9.1	.92**	2.4±0.7	.78**

* $p < .05$, ** $p < .001$

Conclusion: Quantification of regional MBF and MFR by myocardial contrast echo-PPI are feasible and accurate for mid and apical LV. This real-time perfusion imaging should have important clinical implications for detection and quantification of coronary stenoses. However, other diagnostic methods may be necessary for assessment of basal LV coronary disease.

1211-157 Adenosin Infusion to Assess Coronary Flow Reserve by Myocardial Contrast Echo Is Limited by Variability of Intensity Increase Over Time

Mario Togni, Stephane Lafitte, Barry B. Peters, Ajit Raisinghani, Monet Strachan, Oiling Kwan, Anthony N. DeMaria. *University of California, Division of Cardiology, San Diego*

Although vasodilator stress produced by adenosine (ADN) infusion has been proposed to assess coronary flow reserve by MCE, few data exist regarding the magnitude and time-course of intensity change induced by this agent. Therefore, the aim of this study was to assess the time-course of opacification produced by a 6 minute infusion of ADN at 150 mg/kg/min. Studies were performed in 8 adult pts in whom ADN 99mTc-sestamibi SPECT scans were normal. MCE was performed using low-energy real-time power pulse inversion imaging (ATI) in the apical 4-chamber view during a constant IV infusion of Optison at 0.45 to 0.55 ml/min. MCE replenishment curves were acquired by plotting the return of signal intensity over time after high energy microbubble destruction and fitting the data to the exponential function $\ln = A(1 - e^{-bt})$, where A is peak plateau signal intensity and b is the rate of intensity increase. Curves were obtained at baseline and at 2 and 4 minutes into ADN infusion and A and b parameters derived for the apex (A), septum (S) and lateral wall (L). BP was unchanged while HR increased from 69 ± 9 (mean \pm SD) to 89 ± 13 at 2 minutes and 4 minutes. No significant change was observed in A for any time or segment. The b parameter increased significantly from baseline to 2 min of ADN in all segments, and then decreased to baseline values at 4 min despite continuous ADN infusion (TABLE). Thus, ADN produces a significant increase in the rate of intensity increase by MCE which varies in magnitude during continuous infusion. The data indicate that the optimal time for ADN-MCE stress is 2 minutes after starting ADN infusion.

Segment	b baseline	b 2 min	b 4 min
A	0.41 +/- 0.36	1.28 +/- 0.82 *	0.61 +/- 0.6
S	0.36 +/- 0.18	1.54 +/- 0.95 **	0.69 +/- 0.43 #
L	0.28 +/- 0.13	0.96 +/- 0.45 **	0.55 +/- 0.44 #

* $p < 0.05$ to baseline, ** $p < 0.01$ to baseline, # $p < 0.001$ to 2 min

1211-158 Potential of Dipyridamole Stress Myocardial Contrast Echocardiography for the Diagnosis of Unstable Angina

Akinobu Katoh, Hiroshi Ito, Koichi Yamamoto, Yasunori Shintani, Masashi Ikushima, Koji Tanaka, Yorihiro Higashino, Kenshi Fujii. *2-4-32 Umeda, Kita-ku, Osaka, Japan*

The combination of myocardial contrast echo (MCE) and dipyridamole (DYP) stress may allow the assessment of myocardial perfusion abnormality in ischemic heart disease. The aim of this study was to determine the ability of DYP stress MCE for the diagnosis of unstable angina in Coronary Care Unit. Study population was consisted of 22 patients (pts) referred for suspected unstable angina (UA). On admission, MCE was performed during slow intravenous bolus (2-3ml) of Levovist and intermittent harmonic power Doppler was performed with SONOS5500 at intervals of 2 or 4 cardiac cycles at baseline and 1 or 2 cardiac cycles after DYP (0.56 mg/kg). We recorded 2 chamber and 4 chamber images for visual analysis by 2 independent observers. ASE 16 segment model was used to analyze regional wall motion and perfusion. All pts underwent coronary angiography (CAG) within 24 h after MCE. PD and wall motion abnormality (WMA) were compared. **Results:** No pts showed shock, hypotension or intractable attack during the examination. CAG showed 14 pts with CAD and 8 pts without significant lesions. 11 of 12 patients with PD had significant (>75%) coronary stenosis, but only 3 of 10 pts without PD had coronary stenosis. MCE can detect myocardial ischemia with sensitivity of 79% and specificity of 70%. Region of PD was correlated with the perfusion territory of occluded coronary artery in each patient. WMA can detect myocardial ischemia with high specificity of 100% but low sensitivity of 44%. **Conclusion:** Early triggered MCE with DYP stress is safe and useful for the diagnosis of UA in the CCU. MCE showed a significant tendency to be more sensitive than WMA.

ORAL CONTRIBUTIONS

807 Featured Oral Abstract Session: Advances in Nuclear Cardiology—Bench to Outcomes

Tuesday, March 20, 2001, 10:30 a.m.-Noon
Orange County Convention Center, Room 414A

10:45 a.m.

807-2 In Vivo Detection of Endothelial Activation

Mehran M. Sadeghi, Jeffrey S. Schechner, Albert J. Sinusas, Jagat Narula, Barry L. Zaret, Jeffrey R. Bender. *Yale University School of Medicine, New Haven, CT, Hahnemann University, Philadelphia, PA*

Background: The hallmark of endothelial cell (EC) activation, an early step in the development of pathologic states such as atherosclerosis and graft vascular disease, is upregulation of EC adhesion molecules [e.g. vascular cell adhesion molecule-1 (VCAM-1)]. Presently there are no reliable non-invasive methods for the detection of local EC activation in vivo. As proof of principle for imaging EC activation, we evaluated the potential for imaging of a labeled anti-VCAM-1 antibody in a new chimeric mouse model. **Methods:** Human skin, utilized as a source for human microvasculature, was grafted to severe combined immunodeficiency mice. ^{125}I -labeled E1/6, a mouse monoclonal antibody (IgG1 κ) against human (but not mouse) VCAM-1 was evaluated for in vivo detection of EC activation in the vasculature of the skin grafts. **Results:** The Kd (21 ± 12 nM) and number of binding sites in activated [tumor necrosis factor (TNF)-treated] human umbilical vein EC ($1.9 \times 10^6/\text{cell}$) were determined by Scatchard analysis. In human skin grafts (HS), the baseline levels of VCAM-1, as detected by immunohistochemistry were markedly increased by intradermal injection of TNF. 24 hours after iv injection of $20 \mu\text{Ci}$ of ^{125}I -E1/6 (whole antibody or F(ab') $_2$ fragments) there was increased uptake of the antibody in HS relative to mouse skin (MS), as detected by autoradiography and gamma counting (Mean \pm SEM: 2.1 ± 0.2 fold, n=6 grafts). To assess differences in vascular blood volume which could affect the signal intensity, we compared the uptake of $^{99\text{m}}\text{Tc}$ -mouse RBC ($200 \mu\text{Ci}$, 10 minutes) in HS and MS. There was more $^{99\text{m}}\text{Tc}$ -RBC uptake in HS relative to MS (1.5 ± 0.3 , n=6), indicating the higher vascularity of HS. When normalized to blood volume there still was increased uptake of ^{125}I -E1/6 (1.5 ± 0.2 fold, n=3), but no uptake for an irrelevant isotype-matched control antibody (MOPC-21) (1.0 ± 0.3 fold, n=2) in HS relative to MS. **Conclusion:** These findings serve as proof of principle for in vivo imaging of EC activation. Future studies directed toward the use of highly specific, rapidly clearing antibody fragments and oligopeptides appear promising.

11:00 a.m.

807-3 Pravastatin Improves Stress Induced Radionuclide Myocardial Perfusion Abnormalities by Six Months: Coronary Artery Disease Regression SPECT Monitoring Trial

Ronald G. Schwartz, Thomas A. Pearson, Daniel J. Williford, Maria L. Mackin, Ashish Awasthi, Abrar Shah. *University of Rochester School of Medicine & Dentistry, Rochester, NY*

Background: Pravastatin improves cardiovascular event rates by 6 months in primary and secondary prevention intervention trials; however, reliable strategies to identify effective clinical response prior to clinical events have not been identified. We hypothesized improvement in major prognostic variables of radionuclide ECG-gated SPECT myocardial perfusion imaging (MPI) during serial monitoring correlates with the established time course of therapeutic effectiveness of this statin. **Methods:** We studied 20 dyslipidemic patients (35% women) with stress-induced perfusion defects by rest thallium-201 / stress technetium-99m sestamibi MPI at baseline, and performed serial studies at 6 weeks and 6 months of pravastatin 40 mg qhs. Summed scores with stress (SSS), rest (SRS) and score differences (SDS) of perfusion abnormalities were measured with a 20 segment LV model by the Cedars method. Routine quantitative LVEF and end systolic volume index (ESVI) standardized in our nuclear cardiology laboratory were also performed. **Results:** By pill count, compliance was $\geq 95\%$ in all 20 patients. (Mean \pm S.D.)

	LDL (mg/dl)	SSS	SRS	SDS	LVEF (%)	LVESVI (ml/m 2)
Baseline	134 \pm 33	12.6 \pm 5.7	4.8 \pm 4.3	7.9 \pm 4.1	54 \pm 8	41 \pm 16
6 Weeks	90 \pm 18	12.0 \pm 7.5	5.9 \pm 4.7	6.1 \pm 6.9	51 \pm 8	43 \pm 15
6 Months	95 \pm 21	9.4 \pm 6.2	5.6 \pm 5.0	3.8 \pm 6.5	53 \pm 8	39 \pm 14

LDL declined 33% by 6 weeks ($p < .001$). In contrast, group mean SSS and SDS were reduced only at 6 months ($p \leq 0.01$; paired t-test, 2-tail vs. baseline). A trend of reduced SSS at 6 weeks ($p = 0.08$) was noted. By 6 months, SSS was lower in 13, unchanged in 2 and higher in 5 patients; LVEF and LVESVI did not change. **Conclusion:** In compliant dyslipidemic patients with baseline MPI ischemic defects, (1) pravastatin therapy over 6 months improved stress perfusion abnormalities, and (2) did not change SRS, LV EF or ESVI. (3) The time course of reduced SSS and SDS paralleled documented clinical benefit rather than LDL reduction. (4) Longer term study of SPECT MPI and clinical outcomes may identify effective clinical response to statin therapy and facilitate optimal medical and / or revascularization therapy.

807-4 Nuclear Cardiology Is an Effective Gatekeeper

11:15 a.m.

Todd D. Miller, Timothy F. Christian, David O. Hodge, Raymond J. Gibbons. *Mayo Clinic, Rochester, MN*

Background: Since patients with normal single photon emission computed tomography (SPECT) images are at low likelihood of significant coronary artery disease (CAD) and have an excellent prognosis, nuclear cardiology has been proposed as a gatekeeper to prevent unnecessary cardiac catheterization (CC). The goal of this study was to examine referral patterns to CC in patients with normal myocardial perfusion by SPECT imaging.

Methods: Stress SPECT results were reviewed in 14,499 patients without history of myocardial infarction or PTCA/CABG who underwent imaging between January 1986 and December 1995.

Results: Referral to CC within 3 months after SPECT occurred in 1905 patients (13%). SPECT images were normal in 7617 patients (53%). Only 99 patients (54 men, 45 women, age 60±11 years) without perfusion defects, representing 0.7% of the total population and 1.3% of those without perfusion defects, were referred for CC. Thirty-four patients had a clinical history of typical angina. Five patients had a myocardial infarction or cardiac arrest after SPECT. Other important findings included an ischemic ECG in 32 patients, cardiac enlargement in 11 patients, and increased T₋₂₀₁ lung uptake in 4 patients. CC results are summarized below (see Table).

	No CAD	1-vessel	2-vessel	3-vessel
# of patients	67	14	12	6

Conclusions: 1) Referral to CC in patients without perfusion defects on SPECT images is very uncommon, indicating that nuclear cardiology serves as an effective gatekeeper. 2) A significant percentage of patients with normal myocardial perfusion by SPECT imaging referred for CC have clinical or stress SPECT findings worrisome for CAD despite the perfusion image results. 3) Triple-vessel CAD resulting in "balanced hypoperfusion" as a cause of normal perfusion images occurs in a very small percentage of patients.

11:30 a.m.

807-5 Multicenter Evaluation of Automated Quality Control of Transmission Scans for Attenuation Correction in Myocardial Perfusion SPECT

James R. Galt, Samia M. Arram, James A. Case, James Cullom, Isam Habboush, Ling Shao, Horace Hines, Timothy M. Bateman, Ernest V. Garcia, Multi-Center Trial Investigators. *Emory University School of Medicine, Atlanta, GA, Cardiovascular Consultants, Kansas City, MO*

Background: Widespread acceptance of routine clinical utilization of attenuation correction (AC) for myocardial perfusion SPECT has been hampered by concerns about image inconsistencies and inaccuracies. Recent research has focussed attention on the variable quality of transmission scans (Tx), due to technical violations poorly understood by most physicians and technologists. We therefore developed a series of automated quality control (AQC) algorithms that assess and report on Tx quality. This multi-center evaluation was designed to validate performance of the Tx AQC.

Method: Experts from 6 independent labs agreed to prospectively test AQC in consecutively imaged pts. A total of 232 pts were imaged (306 scans: 232 stress, 74 rest), ranging from 15 to 69 per lab. Tx were acquired with Gd-153 scanning line sources simultaneous with Tc-99m myocardial perfusion SPECT (ADAC Vantage Pro™ with ExSPECT II™). AQC tested for *low transmission counts* due to weak sources and/or large pts, *truncation* of the body from the camera's field of view, and *banding* due to mechanical malfunctions or erratic heart beats in gated acquisitions. The results of the AQC were available to the operator immediately after acquisition and when the emission scans were read. Each lab completed surveys comparing their visual assessment of the Tx with the AQC.

Results: Inadequacies in Tx were recorded as Visualized (V) or Non-Visualized (NV) from the visual assessment and Reported (R) or Not-Reported (NR) from the AQC. Concordance between the two is given in the table.

Exam	Test	% Concordant		% Discordant	
		NV&NR	V&R	NV&R	V&NR
Stress	Low Counts	78	6	15	1
	Banding	98	0	1	1
	Truncation	52	28	20	0
Rest	Low Counts	61	1	38	0
	Banding	100	0	0	0
	Truncation	65	15	17	3

Note the high degree of concordance. Importantly, note that in the discordant cases, very few violations were recognized by visual assessment but not by the AQC.

Conclusion: This multi-center validation of Tx AQC in myocardial perfusion SPECT indicates a high sensitivity to Tx violations. Thus, the AQC algorithms provide the clinician with a valuable tool to objectively identify Tx that should be closely scrutinized due to their potential to erode the attenuation corrected SPECT image quality.

11:45 a.m.

807-6 Incremental Prognostic Value of Gated Myocardial Perfusion SPECT in Elderly Patients

Sean W. Hayes, Enrique F. Schisterman, Howard C. Lewin, Leslee J. Shaw, Raluca D. Agafitei, John D. Friedman, Guido Germano, Daniel S. Berman. *Cedars-Sinai Medical Center, Los Angeles, CA*

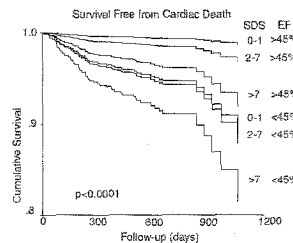
Background: Stress myocardial perfusion SPECT (MPS) effectively risk stratifies elderly patients for cardiac events, but the incremental value of ejection fraction (EF) from gated MPS is unknown.

Methods: Of 2003 consecutive patients ≥ 70 years old who underwent exercise or adenosine gated MPS, 26 (1.3%) were lost to follow-up and 238 pts were censored for early revascularization (≤ 60 days post MPS). The remaining 1739 pts were followed up 662 ± 238 days (all ≥ 1 year). The mean age was 77.1 ± 5.2 years, 44.1% were women, and 54.3% underwent adenosine stress. Summed stress (SSS) and rest (SRS) perfusion scores were calculated by adding 20 visually assessed stress and rest segment scores using a 5-point scale (0=normal and 4=no uptake) with SSS categories of normal (0-3), mildly abnormal (4-8), or moderately to severely abnormal (>8). Summed difference scores (SDS) were the difference between SSS and SRS; SDS categories were no ischemia (0-1), mild to moderate ischemia (2-7), and severe ischemia (>7). EF categories were ≥45% and <45%. Nonfatal MI and cardiac death were classified as hard events. Risk factors, type of stress, SRS, and SDS and EF categories were evaluated by Cox proportional hazards method for predicting cardiac events.

Results: EF ($\chi^2 = 13.8, p=0.0002$) added incremental value to SDS ($\chi^2 = 9.0, p=0.0116$), SRS ($\chi^2 = 7.4, p=0.006$), and type of stress ($\chi^2 = 9.1, p=0.002$) for the prediction of cardiac death. Risk stratification by SDS and EF identified more patients (64.6%) as low risk for CD (<1% annual risk) than by SSS (49.9%) alone ($p<0.001$).

Annualized Cardiac Death Rates

	SDS 0-1	SDS 2-7	SDS >7
EF ≥45%	0.4%	0.9%	2.0%
EF <45%	5.6%	5.5%	6.4%



Conclusion: Functional data (EF) from gated MPS adds significant incremental value for risk stratification of elderly patients over perfusion data alone. Moreover, the combined assessment of function and ischemia correctly classified significantly more elderly patients as low risk than perfusion alone.

ORAL CONTRIBUTIONS

858 Three-Dimensional Echocardiography

Tuesday, March 20, 2001, 10:30 a.m.-Noon
Orange County Convention Center, Room 414C

10:30 a.m.

858-1 Real-Time Three-Dimensional Echocardiography and Cine-Ventriculography for Determining Left Ventricular Volumes in the Presence of Left Ventricular Aneurysms

Marta Sitges, Michael Jones, Takahiro Shiota, David M. Caden, Jian Xin Qin, Hiroyuki Tsujino, Fabrice Bauer, Yong Jin Kim, Lisa A. Cardon, Maureen G. Martin, Arthur D. Zetts, Julio A. Panza, Patrick M. McCarthy, James D. Thomas. *The Cleveland Clinic Foundation, Cleveland, OH, National Institutes of Health, Bethesda, MD*

Background: Cine-ventriculography (CV) has been widely used as a reference standard for left ventricular (LV) volume measurements. Three-dimensional methods theoretically provide a better approach for LV volume estimation because they do not require geometric assumptions. Our aim was to compare the accuracy of real-time three-dimensional echocardiography (RT3DE) and CV for LV volume determinations.

Methods: We studied 16 sheep with LV aneurysm and 9 sheep without LV aneurysm (6 normal, 3 with chronic mitral regurgitation (MR)). Both end-diastolic (EDV) and end-systolic (ESV) LV volumes were determined by RT3DE and biplane CV (RAO+LAO). Stroke volume (SV) was derived by subtracting ESV from EDV. Ejection fraction (EF) was also derived. Electromagnetic flow probes (EM) placed around the aortic root and at the mitral annulus for the MR sheep, were used to determine the reference SV. Additionally, 7 patients with LV aneurysms were studied with RT3DE and single plane CV (RAO).

Results: In animals, correlation between SV by RT3DE and by EM was excellent ($r = 0.98, \Delta = -1 \pm 1.4$ ml, $p<0.01$), while correlation between SV by CV and by EM was only fair ($r = 0.53, \Delta = -4 \pm 7$ ml, $p<0.01$). However, when only non-aneurysmal LV ($n = 9$) were considered, correlation between CV and EM derived SV was also good ($r = 0.82, \Delta = -6 \pm 7$ ml, $p<0.01$). No significant correlation was found between SV by CV and by EM in sheep with LV aneurysms ($r = 0.36, p = NS$). Good correlations were found for EDV, ESV and EF by RT3DE and by CV although CV showed a tendency to underestimate LV volumes as compared to RT3DE ($r = 0.82, \Delta = -7 \pm 18$ ml for EDV; $r = 0.83, \Delta = -4 \pm 17$ ml for ESV; r

= 0.80, Δ = $-2\pm 9\%$ for EF). In patients with LV aneurysms, all LV volumes were underestimated by CV as compared to RT3DE, although EF was not significantly different by the two methods (see table)

	RT3DE	CV	p
EDV (ml)	202 \pm 57	125 \pm 43	<0.01
ESV (ml)	140 \pm 46	85 \pm 42	<0.05
SV (ML)	62 \pm 21	40 \pm 13	<0.05
EF(%)	32 \pm 9	34 \pm 15	NS

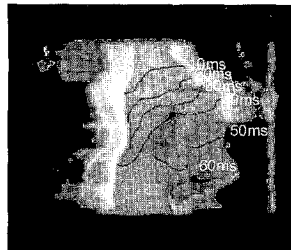
Conclusions: RT3DE provides an easy and feasible approach for determining LV SV and can be used as a more accurate reference standard than CV, particularly when asymmetric cardiac chambers are involved.

10:45 a.m.

858-2 True Electro-anatomical Mapping Achieved by the Simultaneous use of a Right Atrial Basket Catheter and 3D Intracardiac Echocardiography

Ron D. B. Simon, Reza Razavi, Marc Miquel, Artur Baszko, Edward J. Baker, Jaswinder S. Gill. *Guy's and St Thomas' Hospitals, London, United Kingdom*

Background: As ablation becomes more anatomical, based upon application of linear lesions between non-conducting anatomical / electrical areas, the identification of detailed anatomy together with electrical behaviour becomes increasingly important. This study aims to achieve true electroanatomical mapping by the use of 3D intracardiac imaging of the right atrium combined with use of a right atrial basket to obtain detailed electrical information. **Methods:** We studied 5 patients requiring atrial flutter ablation. A 9F, 9MHz intracardiac echo catheter (Boston Scientific) was pulled back from SVC to IVC using respiratory and ECG gating. The images, recorded on a Clearview ultrasound machine, were reconstructed using commercially available software by TomTec. The intracardiac basket was placed into the atrium using the markers and the standard program to allow orientation. Both iso-potential and iso-chronal maps were obtained from the basket in sinus rhythm, pacing from different sites within the atrium and in atrial flutter. We obtained 3D cardiac MRI on a different date for anatomical validation. **Results:** Both iso-potential and iso-chronal maps could be constructed and superimposed on the ICE image. The maps with pacing were consistent with that which was expected, confirming the validity of this approach. We were able to visualise changes in activation sequence following the placement of bidirectional isthmial block. Figure: The septal wall of the right atrium with the Triangle of Koch is shown as an iso-chronal electro-anatomical map in sinus rhythm.



Conclusions: True electroanatomical mapping is possible by the use of 3D reconstruction of the right atrium with electrical activation obtained from an intracardiac basket. Further developments in software will allow this to be done simultaneously with greater rapidity.

11:00 a.m.

858-3 Quantification of Aortic Regurgitation (AR) From Mitral and Aortic (Ao) Stroke Volumes Measured Using a Three-Dimensional (3D) Digital Color Doppler Method in a Chronic Animal Model

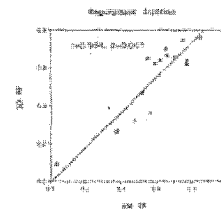
Jong-Soo Lee, Michael Jones, Paul R. Detmer, Xiang-Ning Li, Rosemary A. Rusk, Xiaokui Li, David J. Sahn. *Oregon Health Sciences University, Portland*

Background: We have developed a new color 3D method for quantifying AR flow by subtracting forward mitral from forward Ao flow, which we have tested in a chronic animal model.

Methods: The Ao valve was partially resected in 5 sheep 6 months before the study. Simultaneous hemodynamic and echo measurements were made on open-chest animals with Ao and pulmonary flow derived from electromagnetic (EM) flow meters balanced against each other. Volume loading and administration of sodium nitroprusside or angiotensin produced a total of 17 hemodynamic states. An ATL HDI5000 system was used to sequentially image aortic and then mitral flow with a 7.4MHz probe placed epicardially. 3D datasets were generated by rotational acquisition in 6° increments over 180° with a Nyquist limit of 57.7-76.9cm/sec and ECG gating to systole for the Ao and diastole for mitral inflow. Instantaneous flow rates were generated by integration of velocities perpendicular to the direction of flow over curved surfaces in the proximal ascending Ao and mitral inflow during 5-8 phases of systole or diastole, respectively. Regurgitant flow was derived by subtracting mitral from Ao forward flow for the 3D Doppler method and pulmonary from Ao flow for the EM method.

Results: There was good correlation between regurgitant volumes calculated by the 3D color Doppler method and the EM method ($r = 0.90$; $SEE = 9\%$; $p = 0.001$).

Conclusion: This digital 3D color Doppler technique accurately quantified AR in this animal model, and has major advantages over pulsed wave and 2D color Doppler methods for estimating Ao flow and especially for estimating mitral flows.



11:15 a.m.

858-4 Contrast Enhanced Real-Time 3D Stress Echocardiography Improves Endocardial Delineation and Reduces Scanning Time: Comparison With Unenhanced 3D and Conventional 2D Stress Echocardiography

Andreas Franke, Christian H. P. Jansen, Laurent Visser, Rainer Hoffmann, Harald P. Kuehl, Peter Hanrath. *Medizinische Klinik I, University Hospital, Aachen, Germany*

Because real-time 3D echocardiography (3D) allows to acquire a complete data set within one single heart beat, it could be the optimal modality for rapid image acquisition in dobutamine stress echo (DSE). However, 3D is limited by poor image quality in unselected patients (pts). To improve endocardial visibility (EVIS), a combination of 3D with second harmonic imaging (SHI) and left heart contrast agents (CON) was used during DSE and compared to standard 2D DSE.

Methods: A DSE was performed in 25 pts (62 \pm 7years, 19 male) with impaired fundamental image quality (≥ 2 ASE segments poorly visible) using a high-end 2D ultrasound machine (Agilent Sonos 5500) for 2D image acquisition from 4 standard views and a 3D scanner with SHI capability (Volumetrics) for 3D acquisition from a single apical transducer position.

At baseline and peak stress 5 complete data sets were acquired in every pt using: [1] fundamental 2D (2D), [2] harmonic 2D (2DSHI), [3] unenhanced 3D imaging (3D), [4] 2D SHI imaging with left ventricular (LV) opacification after bolus injection of 1-2 mL SonoVue™ (Bracco-Byk-Gulden; 2DCON), and [5] using 3D combined with SHI and contrast enhancement (3DCON). EVIS was analyzed in all 16 standard LV segments and graded from 0=poorly, 1=moderately to 2=well defined.

Results are given in the table.

	2D	2DSHI	3D	2DCON	3DCON
Mean EVIS score	1.1 \pm 0.3	1.4 \pm 0.4*	0.8 \pm 0.4	1.4 \pm 0.3*	1.3 \pm 0.5*
Overall % of evaluable segments (EVIS>0)	62.3	71.1	39.1**	69.3	63.0
Baseline scanning time (s)	139 \pm 54	145 \pm 52	28 \pm 8**	86 \pm 29	31 \pm 7**
Peak dose scanning time (s)	-	87 \pm 43	30 \pm 6**	59 \pm 19	21 \pm 5**

*=p<0.05 vs. 2D and 3D; **=p<0.05 3D or 3DCON vs. all other modalities

Conclusions: 2DSHI and 2DCON improved EVIS to a similar extent compared to fundamental 2D. Unenhanced 3D DSE was inadequate due to poor EVIS in a majority of segments (60.9%), whereas endocardial delineation in 3DCON was similar to 2D techniques, thus allowing future clinical use of 3D DSE with the benefit of a significantly reduced acquisition time.

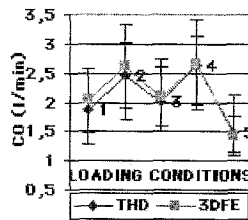
11:30 a.m.

858-5 Dynamic Three-Dimensional Freehand Echocardiography: In Vivo Validation of Cardiac Output Measurement Under Different Hemodynamic Conditions

Silvana Müller, Thomas Bartel, Guido Caspari, Raimund Erbel, Otmar Pachinger. *University Innsbruck, Innsbruck, Austria, University Essen, Essen, Germany*

Background: The purpose of the present study was to evaluate the accuracy and feasibility of transthoracic cardiac output (CO) determination using dynamic three-dimensional freehand echocardiography (D3DFE). **Methods:** In 6 anesthetized dogs the heart was exposed and suspended in a pericardial cradle. A saline bath was employed providing an interface between transducer and heart. An ultrasound system Sequoia C256 (Acuson Inc., Mountainview, U.S.A.) equipped with a 3.5/1.75 MHz receive/transmit transducer was used. To track the position and orientation of the image planes a magnetic field system (Ascension Technology Inc., Burlington, U.S.A.) was combined with a Windows NT workstation for three-dimensional image processing (TomTec Inc., Munich, Germany). CO was comparatively measured using D3DFE according to the average rotation method and thermal dilution (THD). Therefore, the animals were exposed to 5 different hemodynamic conditions (1-baseline, 2-dobutamine, 3-sodium nitroprusside, 4-saline, 5-occlusion of the left anterior descending coronary artery (LAD)). **Results:** CO obtained by D3DFE was found to be in good agreement with THD measurements: $y=0.99x+0.11$; $n=30$; $r=0.98$; $P<0.0001$; $SEE=0.094$. With respect to every single steady state there were no statistically significant differences between 3DFE and thermal dilution measurements ($P>0.05$). Data acquisition and volumetric analysis took 16.4 \pm 2.9 minutes. The

data sets can be also used for three-dimensional image reconstruction (3DIR). **Conclusions:** The novel D3DFE was demonstrated to be an accurate and multi-modal approach to CO measurements independent of hemodynamic conditions and 3DIR.



11:45 a.m.

858-6 Serial Changes of Left Ventricular Function in Dogs Following Myocardial Ischemia-Reperfusion Injury: A Real-Time 3-Dimensional Echocardiographic Assessment

Jian Xin Qin, Takahiro Shiota, Marta Sitges, Kai Wang, Zhongmin Zhou, Xiaorong Zhou, XiYi Hang, Yong Jin Kim, Fabrice Bauer, Neil L. Greenberg, James D. Thomas. *The Cleveland Clinic Foundation, Cleveland*

Background: Real-time 3-dimensional echocardiography (RT3DE) provides a unique technique to accurately quantify left ventricular (LV) volumes especially for asymmetric LVs caused by regional wall motion abnormalities. The purpose of this study was to employ RT3DE for quantitative evaluation of LV systolic function following myocardial ischemia-reperfusion injury in canine experimental models.

Methods: Acute mid left anterior descending (LAD) coronary occlusion was created by balloon catheters in 10 adult mongrel dogs. After 90 min LAD occlusion, the myocardium was reperfused by deflating the balloon. Transthoracic RT3DE was performed at baseline, after 90 min LAD occlusion, 2 hrs after balloon deflation and 1 week later. LV end-diastolic (EDV) and end-systolic (ESV) volumes were determined by RT3DE with multipanar Simpson's rule. The LV was stained by TTC to determine the size of infarcted myocardium after the animal was sacrificed.

Results: Myocardial infarction was confirmed by TTC stain in all removed heart (infarcted size $8 \pm 6 \text{ cm}^2$). In all 10 dogs, akinesis of the apical segments was observed by RT3DE during LAD occlusion and reperfusion. LV EDV was significantly decreased after 2 hrs reperfusion ($p < 0.05$) while ESV significantly increased both at 90 min LAD occlusion and after 2 hrs reperfusion (both $p < 0.05$) in comparison with those before LAD occlusion. LV stroke volume (SV) and ejection fraction (EF) significantly decreased at 90 min LAD occlusion and remained at same level after 2 hrs myocardial reperfusion. Both LV volumes and EF tended to recover after 1 week myocardial reperfusion (table).

	EDV (ml)	ESV (ml)	SV (ml)	EF (%)
Baseline	38 ± 8	15 ± 3	23 ± 7	59 ± 7
Occlusion	34 ± 6	$22 \pm 5^*$	$13 \pm 2^*$	$37 \pm 6^*$
2 hrs reflow	$31 \pm 5^*$	$20 \pm 5^*$	$11 \pm 3^*$	$37 \pm 9^*$
1 w reflow	35 ± 4	18 ± 4	$17 \pm 3^{\#}$	$49 \pm 9^{\#}$

* vs baseline $p < 0.05$; # vs occlusion and 2 hrs reflow $p < 0.05$.

Conclusion: RT3DE demonstrated that acute myocardial ischemia and reperfusion injuries caused LV regional wall motion abnormalities and significant systolic dysfunction both during LAD occlusion and during reperfusion. Despite the presence of infarcted tissues, LV function partially recovered at 1 week after reperfusion.

POSTER SESSION

1240 Quantitative Myocardial Perfusion Imaging with Echo

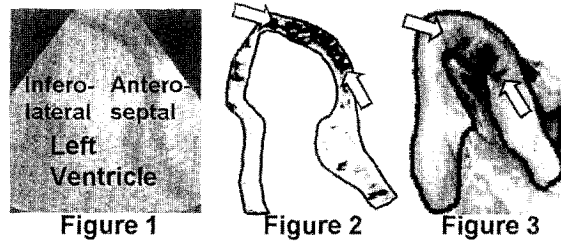
Tuesday, March 20, 2001, Noon-2:00 p.m.
Orange County Convention Center, Hall A4
Presentation Hour: Noon-1:00 p.m.

1240-133 Parametric Myocardial Contrast Perfusion Analysis: User-Independent Recovery of Harmonic Spectra From Attenuated Acoustic Signals

Marek Belohlavek, Kjetil Viggen, Toshihiko Asanuma, Virginia B. Bartleson, James B. Seward. *Mayo Clinic, Rochester, MN*

Background: Signal attenuation and subjectivity hamper differentiation of perfused and nonperfused regions by harmonic myocardial contrast imaging (MCI). We have developed an adaptive physical model of the received acoustic broadband spectra. In this study, we test fundamental and harmonic spectral recovery from acoustic data attenuated beyond perfusion differentiation by conventional MCI approaches (Figure 1). **Methods:** A physical model involving constrained Gaussian curve fitting was used to recover the fundamental and harmonic spectral components from attenuated broadband radiofrequency ultrasound signals. A ratio of the fundamental to harmonic peak spectral amplitude was calculated and used as a parameter of perfusion. The method was tested in 6 open-chest pigs after LAD coronary artery occlusion using Sonazoid microbubble infusion, intermittent MCI with a GE Vingmed System V, and interposed silicone pads to test clinically relevant (5 dB, 10 dB, and 15 dB) attenuation levels. **Results:** The model auto-

matically recovered the peak fundamental and harmonic spectral amplitudes, even at high levels of attenuation. Parametric color-coded images (Figure 2 is an example converted to B/W) were created using the fundamental to harmonic peak spectral ratio calculated for each image pixel. Correspondingly dissected stained specimens (Figure 3) were used for reference comparison of the extent of perfused and nonperfused (arrows) myocardium.



Conclusions: The novel adaptive physical model automatically recovers fundamental and harmonic spectral components at high levels of acoustic signal attenuation and generates parametric display of perfusion distribution. The technique represents an objective and quantitative approach to myocardial perfusion distribution analysis by MCI.

