evaluate 1) the association between LP and a change in left ventricular function and 2) the effect of acute (<24 h) i.v. enaprilat followed by 3–6 months of oral enalapril on the presence of LP.

Left ventricular function was evaluated by echocardiography day one, at discharge and after 3–6 months using global wall motion determined ejection fraction (WMI-EF). LP was measured at discharge and after 3–6 months using 2 out of 3 criteria (40 Hz): 1. QRS-duration > 115 ms, 2. RMS 40 < 20 microV and 3. LAS > 38 ms.

At discharge LP was present in 25% (n = 14) of the pts prospectively randomised to enalapril (n = 28)/placebo (n = 28).

WMI-EF in pts with/without LP at discharge:

|	day 1	discharge	3–6 months
LP + (WMI-EF)	43.2 ± 8.1	45.3 ± 7.8	44.1 ± 9.3
LP – (WMI-EF)	46.8 ± 9.9	51.3 ± 8.7	53.1 ± 8.7
	p = NS	p < 0.03	p < 0.01

At discharge LP was present in 12/28 pts on placebo and 2/28 pts on enalapril (p < 0.01). At 3–6 months LP was present in 11/27 pts on placebo and 3/28 on enalapril (p < 0.05).

Thus 1) LP predicts a lack of improvement in left ventricular function and 2) early ACE-inhibitor treatment may modify the presence of LP after myocardial infarction.

961-80   Surface Laplacian ECG Maps Provide a Sensitive and Localizing Measure of Cardiac Ischemia

David E. Leeman, Samuel J. Shubrooks, Kevin S. Librett, Paul E. Grimshaw, Richard J. Cohen. Deaconess Hospital, Boston, MA; Massachusetts Institutue of Technology, Cambridge, MA

To test the hypothesis that Laplacian surface electrocardiography provides a sensitive and local measure of coronary ischemia, we studied six consecutive patients undergoing balloon angioplasty. Three self-adhesive pads of electrodes containing 84 multipolar Laplacian electrodes were applied to the anterior and left-lateral thorax. Laplacian electrograms and a standard 12 lead ECG were recorded prior to and during each balloon inflation. The ratio of ST segment shift to baseline QRS amplitude (ST/Q) was computed for the Laplacian electrodes and the standard 12 leads. Defining $ST/Q = 0.1$ to be the minimum significant ST shift, Laplacian maps in all six patients revealed a significant ST shift during balloon inflation while the 12 lead ECG revealed a significant ST shift in only three patients. The mean peak value of ST/Q in the Laplacian maps was 0.40 versus 0.13 in the 12 lead ECG (p = 0.01). Laplacian maps of ST/Q showed localized elevation over the expected region of distribution of the occluded vessel, often surrounded by a region of negative ST/Q. The unipolar leads revealed a diffuse bipolar pattern of ST segment shift. Conclusion: Body surface Laplacian mapping may provide a sensitive and accurate noninvasive means of detecting and localizing cardiac ischemia, superior to the 12 lead ECG.
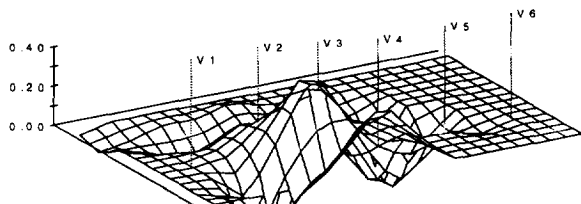
Laplacian ST/Q map during distal left anterior descending coronary artery occlusion.

961-81   Time Domain and Spectral Turbulence Analysis of Signal Averaged Electrocardiography as Prognostic Determinants in Idiopathic Dilated Cardiomyopathy

Yi Gang, Philip J. Keeling, Jonathan H. Goldman, Katerina Hnatkova, Sonia Bent, William J. McKenna, Marek Malik. Department of Cardiological Sciences, St. George's Hospital Medical School, London, UK

Identification of patients with idiopathic dilated cardiomyopathy (IDC) with poor prognosis [sudden death (SD) or progressive heart failure (PHF)] represents a major management problem. The signal averaged electrocardiogram (SAECG) is potentially a non-invasive marker of clinical outcome in IDC. This study compared the ability of time domain (Td) and spectral turbulence analysis (STA) of the SAECG to predict SD/PHF in IDC patients. SAECG were recorded in 58 consecutive patients with IDC (WHO criteria; age 41 ± 14 years) presenting to our hospital and followed over 26 ± 19 months. During the follow up 17 patients had SD/PHF and 41 remained symptomatically and echocardiographically stable. In this population, 27 patients with left bundle branch block or who took anti-arrhythmic drugs had been excluded. Conven-