1240-134 Quantitative Assessment of Myocardial Perfusion by Myocardial Contrast Echocardiography With Harmonic Power Doppler Imaging

Kazuaki Tanabe, Tomoko Tani, Minako Katayama, Toshikazu Yagi, Koichi Tamita, Kenji Yamabe, Atsushi Yamamoto, Tsutomu Takagi, Junichi Nagai, Shigefumi Morioka. *Kobe General Hospital, Kobe, Japan*

Background: Harmonic power Doppler imaging with second-generation contrast agents has been used for visual assessment of myocardial perfusion. We quantitatively evaluated myocardial perfusion with harmonic power Doppler imaging during intravenous infusion of Levovist. **Methods:** We studied 53 patients with known coronary artery diseases. Myocardial contrast echocardiography with harmonic power Doppler imaging was performed during intravenous Levovist both at baseline and adenosine triphosphate (ATP) stress (0.15mg/kg/min for 2 min) in apical 4-chamber or 2-chamber view. Harmonic power Doppler imaging was done at maximal mechanical index using from 1:1 through 8:1 intermittent-triggered at end-systole. An off-line image analysis system with QuantiCon software (EchoTech 3D Imaging Systems, Germany) was used for calculating the peak intensity (dB) ratio (PIR) of color pixels of risk area to control area both at baseline and ATP stress. **Results:** Constant perfusion defect at risk area was observed in 3 patients. ATP stress revealed a reversible perfusion defect or low perfusion in 10 patients. In patients with significant stenosis (>75%) of left anterior descending artery (LAD), the rate of perfusion at risk area and PIR were significantly reduced during ATP stress compared to patients without significant LAD stenosis (PIR: 0.71 ± 0.21 vs. 0.45 ± 0.19 , $p < 0.01$). Cut-off point of PIR was 0.5 for the detection significant LAD stenosis. **Conclusions:** Quantitative assessment of harmonic power Doppler imaging during intravenous Levovist and ATP stress may detect reversible myocardial perfusion abnormality in patients with critical coronary artery stenosis.

1240-135 Power Pulse Inversion and Pulse Inversion: Do These New Techniques Allow the Recording of Contrast Replenishment Curves?

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Background: Replenishment curves following ultrasound induced bubble destruction have been found to correlate well with blood flow using Harmonic B-Mode and Power Doppler. However, these techniques are limited by high emission power and intermittent imaging. The aim of the study was to evaluate whether the two new low emission power techniques Power Pulse Inversion (PPI) and Pulse Inversion (PI) allow the real time assessment of tissue perfusion using the contrast replenishment kinetics following ultrasound induced destruction of microbubbles. **Materials:** PPI and PI imaging were performed in a kidney perfusion model during continuous infusion (0.12ml/min) of Definity™ using an HDI-5000 ultrasound machine (ATL, Bothell, WA). At steady state of tissue enhancement contrast was destroyed by emission of echo-bursts at high mechanical index ($MI=1.3$). Consecutively, contrast replenishment kinetics were assessed at low emission power ($MI=0.09$) in real-time imaging modes (PPI: 12Hz; PI: 25Hz). Regions of interest (ROI) of variable sizes were placed in the renal cortex and bigger arteries to compare replenishment of macro- and microcirculation. Non-linear curve fitting was performed using the mathematical model $y=A(1-e^{-\beta t})$ with A as the parameter describing blood volume and β as a parameter describing the velocity of contrast replenishment. **Results:** Replenishment curves could be obtained in all analyzed renal segments. A was significantly higher in bigger arteries compared to renal cortex ($p < 0.001$). β was found to be significantly higher in the arteries as compared to the cortex ($p < 0.001$). The standard deviation of β diminishes with increasing size of the ROI. **Conclusion:** The acquisition of replenishment curves following ultrasound induced destruction of contrast microbubbles is feasible at low power using PPI and PI. Assessment of replenishment kinetics allows to distinguish between macro- and microcirculation. The size and the position of the ROI have an important impact on the generation of replenishment curves in both imaging modalities.

1240-136 Real-Time 3D Echocardiography With Real-Time Volume Rendering Enhances Detection, Characterization And Localization of the Extension of Left Ventricular Apical Thrombi

Antonio J. Chamoun, Marti McCulloch, Tianrong Xie, Sangeeta Shah, Masood Ahmad. *University of Texas Medical Branch, Galveston, TX*

Background: Detection of LV apical thrombus (LVT) is commonly based on 2D echocardiography however, often the diagnosis is not conclusive. Real-time 3-dimensional echocardiography with real-time volume rendering (RT-3D-RTVR) offers unique spatial definition of LVT.

Methods: Thirty patients (pts), 52.2±13.4 yrs with a suspicious or definite LVT on 2D underwent RT-3D-RTVR on the same day. All RT-3D-RTVR studies were reviewed by two independent observers. RT-3D was considered diagnostic for LVT, if LVT was visualized in all imaging planes; negative, if it was not visualized in any plane and suspicious, if it was not visualized in all planes. LVT was characterized as echolucent, echogenic or calcified and proximal extension at 2cm from the apex was localized. Mobility was graded from fixed, to mobile and highly mobile.

Results: Five pts had definite LVT and 25 pts had suspicious LVT on 2D. By RT-3D RTVR, LVT were reclassified as definite in 16 pts, negative in 5 pts, suspicious in 4 pts and 5 pts had false tendons or trabeculae. The interobserver agreement for RT-3D interpretations of LVT was 93.3%. In 16 pts with definite LVT on RT-3D RTVR, LVT was echolucent in 8, echogenic in 10 by 2D and by RT-3D RTVR 13 pts were echogenic and 3 had calcified LVT. The mobility was graded as 14 fixed, 1 mobile and 1 highly mobile by 2D whereas by RT-3D RTVR, 3 were fixed, 11 mobile and 2 highly mobile. Extensions of the LVT at 2 cm from the apex defined only by RT-3D RTVR were inferoseptal 3, inferolateral 3, anteroseptal 3, inferolateral 3, 1 inferoseptal and inferolateral and 2 in all four locations. Figure (arrows) show an apical thrombus in 2D 4-chamber view which was a false tendon by RT-3D RTVR viewed from apex to base.

Conclusions: RT-3D clarifies echo findings in 2D suspicious for LVT and offers improved definition of echogenicity, mobility and extension of LVT. These findings may potentially impact medical management of this growing patient population.



POSTER SESSION

1241 Computed Tomography/Magnetic Resonance Imaging: Coronary Calcification—Risk and Correlates

Tuesday, March 20, 2001, Noon-2:00 p.m.
Orange County Convention Center, Hall A4
Presentation Hour: Noon-1:00 p.m.

1241-137 Coronary Artery Calcium Scores Show Excellent Agreement Between Fast Gated Helical CT and EBCT in Two Large Populations of Similar Age and Coronary Risk

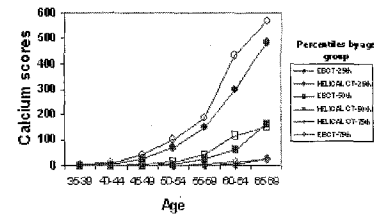
Peter L. Thompson, David Grout, Mark Nidorf, Sudheera Nair, Ross G. T. Walker. *West Australian Heart Research Institute (Gairdner Campus), Perth, Australia, Sydney Heart Image of Sydney Adventist Hospital, Sydney, Australia*

Background: Recent direct comparisons in small number of subjects show excellent correlation of assessment of coronary artery calcium score by EBCT and fast gated helical CT. Since large-scale direct comparisons are unlikely, we performed an indirect comparison of the techniques in two large series.

Methods: Subjects were examined using a Toshiba Aquilion fast gated helical CT (n=7409) and compared with data published by Raggi et al (Circulation 2000; 101:850-5) using the Imatron EBCT (n=9728).

Results: There were no differences between the groups in mean age, proportion of smoking, diabetes and a family history of coronary artery disease; there was higher proportion of hypertensive subjects in the EBCT group. The percentiles of coronary artery calcium scores were compared by age. In each 5 year age group there was excellent correlation between the two methods for calcium scores in the 25th percentile (r=0.91), 50th percentile (males, r=0.94 and females, r=0.99) and 75th percentile (males, r=0.99 and females, r=0.91).

Conclusion: Scanning using fast gated helical CT and EBCT have similar capacity to detect and quantify coronary atherosclerosis.



1241-138 Coronary Calcium Score > 1000: A Very High Risk Subgroup for Myocardial Infarction or Death Identified by Electron Beam Tomography Screening

Roberto Wayhs, Allan B. Zelinger, Paolo Raggi, V. Ganeshram. *Christ Hospital and Medical Center, Oak Lawn, IL, University of Illinois-Chicago, Chicago, IL*

Background: High coronary calcium scores measured on Electron Beam Computed Tomography (EBCT) have been shown to correlate with greater total plaque burden and with the presence of angiographically significant coronary artery disease (CAD). We sought to determine the incidence of hard coronary events (HCE), defined as myocardial infarction and coronary death, in a cohort of asymptomatic persons screened by EBCT and found to have very high calcium scores (CS>1000). We also compared the HCE rate in this cohort with that of symptomatic historical controls with severe abnormalities on SPECT perfusion imaging. **Methods:** We followed the clinical outcomes of 104 asymptomatic subjects who underwent EBCT and had an initial CS>1000. 6 subjects were excluded from f/u because EBCT results led to immediate further assessment by stress testing or angiography. **Results:** The results of the clinical f/u for HCE are reported in table 1. Subjects with CS>1000 suffered a HCE at an annualized rate of 25% and those with events had greater initial CS's than subjects without HCE. The rate of HCE in subjects with CS>1000 was significantly higher than that of historical symptomatic controls with severe perfusion abnormalities on SPECT imaging, who suffered HCE at an annual rate of 10-15% (p<0.02). **Conclusions:** The presence of very high calcium scores (CS>1000) on a screening EBCT in asymptomatic persons portends a very high risk for HCE in the short-term. This risk appears to be even greater than the risk associated with a severe abnormality on a SPECT perfusion study conducted in symptomatic patients.

EBCT / SPECT

	Number of Pts	Age	Men	Score	Average Months to HCE	Annualized Rate
EBCT	98	62	71%	1328 (±287)	17.5	25%*2,*4
EBCT (pts with HCE only)	35	61	77%	1548 (±296)	17.5*1	42%*2,*3 (100% by 28 mo) *1 p<0.05 *2 p<0.02
SPECT	1000	50-75	65%	Severe Defects	24-36*1	15%*4,*3 *3 p<0.01 *4 p<0.02

1241-139 Coronary Artery Calcification Scanning for Chest Pain in the Emergency Department: A Prospective Blinded Study

Dennis A. Laudon, Thomas R. Behrenbeck, Larry F. Vukov, Patrick F. Sheedy, II, John A. Rumberger, Jerome F. Breen. *Mayo Clinic, Rochester, MN*

Background: Chest pain results in more than 6 million Emergency Department (ED) visits each year in the U.S. This prospective, blinded study was undertaken to assess if coronary calcification scanning by electron beam computed tomography (EBT) would assist in the rapid and safe work-up of these patients. **Methods:** The study consisted of 270 patients admitted to the ED of a large tertiary care hospital (111 women aged 40-64 years (mean 51.8) and 159 men aged 30-55 years (mean 44.0)). Patients presented with angina-like chest pain, had indeterminate initial ED evaluations (negative enzymes, non-diagnostic ECG), and were admitted for further evaluation to the chest pain unit. All patients underwent EBT of the coronary arteries during the ED visit, along with other cardiac testing as deemed necessary by staff physicians. Attending physicians were blinded to the results of the EBT scan. Patients were followed for six months post visit for cardiac events (MI, cardiac death). **Results:** Of the 270 enrolled patients, 263 underwent other cardiac testing. This cardiac testing included TMET (n=207), coronary angiography (n=48), stress radionuclide testing (n=29) and echocardiography (n=43). Results of EBT and cardiac testing were concordant in 166 patients (63%) (negative 132 patients (50%), positive 34 patients (13%)), positive for EBT and negative for cardiac testing in 95 (36%). During follow-up, no cardiac event was recorded in patients with a negative scan. At presentation, a negative EBT was associated with positive cardiac testing in 2 patients. One patient had a false positive TMET by an independent staff cardiologist review (patient was cardiac event free at one-year follow-up). The other negative scan occurred in a young male with an acute anterior MI requiring stenting of a 90% stenosis. The sensitivity of EBT was 97% with a negative predictive value of 99.3%. Specificity was 60%. **Conclusion:** 1) Coronary artery calcification scanning with EBT is a rapid and efficient screening tool for patients admitted to the ED with angina-like chest pain and indeterminate initial evaluations. 2) Our study suggests that a negative coronary calcification scan allows rapid discharge from the ED.

1241-140 Long-Term Changes in Coronary Calcium Score as Evaluated by Electron Beam Tomography Scan

Raul Alonso, Rachel Eidelman, David G. King, Gervasio Lamas, Arthur Agatston. *Mount Sinai Medical Center, Miami Beach, FL*

Background: Electron beam computed tomography (EBT) is a noninvasive technique used to quantify coronary calcium. Recent studies have calculated yearly rates of progression of calcium score (CS) based on short to medium term follow-up. Rates of CS progression over a decade have not been reported. **Methods:** In 1988 to 1992, volunteers were scanned on an Imatron C-100 EBT scanner, using the standard protocol (Agatston method). Follow-up scans were performed on 45 survivors between 1999 and 2000 with an Imatron C-150 XT scanner. **Results:** Age at baseline, was 49±10 (range 29–69). Thirty-six (80%) were men. The average follow-up period was 123 ±14 months (range 96 to 143). The average CS at baseline was 46 ±114 (range 0 to 560). There were 23 subjects with an initial score of 0. For all, the average 10 year follow-up CS was 213 ±424 (range 0 to 2376; p<0.001). Subjects with a CS of zero at baseline had an average CS of 9±15 (range 0 to 46; p=0.014). Subjects with a CS >0 at baseline increased an average of 333 ±408 (range -2 to 1815). The rate of increase in CS for patients with an initial CS>0 was 31±36 per year (range 0 to 160, median 20). In order to control for baseline score, we normalized the 10-year increase in score and expressed it as percent of baseline score. Subjects with a baseline CS >0 increased by 77% ±20 per year (range -12% to 348%, median 42%). Age at baseline did not correlate with CS increase at follow-up. However, in the overall group, 10-year CS increase correlated closely with baseline CS (R=0.8; p<0.001). **Conclusions:** CS over a 10-year follow-up exhibits a bimodal progression. Subjects with a CS=0 at baseline, increase minimally. In contrast, those with a CS>0 increase substantially. In interventional studies using CS to measure coronary disease progression, subjects with a high CS at baseline should be selected. These long-term results suggest that for those with a CS = 0 at baseline, re-scanning within a decade will be of limited utility.

1241-141 Physical Activity and Coronary Calcium: The Cedars-Sinai Cardiovascular Observational Study

Arlene Ledesma, Enrique F. Schisterman, Howard C. Lewin, Sean W. Hayes, John D. Friedman, Guido Germano, Ishac Cohen, Romalisa S. Miranda, Amy M. Gallagher, Daniel S. Berman. *Cedars-Sinai Medical Center, Los Angeles, CA*

Background: Physical activity has long been recognized as a protective factor against cardiovascular disease; however, the active biological mechanisms are not yet completely understood. **Methods:** Cardiac electron beam computed tomography (EBCT) was performed in 2,969 healthy participants (age=53.99±10.55) of the Cedars-Sinai Cardiovascular Observational Study. The total coronary calcium score (CCS) was determined using the Agatston method. A self-reported physical activity score (scale 0-10, 0=none to 10=greatest) was assessed in all study participants along with measurements of known risk factors, serum lipids and glucose. Multivariate regression analysis was utilized to evaluate the relationship between CCS and physical activity. CCS was log transformed for purposes of this analysis. **Results:** Mean CCS and physical activity were 223.20±556.24 and 5.25±2.20, respectively. As previously reported by others, age, gender, total cholesterol, glucose and body mass index were strongly associated with CCS. After adjusting for these possible confounders, physical activity was found to be inversely associated with CCS ($\beta = 0.02$, p<0.05). **Conclusions:** The findings support previous studies that physical activity is significantly and inversely associated with coronary calcium score by EBCT, consistent with its important role in the prevention of coronary atherosclerosis.

POSTER SESSION

1242 Refining Risk Stratification: Global Scores and Beyond

Tuesday, March 20, 2001, Noon-2:00 p.m.
Orange County Convention Center, Hall A4
Presentation Hour: Noon-1:00 p.m.

1242-142 Predictive Probability of Cardiac Death for Clinical, Exercise, and Myocardial Perfusion Data Using Cross Validation Techniques

Enrique F. Schisterman, David Faraggi, Guido Germano, Daniel S. Berman. *Cedars-Sinai Medical Center, Los Angeles, CA, Haifa University, Haifa, Israel*

Background: Accurate classification of an individual's risk of cardiac death (CD) is central in guiding patient (pt) management. However, methods for accurately combining clinical and non-invasive test information have been lacking. The purpose of this study was to create a series of predictive models that estimate the individual probability of CD and its confidence intervals based on information available in a given patient and to compare the discriminating ability of the models for CD based on a standard cut point of 1% annual CD. **Methods:** A series of 16158 consecutive pts who underwent rest Tl-201/stress Tc-99m sestamibi dual-isotope myocardial perfusion SPECT (MPS) were followed up for CD (mean follow-up 1.62±0.73 years, all follow-up > 1 year, 6.1% lost to follow-up). The cohort was randomly divided into a learning set (n=8,173) and a validation set (n=7,985). The learning set contained 180 pts suffering CD and 7993 controls. From the controls, we randomly selected 360 pts without replacement to create 10 groups of live pts. Each of these groups were then paired with the 180 CD pts to create 10 datasets.

Using logistic regression, we estimated the effects in 9 different models for each of the datasets and its variance-covariance matrix. The factors considered to create the models were age, sex, symptoms, history of coronary artery disease, diabetes, smoking, diastolic pressure, hypertension, family history, rest electrocardiogram, Duke treadmill score, type of stress test, and nuclear variables (summed rest score and summed stress score). Correction for prevalence of disease was implemented. We validated these models with the validation set and estimated the area under the ROC curve for each model. Sensitivity and specificity for CD were calculated. Results for the basic and most comprehensive of the 9 models:

	Area	Sensitivity	Specificity
Age, sex, symptoms, prior MI	0.77	0.93	0.38
Full model (all sig. risk factors)	0.85	0.94	0.56

Conclusions: Robust models using random sampling of controls and cross validation techniques have been developed which accurately estimate the probability of CD in individual patients. These models may be clinically useful in guiding patient management decisions.

1242-143 Low Event Rate in Patients Undergoing Stress Only Perfusion Imaging With Attenuation Correction

Peter B. Gibson, William Hudson, Lynne L. Johnson. *Rhode Island Hospital/Brown University, Providence, RI*

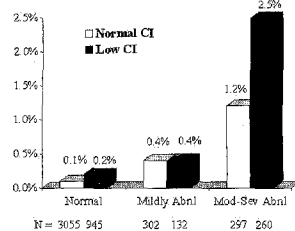
Background: The need for performing rest in addition to stress imaging to confirm normalcy is due largely to defects created on the stress images by attenuation artifacts. A low cardiac event rate in patients undergoing stress only perfusion imaging with attenuation correction (AC) would help validate the safety of this imaging modality. **Methods:** Patients with moderate pretest probability for CAD referred for chest pain evaluation from 7/1/97 to 7/1/99 were scheduled for a 2 day stress/rest gated SPECT perfusion imaging study with Tc-99m sestamibi. Patients were imaged on a variable angle camera with AC using Gd-153 scanning line sources (Vantage™ ADAC, Milpitas CA). If the stress scan with AC was normal the patient did not return for rest scan and was followed. Patients whose stress scans showed subdiaphragmatic activity or incomplete correction for attenuation artifact and patients with known cardiomyopathy or low LVEF on gated study underwent rest imaging. **Results:** 664 patients had stress only AC SPECT studies. Follow-up was obtained on 528 (80%). There were 189 males and 339 females. The mean follow-up was 23±6 months. The age at the time of scan was 51±12 years. The mean weight was 180±40 lbs and mean height was 66±4 inches. Risk factors included the following: 13% had diabetes, 40% had a positive family history of CAD, 25% smoked cigarettes, 42% had hypertension, and 30% had hyperlipidemia. Of the women 25% were post-menopausal. All patients ran on the treadmill. The mean treadmill time was 6 mins and 23 sec. The mean peak HR achieved was 146±19 or 92±12 percentage of predicted. Stress ECG's were non-ischemic in 88%, ischemic in 3%, and borderline in 8%. The non-AC stress perfusion SPECT images showed either breast or diaphragmatic attenuation artifacts of moderate severity in 33% of patients and mild or minimal in the remainder. During the follow-up time there were 2 non-cardiac deaths (CVA and lung cancer) and one non-fatal MI giving the overall cardiac event rate of 0.002. **Conclusion:** These results support stress only imaging in medium probability patients as a safe, time, and cost efficient imaging modality.

1242-144 The Incremental Prognostic Value of Chronotropic Index on the Prediction of Cardiac Death in Patients Undergoing Myocardial Perfusion SPECT Imaging

Babak Azarbal, Howard C. Lewin, Enrique F. Schisterman, Sean W. Hayes, John D. Friedman, Ishac Cohen, Xing-Ping Kang, Daniel S. Berman. *Cedars-Sinai Medical Center, Los Angeles, CA*

Background: The chronotropic index (CI), a measure of heart rate (HR) response to exercise that accounts for age, physical fitness, and resting HR, has been shown to be an independent predictor of cardiac death (CD) in pts undergoing stress testing. Previous work comparing CI to Myocardial Perfusion SPECT (MPS) has considered MPS as simply normal or abnormal. We sought to determine the prognostic value of CI when combined in a comprehensive MPS model. **Methods:** 5558 consecutive pts undergoing exercise MPS with no history of angiography, revascularization (revasc), heart failure, or valvular heart disease, and not on beta-blockers were followed-up for 20.8±4.5 months (96% complete) for CD; all follow-up>1 year. 329 pts underwent early revasc and were censored from prognostic analysis. CI was defined as %HR reserve/% metabolic reserve. A low CI was defined as CI < 0.8, as previously reported. MPS interpretation was performed using a 20-segment, 5-point model from which the summed stress score (SSS) was derived. Pts were categorized based on the SSS. Cox regression models were performed. **Results:** The pt population was 59% male, 61±12 years old, with 5% of pts having a history of MI. 1337 (27%) pts had a low CI and there were 27 CD during the follow-up period. After adjusting for the univariate predictors of CD (age, pre-test likelihood of ischemia, family history of CAD, and history of MI), both the SSS and the CI were found to be predictive of CD (p<0.001 and p=0.004, respectively). There was significant stratification for CD across the SSS categories (p<0.05) with further stratification of pts with mod-severe SSS by the CI (p < 0.05). **Conclusions:** The CI provides incre-

mental value for prediction of CD when combined in a comprehensive MPS model. Pts undergoing exercise MPS with a mod-severe SSS who had a $CI \geq 0.8$ are at relatively low risk for CD and may benefit from aggressive medical therapy as opposed to revasc.



1242-145 Prognostic Value of Ischemic Localization on Myocardial Perfusion SPECT

Xingping Kang, Daniel S. Berman, Enrique F. Schisterman, Sean W. Hayes, Howard C. Lewin, James Gerlach, Ishach Cohen, Guido Germano, Raluca D. Agafitei, John D. Friedman. Cedars-Sinai Medical Center, Los Angeles, CA

Background: Whether the location of myocardial ischemia provides prognostic information is unclear. **Methods:** We studied 4,366 consecutive pts (age 68 ± 11 , 31% females) who had a rest 201Tl/stress 99mTc sestamibi dual-isotope myocardial perfusion SPECT (MPS) with a stress perfusion abnormality in a single coronary territory. MPS was scored visually using a 20-segment, 5-point scale system (0=normal, 4=absent uptake). Summed stress scores (SSS) were obtained by adding the 20 segment scores. SSS 4-8 was mildly (M) and SSS >8 moderately to severely (S) abnormal (abnl). 4,199 pts (96.2%) were followed for 23.5 ± 7.6 months. 540 pts (12%) with early revascularization (revasc) (<60 days after MPS) were censored for prognosis analysis. **Results:** (See Table) The rates for cardiac death (CD), nonfatal MI, referral to early cath and early revasc were stratified for M vs. S abnl according to defect territory [left anterior descending (LAD, M/S=824/684), left circumflex (LCX, M/S=417/157), or right coronary (RCA, M/S=1181/936)]. After adjusting for history and pre-scan likelihood of CAD, and severity of MPS defect, Cox proportional hazard model showed no difference among the coronary territories with respect to MI-free survival ($p=ns$).

	LAD	LCX	RCA
SSS	$10.7 \pm 6.9^*$	7.9 ± 4.0	9.9 ± 5.3
CD(M/S)	2.1%/4.7%†	2.6%/2.5%	1.9%/5.4%†
MI(M/S)	3.0%/3.4%	2.4%/2.5%	2.6%/3.0%
Cath(M/S)	21%/37%†	20%/39%†	20%/26%†‡
Revasc(M/S)	8%/23%†	9%/24%†	9%/15%†‡

* $p < 0.05$ among groups; † $p < 0.05$ vs. M group; ‡ $p < 0.05$ vs. other groups. **Conclusions:** In pts with a single defect on MPS, CD and MI occurred at similar rates for all 3 territories. Compared to other territories, severely abnl RCA defects had lower early cath and revasc rates, and severely abnl LCX defects had a trend toward lower CD.

1242-146 Infarct Size as a Longterm Indicator of Outcome After Coronary Bypass Surgery (CABG)

Kheng-Thye Ho, Todd D. Miller, Timothy F. Christian, David O. Hodge, Raymond J. Gibbons. Mayo Clinic, Rochester, MN

Background: Infarct size measured early post-MI predicts outcome after thrombolytic therapy. We prospectively studied if infarct size measured by SPECT TI-201 imaging pre-operatively was associated with outcome post-CABG. **Methods:** 211 patients underwent TI-201 imaging between 1/1/89 - 12/31/91 and first CABG within 3 months after the study. Infarct size was quantitated by the number of pixels in five short-axis slices falling below a threshold of 70% of maximal counts per slice according to previously reported formulae. The outcome endpoint was cardiac death post-CABG. Follow-up was 97.7% complete at a median of 6.8 years. **Results:** The mean age was 65 years, 168 (80%) were male. 56 (25%) had evidence of a previous myocardial infarction. The majority had triple vessel (61%) or left main (27%) CAD at the time of operation. Mean pre-operative LVEF was $61 \pm 16\%$. Mean time to surgery after imaging was 19 ± 21 days. 57 patients (33%) of the cohort had increased pulmonary uptake of TI-201 on stress imaging. The quantitative mean left ventricular infarct size was $13.0 \pm 14.1\%$. There was only 1 post-operative death in the cohort. Over 6.8 years, there were 30 cardiac deaths and 28 non-cardiac deaths. 25 patients had non-fatal MIs and 16 had repeat revascularization procedures performed beyond three months after CABG. The 5-year survival free of cardiac death after CABG was 92.5% in general and 93.8% and 90.0% for infarct size < 20% and > 20% respectively. Infarct size was significantly associated with cardiac death (chi-square = 6.7, $p = 0.0094$). **Conclusions:** Quantitative infarct size assessed by SPECT TI-201 imaging is predictive of survival free of cardiac death after CABG. Infarct size of 20% of the left ventricle identifies the patients with worse outcome.

1243 Topics in Clinical Echocardiography

Tuesday, March 20, 2001, Noon-2:00 p.m.
Orange County Convention Center, Hall A4
Presentation Hour: Noon-1:00 p.m.

1243-147 Superior Safety of Optically-Guided Versus Traditional Transesophageal Echocardiography

Marco R. Di Tullio, Jonathan E. Aviv, Ian S. Storper, Christine D. Bussey, Deborah R. Gersony, Sang Kim, Joel Guss, Mark Murphy, Steven Corwin, Shunichi Homma. Columbia University, New York, NY

Background: Transesophageal echocardiography (TE) is a remarkably safe semi-invasive procedure. Major complications, such as pharyngeal or esophageal lacerations, are rare, but potentially devastating. The frequency of minor trauma to the hypopharyngeal and laryngeal structures is not established, and may be greater than commonly believed. **Methods:** We performed TE under transnasal endoscopic monitoring in 60 consecutive patients (22 M, 38 F) referred for TE. Patients were randomly assigned to have TE performed in the traditional, blind fashion (32), or under direct visualization (28). TEs were performed by operators with different levels of expertise. The frequency of complications and hypopharyngeal or laryngeal contacts by the TE transducer was assessed by two otolaryngologists blinded to the patients' study condition.

Results: No major complications were observed with either technique. Minor, self-limiting complications not requiring intervention were observed in 7/32 cases (21.9%) with the traditional technique (4 superficial mucosal abrasions of pyriform sinuses, 1 mucosal abrasion of the posterior pharynx, 1 pyriform hematoma, 1 arytenoid hematoma), and in 0/28 cases (0%) with the optical technique ($p=0.009$). These complications were significantly more frequent in patients under therapeutic systemic anticoagulation (5/11, or 45.5%) than in patients not anticoagulated (2/21, or 9.5%; $p=0.03$). Frequencies of hypopharyngeal and laryngeal contacts for the two techniques were as follows:

	Traditional (%)	Optical (%)	P-Value
Arytenoids	81.3	3.6	<0.0001
Vocal Folds	25.0	3.6	<0.0001
Pyriform Sinuses	62.5	10.7	<0.0001

Conclusions: 1) Optically-guided TE results in far fewer hypopharyngeal and laryngeal contacts than traditional, blind TE. 2) This may result in a decreased frequency of potentially significant complications, especially in anticoagulated patients.

1243-148 Atrial Septal Mobility Does Not Prevent Successful Transcatheter Closure of Patent Foramen Ovale

Nandita S. Sekar, Mary Etta King, Brendan M. MacQuillan, Judy W. Hung, James L. Januzzi, Igor F. Palacios, Michael H. Picard. Massachusetts General Hospital, Boston, MA

Background: Transcatheter closure of interatrial communications has become a common alternative to operative closure, however the technique may be limited by inability to deploy the device or the presence of significant residual shunting. Mobile or redundant septal tissue has been implicated as a possible cause of unsuccessful closure. To improve the selection of subjects for transcatheter closure, we examined septal excursion by transesophageal echo to determine if this variable precluded successful insertion with the buttoned device. **Methods:** Forty-nine patients at our institution undergoing transcatheter closure of a patent foramen ovale have been reviewed. Device closure was performed with an early generation button device. Septal excursion was evaluated by transesophageal echo blinded to outcome. Septal excursion was defined as the maximal excursion of the interatrial septum, on either side of the plane connecting the superior and inferior attachment points. Unsuccessful closure was defined as post-procedural shunting greater than moderate in degree, subsequent cardiac surgery for defect closure, recurrent attempts at closure and the inability to deploy the device. **Results:** The mean (\pm SD) age of patients was 47.3 ± 17.8 years (male: female, 29:20). Five patients underwent subsequent cardiac surgery, 2 required reintervention, in 1 patient the device was not successfully deployed and 8 patients had post-procedural shunting greater than moderate in degree. The septal excursion in patients with an event was 9.0 ± 3.8 mm and in patients without events 10.0 ± 4.5 mm ($p=ns$). **Conclusion:** Despite concerns that septal mobility may compromise the ability to successfully close a patent foramen ovale with a transcatheter device, our results do not support this.

1243-149 Echocardiographic Characteristics of Professional Football Players

William B. Abernethy, III, Joseph K. Choo, Adolph M. Hutter, Jr., Massachusetts General Hospital, Boston, MA

Background: Intense physical training is associated with morphological changes of the heart. The echocardiographic features of elite football players have not been studied. **Methods and Results:** Cardiac morphology and function as assessed by rest and stress echocardiography in 156 asymptomatic National Football League players. Resting and stress ejection fraction (EF), wall thickness, and diastolic left ventricular internal diameter (LVID) were measured. Left ventricular mass was calculated; as was relative wall thickness (RWT) defined as septal and posterior wall thickness divided by LVID. Control data were obtained from published studies.

Results:

	Athletes	Controls
Resting EF	58% (+/- 4.4)	67% (+/- 2.6)
Stress EF	76% (+/- 14.1)	
LVID (mean)	53 mm (+/- 0.5)	49.6 (+/- 0.6)
Maximum wall thickness (mean)	11.7 mm (+/- 0.2)	8.8 (+/- 0.2)
LV mass/BSA	103 (+/- 22.9)	101.9 (+/- 28)
RWT	0.423 (+/- 0.1)	0.356 (+/- 0.014)

Fifty six players (39%) had an EF of 50-55%. There was no correlation between LVID or maximal wall thickness and body surface area. Only four players (3%) had an LVID > 61 mm and only two players (1%) had a wall thickness > 15 mm.

Conclusion: Contrary to popular belief, the resting left ventricular ejection fraction of healthy professional football players is not supranormal, and a significant number have low normal ejection fractions which become hyperdynamic with exercise. Both wall thickness and LVID are increased. There is a high RWT, reflecting an emphasis on strength training.

1243-150 Cardiac Conduction Abnormalities Complicating Infective Endocarditis

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Objective: We examined the incidence of electrocardiographic (ECG) conduction changes in a large, prospective cohort with suspected endocarditis and correlated changes with echocardiographic evidence of invasive infection and mortality.

Background: Cardiac conduction abnormalities occur in endocarditis and have been associated with increased infection extension and mortality. There have been no prospective studies of ECG conduction changes in endocarditis.

Methods: One hundred thirty seven of 1396 (10%) suspected cases of endocarditis were classified as "definite" or "possible" by the Duke Criteria and had an interpretable ECG. ECG conduction changes were classified as old (preexisting hospitalization); new (evident on admission or developed during hospitalization); or indeterminate. New or indeterminate abnormalities were considered "ECG conduction changes". Echocardiogram results were reviewed to identify infected valves and invasive infection.

Results: ECG conduction changes were present in 36/137 (26%) patients. Patients with ECG conduction changes were more often male (69% vs. 46%; p=0.005) and had a prosthetic valve (47% vs. 23%; p<0.001). There were no significant differences in microbiology results or treatment with cardiac surgery. In 76 (55%) patients, at least one infected valve was identified by echocardiography and 15/76 (20%) patients were determined to have evidence of invasive infection. Eight of 15 (53%) invasive infections exhibited ECG conduction changes compared to 16/61 (26%) isolated valve infections (p=0.046). Eleven of 36 (31%) patients with ECG conduction changes died during hospitalization, compared to 15/101 (15%) patients without changes (p=0.039).

Conclusions: ECG conduction changes commonly occur in endocarditis despite more sensitive diagnostic criteria and are associated with increased mortality and invasive infection.

POSTER SESSION

1244 Stress Echocardiography: Coronary Flow Reserve and Ischemia

Tuesday, March 20, 2001, Noon-2:00 p.m.
Orange County Convention Center, Hall A4
Presentation Hour: Noon-1:00 p.m.

1244-151 Assessment of Coronary Flow Velocity With Transthoracic Doppler Echocardiography During Dobutamine Stress Echocardiography

Masaaki Takeuchi, Hidetoshi Yoshitani, Chinami Miyazaki, Shinichiro Otani, Kazuo Sakamoto, Junichi Yoshikawa. *Tane General hospital, Osaka, Japan, Graduate School of Medicine, Osaka City University, Osaka, Japan*

Background: Coronary flow velocity (CFV) in the distal part of the left anterior descending coronary artery (LAD) can be measured by transthoracic Doppler echocardiography (TTDE), but its feasibility and incremental value during dobutamine stress echocardiography (DSE) has not been determined. **Methods:** To explore this, we performed DSE (3-minute stages up to 40 mcg/kg/min of dobutamine with atropine, if required) in 120 consecutive patients with known or suspected coronary artery disease. After 2ml of bolus injection of Levovist (300 mg/ml), we acquired 4 standard stress views by harmonic imaging. Subsequently, we recorded CFV in the distal LAD by TTDE (S12 probe, HP5500, Agilent Technologies) at baseline and each stage of dobutamine infusion. Segmental wall motion in the LAD territory (9 segments by 16-segment model) was assessed from 0: hyperkinesis to 4: dyskinesis, and regional wall motion score index (WMSI) was calculated. Diastolic average peak velocity (APV) and coronary flow velocity reserve (CFVR), defined as a ratio of APV at peak stress to basal APV, was obtained. **Results:** CFV was successfully recorded in 110 patients (92%) at baseline and during dobutamine infusion. HR increased from 66 ± 12 bpm to 127 ± 16 bpm (83% of age predicted maximum HR). CFV could be obtained up to the final stage in 90 patients (82%) and one stage before the final stage in 17 patients (15%). Mean value of CFVR was 2.46 ± 0.82 (range: 0.87 to 4.40). There was significant correlation between WMSI at peak stress and CFVR (r=0.60,

p<0.001). Significant correlation was also noted between delta WMSI (WMSI at baseline - WMSI at peak stress) and CFVR (r=0.70, p<0.001). CFVR was significantly lower in patients who developed stress induced wall motion abnormality (WMA) in the LAD territory than those without (1.65 ± 0.50 vs. 2.83 ± 0.67, p<0.001). A CFVR<2.1 had a sensitivity of 85% and a specificity of 87% for the presence of stress induced WMA. **Conclusion:** Assessment of CFV in the distal LAD during DSE was feasible in the majority of cases, and provides additional information about the functional aspect of coronary circulation in the LAD territory.

1244-152 The Resting Doppler Flow Profile of Left Internal Mammary/Left Anterior Descending Artery May Affect the Evaluation of Flow Reserve With Adenosine and Dobutamine

George Athanassopoulos, Nikos Koutsogiannis, Margarita Marinou, G. Karatasakis, D.V.Cokkinos. *Onassis Cardiac Surgery Center, Athens, Greece*

Background: Noninvasive flow reserve of left internal mammary (LIMA CFR) by Doppler echo is of clinical value for interrogation of patency of LIMA/left anterior descending (LAD). However, many variables may affect resting flow. We assessed the relationship between LIMA CFR and resting Doppler flow profile, and evaluated the vasodilatory effect of adenosine (ADEN) vs DOB. **Methods:** We studied 44 consecutive patients with LIMA (41 men, median age 60) with a median time elapsed from CABG 5 years. Reasons for the reevaluation were recurrence of symptoms and/or interrogation for the culprit zone in case of multiple sites of ischemia by scintigraphy. CFR was estimated during the infusion 300µg/kg/min of DOB (CFRDOB) and at the end of 140µg/kg/min (CFRADEN). Doppler parameters of proximal LIMA from supraclavicular fossa were the peak velocities (V) and the respective time velocity integrals (TVI) at systole (S), and diastole (D), at rest (R) and during hyperemia by DOB, ADEN. All had coronary arteriography within 3 months.

Results: There were significant linear relationships between CFR and resting TVI profile of S, D and both (S+D) for either CFR/ADEN and CFR/DOB (CFR/ADEN: r=0.48, 0.57 and 0.68, CFR/DOB: r=0.35, 0.62 and 0.72 for S,D, S+D respectively, all with p<0.05). There were 9/44 pts with a severely impaired CFR/ADEN (<1.4). However 6/9 pts had a resting D (VTI) greater than 10 cm. There were also 13/44 pts with a severely impaired CFR/DOB (<1.2). However 9/13 pts had a resting sum of S+D greater than 22 cm. **Conclusion:** Coronary flow reserve in LIMA is related to resting graft flow. Patients with high resting systolic or mainly diastolic flow may have increased distal coronary bed vasodilation at rest and may not manifest an additional hyperemic change due to already exhausted flow reserve irrespectively from the direct (ADEN) or indirect (DOB) stressor used to elicit the vasodilatory effect. Thus a corrected value of LIMACFR may be necessary to improve diagnostic yield for LIMA/LAD patency.

1244-153 Noninvasive Assessment of the Left Anterior Descending Coronary Artery Flow Reserve in Kawasaki Disease During Supine Bicycle Doppler Echocardiography

Manatomo Toyono, Kenji Harada, Masamichi Tamura, Kenji Yasuoka, Goro Takada. *Akita University, Akita, Japan*

Background: Coronary flow reserve (CFR) under pharmacological interventions is reduced in patients with Kawasaki disease (KD). Pharmacological interventions, however, provide only limited information on CFR under physiological conditions. To assess CFR during exercise in patients with KD, transthoracic Doppler echocardiography (TTE) was performed at rest and during supine bicycle exercise. **Methods:** Twenty-three KD patients (12-16 years) and 16 controls (13-18 years) were studied. All KD patients have been followed more than 10 years from onset. KD patients were divided into 2 groups: Group 1 (n=12) was consisted of subjects with normal coronary angiographic findings in acute stage, Group 2 (n=11) was consisted of subjects with regressed coronary aneurysms in the left anterior descending artery (LAD). TTE studies were performed at rest and during a submaximal exercise on supine ergometer. Peak diastolic coronary flow velocity of LAD (CFV) was recorded by pulse Doppler under the guidance of color Doppler flow mapping. CFR was calculated as the ratio of exercise to rest CFV. **Results:** CFV was satisfactorily recorded in 20 KD patients (87%) and in 14 controls (88%). The rest CFVs did not differ among groups. CFVs increased significantly by exercise in all groups. CFR in Group 2 was lower than those in Group 1 and controls (Table). **Conclusions:** This study suggests that the KD patients with regressed coronary aneurysms have impaired CFR to the physical stress by exercise. As an impaired CFR may represent an important factor of late vascular complications, there is a need for long-term cardiological survey for this group. Noninvasive technique with TTE is available usefully and ethically for this group in assessing the CFR.

Table (*p<0.05 vs Group2)

	CFV-Rest	CFV-Exercise	CFR
Control	28±7	49±9*	1.74±0.09*
Group1	31±9	51±10*	1.65±0.11*
Group2	30±6	39±8	1.31±0.07

1244-154 Blunting of the Ischemic Preconditioning Effect by Acute Smoking: A Dobutamine Stress Echocardiography Study

Dany E. Sayad, Robert Black, Ali Nasser, Daniel Parnassa. *University of South Florida, Tampa VAMC, Tampa*

Background: Recent studies have focused on the underlying mechanism and various mediators for ischemic preconditioning (IP) in man. However, the effect of smoking on IP is unknown. The aim of this study was to describe a simple noninvasive model of IP, and to study the effect of smoking on IP. **Methods:** We studied 12 patients with positive dobutamine stress echocardiography (DSE). All patients underwent 2 consecutive DSE. The study population consisted of 2 groups. The non-smoker group (NSG, n=7) did not

smoke between the 2 DSE, while the smoker group (SG, n=5), smoked one cigarette between the 2 DSE. **Results:** The nonsmoker group had higher ischemic thresholds with the second DSE. Ischemia was present at higher heart rate (95 vs 107, p=0.02), higher systolic blood pressure (142 vs 153, p=0.05), higher double product (14K vs 17K, p=0.03), and later time (524 sec vs 641 sec, p=0.02) in the second DSE compared to the first DSE. While, ischemia was present at lower thresholds in the smoking group with the second DSE. Ischemia was present at lower systolic blood pressure (158 vs 130, p=0.01), lower double product (18K vs 13K, p=0.05), and earlier in time (526 sec vs 329 sec, p=0.04) **Conclusions:** DSE represents a simple noninvasive method for the assessment of IP in man. The effect of IP seen with DSE is blunted by the cigarette smoking.

n=12	NSG study1	NSG study2	P	SG study 1	SG study 2	P
SD= standard deviation	value			value		
heart rate (beat/min)	95 SD 22	107 SD 21	0.02	112 SD 21	99 SD 17	0.16
systolic BP mmHg	142 SD 17	153 SD 18	0.05	158 SD 15	130 SD 13	0.01
Double productX1000	14 SD 3	17 SD 3	0.03	18 SD 5	13 SD 4	0.05
Time for ischemia (sec)	524 SD 160	641 SD 154	0.02	526 SD 169	329 SD 176	0.04

POSTER SESSION

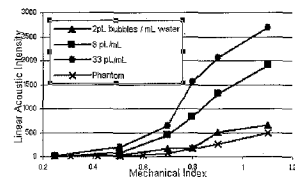
1245 Contrast Echocardiography: Imaging Parameters

Tuesday, March 20, 2001, Noon-2:00 p.m.
Orange County Convention Center, Hall A4
Presentation Hour: Noon-1:00 p.m.

1245-155 Effect of Mechanical Index on Echocardiographic Image Intensity

Neil L. Greenberg, Brian B. Ghoshhajra, Kasturi K. Ghia, Mario J. Garcia, James D. Thomas. *The Cleveland Clinic Foundation, Cleveland, OH*

Mechanical index (MI) is a measure of ultrasound acoustic pressure imparted by a transducer. Finding the proper MI for contrast echocardiographic myocardial perfusion imaging involves trade-offs, as low MIs return an image of lesser intensity, while high MIs are more subject to signal saturation, attenuation, and bubble destruction. In order to have a chance at quantifying myocardial perfusion by echocardiographic contrast, a linear relationship must exist between contrast concentration and measurable image intensity, requiring careful selection of MI. Four different imaging modalities to characterize the relationship between MI and echocardiographic image intensity. **Methods:** A novel contrast agent (Sonazoid, Nycomed Imaging AS) was injected into a uniformly stirred *in vitro* water tank to produce a range of concentrations (0 - 133 pL bubbles/mL water, approximately 10,000 bubbles/mL). These experiments were performed over a range of MIs (0.1 - 1.1). Triggered images were acquired using ATL HDI5000 and Agilent Sonos 5500 ultrasound systems. Linear acoustic intensity values were obtained using HDILab software. **Results:** The relationship between MI and image intensity demonstrates a consistent, critical MI (between 0.5 and 0.7) where intensity increases abruptly (graph). This differs from the 2nd order polynomial response given by ATS Laboratories' grayscale tissue phantom. A linear response in signal intensity to changes in concentration is observed for MI < 0.7 for general and contrast harmonics, Ultraharmonics, and Pulse Inversion imaging modalities. **Conclusions:** Low MIs (≤ 0.2) may produce images that are difficult to visualize, while higher MIs (≥ 0.9) may produce images that exceed the dynamic range of the system and cause attenuation at high concentration. Imaging between MIs of 0.5 and 0.7 may produce optimal signal to noise ratio without undesirable destruction and attenuation.

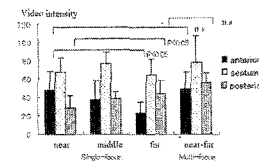


1245-156 Multi-Focus Setting Improves the Heterogeneity of Myocardial Opacification in Contrast Echocardiography

Masao Daimon, Fuminobu Ishikura, Haruka Kobayashi, Yasushi Kashiwagi, Shintaro Beppu. *School of Allied Health Sciences Osaka University Faculty of medicine, Osaka, Japan*

Background: Heterogeneous opacification exists between near and far regions from the transducer depending on the depth of focus point in myocardial contrast echocardiography. Multi-focus is a new technique in which two points of focuses can be set. The aim of this study was to examine the efficacy of multi-focus for improvement of this heterogeneous opacification. **Methods:** Myocardial contrast echocardiography was performed in five closed chest dogs using triggered (1 to 4 cardiac cycle) second harmonic technology following intravenous injection of 0.1ml of OptisonTM. Short axis view was recorded and baseline subtracted video intensity (VI) was calculated at anterior, septum, posterior walls. Three different single focus points and one set of multi-focus were examined. The single focus point was set at near (2cm), middle (4cm) and far (6cm), and multi-focus was the combination of near and far focuses. **Results:** Using single focus, VI of the posterior

wall at near focus significantly less than at far focus, while VI of the anterior wall at far focus significantly less than at near focus (p<0.05, respectively). Difference of VI between the anterior and posterior walls was also significant by either focus point (p<0.05, respectively). Using multi-focus, VIs of both walls were high and not different. **Conclusion:** Multi-focus may be an advantageous method for improved imaging of myocardial opacification in myocardial contrast echocardiography.



1245-157 Quantitative Ultraharmonic Myocardial Contrast Echocardiography: Human Subjects With Normal Angiography

Anita M. Kelsey, Francis J. Kiernan, Daniel B. Fram, Emily Schopick, Lisa V. Carl, Bridget Smith, Alwyn D'Sa, Marc Fierman, Linda D. Gillam. *Hartford Hospital, Hartford, CT, Agilent Technologies, Andover, MA*

Background: Ultraharmonics Contrast Imaging (UCI) is a new high mechanical index (MI) intermittent grayscale imaging technique using wide receiver bandwidth for detection of contrast microbubbles in myocardium. Quantitative analysis of contrast replenishment curves have previously been shown to provide information about coronary flow (initial slope of replenishment curve) and regional blood volume (plateau intensity relative to LV cavity intensity). The purpose of this study was to quantitate myocardial perfusion using this method in pts without obstructive CAD. **Methods:** Within 24 hours of angiography, 12 pts with normal systolic function and no obstructive CAD (stenosis < 50%) underwent UCI. The angiograms were assessed by 2 readers in blinded fashion. Using a continuous infusion of Optison, triggered end-systolic ultrasound images (mid T wave) in apical 4 and 2 chamber views were acquired on an Agilent Sonos 5500 system using 1.3/3.6 MHz probe with MI=1.6. Triggered pulsing intervals (PI) of 1:1, 1:3, 1:5, 1:7, and 1:9 cardiac cycles were used to allow for microbubble replenishment in the imaging plane. Regional replenishment kinetics for each of the myocardial bed (MB) were evaluated using on-line prototype acoustic densitometry. Time-Intensity data was fitted to a first order exponential function ($I(t) = A(1 - \exp(-Bt))$) where B is proportional to the replenishment rate and A is the steady-state plateau intensity. The signal levels in the LV cavity were measured to ensure opacification was constant for each PI. **Results:** For each of the perfused MB, replenishment kinetics analysis was performed. Based on the mean LV cavity signal of 53 +/- 1 dB, the mean regional myocardial enhancement (A) for each MB was (LAD 6.73 +/- 1.6 dB, Cx 6.65 +/- 1.6 dB, RCA 5.90 +/- 0.9 dB). The mean time taken for the intensity to reach within 90% of the final plateau intensity (related inversely to B) was 3.24 +/- 1.7 cardiac cycles. In these 12 pts, 88% of perfused MB's were quantitated as normally perfused by UCI, defined as plateau of greater than 5 dB at 5 heart cycles. **Conclusions:** The results indicate that quantitative Ultraharmonic Contrast Imaging is a feasible method for analysis of myocardial perfusion in normal patients.

1245-158 Parametric Imaging for Visualisation of Replenishment Kinetics Following Ultrasound Induced Destruction of Contrast Microbubbles: In Vitro Validation Studies and First Results in Humans

Klaus Tiemann, Alexander Ehigen, Jörg Köster, Christoph Pohl, Thomas Schlosser, Christian Veltmann, Stefan Lohmaier, Stefanie Kuntz-Hehner, Berndt Lüderitz, Harald Becker. *Dept. of Cardiology, Bonn, Germany*

Background: The assessment of contrast replenishment kinetics following ultrasound induced destruction of microbubbles has been found to correlate well with blood flow. Parametric imaging of the time constant (β) of the replenishment curve (RPC) was proposed to facilitate analysis of tissue perfusion and to allow visual assessment of perfusion. The purpose of this study was to validate a newly developed tool to create parametric images derived from real-time perfusion imaging at low emission power (Power Pulse Inversion (PPI)). **Methods:** The software simultaneously calculates the β values in the entire sector of aligned PPI recordings using grid sizes varying from 1x1 pixel to 20x20 pixel. The results are displayed in a color coded map indicating different time constants. By placing a cursor in arbitrary regions the complete replenishment curves can be obtained as well. A perfusion phantom was used to study the impact of grid size on contrast replenishment curves. The results of parametric imaging were compared with an available program which uses manual placement and processing of single ROIs. In 6 healthy volunteers parametric imaging was performed using a continuous infusion of Optison and acquisition of 1 systolic frame/cardiac cycle. **Results:** Replenishment curves could be derived by both methods. No significant differences were found for β values for different grid sizes using the parametric approach (p=0.59). In addition, mean β of the parametric values was not significantly different from the β of mean as derived by the single ROI (p=0.6). However, for the single vessels the ROI size had a significant impact on the time constant. As theoretically predicted, the β values in the parametric image were always highest in the central part of the vessel, where flow velocities had peak values as well. In the patients parametric imaging provided homogeneous color coding of the myocardium when grid size exceeded 3 x 3 pixels. **Conclusion:** Parametric Imaging provides a visual display of the replenishment kinetics of the entire cross section area. This new method has the potential for a quick visual assessment of myocardial perfusion.

ORAL CONTRIBUTIONS

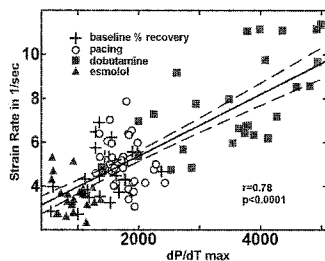
866 Stress Echocardiography: Doppler Applications

Tuesday, March 20, 2001, 2:00 p.m.-3:30 p.m.
Orange County Convention Center, Room 414A

866-1 Can Ultrasonic Strain Rate Imaging Quantify the Changes in Systolic Function During Dobutamine Infusion, B-Blockade, and Atrial Pacing? An Experimental Study

Frank Weidemann, Fadi Jamal, Tomasz Kukulski, Bart Bijnen, Ivan De Scheerder, Liv Hatle, George R. Sutherland. *Cardiology Department, University Hospital Gasthuisberg, Leuven, Belgium*

Strain Rate Imaging has been validated in vitro and in vivo for the quantification of regional myocardial function. The aim of this study was to investigate whether the ultrasonic deformation indices could accurately quantify the changes in myocardial function during varying inotropic states and heart rates. **Methods and results:** In 20 closed-chest pigs, regional function was monitored using color myocardial velocity acquisitions in a short axis view and compared to maximal left ventricular dP/dt as a global systolic function parameter. Heart rate (HR) and global contractility were varied using right atrial pacing (100-180/min, n=7), incremental dobutamine infusion (2.5-20 mg/kg/min, n=7) and continuous esmolol infusion + atrial pacing (0.5 mg/kg/min, pacing 100-180/min, n=6). Peak radial systolic strain rate (SR) of the posterior wall was calculated as the myocardial velocity spatial derivative and averaged 5.1±0.9 sec⁻¹ at baseline. During pacing, both SR and dP/dt max were unchanged. Dobutamine induced a linear increase in SR and dP/dt max with increasing HR (from 96±9 to 175±11/min). Conversely, SR and dP/dt max were reduced during betablockade but remained stable during combined esmolol infusion and pacing. SR and dP/dt max correlated linearly over a wide range of inotropic states and HR (Figure). **Conclusion:** Strain Rate Imaging can quantify regional myocardial systolic function over the physiological range of heart rates and different contractile states. This suggests that this bedside non-invasive method would be suitable for quantitative stress echo.



866-2 Abnormal Intraventricular Flow Velocities in Patients With Angina-Like Chest Pain and Angiographically Normal Coronary Disease

Hans Vandekerckhove, Jozef Bartunek, Eddy Van Schuerbeeck, Linda Mortier, Benedicte Heyndrickx, Brian Roelandt, Koen Erard, Bernard De Bruyne. *Cardiovascular Center, Aalst, Belgium*

The mechanism of angina-like (AL) pain in patients (pts) with normal coronary arteries remains controversial. Of note, hyperdynamic contractile response to adrenergic stimulation with abnormal intraventricular flow velocities (AIFV) has been reported in pts with normal coronary arteries. Thus, we tested the hypothesis that the AL pain in such pts is related to a hyperdynamic response to beta-adrenergic stimuli. Accordingly, 48 pts with AL pain (no LV hypertrophy and valvular disease) underwent dobutamine echocardiography (DE). Twelve asymptomatic pts served as controls (C). AIFV were defined as a dagger-shaped Doppler spectrum >3 m/s. Plasma noradrenaline (NOR), adrenaline (ADR) and plasma renin activity (PRA) were determined. Pts with AIFV were re-studied after 6 weeks therapy with betablockers. **Results:** Pts with AL pain had higher IFV (1.11±0.16 vs 0.85±0.06 m/s, p<0.01). Fifty two % (25/48) of pts with AL pain developed AIFV vs only 8% (1/12) of C (p<0.001). The AIFV were associated with a larger decrease in LVESD during DE and a higher PRA (table, *p<0.05). There were no differences in plasma NOR and ADR (0.65±0.56 vs 0.47±0.41 µg/L and 0.34±0.32 vs 0.16±0.26 µg/l). After betablockers therapy, pts with AIFV had lower angina score (0.9±1.4 vs 5.2±2.1, p<0.001), lower PRA (8.4±6.5, p<0.001) and a lower AIFV during DE (2.5±1.4 m/s vs 3.7±0.6 m/s, p<0.01) as compared to baseline. **Conclusions:** 1. Pts with AL pain and a normal coronary angiogram are prone to develop hyperdynamic response to beta-adrenergic stimulation. This appears to be related to higher plasma renin levels. 2. Betablockers induce a parallel decrease in symptoms, contractile response and plasma renin activity. 3. This suggests that a myocardial hypersensitivity to beta-adrenergic stimulation may play a role in AL pain in patients with normal coronary arteries.

	Change in LVESD(%)	Change in LVEDD(%)	PRA (ng/ml)
AL+AIFV (n=25)	-22.8±11.9*	-6.9±8.2	19.5±15.3*
AL+NoAIFV (n=23)	-8.4±11.8	-3.4±12.7	8.3±7.2

866-3 Early Diastolic Flow Propagation Velocity (Vp) During Dobutamine Stress Echocardiography (DSE)

Takahiro Ohara, Yuji Hashimoto, Akihiko Matsumura, Kenichi Hurumi, Ryoji Watanabe, Tomoyuki Watanabe, Ryoko Wakizono. *Kameda Medical Center, Chiba prefecture, Japan*

Background: DSE is less diagnostic in 1 vessel disease than in multi-vessel disease. Vp is thought to be a sensitive marker to detect diastolic dysfunction. We investigated the availability of Vp measurements during DSE. **Methods:** To evaluate coronary artery disease, 243 consecutive patients underwent DSE and coronary angiography (CAG). After exclusion criteria (post CABG, atrial fibrillation, inadequate recordings or stress), 62 patients (age 67 ± 9 yrs, 45 male, 17 female) were analyzed. The left ventricular wall was divided into 16 segments, and wall motion score index (WMSI) was calculated according to a five-point scale: 1, normal; 2, mild hypokinetic; 3, severe hypokinetic; 4, akinetic; 5, dyskinetic. Vp was measured using color M-mode Doppler echocardiography. Vp ratio was determined as peak Vp divided baseline Vp. **Results:** Forty-eight (77%) patients had a significant coronary stenosis on CAG (CAD group). One vessel disease was in 20 patients. Using only WMSI, the sensitivity (Sens), the specificity (Spec), and the accuracy (Ac) were 54%, 92%, and 63%, respectively. Vp ratio and Peak Vp were significantly decreased in CAD group than in non-CAD group (0.96 ± 0.22 vs 1.20 ± 0.28 and 421 ± 95 mm/sec vs 589 ± 240 mm/sec, respectively). If not only WMSI but also Vp ratio < 1 or peak Vp < 500 mm/sec were considered as positive, improved Sens and Ac were obtained (Table 1). Improved Sens was also obtained in patients with 1 vessel disease (Table 2). **Conclusion:** Vp measurements during DSE are clinically available to improve diagnostic ability of DSE in patients with CAD. It is possible that Vp ratio < 1 or peak Vp < 500 mm/sec is a new standard for the judgment of DSE, which is easily and simultaneously obtained during DSE.

Table 1			Table 2		
	Sens	Spec	Ac		Sens
WMSI	54%	92%	63%	WMSI	40%
Vp ratio < 1	63%	78%	66%	Vp ratio < 1	55%
Peak Vp < 500 mm/sec	83%	64%	79%	Peak Vp < 500 mm/sec	85%
WMSI or Vp ratio < 1	81%	71%	79%	WMSI or Vp ratio < 1	70%
WMSI or Peak	90%	57%	82%	WMSI or Peak	90%
Vp < 500 mm/sec				Vp < 500 mm/sec	

866-4 The Effect of Dobutamine Stress on Left Ventricular Long Axis Function and Early Diastolic Filling in Patients With Coronary Artery Disease

Alison M. Duncan, Christine A. O'Sullivan, Wei Li, Derek G. Gibson, Michael Y. Henein. *Royal Brompton Hospital, London, United Kingdom*

Background: The onset of left ventricular lengthening becomes delayed during acute coronary occlusion, and normalizes after revascularization. **Aim:** To study the effect of pharmacological stress on long axis behavior, and to identify stress-related changes in the timing of early diastolic filling. **Methods:** 42 patients with coronary artery disease, 22 with normal ventricular cavity size (aged 63±10 years) and 20 with dilated cavity and a restrictive filling pattern (E wave deceleration time <120ms, aged 65±8 years), were compared with 17 age-matched controls. All groups were studied at rest and at peak dobutamine stress, using Doppler echocardiography. The time from end systole to the onset of long axis lengthening was measured, as was the time from A2 (second heart sound) to peak early diastolic filling (A2-E). **Results:** At rest, in controls, A2 to onset of lengthening and A2-E were 57±12ms and 156±17ms, respectively. All patients with normal LV cavity size developed ischemia at peak stress, 34 with ST shift, and 8 with T wave inversion. In patients with normal cavity, A2 to onset of lengthening was prolonged (79±16ms, p<0.001) but A2-E was normal (147±21ms). By contrast, A2 to onset of lengthening was longer (72 ±24ms, p<0.01), and A2-E was shorter (127±22ms, p<0.001) in patients with dilated cavity compared with controls. Response to stress:

Variables	Controls	Normal LV cavity	Dilated LV cavity
A2-OL (ms) Stress-rest	-30+/-5*	7+/-13	15+/-4*
A2-E (ms) Stress-rest	-35+/-5*	8+/-10	27+/-7*
Correlation (r) A2-OL vs A2-E	0.8*	0.76*	0.79*

*: p<0.001

Conclusion: The delay in long axis lengthening is closely associated with delayed peak early diastolic filling. Since this relationship is maintained in patients with ischemic cardiomyopathy and a restrictive filling pattern, it may be used as an independent marker of ischemic LV disturbances, irrespective of loading conditions.

866-5 Regional Diastolic Dysfunction Measured With Tissue Doppler Correlates With Ischemia During Dobutamine Echo

Ofeilia Najos, Peter Cain, Danielle Spicer, Thomas Marwick. *UQ Dept of Medicine, Princess Alexandra Hospital, Brisbane, Australia*

Background: Transmittal flow is used to assess diastolic dysfunction but its utility during dobutamine echo (DbE) is limited because it is load dependent and reflects global function. Tissue Doppler (MDV) may avoid these limitations; we sought to compare diastolic MDV in segments with normal and abnormal wall motion (WM) and angiography (stenoses >70%). **Methods:** 20 low probability and 47 patients with CAD who underwent DbE and angiography were studied. A standard DbE protocol was used with MDV obtained at baseline (b), low dose, pre-peak and peak (p) stress. Segments were categorized as ischemic (isc - new/worsening WM), scar (resting WM, no change), or normal (nl). MDV waveforms in the basal and mid-segments were used to measure peak systolic

2:30 p.m.

2:00 p.m.

2:15 p.m.

2:45 p.m.

3:00 p.m.

velocity (Sm,cm/s), early filling (E wave,cm/s), late filling (A wave,cm/s), isovolumic relaxation time (IV ms), and E deceleration time (DT ms). **Results:** Compared with normal, patients with angio CAD showed blunting of the E wave (7.5 vs 5 cm/s, p<.001), shortening of the DT (52 vs 40ms, p<.001) and IV (54 vs 50ms,p<.001) at peak. There were no changes in A wave. The same pattern was seen when baseline and peak MDV diastolic indices were compared in normal & ischemic segments p-value *.0005 †.005 ‡.05.

	Eb	Ep	Ab	Ap	IVb	IVp	DTb	DTp
LAD nl	5.9	6.0	5.6	9.0	79	59	83	47
LAD isc	4.4*	3.1†	4.9	6.5*	85	41	79†	26*
LCX nl	6.4	8.2	5.9	8.7	70	56	80	56
LCX isc	4.5	5.4‡	5.5	7.4	60	36*	61*	48*
RCA nl	6.8	8.7	6.8	9.1	79	64	93	55
RCA isc	5.6‡	4.6	7.1	9.2	66	71‡	56‡	33

MDV systolic velocity did not correlate with any of the MDV diastolic measures. **Conclusion:** Diastolic function is sensitive to ischemia. MDV can be used to document diastolic dysfunction in ischemic segments at DbE and in segments subtended by coronary stenoses.

3:15 p.m.

866-6 Quantitative Stress Echocardiography in Hypertrophic Cardiomyopathy: Assessment of Myocardial Velocities in Patients With Chest Pain

Munmohan Virdee, Yoshihisa Matsumura, Sami Firoozi, William McKenna. *St George's Hospital Medical School, London, United Kingdom*

Background: Chest pain due to myocardial ischaemia occurs in the absence of occlusive coronary disease in Hypertrophic Cardiomyopathy (HCM). Ventricular long axis function, reflecting subendocardial fibre contraction, is likely to be impaired in patients with transmural or subendocardial ischaemia.

Methods: Twenty six patients (pts) with HCM (39 ±12yrs, 85% male) underwent maximal upright bicycle stress echocardiography. Nine pts gave a clinical history of chest pain (group A), 17 pts did not (group B). Lateral mitral annular velocities were recorded at rest and during exercise stress using pulsed wave tissue Doppler from the apical position.

Results: There was no difference between groups A and B for age, sex, peak workload or peak heart rate during stress. Patients in group A had a higher septal thickness (23 ±4 vs 19 ±3mm, p=0.03) and Wigle score (7.6 ±1.3 vs 5.4 ±2.3, p=0.015) than those in group B. There was no difference between groups A and B for cavity dimensions, posterior wall thickness, mitral inflow velocities, fractional shortening, LVEF or outflow tract gradient.

	Resting	During Stress	p (rest vs stress)
Lateral Annular peak Systolic Velocity (cm/s)	Group A 11 ±3	16 ±5 *	0.004
	Group B 13 ±4	21 ±4 *	<0.001
Longitudinal Shortening (cm)	Group A 11 ±1	16 ±3	0.01
	Group B 12 ±2	17 ±4	<0.001

*group A vs B, p=0.009

Lateral annular diastolic velocities at rest and during stress were no different between the two groups.

Conclusions: Longitudinal systolic function is impaired during stress in HCM pts with a clinical history of chest pain, and may reflect the presence of subendocardial ischaemia.

ORAL CONTRIBUTIONS

867 Optimizing Assessment of Myocardial Viability

Tuesday, March 20, 2001, 2:00 p.m.-3:30 p.m.
Orange County Convention Center, Room 414C

2:00 p.m.

867-1 Time Course of Improvement of Left Ventricular Function Post Revascularization: Repetitively Stunning vs Hibernation

Jeroen J. Bax, Abdou Elhendy, Don Poldermans, Jan H. Cornel, Paolo M. Fioretti, Cees A. Visser, Frans C. Visser. *Leiden University Medical Center, Leiden, The Netherlands, Free University Hospital Amsterdam, Amsterdam, The Netherlands*

Background: Improvement of left ventricular (LV) function post-revascularization may take additional time beyond the frequently used follow-up of 3 months. Early vs late recovery of function may be dependent on the underlying mechanism of LV dysfunction. In the present study we have compared the time-course of recovery of LV function post-revascularization in patients with hibernation and repetitive stunning. **Patients and methods:** Patients (n=24) with ischemic cardiomyopathy (LVEF 29±7%) who were scheduled for CABG, underwent a perfusion study (using resting thallium-201 SPECT) and a metabolic study (using FDG SPECT during hyperinsulinemic glucose clamp). Functional follow-up by resting echocardiography was performed early (3 months) and late (14 months) after revascularization. Dysfunctional segments were classified as hibernating in the presence of reduced perfusion with increased FDG uptake and as repetitively stunned in the presence of normal perfusion/FDG uptake. **Results:** 57 segments were classified as repetitively stunned and 62 as hibernating. Early recovery was observed in 61% of stunned segments and 31% of hibernating segments. Late (or addi-

tional recovery) was observed in 9% of stunned segments and 61% of hibernating segments. No recovery was observed in 30% of stunned segments and 8% of hibernating segments. **Conclusion:** Hibernating myocardium may take longer time to (fully) recover following revascularization.

2:15 p.m.

867-2 Relation Among Contractile Reserve, 201-Thallium Uptake and Collateral Angiographic Circulation in Collateral-Dependent Myocardium: Clinical Implications Regarding the Evaluation of Myocardial Viability

Federico Piscione, Giuseppe De Luca, Pasquale Perrone Filardi, Mariella Prastaro, Emanuele Barbato, Santo Dellegrottaglie, Leonardo Pace, Ciro Indolfi, Paolo Golino, Massimo Chiariello. *Department of Internal Medicine and Cardiology - Federico II University, Naples, Italy, Department of Nuclear Medicine - Federico II University, Naples, Italy*

Background: Low-dose dobutamine echocardiography (LDDE) is the most common test used to identify myocardial viability. But it has been demonstrated that contractile reserve depends on coronary flow reserve that is particularly reduced in territories supplied by an occluded vessel. Thus the aim of this study was to compare LDDE, 201-thallium tomography (TL) and collateral angiographic circulation (CAC) to collateral-dependent myocardium in order to identify the most reliable test to select patients for myocardial revascularization. **Methods:** Seventy-seven consecutive patients (72 men; mean age 56 ± 9 years; mean ejection fraction: 40 ± 10%) with an occluded vessel and regional myocardial dysfunction underwent LDDE (5-10µg/Kg/min) and TL after coronary angiography. Thirty-three patients underwent successful myocardial revascularization (18 percutaneous revascularization) and repeated resting echocardiography 3 months after revascularization. We divided the left ventricle in 12 segments to match functional and perfusional imagings. By ROC curves we identified 65% of TI uptake as the best threshold to identify viable myocardium. The classification of CAC was done according to the Rentrop's classification, dividing myocardial segments with well (Class 2-3) or poor (class 1-0) collateralization degree. **Results:** See Table.

Results	SENSITIVITY (total segments)	SENSITIVITY (akinetiic segments)	SPECIFICITY (total segments)	SPECIFICITY (akinetiic segments)	ACCURACY (total segments)	ACCURACY (akinetiic segments)
LDDE	64%	45%	62%**	88%**	63%	65%
TL	77%	72%*	65%**	76%**	72%***	74%***
CAC	74%	76%*	27%	15%	55%	46%

*p<0.05 vs LDDE, **p<0.0001 vs CAC, ***p<0.01 vs CAC

Conclusions: Our study demonstrates in collateral-dependent myocardium a suboptimal value of sensitivity and accuracy of LDDE compared to TL, that represents the best method to identify myocardial viability, particularly in akinetic segments. A well developed CAC optimally identifies dysfunctional segments with functional recovery after revascularization, but its absence or its poor development does not exclude the recovery after revascularization.

2:30 p.m.

867-3 Viability Index on Electromechanical Mapping Can Determine the Extent of Residual Myocardial Viability in Patients With Ischemic Cardiomyopathy as Defined by Quantitative SPECT Myocardial Perfusion Imaging

Habib Samady, Yi-Hwa Liu, Michael Ragosta, Stephen Pfau, Michael Cleman, Eric R. Powers, C. Joon Choi, Jennifer Hunter, Frans J. Wackers, George A. Beller, Christopher M. Kramer, Denny Watson. *University of Virginia, Charlottesville, VA, Yale University, New Haven, CT*

Background: Left ventricular electromechanical mapping (NOGA) can distinguish viable myocardium from dense scar in the catheterization laboratory, by measuring unipolar voltage (UpV) and linear local shortening (LLS). Whether NOGA can differentiate viable from partially viable myocardium is unknown. We hypothesized NOGA could determine the spectrum of myocardial viability as defined by SPECT myocardial perfusion imaging (SPECT). **Methods:** Twenty six patients (18 men, age 63±10, mean±S.D.) with multivessel CAD and LV dysfunction (LVEF 0.34±0.10), underwent NOGA and SPECT sestamibi (MIBI). LLS, UpV, and a viability index (VI), defined as (LLS x UpV)/10, were measured by NOGA. Quantitative resting MIBI uptake was assessed by SPECT. Both NOGA and SPECT images were divided into 14 matched segments. NOGA variables were assessed in the following three SPECT groups: viable (>75% rest MIBI uptake); partially viable (50-75% rest MIBI uptake); and non-viable (<50% rest MIBI uptake). **Results:** Of 364 available segments, 349 had adequate NOGA points for analysis.