tional Td (40 Hz, Butterworth filter) and STA analysis were performed using Del Mar 183 software. Result There were significant differences in all STA parameters (low slice correlation ratio, interslice correlation mean, interslice correlation standard deviation and spectral entropy) between SD/PHF and stable patients (p < 0.01), but in none of the Td parameters (tQRS, LAD40, RMS40). SD/PHF was more likely in patients with an abnormal (≥3 abnormal STA parameters) compared to a normal STA result (56% vs 19%; p = 0.005). There was a significant difference in event free survival at 1 year between patients with abnormal and normal STA (61% vs 88%; p = 0.03), but the presence of late potentials was not discriminatory (72% vs 82%; p = 0.4). The sensitivity, specificity and total predictive accuracy for predicting SD/PHF were 29%, 85% and 69% (p = 0.2) for Td and 53%, 83% and 74% (p = 0.005) for STA analysis. The positive predictive characteristics curves showed that higher positive predictive accuracies were achieved by STA compared to those of Td analysis. The differences were significant at different sensitivity levels (at 50%, 60%, 70%, p = 0.05; 80%, p = 0.01). The relative risk (95% CI) of SD/PHF was 2.1 (0.7–6.0) for presence of late potentials and 3.5 (1.4–9.2) for abnormal STA result. Conclusion STA analysis of SAECG is a more sensitive and specific predictor of SD/PHF than Td analysis for IDC patients and has an important role in clinical management.

961-82   Abnormal Signal Averaged Electrocardiogram Predicts Mortality in Patients with Non-Ischemic Cardiomyopathy and Severe Congestive Heart Failure

Daniel M. Bloomfield, Kathleen Hickey, Robert R. Sciacca, Marlon S. Rosenbaum, James Coromilas. Columbia University, New York, NY

Patients with severe congestive heart failure have a high mortality; many deaths are thought to be arrhythmic. The presence of late potentials on signal averaged electrocardiograms (SAECG) identifies a substrate for reentrant ventricular arrhythmias. We evaluated the prevalence and prognostic significance of an abnormal SAECG in a prospectively followed population of patients undergoing evaluation for cardiac transplantation. Ninety patients were followed for a mean of 447 days. Twenty-six patients died and 17 patients were censored on the day of transplantation. Kaplan-Meier survival curves were constructed and the effect of SAECG variables was tested with a log-rank test. Fifty-four percent of the patients had a non-ischemic cardiomyopathy and the remainder had an ischemic cardiomyopathy. Fifteen patients had BBB and were excluded from this analysis. The average QRS duration on 12 lead ECG was similar in ischemic cardiomyopathy and non-ischemic cardiomyopathy groups (116 ± 23 vs 115 ± 19 ms, p = ns) and the average fQRS duration was similar in ischemic cardiomyopathy and non-ischemic cardiomyopathy groups (131 ± 26 vs 132 ± 21 ms, p = ns). Forty-four percent of the non-ischemic cardiomyopathy group and 50% of the ischemic cardiomyopathy group had an abnormal SAECG (defined as having 2 of the following: fQRS > 114 msec, RMS < 20 μV, LAS > 38 msec). An abnormal SAECG was associated with mortality in the non-ischemic cardiomyopathy group (p < 0.05) but not in the ischemic cardiomyopathy group (p = ns). Twenty-eight patients had QRS duration ≥ 120 ms on 12 lead ECG. When these patients were excluded, 20% of the non-ischemic cardiomyopathy group and 41% of the ischemic cardiomyopathy group had an abnormal SAECG and an abnormal SAECG still predicted mortality in non-ischemic cardiomyopathy group (p < 0.001) but not in ischemic cardiomyopathy group (p = ns). In conclusion, an abnormal SAECG is associated with increased mortality in non-ischemic cardiomyopathy but not in ischemic cardiomyopathy.

962   New Imaging Protocols and Pharmacologic Stress

Tuesday, March 21, 1995, Noon–2:00 p.m.
Ernest N. Morial Convention Center, Hall E
Presentation Hour: Noon–1:00 p.m.

962-61   Late Redistribution Tl-201/Stress Tc-99m Sestamibi Separate Acquisition Dual Isotope Myocardial Perfusion SPECT: A Feasibility Study

Hosen Kiat, Cyndi Williams, Fan Ping Wang, Guido Germano, Kenneth Van Train, John D. Friedman, Mark Hyun, Daniel S. Berman. Cedars-Sinai Medical Center Los Angeles, California

Rest Tl201(Tl)/stress Tc-sestamibi dual isotope SPECT (DIMPS) is an efficient myocardial perfusion protocol. Patients with rest defects, however, frequently require late Tl redistribution imaging the next day. Thus, we recently implemented a modified DIMPS (M-DIMPS), with 3.5 mCi Tl injected at rest the night before stress testing. On the day of stress testing, 12–18 hr redistribution Tl (late Tl) SPECT was performed prior to stress sestamibi study.