SPECT (No. segments)	UpV (mV)	LLS (%)	VI
Viable (177)	10.2±4.3	8.0±6.4	9.1±9.0
Partially viable (128)	9.0±4.4	6.7±6.4	6.6±7.9*
Non-viable (44)	6.2±2.3*#	3.9±5.3*#	2.5±4.0*#
ANOVA p	<0.001	<0.001	<0.001

*p<0.05 vs. viable, # p<0.05 vs. partially viable. All three variables discriminated viable from non-viable myocardium. However, VI was best able to distinguish viable from partially viable and non-viable myocardium. **Conclusion:** NOGA viability index can discriminate intermediate degrees of viability from non-viable myocardium, as defined by SPECT myocardial perfusion imaging. Thus, NOGA can be used to evaluate the spectrum of myocardial viability in the catheterization laboratory.

867-4

Myocardial Contractile Reserve Assessment by Low Dose Dobutamine Gated SPECT Thallium-201 Improves Prediction of Left Ventricular Wall Motion Recovery After Acute Myocardial Infarction Provided by Thallium-201 Uptake

Marcus V. Simões, Osvaldo C. Almeida-Filho, Antonio O. Pintya, Nadia P. Batista, Cleide M. Antoga, Antonio Pazin-Filho, Benedito C. Maciel, José A. Marin-Neto. *Medical School of Ribeirão Preto - University of São Paulo, Ribeirão Preto, SP, Brazil*

Background: This study aimed to assess the value of simultaneous evaluation of myocardial perfusion and contractile reserve using gated-SPECT-Thallium-201 (g-SPECT) for prediction left ventricular (LV) segmental wall motion (WM) recovery after acute myocardial infarction (AMI). **Methods:** Twenty-six stable post-AMI pts (18 males, 55±12 y.o.) with severe WM abnormalities at 2D-Echo underwent, within 4-8 days of AMI onset, SPECT Thallium-201 stress-redistribution images followed by rest reinjection and two sequential g-SPECT images acquisition: a) at baseline, and b) during low dose dobutamine (LDD) infusion. Segmental uptake of Thallium-201 was done by visual analysis of reinjection baseline SPECT using a 6 point score (normal = 0 to absent = 5) and a 16-segment model. WM evaluation in g-SPECT images at baseline and during LDD was done with a 4 point score (normal = 1 to dyskinesia = 4). Contractile reserve was defined as normal WM at baseline or at least 1 point score improvement in WM during LDD. Vessels with significant obstruction at coronary angiography were revascularized. Control 2D-Echo was performed 2 months after revascularization/discharge for late WM recovery assessment. The criteria used for prediction of myocardial viability were: a) for Thallium uptake: point score <3; and b) for Thallium uptake plus contractile reserve: segments presenting uptake score <3 and contractile reserve. **Results:** Late contractile recovery was documented in 67 of 149 disinnergic segments (45%). Sensitivity, specificity, and global accuracy in predicting WM recovery for Thallium uptake was 81%, 49% and 63%; and for Thallium uptake plus contractile reserve was 64%, 80% and 73%, respectively. ROC curve analysis showed significant difference between the two parameters prognostic accuracy: the measured area under the curve for Thallium uptake was 0.70 and for Thallium uptake plus contractile reserve was 0.79, p = 0.043. **Conclusion:** Contractile reserve assessment is feasible with gated-SPECT-Thallium-201 and provides a significant incremental value when associated to reinjection Thallium uptake for predicting LV function recovery after AMI.

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medical therapy. The changes (mean±SD) in LV remodelling at follow-up are shown in the two groups. There were significant improvements in LVEF and LV volumes in the revascularised group in contrast except for LVEF which did not show any significant change, all other indices of LV remodelling deteriorated significantly in the medical group. MV detected by nitrate-enhanced MIBI SPECT predicted regression of remodelling following revascularisation compared to medical therapy, and this may be an important determinant of survival.

	Rev n=21 Baseline	Follow-up	Medical n=22 Baseline	Follow-up
LVEF (%)	26±7	36±12*	28±6	26±10
LVEDV (mls)	157±37	145±30**	150±64	184±49*
LVESV (mls)	117±19	94±29*	108±38	138±45*
LVM (gms)	224±73	208±50	213±51	247±68*
SI	1.3±0.2	1.4±0.3	1.4±0.1	1.3±0.2*

*P<0.001, **P<0.05

POSTER SESSION

1273 New Doppler Techniques II

Tuesday, March 20, 2001, 3:00 p.m.-5:00 p.m.
Orange County Convention Center, Hall A4
Presentation Hour: 3:00 p.m.-4:00 p.m.

1273-133 Color M-Mode Doppler Flow Propagation of Late Diastolic Velocity Caused by Left Atrial-Left Ventricular Pressure Gradient: An Animal Study

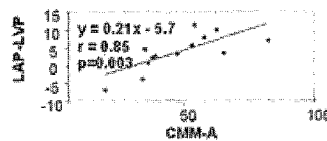
Junko Watanabe, Michael Jones, Takahiro Shiota, Fabrice Bauer, Hiroyuki Tsujino, Yong-jin Kim, Mario J. Garcia, Jian Xin Qin, Marta Sitges, Agnese Travaglini, James D. Thomas. *The Cleveland Clinic Foundation, Cleveland, OH, National Institutes of Health, Bethesda, MD*

Background: Doppler filling patterns are complicated because of confounding effects of left ventricular (LV) relaxation and atrial function. Color M-mode Doppler echocardiography (CMM) flow propagation velocity has been proposed as a new index of LV relaxation. The aim of the study was to evaluate the influence of pressure gradient between the peak of A wave pressure of left atrium (LA) and LV pressure at the same timing of the peak A wave (LAP-LVP) on the late diastolic velocity propagation (CMM-A, cm/sec) measured by CMM in an animal study, in which hemodynamics were strictly controlled.

Methods: Four normal sheep were examined by echocardiography and catheterization simultaneously during 4 different hemodynamic conditions; 1) baseline, 2) blood infusion increasing preload, 3) intravenous angiotensin II infusion increasing afterload, and 4) nitroprusside infusion decreasing preload. LV pressure was obtained from an intracavity catheter-tipped transducer, LA pressure was obtained from another catheter directly inserted into LA. A Toshiba PowerVision was used to obtain CMM from the apical 4-chamber view. CMM-A was measured as the slope of the first aliasing velocity after P wave, from the mitral valve plane to 4 cm distally into the LV cavity. Using conventional pulse Doppler, A Peak wave velocity (Dop-A) was measured.

Results: There was a significant correlation between CMM-A and LAP-LVP ($y=0.21x-5.7$, $r=0.85$, $p=0.003$, see figure), whereas a very weak correlation between Dop-A and LAP-LVP was found ($y=4.2x+38$, $r=0.32$, $p=0.05$).

Conclusions: Late diastolic velocity propagation measured by color M-mode Doppler echocardiography may serve as an accurate non invasive tool for estimating pressure gradient between LA and LV in late diastole.



1273-134 Tricuspid Annular Velocity Using Tissue Doppler Echocardiography to Differentiate Constrictive Pericarditis From Restrictive Cardiomyopathy

Navin Rajagopalan, Mario J. Garcia, Allan L. Klein. *Cleveland Clinic Foundation, Cleveland, OH*

Background: Analysis of mitral annular velocity by tissue Doppler echocardiography has previously been shown to differentiate between constrictive pericarditis and restrictive cardiomyopathy with excellent sensitivity and specificity. The utility of using the velocity of the tricuspid annulus has not yet been reported in these patients. **Methods:** We studied 23 patients (mean age 64; 5 females), 11 with constrictive pericarditis and 12 with restrictive cardiomyopathy, who were diagnosed by a variety of tests including transesophageal echocardiography, magnetic resonance imaging, cardiac catheterization, endomyocardial biopsy, and surgery. Tissue Doppler examination of the lateral aspect of the tricuspid annulus and of the mitral annulus was obtained in all patients, including 7 normals.

Results: The peak early velocity of longitudinal expansion (Peak Ea) was found to be significantly different between the two groups of patients using both the tricuspid and mitral annuli. A cutoff of 13.0 cm/s for peak Ea of the tricuspid annulus differentiated between constrictive pericarditis and restrictive cardiomyopathy with 82% sensitivity and 92% specificity. A cutoff of 8.0 cm/s for peak Ea using the mitral annulus resulted in 100%

867-5

Characteristics of Ischemic Myocardium Detected by Positron Emission Tomography during Left Ventricular Electromechanical Mapping

Khaled A. Nour, Shmuel Fuchs, Julian P. J. Halcox, Ran Kornowski, Rita Mincemoyer, Claiborne Miller-Davis, Vasken Dilisizian, Arshed A. Quyyumi. *Cardiology Branch, National Institutes of Health, Bethesda, MD*

Background: Detection of viability in dysfunctional myocardium currently involves detailed scintigraphic and stress echo assessment. We investigated whether measurement of endocardial voltage (UpV) and linear shortening (LS) during left ventricular electromechanical mapping (EM) using NOGA could detect viability defined by positron emission tomography (PET).

Methods: 15 patients with ischemic cardiomyopathy (EF 33±9%) underwent EM and PET scanning using [¹⁸F]fluorodeoxyglucose (¹⁸FDG) and rest and adenosine ¹³N-ammonia. 178 regions were visually classified as (A) normal: absence of adenosine-induced ¹³N-ammonia defects, (B) ischemic/viable: adenosine-induced ¹³N-ammonia, or resting ¹³N-ammonia/¹⁸FDG mismatch, or (C) scar: matched severe reduction in resting ¹³N-ammonia and ¹⁸FDG uptake.

Results: (Table) Compared to normal (A), UpV was preserved in ischemic/viable segments(B), but was significantly reduced in scarred regions(C). LS was also reduced in scarred areas(C).

Conclusion: NOGA EM can accurately identify scarred myocardial regions defined by PET. This may assist efficient delivery of catheter-based therapy in patients with left ventricular dysfunction undergoing catheterization by providing online assessment of viability. Table: *p<0.05 compared to A and B. #p=0.003 vs. A

	A (normal)	B (ischemic/viable)	C (scar)
LS (%)	8.7±5	7.2±6	5.8±6#
UpV (mV)	9.4±5	9.2±4	7.1±4*

3:00 p.m.

867-6

Nitrate Enhanced 99mTc-Sestamibi SPECT Predicts Regression of Remodelling Following Revascularisation Compared to Medical Therapy in Ischaemic Cardiomyopathy

Roxy Senior, Sanjiv Kaul, Usha Raval, Avijit Lahiri. *Northwick Park Hospital, Harrow, United Kingdom*

Background: Presence of myocardial viability (MV) detected by nitrate-enhanced Tc-99m sestamibi(MIBI) SPECT has been shown to improve regional function following revascularisation (Rev) in patients with ischaemic cardiomyopathy. However, the impact of Rev on the indices of left ventricular (LV) remodelling is unknown. **Methods:** Accordingly pts with heart failure and LV dysfunction (LV ejection fraction <35%) due to coronary artery disease (CAD) underwent nitrate-enhanced MIBI SPECT. Baseline and follow-up (17±7 months) LV ejection fraction (LVEF), end diastolic (LVEDV), end-systolic (LVESV), mass (LVM) and sphericity index (SI) were obtained in 44 pts. Significant MV was considered when ≥5 segments (12 LV segment model) showed at least 50% tracer uptake. **Results:** There were 43 pts with MV of which 23 underwent Rev and 20 continued on

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sensitivity and 92% specificity. Subgroup analysis of the restrictive group revealed that patients with amyloidosis as the etiology of restrictive cardiomyopathy (7 of 12 pts) had a significantly ($p < 0.05$) lower peak Ea of both annuli. **Conclusion:** Tissue Doppler Echocardiography of the tricuspid annulus can be a useful adjunct to the differentiation of constriction and restriction. Furthermore, tissue velocities can help clarify the etiology of disease in restrictive patients.

	Tricuspid Annulus Peak Ea (cm/s)	Mitral Annulus Peak Ea (cm/s)
Constriction	15.3 ± 4.3	13.7 ± 3.8
Restriction	10.1 ± 3.4*	6.5 ± 2.3*
Normals	13.9 ± 2.8†	13.9 ± 2.8†

* $p < 0.05$ constriction vs. restriction; † $p < 0.05$ normals vs. restriction

1273-135 Use of Tissue and Pulsed Wave Doppler Echocardiography in the Aortic-Banded Rats Myocardial Hypertrophy Model

Ismar N. Cestari, Mara D. Pires, Vera M. C. Salemi, Charles Mady, Idágene A. Cestari, Adolfo A. Leirner. *Heart Institute (InCor) University of São Paulo Medical School, São Paulo, Brazil*

Background: Myocardial hypertrophy is a hallmark of pressure-overload heart failure and echocardiography has provided useful insights in the study of diastolic dysfunction. Early diastolic septal velocity (E') and early diastolic filling velocity (E) were determined in the aortic-banded rat model of pressure-overload hypertrophy to better understand their correlation and investigate their applicability in a small animal model of myocardial hypertrophy.

Methods: Male Wistar rats (70-90 g) underwent ascending aorta constriction by the surgical placement of a titanium clip (internal diameter: 0.6 mm; n=5) or sham operation (n=6). High-resolution 2D and pulsed-wave Doppler echocardiography were performed after 8 weeks of surgery in both groups.

Results: Values from echo are listed in the table. Clip placement produced myocardial hypertrophy with increased fractional shortening, myocardial mass index, and posterior wall and septal thickness. Concentric hypertrophy was evident, with decreased end diastolic and systolic LV diameters. Measurement of blood flow velocity before and after the clip permitted an inter-animal estimation of the aorta constriction. Myocardial hypertrophy decreased E and E'.

	Sham	8 wk
Weight (g)	294 ± 29.3	295 ± 7.4
Heart Rate (bpm)	242 ± 26.3	271 ± 21.6
LV Diastolic Diameter (cm)	0.575 ± 0.05	0.417 ± 0.07*
LV Systolic Diameter (cm)	0.281 ± 0.06	0.135 ± 0.049*
% Fractional Shortening	51 ± 8.3	68 ± 6.2*
Mass Index	2.25 ± 0.09	4.25 ± 0.94*
E (m/s)	0.80 ± 0.12	0.61 ± 0.11*
E' (m/s)	0.068 ± 0.02	0.044 ± 0.006*
Septum (cm)	0.179 ± 0.01	0.327 ± 0.05*
Posterior Wall (cm)	0.176 ± 0.01	0.336 ± 0.05*
Aortic Blood Velocity (m/sec)	0.876 ± 0.14	n/a
Max. Blood Velocity Pre-clip (m/sec)	n/a	0.843 ± 0.16
Max. Velocity Post-clip (m/sec)	n/a	3.74 ± 0.84

* $p < 0.05$

n/a: not applicable

Conclusion: Tissue Doppler echocardiography can be used in small rodents and is a sensitive method to detect changes in myocardial velocities during early diastole in the presence of hypertrophy.

1273-136 Angle Dependence of Strain Rate Imaging Compared to B-Mode Strain Measurements: Studies in a Physiologic Myocardial Model

Ikuo Hashimoto, Xiaokui Li, David J. Sahn. *Oregon Health Sciences University, Portland*

Background: Strain rate (SR) values are derived from tissue Doppler (TDI) multipulse interrogation, and though they measure intramyocardial target - target displacement, results may be angle dependent. Our study was designed to validate digital color SR and investigate its angle dependency. **Methods:** A fresh strip of marbled beef (2x3x9cm) as a myocardial model was mechanically lengthened and shortened longitudinally (50-100mm/sec; stretched 17mm), causing it to thicken and thin. As myocardial targets for B-scans, 4 graphite fragments were inserted in a 2cm square pattern. The model was scanned at 90° or 45° angle to the "endocardial" surface on a GE/VingMed System FiVe. Color TDI/SR and simultaneous B-mode 2D images of each cycle were stored on disk for offline analysis. TDI and SR were sampled at the near (ANT) and far (POST) regions of the model every 33msec. Distances between targets in planes parallel (L1) and perpendicular (L2) to stretching were measured from high frame rate B-mode images to independently calculate an SR index.

Results: At 90°, there were no significant differences between ANT and POST in SR (ANT: 0.83 ± 0.50; POST: 0.82 ± 0.51 Hz) and there were close correlations and agreements between digital color SR of both L2 ($r = 0.99$, mean difference = 0.05Hz) and L1 ($r = 0.94$) with B-mode SR. At 45°, digital color SR of ANT was significantly lower than those of POST regions (ANT: 0.32 ± 0.24; POST: 0.53 ± 0.39Hz; $p < 0.0001$), a result also seen in TDI results for those regions. Also at 45°, digital color SR and B-mode SR correlated less well (L2: $r = 0.76$; L1: $r = 0.86$).

Conclusion: SR measurements are angle dependent, producing potential variability between "endocardium" and "epicardium".



POSTER SESSION

1274 Cardiovascular Magnetic Resonance: Flow Reserve, Viability, and Safety

Tuesday, March 20, 2001, 3:00 p.m.-5:00 p.m.

Orange County Convention Center, Hall A4

Presentation Hour: 3:00 p.m.-4:00 p.m.

1274-137 Heating Effects of Magnetic Resonance Imaging of the Brain on Pacemaker Leads: Send/Receive Coils Versus Receive-Only Coils

Roger Luechinger, Firat Duru, Volkert A. Zeijlmaier, Markus B. Scheidegger, Reto Candinas, Peter Boesiger. *Cardiac Arrhythmia Unit, University Hospital Zurich, Zurich, Switzerland, Institute of Biomedical Engineering, University and ETH Zurich, Zurich, Switzerland*

An implanted cardiac pacemaker (PM) is usually regarded as a contraindication for magnetic resonance (MR) imaging due to safety reasons. In vitro experiments showed that significant heating may occur at the tip of PM leads. The aim of this study was to compare experimentally two coils used for brain imaging with regard to heating effects on PM leads. **Methods:** Two different MR head coils (the receive-only coil and the send/receive coil) of a 1.5 Tesla MR-scanner (Philips Gyroscan ACS NT) were used. To simulate a brain examination in a PM patient, a PM lead which was previously shown to cause high heating, was placed inside a large reservoir filled with 20 l saline water (0.45%) as near to the head coil as possible. A cylindrical water phantom was placed in the head coils. For high power irradiation a turbo-spin echo sequence was used. During imaging the temperature changes at the lead tip were continuously measured by a fiberoptic temperature sensor (Luxtron, Santa Clara, CA). **Results:** Heating effects vs. position of the center of the head coils relative to the isocenter are shown in the Figure. At MR isocenter ($x = -35$ cm) temperature increase was $>12^{\circ}\text{C}$. Using the send/receive head coil, temperature increase shows no dependency on locations out of the isocenter. In contrast, the receive-only head coil shows a strong dependency on lead location. However, in both cases, the heating effects were strongly reduced as compared to an MR-investigation of the thorax with the PM in the isocenter. In conclusion, the advantage of a send/receive coil is not only the reduced heating, but also the independence on the position relative to the isocenter of the MR scanner. In case of the receive-only head coil, a small movement of -5 cm out of the isocenter doubles the temperature increase. These results may have clinical implications and give some hints towards heating reduction if MR imaging of the brain becomes an absolute necessity in patients with PMs.

1274-138 Pacemaker Safety During Magnetic Resonance Imaging at 1.5 Tesla

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Background: Permanent pacemakers have represented a contraindication to magnetic resonance imaging and angiography (MRI/MRA). Despite possible interactions, numerous patients have undergone MRI scans without difficulties. Six deaths have occurred without proof of harmful interaction.

Methods: Therefore, a consecutive series of 24 patients with a total of 25 exams and varied models of pacemakers and leads underwent cardiac, vascular, and general MRI scanning. The pacemaker was interrogated, pacing and sensing thresholds, and lead impedances were obtained prior to entering a 1.5 Tesla magnet. No limitations were placed on the type of scans, nor the pacemaker programming. Continuous monitoring of symptoms, noninvasive blood pressure, and electrocardiographic signal were done. Repeat pacemaker interrogation was performed after the scan.

Results: There were no episodes of loss of capture, changes in programming, pacing rate alteration over the magnet rate, or reported symptoms, during the scans. A single device demonstrated pacing inhibition during the scan. Of the 44 leads, none showed a change in impedance, and 29 showed no change in threshold. Of the remaining 15 leads, 8 atrial and 2 ventricular leads experienced a change in threshold to the next highest pulse width or voltage value, while 1 atrial and 1 ventricular lead incremented by 2 settings. One ventricular lead had a decline in voltage threshold to the next lower value and 2 leads could not be tested because of pre-existent battery depletion. Overall, 5 (11%) leads required a change in output to accommodate the altered threshold.

Conclusions: In this unselected series of 24 patients, MRI and MRA scanning in a 1.5 Tesla magnet was found to be safe. Inhibition of the pacing pulse was not found to be necessary to achieve this safety.

1274-140 Transmural Late Enhancement by Contrast Enhanced MRI Predicts No Functional Recovery After Acute Myocardial Infarction

Anna John, Thorsten Dill, Matthias Rau, Wolfgang Ricken, Georg Bachmann, Christine H. Lorenz, Christian W. Hamm. *Kerckhoff Clinic, Bad Nauheim, Germany, Royal Brompton Hospital, London, United Kingdom*

Background: Contrast-enhanced MR has been shown to clearly depict the site of acute myocardial infarction. The aim of this study was to determine whether late enhancement could be used to predict functional recovery after acute myocardial infarction (AMI). **Methods:** 11 patients (pts.) underwent emergency PTCA for AMI. Mean age was 53 (range 44 – 71) years. Exclusion criteria were cardiac rhythm other than sinus, previous myocardial infarction, intervention to more than one lesion and general MR contraindications. MR scans were performed on days 1, 3, 7 and 28 post-AMI using a Siemens Magnetom Sonata 1.5 T. Cine MRI (trueFISP) was performed for volumetry and detection of wall motion abnormalities (WMA). A 3D inversion recovery sequence was used 10 min after Gd-DTPA administration to visualize infarcted (bright) myocardium (defined as "late enhancement"). Observers were blinded to the angiography reports. **Results:** Late enhancement was present in all pts. at all time points. Localisation of late enhancement areas allowed correct definition of the infarct related artery in all cases. 6/11 pts. had transmural infarctions as detected by ce-MR. These 6/11 had persistent WMA at 28 days. 5/11 pts. showed non-transmural late enhancement. Of these, 4 had normal wall motion at 28 days. In the 5th, WMA persisted. In this patient, the infarction was non-transmural, but had a large extent throughout the subendocardium of the inferior and inferolateral wall. **Conclusions:** Transmural late enhancement is associated with lack of functional recovery after AMI, and non-transmural late enhancement in this small pt. group was associated with functional recovery. These results are consistent with those presented by Kim RJ et al. (ACC 2000, NEJM in press). Larger patient numbers are required to further validate the role of late enhancement as a predictor of functional recovery after AMI.

1274-141 Hyper-Enhancement on Non Stress Cardiac MRI Correlates Inversely With Amount of Circumferential Shortening

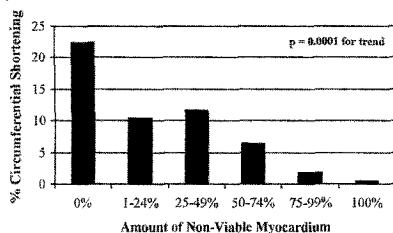
Monvadi B. Srichai, Paulo R. Schwartzman, Bernhard Sturm, Jane M. Kasper, Michael L. Lieber, Richard D. White. *Cleveland Clinic Foundation, Cleveland, OH*

Background: Hyper-enhancement (HE) on cardiac-MRI at rest correlates with non-viable myocardium (NVM), and this technique is able to differentiate degrees of sub-endocardial necrosis. Circumferential shortening (CS) is reduced in areas of NVM, but the reduction may vary according to the amount of sub-endocardial necrosis. This study evaluated whether there is an inverse correlation between amount of HE and degree of CS.

Methods: Thirteen patients with chronic ischemic heart disease and 8 patients with normal hearts underwent non-stress cardiac-MRI using delayed-enhancement (DE) and myocardial tagging (SPAMM) sequences. DE-MRI consisted of a Turbo-FLASH sequence with inversion recovery after injection of Gd-DTPA (0.2mmol/kg). NVM was defined by HE and viable myocardium by nulled signal. Using a 16-segment model, NVM was scored in quartiles according to amount of HE on DE-MRI (graph). Using the myocardial tagged images, CS was calculated using segments containing HE. Measurement was performed using the Argus software (Siemens Medical Systems), at the basal and midventricular levels in the mid-wall of each segment. Normal CS was calculated from the control population (n=8).

Results: Sixty-two segments were evaluated as shown in the graph. Circumferential shortening correlated inversely with the amount on HE (p=0.0001 for the trend).

Conclusion: HE by cardiac-MRI correlates inversely with circumferential shortening, supporting the direct relationship between the amount of myocardial damage and baseline functional impairment.



POSTER SESSION

1275 Assessing Ischemia and Coronary Artery Disease: Implications for Decision Making and Outcomes

Tuesday, March 20, 2001, 3:00 p.m.-5:00 p.m.
Orange County Convention Center, Hall A4
Presentation Hour: 3:00 p.m.-4:00 p.m.

1275-142 Extent and Severity of Coronary Artery Disease in Diabetics with Stress-Induced Ischemia: Results from the Economics of Noninvasive Multicenter Registry

Leslee J. Shaw, Rory Hachamovitch, Daniel S. Berman, D. Douglas Miller. *Emory University, Atlanta, GA, St. Louis University, St. Louis, MO*

Background/Aim: We examined the relationship of stress-induced ischemia to coronary disease(CAD) extent and severity in diabetic and non-diabetic patients referred to coronary angiography after myocardial perfusion SPECT imaging (N=705). **Methods:** CAD extent & severity was assessed by the worst % stenosis and the number of disease vessels visually estimated. Categorical variables were compare by chisquare test. Cox regression modeling was used to assess predictors of death. **Results:** Of the 705 patients, 27% were diabetic. Average age=61, 34% were women, 66% were smokers, 59% were hypertensive. No CAD was noted in 22%, intermediate stenosis in 13%, 1 vessel CAD in 36%, and multivessel CAD in 29%. 3-year cardiac death was 3.1%. Diabetic patients had more ischemia at stress SPECT imaging (p=0.01) and more extensive CAD at catheterization (p<0.0001). In the estimation of cardiac death, ischemia was associated with a significant worsening prognosis in diabetic as compared to nondiabetic patients (p<0.00001). Conversely, diabetic patients with provocative ischemia were less likely to have normal coronary arteries (p<0.0001). The enclosed table details the frequency of false positive stress imaging results in diabetic and nondiabetic patients. By age groups, the combination of advancing age & diabetes was least likely to be associated with false positive stress results. **Conclusion:** For diabetic patients, evidence of provocative ischemia is associated with more CAD and worsening prognosis. Stress-induced ischemia may serve as an effective guide for posttest decision making in the diabetic and nondiabetic patients at risk for CAD.

	N	Stress Ischemia and no CAD >50% stenosis	Stress Ischemia and no CAD >70% stenosis
All patients	705	15.3%	19%
Diabetics	191	8.5%	12.4%
Age 70+ years	40	0%	0%
Age 60+ years	105	4.4%	4.4%
Age 50+ years	160	7.7%	10.8%
Age 40+ years	188	8.6%	11.8%
Age 30+ years	190	8.6%	11.8%

1275-143 Prognostic Value of Technetium-99m Sestamibi Gated SPECT Imaging With Dobutamine Stress

Michael S. Fowler, Deborah M. Katten, Jeffrey F. Mather, Alan W. Ahlberg, Carol C. McGill, William Hudson, Lynne L. Johnson, Gary V. Heller. *Hartford Hospital, Hartford, CT, Rhode Island Hospital, Providence, RI*

Background: Dobutamine stress with myocardial perfusion imaging has become a common procedure in risk stratifying patients for cardiac events when they are unable to adequately perform treadmill exercise and have contraindications to vasodilator stress. However, there is a paucity of data regarding the prognostic value of dobutamine stress combined with gated SPECT Tc-99m sestamibi imaging (DOB-MIBI)

Methods: The joint database acquired by our nuclear laboratories over the past 4 years was screened for patients referred for DOB-MIBI. All patients were clinically referred to evaluate ischemia using graded dobutamine stress (5 to 40mcg/kg/min.). Atropine (0.4 – 1.0 mg.) was given to increase heart rate as required. Perfusion scans were read by an experienced reader using a 7 segment model. Abnormal function was defined as wall-motion abnormality (WMA) of any segment. Follow-up was obtained through telephone and mail contact, hospital records, and physician records. The primary endpoint was cardiac death or non-fatal myocardial infarction.

Results: Of 615 patients identified, six patients were lost to follow up, 113 patients were not gated, and 106 patients were revascularized within 3 months of their study. In the remaining 390 patients, the mean age was 65.0 ± 12.3 years. The mean follow-up time was 16 ± 9 months. Normal perfusion and function were found in 201 (51.5%) patients. The event rate in this group (3.5%) was lower than in the group with a perfusion and/or functional abnormality (10.6%)(P=0.006). As shown in the table, the event rate was higher in patients with both a perfusion and functional abnormality versus normals (13.9%, P=0.001).

Event Rates versus Perfusion or Functional Abnormalities

Group	No Events	Yes Events
Both Normal	194 (96.5%)	7 (3.5%)
Perfusion defect or WMA	82 (93.1%)	6 (6.8%)
Perfusion defect and WMA	87 (86.1%)	14 (13.9%)*

*P=0.001 versus Both Normal

Conclusion: In a heterogeneous group of patients, there is clear prognostic value in a gated DOB-MIBI study that has abnormal perfusion and function compared to a normal scan. There is also a suggestion that the gated wall motion assessment alone provides incremental prognostic value.

1275-144 Does Myocardial Perfusion SPECT Affect the Frequency of Normal Coronary Angiograms in Men and Women?

Howard C. Lewin, Pamela A. Ivey, Clara Lu Brandt, C. Noel Bairey Merz, Enrique F. Schisterman, Sean W. Hayes, John D. Friedman, Daniel S. Berman. Cedars-Sinai Medical Center, Los Angeles, CA

Background Gender differences in normal coronary angiogram (NCA) rates have previously been reported. We examined patients (pts) undergoing coronary angiography in our institution to determine if noninvasive nuclear testing reduced the rate of NCA in men and women over a 7-year period.

Methods All pts were identified from audited records in the Cedars-Sinai Medical Center cardiac catheterization (cath) laboratory database. Pts with previous history of myocardial infarction, PTCA, CABG, valvular or congenital heart disease were excluded from this analysis such that the dataset represents only pts referred for diagnostic coronary angiography. Prior to angiography, pts were categorized as having no prior history of stress myocardial perfusion SPECT (MPS) or MPS within 60 days prior to cath. NCA was defined as <50% luminal diameter in any epicardial artery.

Results: A total of 9,975 pts underwent diagnostic coronary angiography between 1992-1998, of which 3,218 (32.3%) were females. There was a significantly lower NCA rate in those pts undergoing MPS prior to angiography compared to those who did not (11.4% vs. 17.6%, $p < .001$). This reduction was similar in men and women (38% and 32% relative reduction, respectively).

Conclusion Pts referred for diagnostic angiography at Cedars-Sinai Medical Center from 1992-1998 who had a MPS within 60 days of angiography had a significantly lower NCA rate compared to those who did not undergo MPS. This reduction was observed in both men and women.

NCA Rate	Overall	Female	Male
With MPS	11.4% (n = 2435)	15.2%* (n = 804)	9.6%* (n = 1631)
Without MPS	17.6%** (n = 7540)	22.2%*,** (n = 2414)	15.5%*,** (n = 5126)

* $P < 0.01$ men vs. women; ** $P < 0.001$ with vs. without MPS

1275-145 Higher Rate of Cardiac Events in Patients With Smaller Hearts Despite Normal SPECT Myocardial Perfusion and Normal Left Ventricular Systolic Function

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Background: The limited spatial resolution of myocardial perfusion SPECT results in significant blurring & potential underdetection of significant CAD when cardiac size is small. Extensive data indicates that a normal SPECT study predicts very low likelihood for subsequent events. This study investigates whether a normal SPECT has the same meaning in patient populations defined according to heart size.

Methods: Between 1/97 & 6/98, 963 patients had a stress/rest TI-201 SPECT study demonstrating visually normal myocardial perfusion & LVEF $\geq 50\%$ (QGSTM). Based on phantom data indicating the threshold for blur-related errors, patients were classified into 2 groups: A= end-systolic volume (ESV) ≤ 20 ml; B= all others. Patients were followed for a mean of 18 months and a minimum of 12 months (follow-up 98% complete) for non-fatal MI or cardiac death.

Results: Overall, mean age was 61 \pm 12 yrs & 532 (55%) were female. 66% had dyslipidemia, 54% hypertension, 31% known CAD, 11% diabetes mellitus, 15% were smokers & 9% had LVH. Stress was exercise in 646 (67%) & pharmacologic in the remainder. ESV ranged from 1 to 88 (mean 20 \pm 14) ml. Of 10 demographic descriptors, statistically significant differences between Group A (573 pts) & Group B (390 pts) were:

	Group A	Group B	p-value
Age (yrs)	64 \pm 12	59 \pm 13	<0.001
Males	23%	76%	<0.001
Dyslipidemia	69%	61%	0.015
Smoking	12%	19%	0.005
ESV (ml)	11 \pm 5	33 \pm 11	<0.001

There were a total of 9 cardiac events (7 non-fatal MI, 2 cardiac deaths) for an annual event rate of 0.6%. Group A pts had 8 events (6 non-fatal MI; event rate 1.4%) vs only 1 event (ESV in this pt was 24 ml) in Group B pts (event rate 0.3%). 89% (8/9) of events occurred in females ($p=0.048$ vs males).

Conclusions: This large retrospective analysis of hard events following a normal myocardial perfusion SPECT study 1) confirms that these are rare (0.9% cumulative) and 2) identifies event-clustering in pts, predominantly females, with smaller hearts. If substantiated by further studies, this finding should encourage research focussed on refinements in methodology for assessing perfusion in smaller hearts.

1275-146 Relationship Between Clinical Site and Core Lab Assessments of Perfusion and Function on Stress Gated Myocardial Perfusion SPECT

Sean W. Hayes, Leslee J. Shaw, Robert A. O'Rourke, William S. Weintraub, Koon K. Teo, Pamela Hartigan, William E. Boden, James Gerlach, Tara A. Gurtler, Kathryn Hanson, Guido Germano, Daniel S. Berman, COURAGE Investigators. Cedars-Sinai Medical Center, Los Angeles, CA

Background: Recent trials have used core labs (nuclear, echo, angiography) for data analysis in order to eliminate bias and add expertise.

Methods: The COURAGE trial is randomizing ~3000 pts with ischemia (isch) to maximal medical therapy alone or combined with PCI. A nuclear substudy is assessing perfusion and function abnormalities on exercise/adenosine gated myocardial perfusion SPECT (MPS); prerandomization MPS have been obtained in ~25% of pts. Ejection fractions (EF) were obtained automatically using Cedars-Sinai QGS software. MPS was scored visually by both the clinical site and core lab using a 20 segment model and 5 point scale (0=normal to 4=no uptake). Summed stress (SSS) and rest (SRS) scores were obtained by summing the 20 segment stress and rest scores. Summed difference scores (SDS) were obtained by subtracting SRS from SSS. Previously defined scan categories were used: normal (SSS 0-3), mildly (SSS 4-8), moderately (mod) (SSS 9-13), or severely (sev) abnormal (abnl) (SSS >13); amount of isch: none (SDS 0-1), mild (SDS 2-4), mod (SDS 5-7), or sev (SDS >7).

Results: Sites and core lab had excellent agreement in measuring EF (54.1 vs. 53.9%, $r=0.91$). Site perfusion scores were consistently higher than by core lab (SSS, 15.0 vs. 9.2, $p<0.001$; SDS, 10.0 vs. 6.2, $p<0.001$). For SSS, 18 (38%) of 47 scans scored by sites as mod-sev abnl were reclassified as normal or mildly abnl by the core lab ($p<0.0001$). For SDS, 25.3% of scans were reclassified by the core lab from mod-sev isch to no or mild isch, or vice versa ($p=0.049$). The greatest discordance occurred in scans scored as mod isch by sites, with 7 of 9 reclassified as no or mild isch. There was also a discordance in scans scored as sev abnl by sites, with the core lab reclassifying 21 of 37 as normal (1), mild abnl (10), or mod abnl (10) ($p<0.0001$).

Concordance of Site & Core Lab for Ischemia

		Site			
		0-1	2-4	5-7	>7
Core lab	0-1	7	3	4	2
	2-4	3	2	3	4
	5-7	0	1	1	12
	>7	1	1	1	19

Conclusions: Clinical sites and the core lab have excellent agreement for automatically obtained functional data, but clinical sites visually scored perfusion defects more severely than the core lab. The findings underscore the importance of core labs in studies dealing with subjectively analyzed data.

POSTER SESSION

1276 Clinical and Experimental Echo Studies in Diastolic Function

Tuesday, March 20, 2001, 3:00 p.m.-5:00 p.m.
Orange County Convention Center, Hall A4
Presentation Hour: 3:00 p.m.-4:00 p.m.

1276-147 Non Invasive Assessment of Serial Changes in Left Ventricular Diastolic Function During Myocardial Ischemia-Reperfusion

Marta Sitges, Takahiro Shiota, Jian Xin Qin, Yong Jin Kim, Fabrice Bauer, Kai Wang, Zhongmin Zhou, Xiaorong Zhou, Neil L. Greenberg, Mario J. Garcia, James D. Thomas. The Cleveland Clinic Foundation, Cleveland, OH

Background: New echocardiographic methods have been recently introduced for the non-invasive assessment of left ventricular (LV) relaxation. Our aim was to simultaneously analyze the serial changes in several non-invasive indices of LV relaxation during myocardial ischemia-reperfusion.

Methods: 11 mongrel dogs were studied using transthoracic echocardiography at baseline, after 90 minutes balloon-catheter occlusion in the mid left anterior descending coronary artery, 2 hours after balloon deflation and 1 week after. PW Doppler (E velocity) and color Doppler M-Mode flow propagation velocity (Vp) of the mitral inflow were obtained. Isovolmic relaxation time (IVRT) was determined from CW Doppler recordings. Lateral mitral annulus early diastolic velocities (Ea) were also measured using tissue Doppler imaging. LV ejection fraction (EF) was obtained using the Simpson's method. In 5 dogs, the time constant of LV relaxation (Tau) was invasively measured at baseline and after deflation.

Results: Early transmitral peak velocity (E), Vp and Ea significantly decreased during coronary occlusion. However, % change of Vp during coronary occlusion was larger than that of Ea and E (-50 \pm 14 % for Vp versus -22 \pm 37 % for Ea and versus -24 \pm 23 % for E,

p<0.05 for both). After deflation, E and Vp were still significantly lower as compared to baseline. After 1 week, all diastolic parameters returned to baseline, although EF was slightly reduced (49±9 versus 59±7, p<0.01)

	E (m/sc)	IVRT(msc)	Vp (cm/sc)	Ea (cm/sc)
Baseline	0.6±0.1	85±11	66±15	11±3
Occlusion	0.4±0.1*	111±22**	31±6*	8±2*
Deflation	0.4±0.1*	104±20**	42±8*	9.3±2
1 week	0.6±0.1	79±14	66±15	11±2

*p<0.05 versus baseline, **p=0.07 versus baseline.

Correlation with Tau was better for Vp (r=0.84, p<0.01) than for Ea (r=0.60, p=0.06) or E (r=0.5, p=NS).

Conclusions: This study demonstrated that LV relaxation was impaired during myocardial ischemia, but recovered after reperfusion. Among the several non-invasive parameters of LV relaxation, Vp was found to be the most sensitive in response to myocardial ischemia.

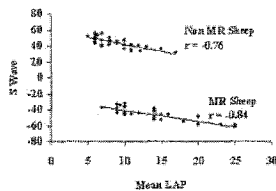
1276-148 Relationship Between the Left Atrial and Left Ventricular Pressures and Pulmonary Venous Flow Velocities in Animals With and Without Mitral Regurgitation

Dene Wesley Daugherty, Michael Jones, Takahiro Shiota, Dag Teien, Fabrice Bauer, Marta Sitges, Jian Xin Qin, Hiroyuki Tsujino, Arthur D. Zetts, Julio A. Panza, James D. Thomas. *The Cleveland Clinic Foundation, Cleveland, OH, The National Institutes of Health, Bethesda, MD*

Background: Pulmonary venous flow velocities and pattern have been proposed as possible estimates of left ventricular (LV) filling pressures. However, the presence of mitral regurgitation (MR) may complicate this estimation. The aim of this study was to assess the relationship between mean left atrial pressure (LAP), left ventricular end diastolic pressure (LVEDP), and pulmonary venous flow velocities in the presence or absence of MR in an animal experimental models.

Methods: Seventeen sheep were tested, 9 without MR and 8 with MR. MR was created by surgical resection of the chordae tendineae. Each sheep was studied under four different loading conditions (baseline and after blood, angiotensin, and nitroprusside infusion). Left atrial and LV pressures were recorded with high fidelity pressure catheters. Pulsed-wave Doppler was used to quantify the pulmonary venous flow velocities. Mean LAP, LVEDP, and peak systolic (S) and peak diastolic (D) pulmonary venous flow velocities were measured at every one of the 4 different hemodynamic stages.

Results: In all the sheep with MR, the pulmonary venous S velocities were reversed. Pulmonary venous S velocity showed a significant negative correlation with mean LAP both in the sheep with MR and without MR (r=-0.84 and -0.76, respectively, figure).



Pulmonary venous D velocity also showed a significant negative correlation with LVEDP in both groups (r=-0.80 for sheep with MR and -0.72 for sheep without MR).

Conclusions: Even in the presence of MR, pulmonary venous peak S velocity may be useful for estimating mean LAP and pulmonary venous peak D velocity for estimating LVEDP non-invasively.

1276-149 Altered Diastolic Filling in Pulmonary Hypertension: A Mechanistic Approach

H. Mehrdad Sadeghi, Ehtisham Mahmud, Ajit Raisinghani, Neillander Sawhney, Anthony N. DeMaria, Daniel G. Blanchard. *UCSD Medical Center, San Diego, CA*

Background: Right ventricular pressure overload in pulmonary hypertension is associated with abnormal left ventricular (LV) diastolic filling. The "reverse Bernheim effect" describes a redistribution of LV filling from early to late diastole induced by distortion of the interventricular septum (IVS) towards the LV. We sought to evaluate the exact mechanism of this diastolic ventricular interdependence in pts with chronic thromboembolic pulmonary hypertension (CTEPH) in relation to echocardiographic and pressure variables.

Methods: We analyzed the right heart catheterization data and 2-D echocardiograms of 21 consecutive CTEPH patients to obtain right atrial (RA), pulmonary artery (systolic-PAS, diastolic, mean), pulmonary capillary wedge pressures (W), "trans-atrial pressure gradient" (TAG), LV diastolic eccentricity index (EI), and diastolic mitral inflow velocity ratio (E/A). TAG describes the difference between right atrial and wedge pressures (TAG=RA-W). EI is defined as the diastolic LV dimension parallel to IVS divided by that dimension perpendicular to and bisecting the IVS (measured in the parasternal short axis view). **Results:**

Variables	Mean +/- sd
Age	55±11 yrs
RA	9±5 mmHg
TAG	0.3±0.5 mmHg
PAS	82±15 mmHg
E/A	0.7±0.2
EI	1.24±0.3

Mitral E/A<1.0 and IVS flattening were noted in 19 (90%) and 21 (100%) of pts, respectively. EI correlated directly with TAG (r=0.68, p<0.001), and this relationship was not dependent on the severity of pulmonary hypertension by multivariate analysis. However, TAG and pulmonary artery systolic pressure together accounted for E/A ratio more accurately (multivariate r=0.683, p<0.01) than either variable alone. There was also a direct correlation between E/A and EI (r=0.52, p<0.05). **Conclusions:** In CTEPH pts, IVS flattening and LV distortion are associated with abnormal LV diastolic filling dynamics. Utilizing catheter-derived hemodynamic measurements, this study demonstrates direct evidence suggesting a cause-effect relationship between the magnitude of TAG, LV distortion, and altered LV filling dynamics.

1276-150 Left Ventricular Diastolic Dysfunction of Impaired Relaxation Type Is More Likely to Be Present in Patients With Severe Pulmonary Hypertension Than in Patients With Mild or Moderate Pulmonary Hypertension

Ali I. Moustapha, Sangeeta Saikia, Vinod Kaushik, Suzana Diaz, Seung-Ho Kang, Eddy Barasch. *University of Texas Medical School at Houston and Memorial Hermann Hospital, Houston, TX*

Background: Chronic pulmonary hypertension (PHT) may cause left ventricular (LV) diastolic dysfunction in the absence of intrinsic LV disease. The level of severity of PHT required to affect LV filling remains however unknown. We sought to compare the Doppler echocardiographic parameters of diastolic function and interventricular septum (IVS) motion in patients (pts) with different levels of severity of chronic PHT.

Methods: Between July 1998 and June 2000, all pts (N=320) with echocardiographic evidence of PHT were studied. Subjects with evidence of coronary artery disease, LV hypertrophy or LV systolic dysfunction were excluded. Patients were then divided into those with mild or moderate PHT (systolic pulmonary artery pressure, SPAP > 40 and < 60 mmHg, group B, N=63) and those with severe PHT (SPAP ≥60 mmHg, group C, N=57). As a control group, Seventy-five (75) normal subjects (group A) were randomly selected from our health maintenance clinic. SPAP was calculated by tricuspid regurgitant jet method. IVS motion was studied and Doppler echocardiographic parameters of LV diastolic function were compared among 3 groups.

Results: Mean age, heart rate, systemic arterial pressure, and LV ejection fraction were similar in all 3 groups. Mean SPAP was 49.1±5.9 mmHg in group B and 74.1±11.7 mmHg in group C (p< 0.01). Transmittal E/A ratio was significantly lower in group C than in groups A or B. Deceleration time (DT) and isovolumic relaxation time (IVRT) were significantly longer in group C than in groups A or B. No significant differences were noted between groups A and B (table). E/A < 1 was observed in 63.5% of pts in group C compared to 31.2% in group B (p<0.01). Paradoxical IVS motion was noted in 72.2% of pts in group C compared to 6.2% in group B (p<0.01).

Echocardiographic parameters of LV diastolic function in all 3 groups

	Group A (N=75)	Group B (N=63)	Group C (N=57)
E/A	1.3±0.6	1.3±0.5	0.9±0.4*
DT	203.3±44.6	197.5±44.8	226.0±67.7*
IVRT	89.6±15.3	84.2±21.3	112.8±45.2*

* P < 0.05 compared to groups A and B.

Conclusions: LV diastolic dysfunction of impaired relaxation type is more likely to be present in pts with severe PHT than in pts with mild or moderate PHT. This can be potentially caused by the paradoxical IVS motion and may explain some of the clinical manifestations seen in severe PHT.

POSTER SESSION

1277 Dobutamine Stress Echo: Miscellaneous Applications

Tuesday, March 20, 2001, 3:00 p.m.-5:00 p.m.
Orange County Convention Center, Hall A4
Presentation Hour: 3:00 p.m.-4:00 p.m.

1277-151 Effect of Revascularization on Left Ventricular Remodelling in Patients With Severe Chronic Ischaemic Left Ventricular Dysfunction: Influence on Mortality

Roxy Senior, Avijit Lahiri, Sanjiv Kaul. *Northwick Park Hospital, Harrow, United Kingdom*

Background: The benefit of revascularisation (Rev) in pts with severe left ventricular (LV) dysfunction has been measured by improvement in resting regional function alone. The effect of LV geometry is unknown, as is the effect of changes in regional and global function, as well as geometry after revascularisation on long-term outcome. We hypothesised that patients with chronic ischaemic LV dysfunction but viable myocardium will demonstrate benefit from revascularisation beyond simply recovery in regional and global LV function. Revascularisation will also favourably affect geometry, which in turn will improve long-term outcome. **Methods:** Seventy patients with severe ischaemic LV dysfunction (LVEF <0.35) were studied at rest by low dose dobutamine echocardiography to assess viable myocardium. They then underwent revascularisation (n=36) or were treated medically (n=34). Fifty four patients had viable myocardium, while 14 did not. They were evaluated for change in LV function and geometry (both size and shape) at a mean of 21 months later. Further follow-up was performed for a mean of 3.5 years to determine outcome. **Results:** Patients with viable myocardium not only showed improvement in regional and global function (p<0.001), but also in LV geometry (both shape and

size)($p < 0.0001$), which was independent of and incremental to the improvement in function. Of the total beneficial effect of revascularisation of viable myocardium, only half was attributable to improvement in LV function, while the other half was associated with improvement in LV geometry. On long-term follow-up, change in LV end-systolic volume after revascularisation was the only multivariate discriminator between 15 patients who died and 55 who did not. **Conclusion:** The measurement of the effect of revascularisation of viable myocardium in chronic ischaemic heart disease should not only include improvement in resting regional and global LV function, but also LV geometry. The improvement of LV geometry contributes to better LV systolic function, which in turn is the best predictor of survival after revascularisation.

1277-152 Regional Cyclic Variation of Integrated Backscatter Is a Quantitative Marker of Ischemia During Dobutamine Stress Echocardiography: Comparison With Tissue Doppler and Wall Motion Scoring With Angiography

Satoshi Yuda, Jared Dart, Peter Cain, Terri Baglin, Thomas Marwick. *University of Queensland, Brisbane, Australia*

Background: Integrated backscatter (IB) is known to change with ischemia, but prior studies have involved parasternal imaging, which limits evaluable segments (segts). We sought to assess efficacy and feasibility of IB as a quantitative marker of ischemia during dobutamine echo (DbE) from the apical views. **Methods:** We studied 33 pts (22 men, age 56 ± 11 y), 15 with low probability of CAD, 10 with ischemia alone and 8 with ischemia and abnormal resting function) using a standardized DbE protocol. Images from 3 apical views were acquired at 80-120 frames/sec at rest and peak stress and stored in digital cine-loops (System Five). Using a 16 segts model, wall motion (WM) was assessed independently; ischemia was identified as a new WM abnormality, scar as a rest WM abnormality. Myocardial IB and Doppler velocity (MDV) were assessed offline (Echopac 6.0) in the same segts. Significant CAD was defined by quantitative angiography as $>50\%$ stenosis. Peak MDV, cyclic variation (CV) and time to peak IB (tIB, corrected for QT interval) were recorded. **Results:** CV was obtained in 249 segts (86%) at rest and 239 segts (83%) at peak. Of 288 segts, WM identified 158 as normal and 130 as abnormal, of which 56 had ischemia with normal rest WM. Only rest MDV and tIB (not CV) distinguished scar from ischemic segts. Of 10 pts with normal resting WM, CV at rest and peak identified ischemia ($*p < 0.01$ vs rest, $\#p < 0.05$ vs control and $\$p < 0.05$ vs normal segts in CAD).

	Rest			Peak		
	CV (dB)	tIB	MDV (cm/s)	CV (dB)	tIB	MDV (cm/s)
Control	6.5 ± 2.1	0.90 ± 0.14	3.5 ± 2.0	$7.0 \pm 2.3^*$	$0.94 \pm 0.15^*$	$6.9 \pm 3.7^*$
Normal/CAD	7.0 ± 2.9	$0.84 \pm 0.19\#$	4.0 ± 1.6	6.9 ± 2.8	0.90 ± 0.20	$6.9 \pm 3.4^*$
Ischemic	$5.6 \pm 2.2\#,\$$	$0.83 \pm 0.19\#$	4.1 ± 1.8	$5.6 \pm 2.4\#,\$$	0.90 ± 0.27	$6.3 \pm 3.8^*$

Using optimal thresholds of CV (base, mid > 5 dB, apex > 6 dB) and previously defined site-specific thresholds for MDV at peak, the sensitivity of CV, MDV and WM for predicting individual stenosis were 68%, 70% and 73% ($p = 0.66$), with specificity and of 59%, 75% and 63% ($p = 0.04$) and accuracy of 62%, 72% and 68% ($p = 0.08$). **Conclusions:** CV and MDV during DbE can differentiate pts with and without CAD and CV can differentiate abnormal versus normal segts in pts with CAD. Although the accuracy of CV and MDV are comparable to expert WM analysis, MDV appears more specific than CV.

1277-153 Factors With Impact on the Agreement Between Different Readers in the Interpretation of Dobutamine Stress Echocardiograms

Rainer Hoffmann, Don Poldermans, Harald Lethen, Paolo Fioretti, Peter van der Meer, Hans-Peter Tries, Rosanna Ciani, Alexander Katz, Raimund Erbel, Peter Hanrath, Thomas Marwick. *University RWTH Aachen, Aachen, Germany*

Background: Interobserver agreement on the interpretation of dobutamine stress echocardiograms (DSE) has been shown to be only moderate. Knowledge on factors which have an impact on interobserver agreement is important to lower variability in DSE reading.

Methods: 150 DSE (up to 40 $\mu\text{g}/\text{kg}/\text{min}$ dobutamine + 1 mg atropine, second harmonic imaging) were performed by 6 experienced institutions on patients with suspected coronary artery disease. All DSE were interpreted by each center unaware of any patient data apart from the echos. Procedural and echocardiographic factors with impact on reading agreement were determined. Reading agreement was determined as ranging from equal assessment on test positivity or negativity by 3 of the 6 readers (3/6) to 6 of 6 readers (6/6) for each DSE study.

Results: Mean agreement between the 6 institutions on normality or abnormality of DSE result equaled a kappa of 0.55. The wall motion score index (WMSI), the extent of induced wall motion abnormality (WMA) as determined by the number of segments with new WMA and the severity of induced WMA as indicated by the presence of induced akinesia were greater in studies with higher agreement on DSE results. There was a trend towards greater rate-pressure product in studies with greater agreement.

	6/6 (N=67)	5/6 (N=47)	4/6 (N=32)	3/6 (N=4)	P
WMSI Peak DSE	1.42 ± 0.48	1.25 ± 0.33	1.21 ± 0.16	1.30 ± 0.22	0.029
Extent (Segments)	3.3 ± 3.2	2.2 ± 2.1	2.0 ± 1.3	2.4 ± 2.0	0.051
Severity (Akinesia)	37%	11%	6%	0%	< 0.001
RPP ($10^3 \text{ mmHg min}^{-1}$)	21.5 ± 5.8	21.1 ± 7.3	20.3 ± 5.7	18.7 ± 9.6	0.733

Conclusion: A greater severity and extent of induced WMA increases the level of reader agreement. Thus, DSE should not be stopped with the onset of minor WMA.

1277-154 Development of Atrial Fibrillation During Dobutamine Stress Echocardiography Unmasks Left Atrial Mechanical Dysfunction

Dimitrios P. Tsiapras, Alicia Maceira, George Koutroulis, Petros Nihoyannopoulos. *Cardiology Dep, Hammersmith Hospital, IC,NHLI, London, United Kingdom*

The development of atrial fibrillation (AF) is alleged to be a benign complication of dobutamine stress echocardiography (DSE), often self terminated. We hypothesised that a subclinical left atrial (LA) mechanical dysfunction may be a predisposing factor leading to AF during inotropic stimulation with dobutamine.

Methods: All patients (pts) with new onset of AF during DSE were reviewed for the study (AF group). Apical 4 & 2 chamber views were used to calculate Left Atrial Volumes using area-length formula $[(8/3\pi) \cdot LA_{area4ch} \cdot LA_{area2ch} / LA_{length}]$ at a) end systole (LAVmax), b) end diastole (LAVmin) and c) the end of P wave (LAVp). The Total Emptying Volume (TEV: LAVmax-LAVmin), Passive Emptying Volume (PEV: LAVmax-LAVp) and Active Emptying Volume (AEV: LAVp-LAVmin) were calculated. Total (TEF: TEV*100/LAVmax), Passive (PEF: PEV*100/LAVmax) and Active (AEF: AEV*100/LAVp) Ejection Fractions were also calculated. The relative contribution of PEF and AEF to the TEF (PEF/TEF & AEF/TEF) and the PEF/AEF ratio were estimated. These patients were compared with a group of patients (SR group) matched for a) age, b) LV function, c) LV hypertrophy, d) MR severity and e) DSE result. Comparison of measurements between the groups was performed using non-parametric tests.

Results: From 1/1994 to 12/1999, among 1505 DSE studies, 15 pts (0.99%) with new onset of AF were found. Of those, 12 with satisfactory images were reviewed. LA was more dilated in AF group (LAVmax: 74.6 ± 28 vs 48.6 ± 24 , $p < 0.03$, LAVmin 40.8 ± 21 vs 22.4 ± 16.7 , $p < 0.04$) but LAVp (49.9 ± 20.5 vs 36.7 ± 25.3 , p ns) and TEV (33.7 ± 15.1 vs 26.1 ± 8.9 , p ns) were not significantly different. LA EFs are shown below:

	AF	SR	p	AF	SR	p	
TEF (%)	45.6 ± 15.3	57.3 ± 10.1	0.05	PEF/TEF	0.71 ± 0.13	0.48 ± 0.22	0.008
PEF (%)	32.9 ± 13.0	28.9 ± 15.2	0.51	AEF/TEF	0.28 ± 0.13	0.51 ± 0.22	0.008
AEF (%)	20.4 ± 11.6	39.3 ± 10.7	0.001	PEF/AEF	3.2 ± 2.1	1.4 ± 1.5	0.026

During a follow-up of 37 \pm 16 months, 4/15 pts (26%) of Group 1 and 0/12 pts of group 2 were in chronic AF ($p < 0.05$)

Conclusion: New onset of AF during DSE appears to unmask a subclinical mechanical LA dysfunction, which increases the possibility of recurrent and chronic AF in the future.

POSTER SESSION

1278 Myocardial Contrast Echocardiography: Real-Time Imaging

Tuesday, March 20, 2001, 3:00 p.m.-5:00 p.m.
Orange County Convention Center, Hall A4
Presentation Hour: 3:00 p.m.-4:00 p.m.

1278-155 Quantitative Real-Time Myocardial Contrast Echocardiography Demonstrates That Myocardial Blood Volume Increases During Dobutamine Stress in Normal Humans

Bettina Kuersten, Peng Li, Thippeswamy H. Murthy, Federico Paz, Elizabeth Locricchio, Mani Vannan. *University of Michigan Health System, Ann Arbor, MI*

Background: Experimental work in MCE suggests that myocardial blood volume (MBV) increases significantly with dobutamine due to capillary recruitment which is unlike vasodilatation with dipyridamole (Dipy) where there is little change in MBV. We have previously shown by real-time MCE (rt-MCE) that in normal, healthy human volunteers MBV is relatively unchanged with Dipy and that increased myocardial blood flow (MBF) is predominantly due to increase in blood velocity (β). The purpose of this study was to evaluate the changes in MBV and β in various coronary beds with dobutamine stress echo (DSE) in healthy volunteers. **Methods:** 15 healthy volunteers with no history of heart disease and normal resting echo and 12-lead ECG, mean age 27 (range 24-34) years, 3 female, were studied. All received continuous intravenous Optison™ infusion (0.58-1.2 ml/min) at baseline, and during low-dose (10 $\mu\text{g}/\text{kg}/\text{min}$) and peak-dose (40 $\mu\text{g}/\text{kg}/\text{min}$) DSE. Rt-MCE (Power Modulation™, Agilent Technologies) was performed at each of the stages in the apical 4C, apical 2C, PLAX and SAX views. End-systolic frames in optimal loops were analyzed using a previously described technique to measure $A = \text{MBV}$ and $\beta = \text{microbubble velocity}$. **Results:** Of the 45 available coronary territories 1 territory was not analyzable due to attenuation artifact. MBV data for the 3 coronary territories from the 4C view only are shown for all stages of DSE. Changes in β and MBV in other views will be presented. Values are expressed as mean \pm SEM. VI = background subtracted peak video intensity (VI).

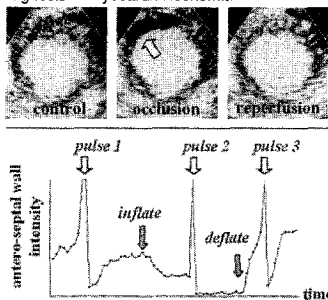
	Baseline VI	Low-Dose VI	p-Value Baseline vs Low-Dose	Peak-Dose VI	p-Value Baseline vs Peak-Dose
LAD	120 ± 5.1	121 ± 6.9	0.91	140 ± 7.4	< 0.006
LCX	117 ± 9.2	123 ± 10.8	0.85	136 ± 8.5	0.09
RCA	91 ± 7.2	102 ± 10.1	0.34	115 ± 8.3	0.02

Conclusions: (1) Quantitative real-time MCE demonstrates a significant increase in MBV in normal humans during DSE. (2) Peak MBV is attained at high-dose dobutamine. Recognition of changes in MBV and β with dobutamine MCE in normal humans may help to detect perfusion abnormalities.

1278-156 Combined Assessment of Myocardial Perfusion and Regional Left Ventricular Function Using Analysis of Contrast Enhanced Power Modulation Images

Victor Mor-Avi, Enrico G. Caiani, Claudia E. Korcarz, Keith A. Collins, James E. Bednarz, Roberto M. Lang. *University of Chicago, Chicago, IL*

Echocardiographic contrast media have been used to assess myocardial perfusion and to enhance endocardial definition for improved assessment of LV function. However, these methodologies have been qualitative or required extensive off-line image analysis. Power modulation is a recently developed imaging technique that provides selective enhancement of microbubble-generated reflections. Our goal was to test the feasibility of using power modulation for combined quantitative assessment of myocardial perfusion and regional LV function in an animal model of acute ischemia. **Methods:** Coronary balloon occlusions were performed in 13 anesthetized pigs. Transthoracic power modulation images (Agilent 5500) were obtained during continuous intravenous infusion of the contrast agent Definity (DuPont) at baseline, during brief coronary occlusion and subsequent reperfusion. Images were analyzed using custom software. At each phase, myocardial perfusion was assessed by calculating mean pixel intensity and the rate of contrast replenishment following high-power ultrasound impulses in 6 myocardial regions of interest. LV function was assessed by calculating regional fractional area change from semi-automatically detected endocardial borders. **Results:** All ischemic episodes caused detectable and reversible changes in both perfusion and systolic function. Perfusion defects were visualized in real time and confirmed by a significant decrease in pixel intensity and reduced rate of contrast replenishment in the LAD territory (figure). Fractional area change was significantly reduced in ischemic segments and restored to baseline level with reperfusion. **Conclusion:** Power modulation allows simultaneous on-line assessment of myocardial perfusion and regional LV wall motion, which may improve the echocardiographic diagnosis of myocardial ischemia.



1278-157 Combined Assessment of Myocardial Perfusion and Segmental Function in Real-Time During Dobutamine Stress Echocardiography

Deepika Gopalakrishnan, Srihari Thanigaraj, Stephanie Loslo, Julio E. Perez. *Washington University School of Medicine, St. Louis, MO*

Background: Recent advances in ultrasonic imaging permit the detection of left ventricular (LV) myocardial perfusion in real-time employing a low-mechanical index, myocardial contrast echocardiography technique. With the advent of this approach, it would be desirable to relate LV myocardial perfusion to function on a segment-by-segment basis during stress echocardiography.

Methods: We studied 27 patients with proven or suspected coronary artery disease referred for a routine, clinically indicated, Dobutamine stress echocardiogram performed according to established standards. Real-time myocardial perfusion images were obtained at rest and at peak stress from apical 4 and 2-chamber views employing one of three digital systems (Sonos 5500 [n = 6], HDI 5000 [n = 18], and Sequoia [n = 3]). Perfusion images were acquired with low mechanical index (0.1-0.18) during intravenous infusion of contrast (Optison®). Transient high mechanical index (1.5) pulses were applied to induce microbubble destruction and assess the replenishment of contrast into the tissue, indicative of myocardial perfusion. Myocardial perfusion and LV wall motion were evaluated in the corresponding segments independently, in a blinded fashion in each patient, grading the myocardial perfusion visually as: 1 = normal, 2 = hypoperfusion, and 3 = absent perfusion, and wall motion similarly (1 = normal, 2 = hypokinesis, and 3 = akinesis, dyskinesis or aneurysmal).

Results: A total of 268 LV wall segments were studied at rest and 252 segments at peak dobutamine stress. In this group, which included patients with resting and induced wall motion abnormalities, the relationship between LV segmental function and myocardial perfusion assessed both at rest (r = 0.59) and peak stress (r = 0.58) was heterogeneous.

Conclusion: Combined assessment of myocardial function and perfusion in real-time during Dobutamine stress echocardiography is feasible in a routine clinical setting. Our study demonstrates the heterogeneity between flow and contractile function, which underscores the importance for an integrated assessment during stress echocardiography.

1278-158 Quantification of Myocardial Blood Flow by Myocardial Contrast Echo: Comparison of Microbubble Agents Which Produce Different Myocardial Signal Intensity

Hisashi Masugata, Barry Peters, Stephane Lafitte, G Monet Strachan, Anthony N. DeMaria. *University of California at San Diego, San Diego, CA*

Background Destroy/refilling curves derived from real-time myocardial contrast echo (MCE) have been shown to detect impaired myocardial perfusion. However, no data exist regarding the effect of variable myocardial signal intensity (SI) upon the ability of param-

eters derived from the curves to quantify altered myocardial blood flow (MBF). The present study compared the ability of two different microbubbles which yielded different peak myocardial SI during real-time MCE to quantify altered MBF produced by graded coronary stenoses. **Methods** Three grades of anterior descending (LAD) stenoses were produced in 8 open-chest dogs. The stenoses were non-flow-limiting at rest, but decreased adenosine-induced coronary hyperemia by 30% (mild), 50% (moderate), and 90% (severe), respectively. Real-time MCE was performed with infusion of 0.67 ml/min BR1 (Bracco; gas phase: sulphur hexafluoride, concentration: 100-500 million/ml) followed by infusion of 0.33 ml/min BR14 (Bracco; gas phase: perfluorobutane, concentration: 400-800 million/ml) using low energy power pulse inversion (ATI) imaging. LAD bed signal intensity (SI) was measured, and myocardial SI versus time after bubble destruction was fitted to an exponential function: $y=A(1-\exp^{-bt})$, where A is the plateau SI, b is the rate of SI rise. **Results** With both microbubbles, A and b were progressively decreased with greater level of stenosis. A obtained by BR14 (mean = 7.2 dB) was significantly greater than that by BR1 (mean = 4.9 dB) (p<0.05) at baseline, however b by BR14 demonstrated no difference from that by BR1 at any grade of stenosis. The fluorescent microsphere-derived MBF ratio in LAD/LCx beds demonstrated significant correlation with the ratio of A obtained by both BR1 (r=0.61) and BR14 (r=0.60), and demonstrated a similar but closer correlation with b obtained by BR1 (r=0.76) and BR14 (r=0.77). **Conclusion** Refilling curves obtained both by BR1 and BR14 can quantify reduced MBF in a stenosed bed. Although peak plateau SI produced by microbubbles used for real-time MCE may differ, the rate of SI rise is not effected and remains a reliable parameter for quantification of MBF.

ORAL CONTRIBUTIONS

874 Computed Tomography/Magnetic Resonance Imaging: Ischemic Heart Disease

Tuesday, March 20, 2001, 4:00 p.m.-5:00 p.m.
Orange County Convention Center, Valencia B

4:00 p.m.

874-1 Non-Invasive Coronary Bypass Graft Imaging After Multivessel Revascularisation

Markus G. Engelmann, Andreas Knez, Alexander von Smekal, Bernd J. Wintersperger, Tanya Y. Huehns, Berthold Höfling, Maximilian F. Reiser, Gerhard Steinbeck. *Medical Department I, University Hospital Großhadern, Munich, Germany, Institute for Diagnostic Radiology, University Hospital Großhadern, Munich, Germany*

Background: Detection of graft patency after multivessel coronary revascularisation by non-invasive imaging techniques could be clinically very useful for follow-up after surgery. **Methods:** Forty consecutive asymptomatic patients who had undergone coronary bypass surgery with at least three grafts were examined by spiral computed tomography or magnetic resonance angiography 24.9±0.3 months after surgery, using conventional angiography as reference. In total, 133 grafts (37 internal mammary artery, 96 venous grafts) were analysed. Spiral computed tomography studies were performed with a sub-second scanner. Magnetic resonance angiography was performed using a three-dimensional contrast-enhanced gradient echo technique with ultrashort echo time during breath-holding. **Results:** For spiral computed tomography, sensitivities were 76% (for the internal mammary artery) and 95% (venous graft). For magnetic resonance angiography, these were 100% (internal mammary artery) and 92% (venous graft). The positive predictive values were 100% for internal mammary artery and venous graft by spiral computed tomography, and 100% for the internal mammary artery, 92% for venous grafts by magnetic resonance angiography. **Conclusion:** Both subsecond spiral computed tomography and contrast-enhanced magnetic resonance angiography are highly accurate and relatively non-invasive approaches of assessing coronary graft patency after multivessel revascularisation and have potential for follow-up assessment in the long term.

4:15 p.m.

874-2 Predicting Hemodynamic Data and Presence of Scar Tissue From Electromechanical Mapping: Correlation With Cardiac Magnetic Resonance Imaging

Emerson C. Perin, Guilherme Silva, Rogerio Sarmento-Leite, Marcus Howell, Raja Muthupillai, Brenda Lambert, Scott Flamm. *Texas Heart Institute, Houston*

Background: Direct myocardial revascularization (DMR) appears to be a promising treatment for patients with refractory angina who are not candidates for conventional revascularization techniques. Recent studies using DMR and upcoming studies using vascular growth factors incorporate left ventricular electromechanical mapping (EMM) to guide the delivery of local myocardial treatment. It is important that EMM be able to accurately distinguish viable myocardium from scar tissue and to precisely reproduce the left ventricular (LV) end-systolic (ESV) and end-diastolic (EDV) volumes and ejection fraction (EF) so that local treatment may be correctly applied. Prior studies have shown good correlation between EMM and SPECT. Magnetic resonance imaging (MRI), using delayed hyperenhancement, has been shown to accurately detect myocardial scar tissue. In this study we compared EMM with MRI for the detection of myocardial scar and hemodynamic data.

Methods and Results: In a prospective ongoing study to enroll 20 patients with severe ischemic heart disease, preliminary data from 10 patients who have undergone both EMM and cardiac MRI testing is presented. Bull's-eye representations comprising a total of 140 myocardial segments were obtained by both methods. Corresponding segments

from EMM and MRI as well as ESV, EDV and LV EF were compared for each patient. EMM defined myocardial scar as those areas with unipolar voltage less than 7.5 mV. The gold standard definition for scar was MRI with delayed hyperenhancement technique. This showed that 57 segments were detected as scar and 13 as healthy tissue. EMM identified 49 of the 57 segments as scar tissue for a sensitivity of 84% and 9 of the 13 segments as healthy myocardium for a specificity of 77%. This represents an accuracy of 84% for the detection of scar by EMM. Spearman correlation of ESV, EDV and LV EF was 0.82, 0.98 and 0.95 respectively ($p < 0.05$).

Conclusions: These preliminary data suggest that EMM provides an accurate real time assessment of myocardial scar and excellent hemodynamic correlation. These encouraging results further corroborate the use of EMM as a platform to successfully guide the application of local myocardial therapy.