T
U
E
S
D
A
Y

P
M

To assess image quality of late Tl, we prospectively studied 107 patients who underwent M-DIMPS. For purposes of comparison between conventional DIMPS and M-DIMPS, a subset (group A, n = 41) also had rest Tl (25 sec/stop, 60 stops) the night before M-DIMPS. Late Tl used 30 sec/stop. Prereconstruction processing used a 2D Butterworth filter (cut-off: 0.5/order 10 for rest Tl, 0.35/order 10 for late Tl). Comparisons were made for cardiac counts (counts/pixel) and quantitative heart to background ratio (H/B ratio). Image quality was assessed visually using a 5 point score (0 = unacceptable, 4 = excellent), based on the evaluation of image uniformity, defect clarity, left ventricular border definition and the apparent H/B ratio. Comparisons between rest Tl and late Tl in 41 group A patients yielded quantitative H/B ratio of 1.63 ± 0.39 and 1.49 ± 0.31 (p = 0.002), and total myocardial counts of 41.4 ± 18.1 and 29.3 ± 11.6 (p < 0.001), respectively. Image quality agreement between rest Tl and late Tl was 90%, with 31 concordant good to excellent and 6 concordant fair studies. Analysis of the 107 late Tl studies by patient weight revealed:

	<150 lbs (n = 31)	150–200 lbs (n = 60)	>200 lbs (n = 16)	p
cardiac counts	30.4 ± 9.6	28.9 ± 13.8	28.9 ± 7.5	ns
H/B ratio	1.49 ± 0.24	1.46 ± 0.32	1.42 ± 0.25	ns
quality = 3 or 4	90%	90%	63%	<0.05*

* >200lbs vs. the other two weight categories

Conclusion: Although quantitatively different, late Tl has acceptable count statistics and comparable visual image quality to rest Tl, establishing the feasibility of late Tl/stress Tc-sestamibi dual isotope SPECT in non-obese (<200 lbs) patients. The protocol allows for final reporting on the same day as stress testing, potentially decreasing the length of hospitalization.

962-62   The Use of Exercise-Rest Same Day SPECT Sestamibi Imaging Protocol in Coronary Artery Disease Detection

Joseph Powers, Salah Bahralilom, Joseph Russel, Virginia Cave, Jaekyeong Heo, Abdulmassih S. Iskandrian. The Philadelphia Heart Institute, Presbyterian Medical Center, Philadelphia, PA

There are several sestamibi imaging protocols, each with certain perceived advantages and limitations. Most published reports are on patients (pts) in clinical trials which may have a hidden bias in pt selection. This study examined our clinical experience using the exercise (10 mCi)/rest (30 mCi) same day SPECT protocol with sestamibi in 132 pts with coronary artery disease (CAD) by angiography and 61 pts with low pre-test probability of CAD. There were 670 pts studied during the same time period but not included because they did not meet the above two criteria. The rest study was combined with first-pass RNA using the Sim-400 gamma camera in 72 pts. There were 112 men and 20 women aged 60 ± 11 years. The pts weight was 179 ± 27 lbs and height was 68 ± 3 inches. The exercise was adequate (≥ 85% of maximum predicted heart rate or positive S-T response) in 85 pts and submaximal in 47 pts. The overall sensitivity of SPECT was 88% (compared to 27% for S-T depression, P = 0.0001); it was 76% in one-vessel, 84% in two- and 98% in three-vessel disease (P = 0.006). The normalcy rate in 61 pts with low probability of CAD was 95%. The perfusion defects in 116 pts with abnormal images were reversible (complete or partial) in 80 pts and fixed in 36 pts. The left ventricular ejection fraction was 50 ± 12% in pts with reversible and 39 ± 9% in pts with fixed defects (P = 0.0003). In the 72 pts with RNA, there were 15 segments with fixed defects. The wall motion was normal in 2 segments, and abnormal in 13. In 129 segments with no fixed defects, the wall motion was normal in 97 (75%). Thus, the exercise-rest same day sestamibi protocol provides a high diagnostic accuracy for CAD detection and high quality functional studies. The protocol may also eliminate the need for rest studies in pts whose exercise studies are normal.