4:30 p.m.

874-3 Left Ventricular Electromechanical Mapping of Myocardial Viability in Ischemic Cardiomyopathy: Validation by Magnetic Resonance Imaging

Habib Samady, C. Joon Choi, Michael Ragosta, Eric R. Powers, Jennifer R. Hunter, Linda Snyder, Joseph M. DiMaria, Christopher M. Kramer. *University of Virginia, Charlottesville, VA*

Background: LV electromechanical mapping (NOGA) is a novel technique for evaluating myocardial viability in the catheterization laboratory. We hypothesized that, in patients with ischemic cardiomyopathy, NOGA-derived voltage could identify segments with contractile reserve by magnetic resonance imaging (MRI). **Methods:** 17 patients (12 men, age 63 ± 9 , mean \pm SD), with LV dysfunction and multivessel CAD underwent NOGA and MRI within 24 hours of each other. Linear local shortening (LLS) and unipolar voltage (UpV) were assessed by NOGA. UpV > 6.0 was considered a marker of viability. Breathhold short-axis cine MRI measured LV mass, end-diastolic and end-systolic volumes, EF, end-diastolic wall thickness, and systolic wall thickening. Breathhold short-axis tagged cine MRI assessed endocardial and transmural % circumferential shortening (%S) at baseline and at peak response to low-dose dobutamine (dob) (5, 10 μ g/kg/min). Both imaging modalities were divided into 12 segments per patient (4 apical, 4 mid, 4 basal) and matched by short axis location. **Results:** By MRI, LV mass was 268 ± 81 g, end-diastolic volume 160 ± 56 ml, end-systolic volume 109 ± 54 ml, and EF $34 \pm 14\%$. Of 204 myocardial segments measured, 193 had adequate NOGA points for analysis. For all myocardial segments, LLS was $7.6 \pm 6.6\%$ and UpV 9.6 ± 4.7 mV. LLS correlated with MRI wall thickening ($r = 0.32$, $p < 0.001$). UpV correlated with endocardial peak dob %S ($r = 0.32$, $p < 0.001$). Segments with UpV > 6 mV by NOGA demonstrated greater wall thickness, wall thickening, and %S at baseline and peak dob, especially in the endocardium, compared to segments with UpV < 6 mV.

	UpV < 6 mV	UpV > 6 mV	P value
Wall thickness (mm)	11.6 ± 3.1	13.1 ± 3.1	0.003
Wall thickening (mm)	2.0 ± 2.5	3.3 ± 2.9	0.007
Transmural baseline %S	5.0 ± 10.3	9.5 ± 8.7	0.002
Transmural peak dob %S	8.1 ± 9.5	14.3 ± 9.1	<0.001
Endocardial peak dob %S	10.1 ± 10.0	18.0 ± 10.9	<0.001

Conclusion: In patients with ischemic cardiomyopathy, myocardial segments with preserved voltage by electromechanical mapping demonstrate greater wall thickness, wall thickening and quantitative response to dobutamine, especially in the endocardium. Thus, NOGA-derived voltage reflects markers of myocardial viability defined by MRI.

4:45 p.m.

874-4 Modern Medical Therapy Limits Ventricular Remodelling Following Anterior Myocardial Infarction

Nicholas G. Bellenger, Jon M. A. Swinburn, Kim Rajappan, A Lahiri, Dudley J. Pennell. *Royal Brompton Hospital, London, United Kingdom, Northwick Park hospital, Harrow, United Kingdom*

Background: Although the process of left ventricular remodelling has been extensively documented, there have been few studies in patients receiving modern medical therapies, many of which may inhibit remodelling. We aimed to use CMR to delineate the natural history of left ventricular remodelling following large anterior myocardial infarction, in the current era of modern medical therapy. **Methods:** Seventeen patients who presented with their first large anterior MI underwent CMR at 2 weeks post infarction, as well as 1, 3 and 6 months post infarction. Volume, function and mass were compared at each time interval and the association of remodelling with a number of clinical variables was analysed. **Results:** There was a significant increase in LVEDVI from 2 weeks to 1 month (101 ± 26 to 106 ± 26 ml/m², $p < 0.05$) but no significant difference thereafter (103 ± 24 ml/m² at 3 months, 102 ± 26 ml/m² at 6 months). Similarly there was a significant increase in LVEVI from 2 weeks to 1 month (62 ± 27 to 69 ± 30 ml/m², $p = 0.007$) but no significant difference thereafter (63 ± 26 ml/m² at 3 months and 62 ± 29 ml/m² at 6 months). There was a significant decrease in LVEF from 2 weeks to 1 month ($40 \pm 13\%$ to $37 \pm 14\%$, $p < 0.05$) followed by a significant increase from 1 month to 3 months ($37 \pm 14\%$ to $41 \pm 13\%$, $p = 0.005$). There was no significant difference between 3 months and 6 months ($42 \pm 14\%$ at 6 months). Throughout the study period there was a significant decrease in LV mass index, with a mean mass of 83 ± 17 g/m² at 2 weeks, 79 ± 16 g/m² at 1 month ($p = 0.007$ vs one week), 73 ± 18 g/m² at 3 months ($p = 0.006$ vs 1 month), and 67 ± 18 g/m² at 6 months ($p = 0.007$ vs 3 months). The only independent predictors of an early increase in LVEVI were increasing age, increasing CK-MB and not receiving treatment with a statin. **Conclusion:** Patients suffering their first large anterior MI treated with modern therapy undergo classical remodelling with infarct expansion and a decrease in EF and LVMI between 2 weeks and 1 month. Thereafter, however, remodelling is prevented

with no difference in EDVI or ESVI and some improvement in EF by 6 months. LVMI, however, continues to decline progressively, most likely due to infarct resorption and prevention of compensatory hypertrophy in the remote myocardium.

ORAL CONTRIBUTIONS

881 Regional Function Analysis With Tissue Doppler

Wednesday, March 21, 2001, 8:30 a.m.-10:00 a.m.
Orange County Convention Center, Room 414A

8:30 a.m.

881-1 Early Apical Relaxation Increases Ventricular Suction During Exercise in Normal Volunteers

Irmien Vlassak, Lisa M. King, Neil L. Greenberg, Michael S. Firstenberg, James D. Thomas, Mario J. Garcia. *Cleveland Clinic Foundation, Cleveland, OH*

Background: In the healthy left ventricle (LV) a forceful relaxation creates a suction effect that allows the heart to fill at relatively low pressure. This suction effect appears to be caused, at least in part, by earlier relaxation of the apex generating a negative intraventricular apex-to-base pressure gradient (IVPG) at the onset of the LV filling. We have recently demonstrated that IVPG may be determined non-invasively from color M-mode Doppler velocity analysis using the Euler hydrodynamic equation relating pressure and velocity. This study was done to determine whether earlier relaxation of the apex and IVPG in normal subjects humans increase during exercise.

Methods: Echocardiography was performed on 15 healthy volunteers (31 ± 4 years) at rest and during exercise (heart rate 100 bpm). M-mode images of the LV were obtained from the parasternal long axis view at the base and the apex. Time from the electrocardiographic R-wave to the onset of LV cavity diastolic expansion (DE) was measured for both basal and apical M-mode recordings. Color M-mode recordings of the LV inflow were acquired from the apical 4-chamber view and stored digitally. IVPG were determined from color M-mode images using the Euler equation.

Results:

	Rest	Stress	p-value
Interval between DE of apex and base (ms)	19.9 ± 20.5	44.5 ± 23.8	0.003
IVPG (mmHg)	3.13 ± 1.04	4.26 ± 1.31	0.0004

Conclusion: IVPG increase with exercise and the increase is associated with earlier relaxation of the apical myocardial segments. This mechanism may contribute to exercise induced augmentation of cardiac output.

8:45 a.m.

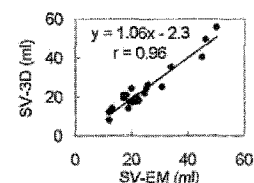
881-2 Combination of Real-Time 3-D Color Doppler Flow Rate Estimation and Pulsed-Wave Doppler Echocardiography for Quantifying Stroke Volume Through the Left Ventricular Outflow Tract

Hiroyuki Tsujino, Michael Jones, Takahiro Shiota, Jian Xin Qin, Lisa A. Cardon, Annitta J. Morehead, Arthur D. Zetts, Fabrice Bauer, Xiyi Hang, Neil L. Greenberg, Julio A. Panza, James D. Thomas. *The Cleveland Clinic Foundation, Cleveland, OH, The National Institutes of Health, Bethesda, MD*

Aims: To develop a reliable non-invasive method to quantify stroke volume (SV) without any geometric assumptions of the velocity distributions in the LV outflow tract (LVOT) by combining real-time 3D color Doppler (RT3DC) and PW Doppler echocardiography.

Methods: A total of 22 hemodynamic conditions were created in 8 sheep. RT3DC data were obtained epicardially using apical views. Peak flow rates (Qp) were calculated by spatially integrating the digital velocity data from the brightest (temporal-peak) cross-sectional color images of the LVOT. Standard PW Doppler was performed to measure the velocity-time integral (VTI) and the peak velocity (Vp). By assuming that the temporal waveforms of velocity and flow are proportional, SV was calculated as $\alpha \times Qp \times VTI / Vp$, where α is a temporal correction factor determined by the numerical modeling to predict the impact of volumetric frame rates on Qp estimation. An electromagnetic (EM) flow probe was utilized to obtain reference SV.

Results: Compared to EM derived SV (range, 12-50 ml), SV by conventional PW Doppler overestimated by 19%. Without temporal correction, SV by 3D correlated well with the EM but with an underestimation of 18%, primarily due to low temporal resolution of 6-10 volumes per second. Applying a correction factor ($\alpha = 1.22$) predicted by numerical modeling, there was an excellent linear relationship between EM and 3D SV ($\Delta = -0.9$ ml, $y = 1.06x - 2.3$, $r = 0.96$, $p < 0.01$, Figure).



Conclusion: By combining the time-velocity information by PW and the peak-flow rate by RT3D color Doppler, this new method allowed accurate estimations of stroke volumes without relying on any assumptions of the spatial velocity distributions in the LVOT.

881-3 Comparison of Myocardial Strain Rate Imaging and Triggered Myocardial Contrast Echocardiography to Detect the Culprit Vessel and for the Diagnosis of Severe Coronary Artery Disease

Marcelo Carneiro, Michael L. Lieber, Shashidhar Sathyanarayana, Jill Odabashian, Jeanne Drisko, Jing P. Sun, Christine Whitman, Susan Jasper, Annitta Morehead, Allan L. Klein. *The Cleveland Clinic Foundation, Cleveland, OH*

Background. Strain Rate Imaging (SRI) is a new echocardiography modality capable of measuring segmental systolic function that is translation independent, while triggered Myocardial Contrast Echocardiography (MCE) gives us important information on myocardial blood flow. The aim of this study was to establish the ability of SRI and MCE to detect the culprit vessel in patients with acute myocardial infarction (MI) and to identify patients with severe coronary artery disease (CAD).

Methods. Our population consisted of 28 patients in the coronary care unit, with acute MI, prior to coronary intervention and with at least 1 vessel with a coronary stenosis > than 50% by Cardiac Cath. The culprit vessel was defined as the artery responsible for the acute MI by cardiac cath and/or ECG. Using a GE-Vingmed System V scanner, SRI cine-loops were obtained for analysis offline. After SRI acquisition, MCE was performed in the apical 4 chamber view in progressively increasing pulsing intervals (PI) from 1 to 10. Video intensity (VI) values were obtained (dB) and data was fitted into the exponential function: $A \cdot (1 - e^{-t/10})$. We used A/t (rate of replenishment) to assess myocardial perfusion with 12dB/heart beat as our cutoff value.

Results. Both SRI and MCE (A/t) can be used to detect the culprit vessel in patients with acute MI, with a good correlation for both methods (see table). Using a cutoff of $-0.85s^{-1}$, SRI had a slightly better sensitivity, specificity and accuracy for CAD than MCE.

Conclusions. Although MCE (blood flow) and SRI (mechanics) look for different aspects of CAD, both show similar results in the identification of the culprit vessel and for the diagnosis of severe CAD, with a slight advantage for SRI. The information provided by both methods might be complementary and useful in many areas, specially stress echo and myocardial viability.

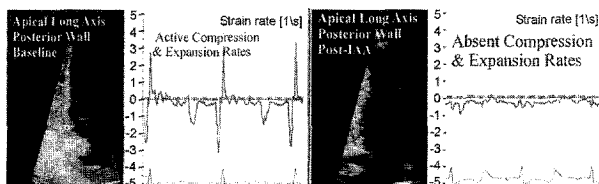
SRI vs. MCE to detect culprit vessel and CAD

	SRI	MCE
Culprit Vessel	r=0.52 p<0.0001	r=0.46 p<0.0001
Sensitivity for CAD	79.2%	77.1%
Specificity for CAD	91.7%	79.2%
Accuracy for CAD	c=0.854	c=0.781

881-4 Strain-Rate Echocardiography: A New Quantitative Tool for Measurement of Regional Myocardial Function During Experimentally Altered Myocardial Energetics

Peter C. Anagnostopoulos, Marek Belohlavek, Petras Dzeja, James B. Seward. *Mayo Clinic, Rochester, MN*

Background: Strain-rate imaging is emerging as a clinically relevant tool for determining regional myocardial function and is less influenced by extraneous activity than tissue Doppler imaging. The purpose of this study was to examine the ability of strain-rate imaging to detect local myocardial dysfunction due to experimentally altered energetics. **Methods:** Echocardiographic and tissue velocity images were obtained from anesthetized, open-chest pigs at baseline, after ten-minutes of intracoronary iodoacetamide infusion (mid-LAD or mid-LCX), and during two-hours of recovery. Iodoacetamide (IAA) effectively inhibits myofibrillar creatine kinase, thereby uncoupling myocardial contractility, crossbridging, and calcium transport. The tissue velocity images were analyzed for strain-rate and compared to the regions affected by IAA. Myocardial biopsies were obtained during diastole at each stage from regions both inside and outside the infusion zone using a modified side-biting biopsy device frozen in liquid nitrogen to assure rapid freezing of tissue preserving the enzymatic activity and nucleotide levels. These biopsies were assayed for ATP and creatine kinase activity. **Results:** Intracoronary IAA infusion caused localized changes in myocardial physiology: echocardiographically, the tissue became more echogenic, thicker, and exhibited akinesia. Strain-rate analysis of the affected region demonstrated a near complete loss of both expansive and compressive rates indicating the myocardium was neither distensible nor compressible (Figure 1). Enzymatic activity demonstrated a 10-fold reduction in creatine kinase activity despite near normal ATP levels. **Conclusion:** These results suggest that IAA is a potent inhibitor of myofibrillar creatine kinase and strain-rate imaging can detect and quantify changes in regional myocardial function during experimentally altered energetics.



881-5 Differentiation Between Physiologic and Incipient Pathologic Left Ventricular Hypertrophy. Study With Tissue Doppler

José L. Zamorano, Carlos Almería, Raúl Moreno, Walter Taua, Adalia Aubele, Luis Mataix, José L. Rodrigo, Luis Sanchez-Harguindey. *Hospital Clinico San Carlos, Madrid, Spain*

Doppler Tissue Imaging (DTI) allows to precisely quantify the myocardial systolic and diastolic velocities. We have previously DTI parameters in pathologic left ventricular hypertrophy. To evaluate whether DTI allows to differentiate the physiologic and pathologic left ventricular hypertrophy, we compared DTI parameters between 20 isometric athletes (A) and 15 young patients with recently diagnosed hypertension (H). Patients did not differ according to age and gender distribution. The following parameters were measured in mid-posterolateral (PL) and basal anteroseptal (AS) segments: peak velocity (cm/sec) of systolic wave s, and peak velocities (cm/sec) of early (e) and late (a) waves. The comparison between both groups is summarized:

	s-AS	e-AS	a-AS	s-PL	e-PL	a-PL
H group	6.8±1.9	9.8±3.2	8.0±2.2	6.4±2.0	11.0±5.0	9.2±4.3
A group	8.1±1.11	5.2±2.7	3.5±3.2	4.6±2.5	11.4±3.3	3.0±2.3
p value	NS	<0.01	<0.01	0.03	NS	<0.01

Left ventricular mass index: 125.2±47.3 vs. 138.7±26.6 in groups H and A, respectively (p=0.03). **Conclusion:** DTI allows the differentiation between physiologic and early pathologic left ventricular hypertrophy.

881-6 Influence of Acute Alterations in Loading Conditions on Mitral Annular Diastolic Velocities Measured by Tissue Doppler Echocardiography

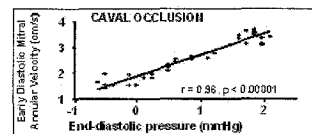
Didier Jacques, Michael R. Pinsky, Peter Harrigan, John Gorcsan, III. *University of Pittsburgh, Pittsburgh, PA*

Background: Early diastolic mitral annular velocity by tissue Doppler has previously been reported to be a load-independent measure of diastolic function. However, this has remained controversial, and the influence of acute changes in preload and afterload on mitral annular velocity over a range of contractility is not well known.

Methods: Six open-chest dogs had placement of high-fidelity pressure catheters and pulsed-tissue Doppler measures of the mitral annulus were recorded from an apical site. Changes in preload and afterload were induced by vena caval and aortic occlusions, respectively during baseline, after dobutamine (5-10 µg/kg/min) to increase contractility and esmolol (100-400 µg/kg/min) to decrease contractility.

Results: Decreases in preload were associated with consistent decreases in early diastolic mitral annular velocity. Changes in left ventricular end-diastolic pressure from 7.7±5.6 to 2.0±3.4 mmHg and early diastolic mitral annular velocity from 4.9±1.6 to 3.5±1.3 cm/sec, (*p<0.05 versus baseline) were significantly correlated (r = 0.80±0.12, p<0.0001) (figure). Early diastolic mitral annular velocity correlated with changes in preload during baseline, dobutamine and esmolol infusions. Increases in afterload, however, were not associated with significant alterations in early diastolic mitral annular velocity, remaining unchanged from 4.6±1.2 to 3.9±1.2 cm/sec (p = not significant) during aortic occlusion while left ventricular systolic pressure increased from 123±22 to 161±29 mmHg (*p<0.001 versus baseline).

Conclusions: Early diastolic mitral annular velocity is dependent on acute changes in preload within the range of pressures studied in this animal model. Early diastolic mitral annular velocity, however, is relatively not dependent on afterload. These data may impact on the tissue Doppler assessment of diastolic function in humans.



ORAL CONTRIBUTIONS

882 Assessment of Myocardial Blood Flow in Disease States by Nuclear Imaging Techniques

Wednesday, March 21, 2001, 8:30 a.m.-10:00 a.m.
Orange County Convention Center, Room 414C

882-1 Improvement of Coronary Vasodilatation Capacity After Single LDL-Cholesterol Apheresis: Does the Initial LDL-Cholesterol Level Influence the Therapeutic Effect?

Klaus P. Mellwig, Detlev Baller, Wolfgang Burchert, Dieter Horstkotte. *Heart Center NRW, Bad Oeynhausen, Germany*

In patients with severe hypercholesterolemia, quantitative improvement of coronary vasodilatation capacity can be achieved within 24 hours by single LDL apheresis (APH). Is this also true for initially low LDL concentrations.

In patients (n=35, 8 women, mean age 48±8 ys) with advanced coronary heart disease and hypercholesterolemia, myocardial blood flow was determined at rest (MBF_{bas}) and after pharmacologic recruitment of coronary flow reserve (CFR) by dipyridamole (MBF_D) immediately before and approx. 24 h after APH (H.E.L.P. procedure) using quantitative positron emission tomography (PET). CFR was calculated from the ratio MBF_D/MBF_{bas}, the minimal coronary resistance (MCR) from the mean arterial pressure/MBF_D ratio. Lab data were obtained immediately before the first (PRE) and the second (POST) PET scanning. We compared patients with high LDL (group A: n=24, mean > 125 mg/dl) and low LDL (group B: n=11, mean < 125 mg/dl).

In both groups, the reduction of total cholesterol, LDL and fibrinogen as well as the minor decline of plasma viscosity (Tab. 1) led to an improvement of coronary vasodilation capacity (Tab. 2).

Table 1

Groups	A-pre	A-post	B-pre	B-post
Total cholesterol (mg/dl)	276±54	151±27	200±23	130±25
LDL cholesterol (mg/dl)	206±52	85±26	125±20	62±12
Fibrinogen (mg/dl)	286±53	149±33	313±81	179±45
Plasma viscosity (mPas)	1.29±0.08	1.20±0.08	1.30±0.13	1.17±0.07

Table 2

	CFR-pre	CFR-post	MCR-pre mmHg/min100g/ml	MCR-post mmHg/min100g/ml
Group A	2.22±0.88	2.82±1.08	0.54±0.22	0.42±0.15
Group B	1.95±0.81	2.36±0.81	0.58±0.18	0.46±0.14
p-value	<0.0001	<0.0001		

Even with near to normal LDL values, a significant LDL reduction and improvement of blood rheology can be achieved by APH and results in an increase of coronary vasodilation capacity. Independent of the initial LDL concentration, LDL reduction in combination with an additional improvement of blood rheology has proved to be of major importance for patients with advanced coronary heart disease.

8:45 a.m.

882-2 Role of Nitric Oxide and Alpha-Adrenergic Vasoconstriction in Regulation of Hyperemic Myocardial Perfusion

Niels H. Buus, Morten Böttcher, Flemming Hermansen, Mikael Sander, Torsten T. Nielsen, Michael J. Mulvaney. Aarhus University, Center for Clinical Pharmacology, Aarhus, Denmark, Aarhus University Hospital, Department of Cardiology, Aarhus, Denmark

Background: Myocardial hyperemic perfusion induced by adenosine is used both in clinical diagnosis of coronary heart disease as well as scientific investigations of the myocardial microcirculation. The objective of this study was to clarify whether adenosine-induced hyperemia is mediated by nitric oxide (NO), and whether the hyperemia is blunted by reflex increases in adrenergic activity. **Methods:** Myocardial perfusion was measured with positron emission tomography. Twelve healthy males were scanned in 2 different randomly assigned scan sequences each consisting of 3 scans. Firstly, perfusion was measured at rest. Secondly, either saline or the NO synthase inhibitor NG-nitro-L-arginine methyl ester (L-NAME, 4 mg/kg) was infused and adenosine-induced (140 µg/kg/min for 6 minutes) hyperemia was determined. Thirdly, in both scan sequences, the alpha-adrenoceptor blocker phentolamine (10 mg) was infused and adenosine-induced hyperemia was determined again. **Results:** Resting perfusion was similar in the two scan sequences (0.69 ± 0.04 and 0.66 ± 0.04 ml/min/g). L-NAME increased mean arterial blood pressure by 12 ± 2 mmHg and reduced heart rate by 16 ± 2 beats/min per minute (P<0.01). Adenosine-induced hyperemia was lower when preceded by L-NAME compared to saline infusion (1.50 ± 0.16 vs. 1.90 ± 0.09 ml/min/g, P<0.01). L-NAME also abolished the adenosine-induced increase in heart rate. After infusion of phentolamine, adenosine-induced hyperemia increased significantly only after L-NAME treatment, reaching similar levels as during saline treatment (2.05 ± 0.12 vs. 2.10 ± 0.10 ml/min/g, P=NS). **Conclusion:** Inhibition of NO synthesis with L-NAME attenuates adenosine-induced myocardial hyperemia. This is due to an alpha-adrenergic mediated vasoconstriction, which is normally opposed by NO. We conclude that sympathetic coronary vasoconstriction is attenuated by NO during adenosine-induced myocardial hyperemia.

9:00 a.m.

882-3 Effect of Diabetes Type on Coronary Microvascular Function

Marcelo F. Di Carli, James Janisse, George Grunberger, Scott Jacober, Joel Ager. Wayne State University, Detroit, MI

Background: Coronary vascular tone is impaired in patients with diabetes mellitus (DM). However, the factors (i.e., hyperglycemia and insulin resistance) contributing to this defect remain controversial. Our objective was to examine the effect of type 1 (insulin deficiency) and type 2 (insulin resistance) DM on coronary vascular function. **Methods:** We studied 34 subjects with DM (17 with type 1 and 17 with type 2) (42±7 years), who were free of overt cardiovascular complications, and 10 age-matched healthy controls. PET imaging was used to measure myocardial blood flow (MBF) at rest, during adenosine-induced hyperemia (reflecting primarily endothelium-independent vasodilation), and in response to cold pressor testing (CPT) (reflecting primarily endothelium-dependent vasodilation). **Results:** The 2 groups of diabetics were similar with respect to age and glycemic control. However, the duration of diabetes was longer (21±12 vs 6±4 years, P<0.05) and HDL-C levels were higher (52±14 vs 39±9 mg/dl, P<0.05) in type 1 than in type 2 diabetics. Basal MBF was similar in the three groups studied. The increase (from baseline) in MBF with adenosine was similar in the subjects with type 1 (161±18%) and type 2 (185±19%) DM, but significantly lower than in the controls (351±43%) (P<0.001

for the comparison with both groups of diabetics). Similarly, the increase in MBF during the CPT was comparable in the subjects with type 1 (23±4%) and type 2 (19±3%) DM, but significantly lower compared to the controls (66±12%) (P<0.0001 for the comparison with both groups of diabetics). These differences remained significant after adjusting for diabetes-associated metabolic abnormalities and autonomic neuropathy. **Conclusions:** These results demonstrate markedly reduced endothelium-dependent and -independent coronary vasodilator function in subjects with both type 1 and type 2 DM. Because patients with type 1 DM are insulin deficient (rather than insulin resistant, the hallmark of type 2 diabetes), these results provide further support for a key role of hyperglycemia in the pathogenesis of vascular dysfunction in diabetes.

9:15 a.m.

882-4 Impact of Serum Sex Hormones on Severe Ischaemia in Postmenopausal Women With Chronic Coronary Artery Disease

Ayse Emre, Mehmet Yazicioglu, Metin Gursurer, Yasemin Yakut, Birsen Ersek. Siyami Ersek Thoracic&CV Surgery Center, Istanbul, Turkey, Zeynep Kamil Maternity Hospital, Istanbul, Turkey

Background: Although Heart and Estrogen/Progestin Replacement Study failed to demonstrate a reduction in clinical events in postmenopausal women with coronary artery disease (CAD), estrogen was shown to regulate endothelium-dependent vasodilation, LDL oxidation and vascular smooth muscle proliferation in other studies. No study has yet defined an alteration in endogenous sex hormone levels, particularly estrogen, in relation to severe ischaemia in postmenopausal women with established CAD. **Methods:** In order to investigate this, 98 patients (pts) (mean age 57±7 yrs) with angiographically documented CAD and 44 age-matched healthy female control subjects were studied. None of the pts were on hormone replacement therapy. Blood samples were taken for estradiol, free and total testosterone, dehydroepiandrosterone (DHEAS), sex hormone binding globulin (SHBG) and insulin measurements on the day of exercise TI-201 SPECT imaging. SPECT images were divided into 20 segments. Pts with >5 redistribution defects (RD) were considered to have severe ischaemia. **Results:** 3 different groups were identified: 1) Severe ischaemia= >5 RD (n=43); 2) Mild-moderate ischaemia= 1-4 RD (n=55); 3=Control group (n=44). Estradiol levels were found as 16.4±5.8, 29.9±7.2, and 41.1±8.0 pg/mL in groups 1, 2 and 3, respectively, with group 1 having a significantly lower value compared to groups 2 and 3 (p=0.02, p=0.001, respectively). Free testosterone levels were 1.72±0.36, 1.31±0.30 and 1.02±0.38 pg/mL in groups 1, 2 and 3, respectively, with group 1 having a significantly higher value compared to groups 2 and 3 (p=0.04, p=0.01, respectively). Total testosterone (32.5±4.2, 32.1±5.0 and 29.2±5.4 ng/dl), DHEAS (81.7±32.0, 80.1±22.6 and 79.2±30.4 µg/dl) and SHBG levels (6.62±3.0, 6.81±2.80, and 6.56±2.82 mg/L) were similar. Stepwise multiple regression analysis identified only estradiol (p=0.001), free testosterone (p=0.01) and total cholesterol (p=0.02) as independent predictors of severe ischaemia. **Conclusion:** These data suggest that decreased estradiol and elevated free testosterone levels might be important factors for the development of severe ischaemia in postmenopausal women.

9:30 a.m.

882-5 Influence of Angiographic Collaterals on Myocardial Perfusion in Patients With Chronic Total Occlusion of a Single Coronary Artery and No History of Myocardial Infarction

Fatma A. Aboul-Enein, Saibal Kar, Sean W. Hayes, Raj Makkar, Howard C. Lewin, John D. Friedman, Daniel S. Berman. Cedars-Sinai Medical Center, Los Angeles, CA

Background: It has been hypothesized that collaterals (coll) protect against stress induced ischemia. The effects of coll in chronic total occlusions (CTO) have not been systematically studied.

Methods: We identified 59 consecutive patients with single vessel CTO, no other significant (>50%) stenosis or no history of myocardial infarction (MI) who had rest TI201 stress (exercise or adenosine) Tc-99m sestamibi myocardial perfusion SPECT (MPS) and coronary angiography within 6 months. The mean age was 68±11 years, 30% were females, and 40.7% underwent adenosine stress. Coll were graded according to Rentrop classification: 0=none, 1=filling of side branches only, 2=partial filling of the epicardial segment, 3= complete filling of the epicardial segment. Grades 0 and 1 were grouped together for analysis. MPS was scored visually using a 20 segment, 5 point scale, 0=normal to 4=no uptake. Summed stress (SSS) and rest scores (SRS) were obtained by summing the 20 stress and rest segment scores respectively. Summed difference scores (SDS) were obtained by subtracting SRS from SSS. Exercise and perfusion variables were analyzed according to coll grade using ANOVA.

Results: The mean SSS, SRS, and SDS for the 3 coll groups are shown in the table.

	Grade 0/1 (n=6)	Grade 2 (n=29)	Grade 3 (n=24)
SSS	14.3±10.2	16.3±8.2	14.9±8.7
SRS	6.0±6.8	2.4±5.8	2.1±3.7
SDS	7.5±7.5	13.9±7.9	12.4±8.4

Patients with CTO, even those with excellent coll, have severe and extensive stress perfusion defects as assessed by SSS. There is a trend, however, towards more severe resting perfusion defects in the patients with poor coll (grade 0-1). However these findings did not reach statistical significance, possibly due to the small sample size of this group.

Conclusion: In the setting of single vessel total occlusion of a coronary artery, coll do not appear to protect against stress induced perfusion defects although they may reduce resting perfusion defects. In this patient cohort with no history of MI, the small proportion of patients with poor coll (grade 0-1) suggests that grade 2-3 coll may be protective against myocardial infarction.

882-6 Differences in Dobutamine and Adenosine Coronary Flow Reserve and Their Clinical Implications

9:45 a.m.

Rohan Jagathesan, Edward Barnes, Ornella Rimoldi, Roger J. C. Hall, Rodney A. Foale, Paolo G. Camici. *MRC Clinical Sciences Centre, ICSM, London, United Kingdom, St Marys Hospital, ICSM, London, United Kingdom*

Background: Pharmacological stress is widely used in the assessment of patients with coronary artery disease. A number of stressors are available, each with different mechanisms of action. The increase in myocardial blood flow (MBF) induced by dobutamine (Dob) is secondary to an increase in cardiac workload and mimics the effect of exercise. Adenosine (Ado) induces hyperemia via direct stimulation of purinergic receptors resulting in near maximal coronary vasodilatation.

Aim: Positron emission tomography (PET) is an accurate non-invasive method of measuring absolute myocardial blood flow (MBF). We compared the effects of Dob and Ado on MBF and coronary flow reserve (CFR) in normal subjects to assess differences that may benefit clinical use.

Methods: 20 normal males (age 46±7 years) underwent PET with H₂¹⁵O using either Dob (40µg/kg/min) or Ado (140 mg/kg/min). Each study arm had 10 age-matched subjects. Measurements were made for MBF at rest and peak hyperemia (hyp). MBF-rest was corrected for (RPP) and CFR was calculated as MBF-hyp/MBF-rest.

Results: MBF-rest in each study arm was comparable (Ado=1.23±0.23 vs Dob=1.22±0.28 ml/min/g; p=ns). RPP at peak stress was significantly higher in the Dob group (20512±2703 vs 11364±2751; p<0.0001). Both MBF-peak (4.04±0.51 vs 3.18±0.96 ml/min/g; p<0.03) and CFR (3.36±0.48 vs 2.62±0.58; p<0.01) were significantly greater with Ado compared to Dob. Resting coronary resistance (MAPrest/MBFrest) was comparable for Dob and Ado (73±23 and 72±31mmHg*min*⁻¹*g*ml⁻¹), but minimal coronary resistance (MAPpeak/MBFpeak) was significantly lower with Ado (22±5 vs 76±24 mmHg*min*⁻¹*g*ml⁻¹, p<0.001).

Conclusion: In absolute terms, the peak MBF and CFR recruited by Ado are 25% greater than that achieved by Dob at the standard doses used in this study. The higher CFR and lower minimal coronary resistance demonstrated with Ado suggest greater exhaustion of CFR, which may explain its higher sensitivity in demonstrating the presence of a coronary stenosis. However, Dob CFR reflects a measure of demand ischaemia and may provide a better measure of the functional significance of a coronary stenosis.

1287-134 Left Ventricular Ejection Fraction Remains a Strong Predictor of Long-Term but Not Short-Term All-Cause, Cardiac and Arrhythmic Mortality After Myocardial Infarction: An Analysis of 2828 Patients

Yee Guan Yap, Trinh Duong, Martin Bland, Christian Torp-Pederson, Lars Kober, Stuart Connolly, Robin Roberts, Bradley Marchant, Marek Malik, A. John Camm. *St. George's Hospital Medical School, London, United Kingdom*

Background: Previous studies on predictive values of left ventricular ejection fraction (LVEF) after myocardial infarction (MI) were largely from the pre-thrombolytic era & suffered from low subject numbers & informal mortality evaluation. **Method:** We pooled the individual placebo patient data from EMIAT, SWORD, TRACE and DIAMOND-MI studies, which recruited patients with LVEF<40% after MI. Survival at 2 year was analysed on patients surviving 45 days onwards from MI to allow for different recruitment periods between studies. Effect of LVEF was investigated using Cox regression, adjusted for treatment and study effects and other demographic factors associated with survival (age, sex, previous MI, hypertension history, NYHA class, Q wave, heart rate, smoking & systolic blood pressure). Short-term survival (<45 days) was examined using logistic regression on TRACE and DIAMOND-MI that recruited patients within 2 weeks. **Results:** 2828 placebo patients were pooled (2206 M, age: 65 ± 11). Median LVEF=33 (range:6-40). LVEF significantly predicted long-term (45d-2 year) all-cause (HR: 0.58 (0.49-0.68), p<0.001), arrhythmic (HR: 0.61 (0.48-0.78), p<0.001) and cardiac mortality (HR: 0.51 (0.39-0.66), p<0.001) but not short-term mortality (<45 days) (p=NS for all mortality). Significantly more patients were likely to die of non-arrhythmic than arrhythmic death if LVEF<20% (table: rate per person-year between 45d-2 year). **Conclusions:** Despite modern treatment, LVEF remains a powerful predictor of mortality but only at 2-year post-MI. LVEF is not as specific marker for arrhythmic mortality if LVEF<20% compared with LVEF=31-40%.

LVEF (no. of patients)	Rate per person-year between 45d-2 year (%)		
	All-cause	Arrhythmic	Cardiac
<20% (193)	23.1%	9.4%	10.6%
21-30% (881)	17.5%	7.7%	6.3%
31-40% (1432)	6.8%	3.2%	2.2%

1287-135 Prediction of Cardiovascular Risk by Echocardiography: What Should We Measure?

Patrick R. Hunziker, Fabian Nietispach, Dagmar Keller, Matthias Pfisterer, Peter Buser. *University Hospital, Basel, Switzerland*

Study purpose: To assess the ability to predict cardiovascular events by different echo methods in a prospective studies with hard endpoints. Improved noninvasive cardiovascular risk assessment is needed due to the impact of atherosclerosis on morbidity, mortality, and cost. In 336 consecutive subjects, echocardiography was used to quantify aortic wall elasticity (E^h=Young's modulus times wall thickness), distensibility (dr/dp), pulse wave velocity, left ventricular ejection fraction and left ventricular mass. Events were defined as death attributable to atherosclerosis, myocardial infarction or stroke. **Results:** See table. At one year, 22 events had occurred. Event risk was strongly associated in univariate analysis with the elasticity parameter E^h (Young's modulus times wall thickness), pulse wave velocity, ejection fraction, aortic compliance. Left ventricular mass index did not reach statistical significance in univariate analysis, and the number of cardiovascular risk factors was of borderline significance. In multiple stepwise analysis, three independent parameters emerged: elasticity E^h, left ventricular ejection fraction, and left ventricular mass index. We conclude that echocardiographic prediction of cardiovascular events is feasible and powerful. It is best done by combining a parameter of aortic elasticity with left ventricular ejection fraction and left ventricular mass index.

Echo predictors of cardiovascular events

	t-value	univariate p
Young's Modulus*wall thickness E ^h	3.8	0.0002
Pulse wave velocity	3.6	0.0004
Distensibility (dr/dp)	2.9	0.004
LV ejection fraction	2.6	0.01
LV mass index	1.0	0.33

1287-136 Better Prediction of Left Atrial Thrombus Occurrence in Atrial Fibrillation Patients by Baseline Cardiac Pathology Than by Anticoagulation Status

Adrian Chenzbraun, Zahi Khoury, Shmuel Gottlieb, Tania Goslitzer, Andre Keren. *Bikur Cholim Hospital, Jerusalem, Israel*

Background: Transesophageal echocardiography (TEE) guided cardioversion for atrial fibrillation (AF) is an attractive approach in patients without adequate anticoagulation. The prevalence of TEE-detected thrombi (T) in AF is relatively low and may be confined to high risk pts. Whether cardiac pathology is a better predictor than the anticoagulation status for the presence of T in AF patients is not known. **Methods:** We reviewed the clinical, transthoracic echocardiography and TEE data of 250 consecutive pts (age: 67 + 12 yrs, median duration of AF episode: 30 days, well anticoagulated: 97 pts) who underwent TEE before elective cardioversion. A positive thrombus likelihood index (TLI), based on cardiac pathology was defined as the presence of at least one of the following: organic mitral valve disease, left atrial diameter > 45 mm, decreased LV function, cardiomyopathy. TEE findings were classified as no/low probability for thrombus, suspected thrombus and definite thrombus and were correlated with the TLI and the anticoagulation status. **Results:** On TEE, 16/250 pts (6.4%) had suspected/definite thrombus (T). Age, gender, arterial hypertension, diabetes, were not related to T occurrence by TEE. T was present

POSTER SESSION

1287 Echocardiography and Prognosis

Wednesday, March 21, 2001, 9:00 a.m.-11:00 a.m.
Orange County Convention Center, Hall A4
Presentation Hour: 9:00 a.m.-10:00 a.m.

1287-133 Echocardiographic Derived Variables Predict Intolerance to Carvedilol in Chronic Heart Failure

Faisal Al-Nasser, Wolfram Doehner, Agnieszka Kaczmarek, Piotr P. Ponikowski, Massimo F. Piepoli, Andrew J. S. Coats, Michael Henein. *Cardiac Medicine, National Heart & Lung Institute, Imperial College School of Medicine, London, United Kingdom*

Background: Beta-blockers (BB) have been shown to improve morbidity and mortality in chronic heart failure (CHF). However, not all CHF patients tolerate even small dose of BB. Our aim was to identify baseline clinical characteristics and non-invasive indices which could predict BB intolerance. **Methods:** 46 consecutive CHF patients (63±1 years, 40 men, NYHA-class II/III: 26/20, peak VO₂ 19.6±1.0 ml/kg/min, mean±SEM), >3 months clinically stable referred to our Institution for initiation of BB therapy (carvedilol) were included into the study. All were optimally treated with ACE-inhibitor and diuretics. After baseline clinical assessment, Echocardiographic examination followed by cardiopulmonary exercise testing were performed. Carvedilol therapy was started (3.125mg od) and titrated up to a maximal tolerated dose (aim: 25 mg bd). **Results:** Ten (21%) patients were not able to tolerate the smallest dose of carvedilol (dizziness in 6, weakness and fatigue in 4, dyspnea in 4). There was no difference in clinical characteristics (age: 62 vs. 65yrs; NYHA class: 2.3 vs. 2.5), cardiopulmonary exercise indexes (peakVO₂: 20.2 vs. 17.8 ml/kg/min; anaerobic threshold: 60 vs. 56% of peakVO₂; respectively), echocardiographic measurements of left ventricular dimension (end diastolic diameter: 65 vs. 68 mm, end systolic diameter: 55 vs. 57 mm) and systolic function (shortening fraction: 20 vs. 17%) between these 10 patients and the rest (p>0.2 in all comparisons). However, patients who did not tolerate BB demonstrated severely depressed long axis amplitude (right ventricle: 12±2 vs. 16±1mm; left ventricle: 8±1 vs. 11±1mm; septum: 5±1 vs. 9±1mm, respectively, p<0.05) and shorter isovolumic relaxation time (0±48 vs 53±42ms, respectively, p=0.003). **Conclusion:** Markers of depressed left and right ventricular long axis function and raised filling pressure may be useful in predicting potential BB intolerance which is frequently seen in CHF patients.

Noninvasive Imaging

in none of the 37 patients with negative TLI, though in 26 of them (70%) anticoagulation was unsatisfactory. T was detected in 8/97 (8%) pts with good anticoagulation and in 8/153 (5%) pts with inadequate anticoagulation, all of them with positive TLI. **Conclusion:** These preliminary data suggest that the prevalence of thrombus in AF pts is very low in the absence of organic heart disease, irrespective of the anticoagulation status.

POSTER SESSION

1288 Detecting Coronary Artery Disease and Ischemia: Tracers and Techniques

Wednesday, March 21, 2001, 9:00 a.m.-11:00 a.m.
Orange County Convention Center, Hall A4
Presentation Hour: 9:00 a.m.-10:00 a.m.

1288-137 Multicenter Performance Evaluation of a New Approach to Myocardial Perfusion SPECT Attenuation and Scatter Correction with Resolution Recovery

Timothy M. Bateman, Lynne L. Johnson, Peter L. Tilkemeler, Ami E. Iskandrian, William P. Follansbee, Gary V. Heller, Daniel S. Berman, Samia M. Arram, Ernest V. Garcia. *Mid America Heart Institute, Kansas City, MO, Emory University, Atlanta, GA*

Background: Inconsistent results from current solutions to non-uniform attenuation in SPECT myocardial perfusion imaging have been attributed to quality control (QC) violations and suboptimal transmission (Tx) scan reconstruction. We therefore developed and clinically evaluated a comprehensive approach to attenuation correction (AC) that includes a brief pre-scan technique, automated post-acquisition QC algorithms, and a new Bayesian iterative approach to Tx scan reconstruction.

Methods: Six independent labs unassociated with the developers used scanning Gd-line source hardware (Vantage™ Pro, ADAC) and software (ExSPECT II™) and prospectively completed a comprehensive performance survey for each imaged patient. 237 studies (107 females; 33% 200-300 lbs.) were acquired using 1 of 4 common Tc-99m protocols (184 sestamibi, 53 tetrofosmin). Collected data included patient demographics; Tx and emission scan quality graded 1-5 (5 = excellent); technical violations (poor counts, truncation, gating artifacts); and impact on diagnosis.

Results: Stress and rest Tx scan quality scores averaged 4.5 and 4.6, respectively. Relative to emission scans without AC, 96% of both stress and rest emission scans were graded as improved/unchanged. 4% of emission scans were degraded due to increased activity adjacent to the inferior wall or to inadequate Tx counts. Overall, 85/237 (36%) AC studies (lab range 25% - 58%) were reported superior to matched non-AC studies. AC improvements (vs no change) were more frequent in males (62% vs 50%) and in heavier patients (198 ± 47 vs 177 ± 46 lbs.) (p<0.05 for both). Results were independent of radionuclide or imaging protocol used. 17% of studies were reported superior to the AC program currently in use at each site. Compared to visually assessed Tx scan QC, the automated program identified 96% of technical violations.

Conclusion: This multicenter data demonstrates that a new approach to attenuation correction incorporating both quality control algorithms and Bayesian iterative transmission scan reconstruction, results in improved image consistency and quality relative to either no correction or currently used attenuation correction.

1288-138 Diagnostic Accuracy of Exercise ECG vs SPECT in Patients With a Normal Rest ECG and Without Known Coronary Artery Disease

Su-Min Chang, Felix Keng, Alexandre Alessi, Cristiane R. Alessi, Mario S. Verani. *Baylor College of Medicine/The Methodist Hospital, Houston, TX*

Background: It is controversial whether SPECT adds any incremental information over exercise (EX) ECG in patients (pts) with a normal rest ECG and no history of coronary artery disease (CAD). **Methods:** We retrospectively assessed consecutive pts who underwent EX SPECT studies in our laboratory and had a normal rest ECG, absence of proven CAD, myocardial infarction or revascularization, and underwent coronary angiography within 1 year of SPECT. The pretest likelihood of CAD was 48.7±32%. SPECT was categorized as high-risk if it showed either left anterior descending (LAD) stenosis, multivessel distribution or perfusion defects which involved >15% of the left ventricle. Angiography showed 42 pts (61%) with CAD, 13 pts (19%) with severe CAD (left main [LM] or 3-vessel [3VD]) and 25 pts (36%) with multivessel disease [MVD] or proximal LAD stenosis. Independent predictors of CAD by logistic regression were age >65 years, hyperlipidemia and abnormal SPECT (odds ratio: 16 [p=.02]; 18 [p=.05]; and 12 [p=.04]), respectively. By stepwise logistic regression, only abnormal SPECT (p=.02) and high-risk scan (p=.04) were significant predictors of MVD. The diagnostic performance of EX ECG and SPECT are shown in the table. Combining all EX variables (ischemic ECG changes, angina, blunted blood pressure response, and EX duration < 6 minutes), increased modestly the sensitivity of EX test for detecting severe CAD (from 38 to 45%) and MVD (from

40 to 57%). **Conclusion:** Thus, in pts without known CAD, with a normal rest ECG, SPECT had better diagnostic performance than the EX ECG. EX variables failed to identify more than half of pts with MVD.

	EX ECG	SPECT	p
Sensitivity	38% (16/42)	79% (33/42)	<.001
Specificity	89% (24/27)	70% (19/27)	0.09
Accuracy	58% (40/69)	76% (52/69)	0.03
3VD/LM	38% (5/13)	85% (11/13)	0.01
MVD	40% (10/25)	84% (21/25)	0.003

1288-139 Comparison of Delayed Exercise 99m Tc-MIBI SPET Versus Early Rest 99m Tc-MIBI SPET in Patients With Acute Chest Pain and Normal ECG

Alberto Conti, Chiara Gallini, Barbara Paladini, Maurizio Zanobetti, Iacopo Olivetto, Stefano Grifoni, Giancarlo Berni, Egidio Costanzo, Paolo Ferri, Maria Matteini, Cesco Pieroni. *Azienda Ospedaliera Careggi, FLORENCE, Italy, Italy*

Background: Rest 99m Tc-MIBI myocardial scintigraphy (rest-SPET), has a relevant role in the assessment of patients (pts) with chest pain and non-diagnostic ECG (CP) presenting within the first 3 hours from onset of symptoms. In those with delayed presentation (>3 to 24 hours, representing the majority of CP pts) rest-SPET is less accurate: in these pts, exercise SPET appears more promising. In this study we compare rest SPET in CP pts with early presentation vs. exercise SPET in pts with delayed presentation. **Methods:** A total of 214 consecutive pts with first episode of CP (<24 hours) had a negative first line work-up (ECG, CK-MB, Troponine and Echo. Patients were studied with rest SPET if presenting <3 hours from CP and exercise SPET (maximal, symptom-limited cycleergometer test) after >3 hours. Patients with a positive scan underwent coronary angiography. Patients with negative scan were discharged. End-point of the study was represented by major coronary event(CE) at 6 months. Results are shown in the table. Of the 214 pts, 77 presenting <3 hours from onset of CP (36%) underwent rest-SPET; the remaining 137 pts presenting >3 hours (64%) underwent exercise SPET. None of the 147 pts with negative SPET had evidence of CE at 6 months. Of the 67 pts with positive SPET, 27 had documented coronary artery disease, with a similar proportion in the rest and exercise group (50% vs. 31%, p=ns) and the total accuracy was comparable in the 2 groups. **Conclusions:** The accuracy of exercise SPET in patients with CP and delayed presentation is comparable to that of rest SPET in patients with early presentation. Due to the high negative but low positive predictive value, exercise SPET is especially valuable as a screening tool for the exclusion of coronary heart disease in low-risk patients and implementation of early discharge.

	CE at 6 months	r-SPET (n=77)	Ex-SPET (n=137)	P value	Total (n=214)
True Positive	16 (21%)	11 (8%)	<0.005	27 (13%)	
True Negative	45 (58%)	102 (74%)	<0.05	147 (69%)	
False Positive	16 (21%)	24 (18%)	ns	40 (19%)	
False Negative	0	0	ns	0	
Sensitivity	100%	100%	ns	100%	
Specificity	74%	81%	ns	79%	
+ve Predict.Value	50%	31%	ns	40%	
-ve Predict.Value	100%	100%	ns	100%	
Accuracy	79%	82%	ns	81%	

1288-140 Comparison of Diagnostic Performance of SPECT Using Different Myocardial Perfusion Tracers in Clinical Practice: TI-201, Tc-99m Tetrofosmin, and Tc-99m Sestamibi

Su-Min Chang, Felix Keng, Cristiane R. Alessi, Alexandre Alessi, Mario S. Verani. *Baylor College of Medicine/The Methodist Hospital, Houston, TX*

Background: The use of Tc-99m tetrofosmin (TF) as an alternative to thallium-201 (TI) and Tc-99m sestamibi (MIBI) for the diagnosis of coronary artery disease (CAD) has been validated in controlled clinical trials but is less well studied in clinical practice. **Methods:** Accordingly, we compared the diagnostic performance of these different tracers in a large, unselected population. We studied 5884 consecutive patients (pts) who underwent stress SPECT during a 15 months time span. Stress modality was similar among all 3 tracers. Coronary angiography within one month of SPECT was performed in 1296 pts. TF was used in 180 pts (14%); MIBI in 440 pts (34%) and TI in 676 pts (52%). Significant angiographic CAD was present in 1004 pts (77%), 255 (25%) of whom had left main (LM) or 3-vessel disease (3VD). Risk factors distribution, history of myocardial infarction, revascularization and % of pts with abnormal scan were similar among the 3 groups. Pts in the Tc-99m groups were younger and had higher body mass index (BMI) as compared to the TI group. **Results:** Diagnostic performance is shown in the table. **Conclusion:** Thus, all 3 perfusion tracers were equally sensitive for detecting CAD. The higher specificity and accuracy of TI may be due to a referral bias, with a preferential use of TI in pts with lower BMI.

	TF (n=180)	TI (n=676)	MIBI (n=440)	p = 1 / 2 / 3
Sensitivity	89% (109/123)	91% (498/546)	89% (298/335)	0.37/0.92/0.27
Specificity	54.4% (31/57)	65.4% (85/130)	49% (51/105)	0.15/0.48/0.01
Accuracy	79% (142/180)	86% (583/676)	79% (349/440)	0.02/0.90/0.002
3VD/LM	84% (26/31)	92% (137/138)	95% (82/86)	0.016/0.04/0.33
MVD	90% (63/70)	94% (302/321)	93% (165/177)	0.21/0.39/0.70
Area Under ROC	0.715	0.782	0.688	

p value: 1)between TF and TI / 2)between TF and MIBI / 3)between MIBI and TI

1288-141 Dipyridamole Myocardial Perfusion Imaging According to the ACC/AHA Guidelines for Risk Stratification and Management of Pts Undergoing Vascular Surgery: A Prospective Study

Pierluigi Pieri, Rossana Berta, Giovanni Moscatelli, Daniele Baccos, Patrizia Ghezzi, Francesco Buccoliero, Jeffrey Leppo. *M. Bufalini Hospital, Cesena, Italy*

Background: No prospective studies have addressed the issue of the clinical impact of the ACC/AHA preoperative guidelines and the role of myocardial perfusion imaging (MPI). The aim of this study was to assess the clinical utility of MPI according to a strict adherence to these guidelines. **Methods:** 81 consecutive pts candidates for vascular surgery were prospectively evaluated based on the guidelines according to a risk stratification including: clinical and surgery-specific predictors of operative risk, as well as functional capacity (FC). Dipyridamole-SPECT MPI was done in the following pts: 1)pts with intermediate clinical and either high surgical risk or with poor FC; 2)pts with minor clinical risk but high surgical risk and poor FC. The study end points were perioperative cardiac death and non-fatal MI. **Results:** To date, 62 of the 81 pts have undergone vascular surgery: 23 carotid endarterectomy and 39 aortic or peripheral vascular surgery. Mean age = 72.3 years (range 44-85). Dipyridamole MPI was performed in 18 pts (22.2%) and assessed as normal or abnormal based on the presence of fixed/reversible defects and defect size. Dipyridamole-MPI was abnormal in 15 pts; Reversible defects (intermediate or smaller size) were seen in 12 pts. Fixed defects consistent with previous MI in 3 pts. Clinical management: Based on these studies, surgery was cancelled in only 1 pt. due to high cardiac risk (unstable angina). Coronary angiography was not done in any other pts. In those pts with intermediate or smaller size inducible ischemia by MPI, ECG monitoring was performed for 24 hrs and medical therapy was optimised. None of these pts experienced cardiac death or MI in the perioperative phase **Conclusions:** These preliminary results show that in preoperative vascular surgery pts: 1) risk stratification by rigorous application of ACC/AHA guidelines is associated with a very low risk of perioperative cardiac events; 2) the selected use of dipyridamole MPI in pts at higher clinical risk improves physician confidence in pt management; 3) those with intermediate or small size ischemia by MPI, do not have to undergo routine coronary angiography and myocardial revascularization in order to achieve good outcomes.

POSTER SESSION

1289 Computed Tomography/Magnetic Resonance Imaging: Coronary Imaging, Perfusion, Disease Applications

Wednesday, March 21, 2001, 9:00 a.m.-11:00 a.m.
Orange County Convention Center, Hall A4
Presentation Hour: 9:00 a.m.-10:00 a.m.

1289-142 Comparison of MRI, TEE and Invasive Measurement for Evaluation of Atrial Septal Defects Type II Before and After Transcatheter Closure

Thorsten Dill, Anna John, Thomas Neumann, Roland Brandt, Matthias Rau, Georg Bachmann, Wolfgang Ricken, Christian W. Hamm. *Kerckhoff Clinic, Bad Nauheim, Germany*

Background: The defect diameter, shunt volume and size of the right atrium and ventricle are essential data for planning a transcatheter closure of an atrial septal defect and for post procedure follow up. Invasive balloon sizing of the defect is still mandatory. We tested the value of MRI in the evaluation of those patients and compared the findings to TEE and invasive balloon sizing before closure and on follow up at 1 month.

Patients and methods: In 20 pts, female 11, mean age 43 yrs (18-64) the MR study was performed on 1.5 Tesla Siemens Vision and Sonata systems. The end systolic and end diastolic volumes and diameters of the LV, RV, LA and RA and flow measurements in aorta and pulmonary artery were used for calculation of the Qp/Qs ratio. For defect imaging, a Flash 2D cine gradient echo sequence (TR 60 ms, TE 5 ms, SLT 6 mm) and a Trufisp cine sequence (TR 32 ms, TE 1.6 ms, SLT 5 mm) were used. The data were compared to the 2 D-TEE measurements and the invasively measured Qp/Qs ratio. Transcatheter closure was performed with the Amplatzer septal occluder system. On follow up, MRI and TEE were performed in the same way on the same day. Investigators were blinded to the results of the other technique.

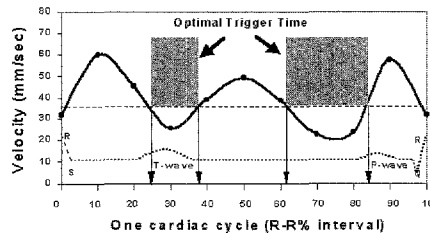
Results: The medium size of the ASD as measured by MRI was 14 mm (8-23mm), and 14 mm (8-22 mm) by TEE, the median balloon stretched defect diameter was 21 mm (15-30). The mean Qp/Qs ratio as measured by MRI was 1.55 (1.3-2.3), invasively measured 1.65 (1.3-2.9). MR data and invasively measured data showed a correlation coefficient of $r=0.85$ (95% confidence interval 0.55-0.96). On follow up, a decrease of the diameter of the RA and RV could clearly be demonstrated as an indicator for improved hemodynamics which correlated well with the flow measurements in aorta and pulmonary artery. As evaluated by MRI and TEE, a complete closure of the defect at one month follow up was achieved in 95% of the patients. No procedural related complications occurred.

Conclusion: Transcatheter closure with the Amplatzer occluder system of atrial septal defects is safe and successful. MRI demonstrated to be feasible and reliable for complete pre- and post procedure evaluation compared to invasive or TEE measurements.

1289-143 Coronary Artery Motion During the Cardiac Cycle and Optimal ECG Triggering for Reducing motion artifact on Coronary Artery Imaging

Bin Lu, SongShou Mao, Nan Zhuang, Bakhsheshi Hamid, Steve C.K Liu, Matthew J Budoff. *Harbor-UCLA Medical Center, Saint John's Cardiovascular Research Center, Torrance, CA*

Background: Coronary artery motion causes image blurring artifact on CT studies. In order to minimize the coronary motion artifact for obtaining good reproducibility and accuracy of coronary calcium study and/or coronary CT angiographic study, we investigated the motion characteristics of the coronary arteries and determined the optimal electrocardiographic (ECG) trigger time during the cardiac cycle for CT data acquisition. **Methods:** Contrast-enhanced multi-slice movie studies of electron-beam tomography (EBT) were performed on 70 subjects. The EBT datasets, which covered an entire cardiac cycle at 58 millisecond intervals, were acquired in short-axis of the heart with ECG triggering. The pixel values in X and Y-axes were measured at multiple intervals during the cardiac cycle to establish the motion distance and velocity of three major coronary arteries. **Results:** Coronary artery motion varies greatly throughout the cardiac cycle and increases with the heart-rate [50.9-165.6 mm/sec from <50 to >110 beats per minute (bpm) in the right coronary artery]. For patients with heart-rate <70 bpm, 71-100 bpm, and >100 bpm, the least motion of right coronary artery occurred in 60-80%, 30-50% and 40-60% R-R intervals, respectively. The greatest motion occurred in 0-20%, 80-100% and 70-90% R-R intervals, respectively. The optimal ECG trigger time located around 35% (31.4-37.6%) or 70% (68.7-71.4%) R-R interval in <70 bpm patients, 50% (47.2-61.1%) R-R intervals in 71-100 bpm patients and 55% (52.8-59.1%) R-R intervals in >100 bpm patients. The minimum scan speed of 35.4-75.5 msec per slice is required to completely diminish cardiac motion artifact. **Conclusion:** For coronary artery screening with EBT or spiral CT, the optimal ECG trigger time should be determined and used according to patient's heart rate, thus greatly reducing coronary motion during 100-msec acquisition.



1289-144 Comparison of Coronary Artery Diameters in Retrospectively ECG-Gated Multislice Spiral CT and Quantitative Coronary Angiography

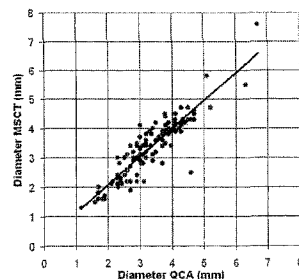
Tom Giesler, Stephan Achenbach, Dieter Ropers, Ulrich Baum, Marc Kachelrieß, Stefan Ulzheimer, Werner Bautz, Werner Moshage, Werner G. Daniel. *University of Erlangen-Nuremberg, Department of Internal Medicine II, Erlangen, Germany, University of Erlangen-Nuremberg, Dept. of Diagnostic Radiology and Institute for Medical Physics, Erlangen, Germany*

Multislice spiral CT (MSCT) is a non-invasive imaging method with high spatial and temporal resolution. In combination with retrospective ECG-gating, it can be applied for coronary artery visualization. In order to assess the accuracy of coronary visualization by MSCT, we compared vessel diameters to quantitative coronary angiography (QCA).

Methods: 25 patients (heart rate: 55-115/min) were studied by MSCT (Siemens Somatom Volume Zoom). During intravenous injection of contrast agent (160 ml at 4 ml/s) a volume data set of the heart was acquired (4x1 mm slice thickness, 500 ms rotation, table feed 1.5 mm/360°). The patient's ECG was simultaneously recorded and permitted retrospective reconstruction of contiguous axial cross-sections (1.3 mm to 1.5 mm slice thickness) using a data acquisition window of approximately 200 ms at any desired interval of the cardiac cycle. Multiplanar reconstructions of the coronary arteries were performed and the vessel lumen was measured at the left main, proximal LAD, LCX, and RCA, and - if possible - first diagonal branch. The coronary artery diameters were compared to those obtained in QCA (mean of two orthogonal projections) performed one day after MSCT.

Results: Vessel diameters were compared at 121 corresponding sites. The mean diameter in MSCT was 3.36 ± 0.99 , in QCA 3.34 ± 0.93 (n.s.). The mean difference was 0.31 ± 0.29 . The correlation coefficient was 0.90 (see graph).

Conclusion: Contrast-enhanced multislice spiral CT permits visualization of the coronary arteries. Vessel diameters correspond closely to those measured in quantitative coronary angiography.



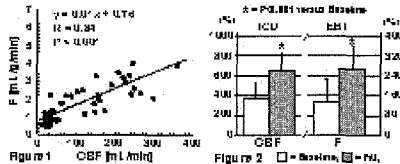
1289-145 Electron-Beam Computed Tomography Permits Accurate Quantitation of Long-Term Changes in Myocardial Perfusion: a Follow-Up Study in Comparison to Intracoronary Doppler Ultrasound

Stefan Möhlenkamp, Amir Lerman, Thomas R. Behrenbeck, Lilach O. Lerman, Patricia E. Lund, Patrick F. Sheedy, II, Erik L. Ritman. *Mayo Clinic and Foundation, Dept of Physiology and Biophysics, Rochester, MN*

Background: Minimally-invasive quantitation of long-term changes in myocardial blood flow (F) should be of clinical value, e.g. to assess improvement in F with therapy. We used a porcine model of vascular maturation to evaluate the ability of electron beam CT (EBT) to quantitate long-term changes in F in comparison to changes in clinically accepted intracoronary Doppler ultrasound.

Methods: EBT-based F and concurrent Doppler-based intracoronary blood flow (CBF) were obtained in the LAD-perfusion bed in 13 normal pigs at baseline (weight:27±2kg) and again 3 months later (follow-up (F/U), weight:55±8kg, P<0.001 versus baseline). F was obtained using indicator dilution principles and rapid intravenous injections of contrast agent (iopamidol 370, 0.33mL/kg over 2sec). CBF- and F-reserves were defined as %-increase in response to 5 min intracoronary infusion of adenosine (100µg/kg/min) in comparison to rest (intracoronary infusion of normal saline at 1mL/min).

Results: We found a linear and significant correlation between F and CBF (Figure 1). CBF at rest tended to increase from baseline to F/U (from 24±8 to 30±12mL/min, P=0.08), while F, which is indexed to myocardial mass, remained unchanged (from 0.9±0.3 to 0.8±0.1mL/min/g, P=NS). CBF and F increased significantly in response to adenosine both at baseline and F/U but these CBF- and F-reserves were significantly higher at F/U compared to baseline (Figure 2).



Conclusion: EBT allows quantitation of long-term changes in F-reserves that are related to myocardial functional maturation. Minimally-invasive EBT may have a role in evaluating long-term changes in myocardial perfusion e.g. to assess therapeutic strategies that target myocardial perfusion.

1289-146 Determination of Left Ventricular Mass With Electron Beam Computed Tomography in Patients With Hypertrophic Obstructive Cardiomyopathy

Alexander Becker, Christoph Becker, Andreas Knez, Alexander W. Leber, Alexander Molnar, Peter Boekstegers. *Department of Medicine I University of Munich, Munich, Germany*

Background: Transcatheter ablation of septal hypertrophy has proven to be an effective treatment of hypertrophic obstructive cardiomyopathy. To monitor the regression of ventricular mass we determined the left ventricular mass with electron beam computed tomography over 12 months in patients with hypertrophic obstructive cardiomyopathy.

Methods: We examined 47 patients, 28 male, 21 female, age 57,3 ± 9,4 years, with electron beam computed tomography and determined the myocardial mass of the hypertrophic segment, the contralateral segment and the total left ventricle before, 7 days, 6, and 12 months after transcatheter ablation of septal hypertrophy. Therefore we used the Imatron C-150 electron beam computed tomograph in the multislice mode. After injection of 70 ml contrast agent we acquired 20 images per RR-interval simultaneously in 8 slices ECG triggered. The endocardial and epicardial borders of the myocardium were marked and the myocardial volume and mass were calculated for the left ventricle, the septal segment and the contralateral segment.

Results: see table. A significant decrease of myocardial mass could be observed already 7 days after transcatheter ablation of septal hypertrophy in the hypertrophic segment and after 6 months in the contralateral segment.

Conclusion: Transcatheter ablation of septal hypertrophy leads not only to a significant reduction of myocardium in the hypertrophic segment but also in the contralateral segment. The myocardial mass could be exactly and reliably determined with electron beam computed tomography.

	before Ablation	after 7 days	after 6 months	after 12 months
ventricular mass (g)	218	210	178	160
septal segment (g)	29.1	24.8	21.2	18.8
kontralateral segment (g)	21.3	20.1	16.6	14.2

POSTER SESSION

1290 Stress Echocardiography and Prognosis

Wednesday, March 21, 2001, 9:00 a.m.-11:00 a.m.

Orange County Convention Center, Hall A4

Presentation Hour: 9:00 a.m.-10:00 a.m.

1290-147 Exercise Wall Motion Abnormalities in the Distribution of the Left Anterior Descending Coronary Artery Are Independently Associated With Adverse Prognosis

Abdoul Elhendy, Douglas Mahoney, Bijoy K. Khandheria, Kelli Burger, Patricia A. Pellikka. *Mayo Clinic, Rochester, MN*

Background: The impact of the location of wall motion abnormalities (WMAs) during stress echocardiography on the prognostic outcome is not known. Objectives: The aim of this study was to find whether the location of WMAs during exercise echocardiography provides incremental prognostic value relative to the extent of WMAs. **Methods:** We studied 4,593 patients with known or suspected coronary artery disease (CAD) by symptom limited exercise echocardiography. An abnormal test was defined as resting or exercise-induced WMAs. The anterior, apical, anteroseptal, and mid inferoseptal segments were assigned to the left anterior descending coronary artery (LAD), the lateral and posterior segments were assigned to the left circumflex, whereas the inferior and basal inferoseptal segments were assigned to the right coronary artery. **Results:** The mean age was 61±12 years (2,403 men and 2,190 women). Resting ejection fraction was 58 ± 8. During a median follow up of 2.8 years, there were 157 hard events (65 cardiac death and 92 non-fatal myocardial infarction). In a stepwise multivariate analysis model, clinical and exercise ECG predictors of cardiac events were age, gender, hypertension, typical chest pain, previous myocardial infarction, smoking, and resting ejection fraction (global Chi2=183). The addition of percentage of abnormal segments at peak exercise provided incremental information to the model (global Chi2=196, p=0.0001). The presence of abnormalities in LAD distribution had an additional independent effect for the prediction of cardiac events (global Chi2=204, p=0.004). **Conclusion:** Exercise WMAs in the distribution of the LAD coronary artery are associated with increased risk of cardiac death and non-fatal myocardial infarction. The risk is independent of the resting ejection fraction and the extent of WMAs during exercise.

1290-148 Incremental Prognostic Value of Exercise Echocardiography in Patients With High Pretest Probability of Coronary Artery Disease

Abdoul Elhendy, Douglas Mahoney, Kelli Burger, Patricia A. Pellikka. *Mayo Clinic, Rochester, MN*

Objectives: The aim of this study was to determine whether exercise echocardiography provides data incremental to clinical parameters for risk stratification of patients with a high pretest probability of coronary artery disease (CAD). **Methods:** The study included 437 patients (241 men and 196 women) with > 0.7 pretest probability of CAD referred for treadmill exercise echocardiography. Patients were excluded if they had a history of myocardial infarction or revascularization. **Results:** Mean age was 65 ± 10 years. Sixty-eight patients (16%) had cardiac events-15 hard events (cardiac death or nonfatal myocardial infarction) and 53 coronary artery revascularization procedures during a median follow-up of 2.7 years. Event-free survival rates in patients with normal and abnormal stress echocardiograms were 98% vs. 80% at 1 year, 95% vs. 73% at 3 years, and 86% vs. 69% at 5 years, respectively. In a multivariate analysis of clinical, exercise stress, and echocardiographic parameters, independent predictors of cardiac events were the percentage of ischemic segments by echocardiography (Chi2 = 12, p < 0.0006), abnormal exercise echocardiogram (Chi2 = 5, p = 0.03), male gender (Chi2 = 12, p = 0.0006), peak exercise heart rate (Chi2 = 7, p = 0.007), and diabetes mellitus (Chi2 = 7, p = 0.009). In an incremental model of clinical, exercise, and echocardiographic variables, the addition of echocardiographic data increased the Chi2 of the model from 62 to 77 (p<0.001). **Conclusion:** Exercise echocardiography provides useful data incremental to clinical parameters for the risk stratification of patients with suspected CAD and a high pretest probability of CAD. Patients with normal exercise echocardiograms have a low event rate despite the high pretest probability and therefore can be exempted from invasive procedures in the 3 years following the test.

1290-149 Coronary Intervention in Patients With Intermediate Stenoses Can Be Deferred on the Basis of Negative Dobutamine Stress Echocardiography

Tom Giesler, Uwe Nixdorff, Susanne Lamprecht, Dieter Ropers, Martin Brück, Jens U. Voigt, Joseph Ludwig, Werner G. Daniel. *University of Erlangen-Nuremberg, Department of Internal Medicine II, Erlangen, Germany*

The objective of this study was to determine the feasibility, safety and outcome of performing or deferring interventions in patients (pts) with known coronary artery disease (CAD), chest pain and angiographically intermediate stenoses based on dobutamine stress echocardiography (DSE) to test the functional significance of the stenosis.

Methods: Our study included 47 pts (34 male, 13 female) with intermediate stenoses by quantitative coronary angiography (diameter stenosis >50% and <70% in two orthogonal projections). DSE was performed within two days after angiography according to the standard titration protocol. In pts with inducible ischemia within the myocardium perfused by the target vessel, intervention was performed (Int-group), while in pts with negative DSE (nonInt-group), the intervention was deferred.

Results: DSE was not evaluable because of poor echogenicity in 3 pts (6%). In 6 pts, intervention was performed (Int-group) due to positive DSE (13%) (2 CABG, 4 PTCA). Intervention was deferred in 38 pts (nonInt-group) due to negative DSE (81%).

	Int-group	nonInt-group	p-value
n	6	38	
Age (years)	58.7±12.0	61.6±10.1	p=0.52 (n.s.)
Ejection fraction (%)	66.3±15.9	65.3±11.1	p=0.84 (n.s.)
Diameter stenosis (%)	58.2±5.1	58.4±4.5	p=0.90 (n.s.)

During follow-up (21±4 months), no cardiac death or myocardial infarction occurred in either group. 11/38 pts (29%) of the nonInt-group developed progressive angina pectoris. In those pts, angiography showed >70% stenosis of the target lesion in 7 cases and other lesions in 4 cases, and interventions were performed (2 CABG, 9 PTCA). In 2/6 pts of the Int-group, Re-PTCA became necessary.

Conclusion: In pts with CAD and intermediate stenoses, DSE is an appropriate test for stratifying the functional relevance of the lesion. Intervention may safely be deferred when DSE is negative. However, in 29% of pts with initially negative DSE an intervention became necessary during follow-up because of progression of atherosclerosis.

1290-150 Kidney Transplantation: A New Approach in the Prevention of Coronary Events in End Stage Renal Disease (ESRD)

Jannah Fatima T. Baltasar, Ofelia P. Saniel, Ernesto B. Baello, Jr. NATIONAL KIDNEY & TRANSPLANT INSTITUTE, QUEZON CITY, Philippines

Background: With an incidence of 42%, cardiac death remains to be the leading cause of death in end stage renal disease (ESRD). There are studies which show that cardiac status improves after kidney transplantation (KT). But it is still unclear if these so-called improvements in cardiac status translate into a better prognosis. **Objectives:** To determine if KT can modify the risk of coronary events in ESRD patients. To determine which variables influence prognosis for coronary events in ESRD patients. **Methodology:** This is a prospective cohort study. Thirty six ESRD patients were referred for cardiac evaluation and had exercise echocardiography (EE) from January 1993-December 1998. Clinical data were gathered. All patients were followed-up on an out-patient basis. Outcome was defined as any coronary event such as unstable angina, acute myocardial infarction, sudden cardiac death and/or revascularization. Two tailed Fisher's exact test and Kruskal-Wallis statistics were used to assess the significance of categorical and continuous variables. Logistic regression was used to assess variables for prognostic significance. **Results:** The only significant variable that was associated with coronary event in non-transplant ESRD patients was a worsening wall motion abnormality (WMA) (p=0.003). One hundred percent of non-transplant ESRD with worsening WMA on EE had coronary event on follow-up. In contrast, only 11% of non-transplant ESRD without WMA had coronary event. Incidence of coronary event was highest during the first 6 months after EE. On the other hand, none of those with worsening WMA but had KT had any coronary event. In a logistic regression model (p=0.025), KT was shown to prevent coronary event (N.B. ESRD had an odds ratio [OR] of 13 while KT had an OR of nearly zero). Other variables which appear to increase the risk of coronary events are worsening WMA (OR=5.81; 95% Confidence Interval [CI]=0.2354-143.4008), ejection fraction (EF) < 40% (OR=4.41;95% CI=0.0144-1346.959), LV > 5 cm (OR=1.7;95% CI =0.0927-33.1219). **Conclusion:** Our study showed that KT can prevent coronary events in ESRD. Furthermore, it showed that worsening WMA on EE is also a powerful predictor of coronary events in ESRD patients.

POSTER SESSION

1291 Left Ventricular Cavity Opacification With Microbubbles

Wednesday, March 21, 2001, 9:00 a.m.-11:00 a.m.

Orange County Convention Center, Hall A4

Presentation Hour: 9:00 a.m.-10:00 a.m.

1291-151 Impact of Optison With Harmonic Imaging on Evaluation of Cardiac Function in Technically Very Difficult Patients in the Intensive Care Unit Setting: Comparison With Transesophageal Echocardiography

Yongqi Yong, David Wu, Valerian Fernandes, Helen A. Kopelen, Sarah Shimoni, Sherif F. Nagueh, Miguel A. Quinones, William A. Zoghbi. Baylor College of Medicine, Houston, TX

Background: Echocardiographic assessment of cardiac function is often crucial, yet difficult, in critically ill patients and may require transesophageal echo (TEE). Whether harmonic imaging (HI) alone or in combination with contrast (HI+C) improves visualization and accuracy of interpretation of technically very difficult studies, to a level comparable to TEE, is unknown.

Methods: 32 patients in the intensive care unit (24 males, mean age 65 yrs, weight 97 Kg, 69% ventilated), who had very difficult studies [≥ 50% (8/16) of segments not visualized with fundamental imaging (FI) from any view], prospectively underwent transthoracic studies with FI, HI, HI+C, and conventional TEE. Readers blinded to other modalities evaluated regional and global LV systolic function.

Results: Total Optison dose averaged 2.3ml (range 0.3 – 9.5ml). No Optison related adverse events were noted except for one episode of nausea. Excellent or adequate endocardial visualization was seen in 13% of segments with FI, and increased to 34%

with HI and to 87% with HI+C (p<0.0001). The frequency of adequate to excellent endocardial visualization by HI+C was similar to TEE (87% vs. 90%; p=ns). Of the 512 total segments, 151 were hypokinetic and 45 were akinetic by TEE. Using TEE as the standard, agreement in exact interpretation of wall motion increased from 48% for FI to 58% with HI and reached 70% with HI+C. HI+C had the best sensitivity in detecting LV wall motion abnormality (FI 67%, HI 75% and HI+C 89%); specificities were similar (FI 70%, HI 75% and HI+C 75%). LV ejection fraction (EF) by TEE averaged 50% (range 22-70%). Estimates of LVEF with all 3 modalities correlated with EF by TEE (r: 0.81-0.87); however EF estimation was possible in only 31% with FI, increased to 50% with HI and further to 97% with HI+C.

Conclusion: In technically very difficult transthoracic studies where TEE is indicated for evaluation of ventricular function, an improvement in feasibility and accuracy of interpretation of regional and global LV function is observed with harmonic and particularly with contrast and harmonic imaging. In this setting, contrast echo provides a safe and effective alternative to TEE for evaluation of left ventricular systolic function.

1291-152 Improvement in the Accuracy of Echocardiographic Assessment of Left Ventricular Remodeling with Contrast: A Prospective Blinded Study comparing Echocardiography with and without Contrast with Electron Beam CT

Helen L. Thomson, Jean-Francois Avierinos, Jerome F. Breen, Maurice E. Sarano. Mayo Clinic and Foundation, Rochester, MN

Background: Assessment of absolute left ventricular (LV) volumes is important in the assessment of LV remodeling, a precursor of LV dysfunction. Echocardiography is believed to underestimate LV volumes and is not considered an accurate tool to assess LV remodeling. The impact of new technology (harmonic imaging, contrast injection) has not been evaluated due to the lack of an accurate reference method. However, electron beam CT (EBCT) has rapid frame rate and allows accurate assessment of LV volumes. We hypothesized that the accuracy of echocardiographic assessment of absolute LV volumes would be improved by the addition of contrast injection, using EBCT as a reference.

Method: 25 patients (13 male, 12 female, mean age 68±14 years) were enrolled in a prospective study. Digital LV images optimized with harmonics were acquired with and without contrast. Volumes were determined by biplane Simpsons method independently and blindly by a single reader. EBCT was performed within 1 hour of echocardiography. Results are expressed as mean ± SE.

Results: Compared to CT, use of harmonics without contrast leads to underestimation of end diastolic volume(EDV) by 75±7ml, end systolic volume(ESV) by 18±3ml and of stroke volume(SV) by 58±ml (p<0.0001 for each parameter by echocardiography without contrast vs EBCT) and EF by 3±1% (p<0.01). Compared to CT, use of contrast leads to no significant difference in measurement of EDV, ESV, SV or EF(p=NS).

	EBCT	Echo w/o Contrast (p vs EBCT)	Echo with Contrast (p vs EBCT)
EDV(ml)	195±1	119±11 (p<0.0001)	195±10 (p=0.96, NS)
ESV(ml)	58±5	40±16 (p<0.0001)	55±4 (p=0.17, NS)
SV (ml)	137±7	79±24 (p<0.0001)	140±7 (p=0.26, NS)
EF (%)	71±1	68±7 (p<0.01)	72±1 (p=0.15, NS)

Conclusions: 1. For the assessment of LV remodeling, the use of harmonic imaging alone is associated with statistical underestimation of LV volume (particularly end-diastolic volume and stroke volume). 2. The combination of harmonic imaging with contrast allows accurate assessment of LV volumes. 3. When the accurate assessment of LV remodeling is required, harmonic imaging with contrast is recommended.

1291-153 Accuracy of the Measurement of the Left Ventricular Mass by Contrast Echocardiography in Rats

Kumiko Hirata, Haruka Kobayashi, Hideo Hirayama, Hiroyuki Watanabe, Masakazu Teragaki, Takashi Muro, Kazuhide Takeuchi, Junichi Yoshikawa, Shintaro Beppu. Osaka University, Osaka, Japan, Osaka City University, Osaka, Japan

Background and Purpose: Noninvasive assessment of cardiac performance in small animals has been required in genetic and pharmacological experiments. However, little data has been elucidated about accurate methods to determine left ventricular (LV) volume and mass using echocardiography. The aim of this study was to determine the accuracy of LV volume and mass measurement using LV opacification (LVO) by contrast echocardiography in rats. **Methods:** LV long and short axes views were recorded using SONOS 5500 (Agilent Technologies) with S12 probe (5–12MHz, 180 Hz frame rate) before and after 0.15 ml bolus administration of 20% dilution of Optison (Molecular Biosystem Inc.) via femoral vein in 15 rats. LV volume and mass were calculated by the area-length method by tracing epicardial and endocardial border at end-diastole in both cases with and without LVO by two independent examiners. The mass was compared with true LV weight of post-mortem specimen. **Results:** Recognition of the epicardial border was identical in both cases with and without LVO, resulting that the epicardial area in the short axis view did not differ from each other (1.50±0.19 vs. 1.47±0.11 cm²). LV cavity area measured with LVO was significantly larger than that without LVO (1.07±0.07 cm² vs. 0.75±0.04 cm², p=0.00001). Consequently, calculated LV mass was significantly larger in cases without LVO. The LV weight calculated by LVO was 0.66±0.06 gram, which did not differ from the true weight of 0.59±0.02 gram. **Conclusion:** LVO using contrast echo via venous injection is useful method to measure the LV mass accurately in rats.

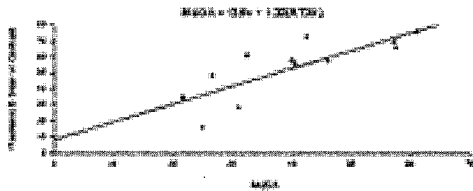
1291-154 Improved Accuracy of Ejection Fraction Measurements in Patients by Real Time 3-D Using Harmonic Imaging and Intravenous Echo Contrast (Definity)

Crispin H. Davies, Heidi M. Conklin, Betty Skipper, Mary E. Joyce, Bruce K. Shively, David J. Sahn. *Oregon Health Sciences University, Portland*

Background: Current 2D methods for assessing LVEF are inherently restricted by geometric assumptions, which real time three-dimensional (RT3D) echo avoids. RT3D is presently limited by poor endocardial definition in patients with suboptimal images. We have investigated whether the combination of Definity® (DuPont Pharmaceuticals, Boston, MA), a suspension of phospholipid coated perfluoropropane microbubbles, and the use of harmonic imaging could enhance endocardial definition and LVEF determination by RT3D.

Methods: 15 unselected patients underwent MUGA scanning with Tc^{99m} yielding LVEF between 0.25-0.65, followed by RT3D in apical views scanning using fundamental (2.5 MHz) and harmonic imaging (1.7 / 2.4MHz), with and without an infusion of 1.3 - 2.6 mL of Definity®, starting at a rate of 101 - 198 μ L/min with a mean total dose of 1.4 ml. For contrast studies, transmit power was reduced < 50% to minimize apical contrast destruction; receiver gains and grey-scale were adjusted to compensate. End systolic and end diastolic frames were blindly selected and 3D volumes measured by planimetry of 9 slice long axis (B scan, sector) and short axis (C scan, parallel) sequences.

Results: Stepwise regression of LVEF for the 12 patients with measurable results in all 4 modes of scanning demonstrated that while the correlation with MUGA was $P = NS$ for fundamental imaging \pm contrast and harmonic imaging studies without contrast; measurements from harmonic B scans augmented with Definity® produced significantly better results ($r = 0.86$, $P = 0.006$, Bland-Altman MUGA-RT3D = 11.3, SD = 11.3).



POSTER SESSION

1292 Regional Function Assessment With Echocardiography

Wednesday, March 21, 2001, 9:00 a.m.-11:00 a.m.
Orange County Convention Center, Hall A4
Presentation Hour: 9:00 a.m.-10:00 a.m.

1292-155 The Relation Between Post-Systolic Shortening and Residual Viable Myocardium After Acute Myocardial Infarction: A Comparison of Strain Rate Imaging With Magnetic Resonance Tomography and Scintigraphy

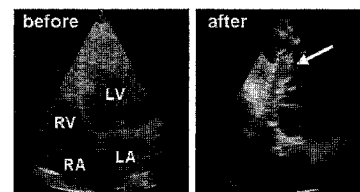
Jens-Uwe Voigt, Matthias Regenfus, Gerd Lindenmeier, Christian Schlundt, Uwe Nixdorff, Frank A. Flachskampf, Werner G. Daniel. *University Erlangen, Erlangen, Germany*

Background: Strain Rate Imaging (SRI) is a new tissue Doppler based method to visualize regional myocardial deformation (Strain, S) and deformation rate (Strain Rate, SR). Both S and SR are altered in a typical way after acute myocardial Infarction (AMI). Recently, post systolic shortening (PSS) was suggested to be a marker of myocardial viability. This study was designed to test whether SRI is able to reliably detect the infarcted region after AMI and whether PSS is related to the extend of viable myocardium in the infarcted segment (SEG). **Methods:** In 9 patients (mean age 50 ± 11 years, 1 female) with recent myocardial infarction (1-6weeks) high frame rate tissue Doppler data of the left ventricular walls were acquired with a System Five ultrasound machine (GE Vingmed, Norway) from an apical window. Strain rate measurement curves and color coded curved M-Mode images were assessed off-line using dedicated research Software. Reduction of systolic SR and the occurrence of PSS - defined as myocardial longitudinal shortening after aortic valve closure - were evaluated. To determine the exact extent of infarcted myocardium, magnet resonance tomography (MRT) was performed. Viability was supposed if the myocardium showed no late enhancement 15min after MRT contrast agent application. Additionally, myocardial viability was confirmed by scintigraphy (SCI). **Results:** In 114 of 162 myocardial SEGs MRT showed less than 50% infarcted muscle. Scintigraphy revealed viability in 88% of those SEGs (Chi-square: $p < 0.0001$). Systolic SR reduction was correlated with the percentage of infarcted myocardium per SEG ($r = 0.87$). PSS, however, could be found in only 2 of 7 SEG with transmural infarction, but 86% of SEGs with 50% of viable myocardium. **Conclusion:** Infarcted myocardium can be reliably visualized by SRI and is characterized by a reduction or inversion of systolic SR. The occurrence of PSS, however, seems to be related to the portion of viable and contractile myocardium within the infarcted SEGs. Our data suggest that a certain portion of viable myocardium is required for the development of PSS.

1292-156 Visualization of Ventricular Early Excitation Site Induced by Ventricular Pacing Using Phase Imaging

Satoshi Nakatani, Hideaki Kanzaki, Akihisa Hanatani, Keiji Hirooka, Yoshio Yasumura, Masakazu Yamagishi, Kunio Miyatake. *National Cardiovascular Center, Suita, Japan*

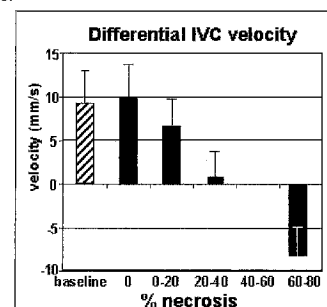
Background: Phase imaging is a new ultrasound imaging technique based on tissue Doppler echocardiography. It can demonstrate the time delay of the first harmonic of a given location in the heart with a time-based color scale by applying the Fourier phase analysis to tissue Doppler-determined myocardial motion-time relation. Thus, phase imaging is considered to demonstrate temporal disturbances at different sites of the heart. **Methods:** To determine whether phase imaging was feasible in visualizing asynchronous contraction induced by ventricular pacing, we recorded and analyzed apical 4 chamber images obtained from 8 patients with permanent pacemaker and 10 normal subjects using phase imaging. A pacing site was at the right ventricular apex in all patients. **Results:** In normal subjects, phase imaging showed homogeneously colored apical 1/2 to 1/3 of the left ventricle, consistent with synchronous contraction in this area. However, in the paced patients, the apical septum which was close to the paced site and the apical lateral wall were colored differently, indicating the time differences in contraction between these areas. In 2 patients from whom we could obtain images before and after pacemaker implantation, phase imaging could demonstrate dramatic changes in color display in the apical area as shown in the figure (arrow). **Conclusion:** Phase imaging is feasible to visualize temporal disturbances in ventricular contraction induced by ventricular pacing. This method may be useful to assess asynchronous contraction in patients.



1292-157 Intracardiac Measurements of Myocardial Velocities During Isovolumic Contraction Predict the Transmural Extent of Necrotic Myocardium

Cristina Pislaru, Charles J. Bruce, Marek Belohlavek, James F. Greenleaf, James B. Seward. *Mayo Clinic, Rochester, MN*

Background: Wall motion during the isovolumic contraction (IVC) consists of short/fast inward/ outward motion toward the center of the LV. This phenomenon can be accurately measured by Doppler myocardial imaging (DMI). We hypothesized that these regional IVC velocities, measured by high-resolution intracardiac ultrasound, predict the amount of viable myocardium. **Methods:** Eight pigs were studied using an open-chest myocardial infarction model. Epicardial markers placed on the anterior LV wall bridged ischemic and normal myocardium. The LAD was occluded for 60min, then reopened for 30min. Pulsed and color M-mode DMI data were collected with a 10F, 8.5MHz phased-array intracardiac catheter (LV cavity) from ischemic, border, and normal demarcated myocardium, from the marker plane. Peak velocities were measured: isovolumic contraction (IVC), ejection (S), isovolumic relaxation (IVR), early diastolic (E), late diastolic (A). The excised heart was double-stained for area at risk and infarct size determination, then sliced through the marker plane. The transmural extent (%) of necrosis was measured in each zone. **Results:** Peak positive IVC was best correlated with % necrosis at 60min occlusion / reperfusion ($r = -0.84 / -0.86$, respectively; $p < 0.0001$) than S, E, and E/A ratio (S: $r = -0.68 / -0.60$; E: $r = -0.45 / -0.81$; E/A: $r = -0.56 / -0.72$; $p < 0.05$ for all). Differential IVC velocity (defined as the difference between peak positive and peak negative velocities) showed the highest correlation with % necrosis ($r = -0.90 / -0.91$, $p < 0.0001$). **Conclusions:** In this animal model, tissue velocity during IVC phase, as measured from intracardiac ultrasound, best predicted amount of viable myocardium compared with regional systolic or diastolic parameters.



1292-158 Is Strain Rate Imaging Superior to Tissue Velocity Imaging in Compensating for Heart or Probe Movement During Acquisition?

Meghan S. Liel, Julia C. Swanson-Birchill, Crispin H. Davies, David J. Sahn. *Oregon Health Sciences University, Portland*

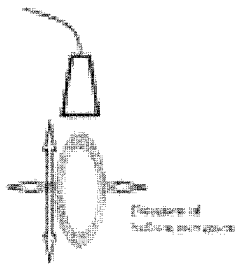
Background: Tissue velocity imaging (TVI) potentially provides information on segmental left ventricular dysfunction but may be limited by an inability to distinguish between myocardial contraction, passive movement with heart motion, or movement of the transducer; strain rate imaging (SRI) would be expected to be resistant to translational errors.

Methods: We developed a double balloon phantom with an interleaving gel layer mimicking the left ventricular myocardium. Three echodense targets were inserted into the gel layer, adherent to the inner balloon, distended with water and suspended in a water bath. Scanning was performed with a 5MHz transducer using a GE/VingMed System Five with data ported to an offline analysis package (EchoPac 6.3). Translational motion of the balloon relative to the scanhead was reproducibly performed both perpendicular (side-to-side) and parallel to the scanlines over two distances (2.5 and 5 mm) and at two velocities (40 and 60/min). TVI and SRI velocities were calculated every 100 msec and compared to B-mode results for the three target points.

Results: Peak TVI and SRI values for a lateral wall target moving side-to-side at a rate of 40/min: TVI values approximated a sinusoidal distribution whereas SRI values appeared randomly distributed, with peak transient SRI values comparable to those recorded in clinical practice (0.3 - 1.0 Hz), despite lack of intertarget motion. SRI was more resistant to parallel balloon motion.

Conclusion: SRI does not appear superior to TDI in compensating for side-to-side translational artifacts.

	Side-to-Side movement		Parallel movement	
	2.5 mm	5.0 mm	2.5 mm	5.0 mm
Translational Distance	2.5 mm	5.0 mm	2.5 mm	5.0 mm
TVI ms ⁻¹	0.17	0.24	0.37	1.08
SRI Hz	1.0	1.75	0.54	0.9



ORAL CONTRIBUTIONS

894 Myocardial Contrast Echocardiography in Coronary Artery Disease

Wednesday, March 21, 2001, 10:30 a.m.-Noon
Orange County Convention Center, Room 414C

894-1 Quantitative Myocardial Contrast Echocardiography Improves the Detection of Hibernating Myocardium That Lacks Contractile Reserve with Dobutamine Echocardiography

Sarah Shimoni, Nikolaos G. Frangogiannis, Constandina J. Aggeli, Kesavan Shan, Sherif F. Nagueh, Michael J. Reardon, Rafael Espada, George V. Letsou, Miguel A. Quinones, William A. Zoghbi. *Baylor College of Medicine, Houston, TX*

Background: Dobutamine echocardiography (DE) and Myocardial Contrast Echocardiography (MCE) can detect hibernating myocardium. However, some viable segments may not show contractile reserve with dobutamine.

Methods: To evaluate whether quantitative MCE parameters improve the detection of viable myocardium that do not exhibit contractile reserve, DE and MCE were performed in 18 patients (age 64±6) with coronary artery disease and depressed systolic LV function (LVEF 29±8%) within 24 hours before bypass surgery. MCE was performed from apical views using intermittent pulse inversion harmonics with increasing triggering intervals during continuous Optison infusion. Images were analyzed quantitatively using HDI lab software.

Results: Assessment of contractile response was feasible in all segments and MCE in 72% of segments. Of the 212 segments analyzed, 169 had severe dysfunction. Of the abnormal segments, 98 had contractile reserve by DE and 71 did not. Segments with contractile reserve had a higher peak contrast intensity (CI) compared to those without contractile reserve [11dB (9-14) vs. 9 dB (7-10), p<0.05], a higher rate of increase (β) of CI [β=0.21 (0.07-0.48) vs. 0.08 (0.03-0.22) p<0.05] and thus a higher product of CI and β, an index of myocardial blood flow [2.14 (0.7-5.8) vs. 0.66 (0.16-2.1) p<0.05]. Of the 169 dysfunctional segments, 66 improved function 3 month after revascularization. The sensitivity and specificity of any contractile reserve by DE for predicting recovery of function were 80% and 54%, respectively. Of the segments with negative contractile response (n=71), 15 recovered function. The product CI*β was higher in these segments that recovered compared to those that did not [5.8 (2.2-7.1) vs. 0.4 (0.07-1.2), p<0.001]. In 14 out of the 15 segments that recovered, CI*β was >1, and was <1 in 42 of 56 segments that did not recover. The overall sensitivity and specificity of MCE using CI*β product (>1) was 90% and 61%, respectively.

Conclusion: Quantitative assessment of resting myocardial perfusion with intravenous MCE can improve the accuracy of DE in predicting recovery of LV function after revascularization and identify viable segments that do not show contractile reserve.

10:30 a.m.

894-2

A Dream Comes True: Noninvasive Delineation of Endocardial Blood Flow and Endocardial/Epicardial Flow Ratio Quantitation by Myocardial Contrast Echocardiography

10:45 a.m.

Taniyel Ay, Guy Van Camp, Agnes Pasquet, Virginie London, Anne Bol, Giovanna Giselu, Guy Heyndrickx, Patrick Rafter, Jacques Melin, Jean-Louis J. Vanoverschelde. *Université Catholique de Louvain, Brussels, Belgium, Vrije Universiteit, Brussels, Belgium*

It was previously shown in animal models that myocardial blood flow (MBF) can be quantitated using myocardial contrast echocardiography (MCE) by measuring the rate of microbubble replenishment after their initial destruction by ultrasound (US) during a constant infusion of contrast. It remains uncertain, however, if this technique has sufficient spatial resolution to resolve endocardial blood flow and endocardial/epicardial (endo/epi) flow ratio, the most sensitive index of myocardial ischemia. Accordingly, we used power modulation imaging, a new technology which is designed to assess microbubble replenishment kinetics in real-time, to test the ability of MCE with PESA to quantitate MBF selectively in the endocardium and the epicardium and to recognize the inversion of the endo/epi flow ratio during ischemia. For this purpose, we studied 6 chronically instrumented dogs with coronary stenosis during adenosine induced hyperemia and occlusion. Real-time MCE-derived A (an index of myocardial blood volume), β (an index of microbubble velocity), and A*β (an index of myocardial blood flow) from the endocardium and the epicardium were compared to radiolabeled microspheres (MS) in the same regions of interest. As expected, radiolabeled MS showed an endo/epi flow ratio >1 in the nonischemic zones (NIZ) and an endo/epi flow ratio <1 in the ischemic zones (IZ) (respectively, 1.25±0.1 and 0.7±0.1, p<0.001). In both NIZ and IZ, MCE-derived A were similar in both the epicardium and the endocardium (respectively, 13.3±2 vs 12.6±2, p=ns; 7.6±2 vs 8.6±2, p=ns). By contrast, MCE-derived β and A*β endo/epi ratios were >1 in the NIZ (respectively, 1.5±0.4 and 1.4±0.5) and <1 in the IZ (respectively, 0.7±0.1 and 0.8±0.2, p<0.001 vs NIZ). Both MCE-derived β and MCE-derived β endo/epi ratio correlated strongly with both MS-MBF and MS endo/epi ratio (respectively, r=0.77, and r=0.79). These data suggest that the real-time power modulation MCE allows accurate quantification of absolute MBF as well as it has sufficient spatial resolution to resolve endocardial blood flow and endo/epi flow ratio to detect myocardial ischemia.

11:00 a.m.

894-3

Detection of Abnormal Myocardial Flow Reserve by Myocardial Perfusion Echocardiography: Validation by Positron Emission Tomography

Lori B. Croft, Joseph A. Diamond, Samantha Buckley, Robert A. Phillips, Andrew Van Tosh, Steven Horowitz, Milena J. Henzlova, Josef Machac, Tamanna Nahar, Martin E. Goldman. *Cardiovascular Institute, Mount Sinai School of Medicine, New York, NY, Beth Israel Medical Center, New York, NY*

Background: Decreased myocardial flow reserve (MFR) is seen with advanced age, diabetes, and hypertension. While positron emission tomography (PET) is a standard method to assess MFR, newer, more readily available and less expensive techniques such as myocardial contrast perfusion echocardiography (MCPE) may provide similar information. **Objective:** To assess the capacity of MCPE to differentiate normal from abnormal MFR.

Methods: MCPE with Optison™ was performed on 11 subjects without epicardial coronary disease defined by either coronary artery catheterization or myocardial perfusion SPECT scans. There were four normal subjects (mean age = 25±2, 2 male, 2 female, systolic BP 100±3 mm Hg) and seven older, abnormal subjects with chronic long-standing hypertension and/or diabetes (mean age = 66±2, 2 male, 5 female, systolic BP 145±7 mm Hg). MCPE was performed using harmonic imaging and Optison™ microbubbles with gated triggering at 1:1 (ATL 5000-CVI™), in a modified mid-ventricular short axis view. MCPE imaging was done at baseline and following dipyridamole (0.56mg/kg) infusion at maximal vasodilatation. Echo analysis was done on an HDI/ATL™ program generating video intensity values and time activity curves in the anteroseptum normalized to the left ventricular cavity at baseline and peak vasodilatation. Echo analysis was blinded to both subject status and PET results. PET MFR was done with the same dose of dipyridamole within seven days. The MFR derived from PET was defined as the ratio of the counts during maximal coronary vasodilatation divided by the baseline counts (myocardial uptake ratio).

Results: The correlation between MCPE and PET was r=0.92 and r²=0.82. MCPE was able to distinguish normal from abnormal subjects (confirmed by PET) with 100% sensitivity and specificity. MFR determined by MCPE was 2.78±0.39 in normal subjects and 1.70±0.11 for abnormal subjects (p=0.008). All seven abnormal subjects had MCPE MFR <=2.0.

Conclusions: MCPE is a noninvasive technique that can reliably detect abnormal MFR in subjects with conditions known to produce microvascular disease.

11:15 a.m.

894-4

Microcirculation Recovery After Primary PTCA and Abciximab Therapy: An Echocontrast and SPECT Evaluation

Anna Sonia Petronio, Carmela Nardi, Roberto Baglini, Ugo Limbruno, Giovanni Paterni, Giuseppe Musumeci, Caterina Palagi, Duccio Volterrani, Rita Mariotti, Mario Mariani. *CardioThoracic Dpt University of Pisa, Pisa, Italy, Oncology Dpt University of Pisa, Pisa, Italy*

Aim of the study was to evaluate abciximab influence on microvascular integrity of the infarct related area in patients (pts) with acute myocardial infarction (AMI) treated with primary coronary angioplasty (PTCA). **Methods:** Thirty four pts (23 male; mean age 56.6 ± 8.4 yrs), with first AMI (<6 hrs after onset), and no contraindication to GPIIb/IIIa inhibitors

therapy, were treated successfully with primary PTCA. Before the procedure pts were randomized to abciximab+conventional therapy (Group A, n = 18) and conventional therapy (Group B, n = 15). Baseline clinical, demographic and angiographic characteristics were similar. Myocardial Contrast Echocardiography (MCE), using intracoronary injection of sonicated contrast medium, was performed immediately after successful infarct-related artery recanalization (onset of pain-reperfusion mean time 240 ± 98 min); at 48 hrs and at 1 month MCE was performed using intravenous injection of echocontrast medium. Stress and rest ^{99m}Tc -tetrofosmin SPECT was carried out at 1 month follow-up. Myocardial perfusion with MCE and SPECT was scored as 0 (absent), 1 (partial) or 2 (normal). Wall motion score index (WMSI) was assessed by 2D-echocardiography on admission and 1 month later. **Results:** Two-hundred-six myocardial segments were evaluated within infarct-related artery regions. Immediately after vessel recanalization MCE showed a normal perfusion (score 2) more frequently among pts of Group A (61.9% vs 54.5%; $p < 0.01$); this result was confirmed at 48 hours (70.3% vs 59%; $p < 0.005$). At one month follow-up, data resulting from SPECT confirmed the recovery of microcirculation in abciximab group (score 2: 71% vs 61.4%; $p < 0.01$) and didn't show ischemia in any of the pts. MCE at 1 month confirmed the same observation (score 2: 75.8% vs 68.9%; $p < 0.05$). At one month follow-up, the infarct-related wall motion abnormalities were significantly less in the abciximab group than in the standard therapy group (Group A: WMSI 1.73 ± 0.42 to 1.27 ± 0.3 ; $p < 0.05$. Group B: WMSI 1.77 ± 0.34 to 1.54 ± 0.2 ; $p = \text{ns}$). **Conclusion:** Abciximab therapy improved the recovery of microvascular perfusion and enhanced the recovery of contractile function in pts with AMI treated with primary PTCA.

11:30 a.m.

894-5 Abnormal Perfusion Precedes Abnormal Function During Dobutamine Stress: Insights into the Ischemic Cascade

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Background. Perfusion abnormalities are thought to develop earlier in the ischemic cascade than wall motion abnormalities (WMA), but this hypothesis has not been tested. We tested this hypothesis in a canine model of multivessel disease during dobutamine infusion.

Methods. 6 open chest dogs were studied. Non-critical stenoses of varying severity were created on both LAD and LCx. Incremental doses of dobutamine were then infused ($10 - 40 \text{ mg} \cdot \text{kg}^{-1} \cdot \text{min}^{-1}$) and MCE and 2D echo were performed at each dose. The former was performed using a continuous infusion of microbubbles and the rate of microbubble replenishment (β) was measured. WT was calculated using the entire contraction sequence from the latter. Both methods have been previously described.

Results. As expected, at rest, there were no differences in WT and β between the two vascular beds. β ratio (between the stenosed and normal bed) decreased, as compared to baseline (0.60 ± 0.21 vs 1.04 ± 0.13 , $p = 0.001$), for mild and moderate stenoses (< 20 mm Hg trans-stenotic gradient, $n = 23$, mean = 14 ± 3 mm Hg) in either bed at the lowest dose of dobutamine ($10 \mu\text{g} \cdot \text{kg}^{-1} \cdot \text{min}$) without a decrease in WT ratio (0.98 ± 0.05 vs 0.99 ± 0.03 , $p = 0.87$). Higher doses of dobutamine were required ($20 \mu\text{g} \cdot \text{kg}^{-1} \cdot \text{min}$) before a decrease in WT was measurable. With more severe stenosis (> 20 mm Hg trans-stenotic gradient, $n = 15$, mean = 26 ± 5 mm Hg) both β and WT decreased concurrently at the same dose of dobutamine ($10 \mu\text{g} \cdot \text{kg}^{-1} \cdot \text{min}$).

Conclusions. Severe coronary stenoses can be detected at the same time during dobutamine stress by both MCE and 2D Echo. Less severe stenoses, however, are detected earlier using MCE than 2D Echo. These results confirm the ischemia cascade hypothesis and indicate that myocardial perfusion imaging may be more sensitive than regional function analysis for the detection of coronary artery disease.

11:45 a.m.

894-6 Serial Evaluation of Myocardial Microvasculature in Patients With Acute Myocardial Infarction Before and After Successful Mechanical Reperfusion Using Venous Contrast Echocardiography

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Background: Dysfunction of myocardial microvasculature has been reported to be associated with acute myocardial infarction (AMI) with potential myocardial no-/low-reflow even after successful reperfusion therapy. We sought to investigate the time course of spatial extent and magnitude of myocardial microvascular dysfunction before and after successful mechanical reperfusion (TIMI 3 flow after reperfusion and after 2 weeks) using serial venous myocardial contrast echocardiography (VMCE). **Methods:** 65 patients with first AMI (LAD $n=29$, RCA $n=25$, LCX $n=8$; CK max. $895 \text{ U} \pm 651 \text{ U/l}$); median [interquartile range] time between symptom onset and reperfusion 12 hours [19.3 hours] underwent VMCE (venous infusion of Optison, intermittent harmonic imaging, 4- and 2-CH views, off-line digital image processing) before (1) and immediately after reperfusion (2) and 2 weeks later (3). Myocardial area with contrast defect (qualitative assessment) on VMCE was planimetric and expressed as percentage of left ventricular myocardium (A). Signal intensity within initial defect was measured by videodensitometry and normalized to the value of the brightest segment of left ventricular myocardium (I). **Results:** 63/65 patients had myocardial contrast defect at 1, 48/65 at 2 and 40/65 at 3. Median values [interquartile range] for A1, A2 and A3 were 20% [17%], 11% [20%] and 7% [16%] respectively. Median values [interquartile range] for I1, I2 and I3 were 28% [21%], 49% [35%] and 59% [45%], respectively. A2 and A3 were significantly different from A1 ($p < 0.0001$); there was a trend towards significant difference between A2 and A3 ($p = 0.08$). I2 and I3 were significantly different from I1 ($p < 0.0001$), but not between each other. **Conclusion:** There was microvascular dysfunction in most patients after mechanical reperfusion of AMI; after initial improvement of microvascular perfusion by mechani-

cal reperfusion of epicardial coronary artery, it is likely that further improvement occurs during the following 2 weeks due to heterogenous restoration of microvascular function within the area of residual (A2) myocardial perfusion defect.