962-63   Stress-only Tc99m-Sestamibi Myocardial Perfusion Imaging in Patients with a Low Probability of CAD: Short-term Follow-up of a Streamlined Perfusion Imaging Protocol

Luke F. Daley, Nancie L. Shea, Elizabeth Oates, James E. Udelson. Tufts-New England Medical Center, Boston, Mass.

Traditional scintigraphic assessment of CAD and ischemia has required a comparison of stress to resting images. In the setting of a high quality normal stress image, there is conceptually low yield from rest imaging; however no data are available to support this concept ad to relate the use of this type of imaging protocol to outcomes. To investigate this type of protocol, we prospectively evaluated 70 patients, mean age 49 ± 11 years (56% women), who had a low-to-moderate pre-test probability of CAD (23 ± 22%, based on Diamond-Forrester criteria prior to stress testing). SPECT imaging was performed following the injection of 20 mCi Tc99m-sestamibi at peak stress. Rest imaging was only performed in the setting of abnormal or equivocal stress images. Of the 70 patients, 83% had treadmill testing; 17% pharmaco-

logic stress. In the patients undergoing treadmill testing, mean exercise time was 10 ± 3 minutes and the maximum predicted heart rate achieved was 93 ± 2%. Chest pain symptoms occurred in 11 patients (16%). In 68 patients, the stress images were interpreted as normal and rest imaging was not performed; in 2 patients stress images were abnormal. Short-term follow-up (5.6 ± 2 months, range 1.5–11 months) was obtained in 68 of 70 patients (97%); among the 66 patients with normal stress-only images, there were no deaths, myocardial infarction, or revascularization; one hospitalization for chest pain resulted in catheterization demonstrating non-critical CAD. Both patients with abnormal stress-only images were subsequently found to have significant angiographic CAD. Hence, in patients selected for a low pre-test probability of CAD, a stress-only protocol will result in the need for few sets of resting images, optimizing camera usage and throughput, with potential cost savings. In the absence of information provided by resting images, a normal stress-only SPECT sestamibi image in this setting is associated with a benign short-term outcome, similar to that reported for a full stress-rest sestamibi protocol.

962-64   Determination of Extent of Viable Myocardium within Infarct-Related Arterial Perfusion Beds Using Intracoronary Tc-99m-Sestamibi Injection

Jeffrey I. Leavitt, Chanh Syravanh, Joseph A. Vita, Martha Nykiel, Donald E. Tow, Thomas P. Rocco. West Roxbury VA Hospital, Boston, MA

Precise determination of the extent of residual viable myocardium within the infarct-related vascular territory in patients with myocardial infarction may be important in assessing potential benefit from revascularization, yet measurement of this parameter has proven difficult. To address this issue, 15 patients with predominantly single-vessel coronary disease and prior myocardial infarction (mean 1 month previously) were studied. Subselective intracoronary Tc-99m-sestamibi injections were performed at the site of epicardial stenosis in the infarct-related artery to measure the extent of myocardium at risk (risk area, RA). A separate injection of sestamibi was performed intravenously at rest to measure infarct size (IS). RA and IS were determined quantitatively by circumferential profile analysis using a threshold value of 60% of peak counts. The ratio of IS/RA was used to reflect the proportion of the area at risk which was non-viable. IS, RA and IS/RA were then compared with clinical and angiographic variables.

As expected, a strong correlation was found between IS and RA (r = 0.82, p < 0.0005); the IS/RA ratio showed an inverse relationship with ejection fraction by ventriculography (p < 0.02). An IS/RA ratio < 0.6 was predictive of better global and regional ventricular function and preserved (TIMI grade 3) antegrade or collateral flow (all p < 0.05). No independent relation was seen between IS/RA or IS and antegrade or collateral flow alone.

Thus: 1) RA size is an important determinant of IS; 2) an IS/RA ratio < 0.6 reflects the presence of residual viable myocardium within the infarct-related arterial bed. The IS/RA ratio is inversely correlated with clinical and angiographic indicators of viability. This parameter may provide an independent means of assessing viability within a given coronary vascular territory.

962-65   Clearance of Thallium-201 from the Blood After Peak Exercise: No Difference in Washout Kinetics Between Early and Late Reinjection

Berthe L.F. van Eck-Smit, Ernst E. van der Wall, Patrick P.A.M. Verhoeven, Aeilko H. Zwinderman, Ernest K.J. Pauwels. University Hospital, Leiden, The Netherlands

Early reinjection (ER) of Thallium-201 (Tl) following post exercise (Ex) imaging has been proposed as an alternative time-saving approach for the evaluation of patients (pts) with ischemic heart disease. However the influence of shortening the interval between Ex and RI on Tl kinetics has not been established before. The aim of the study was to determine the influence of Ex and the time interval between Ex and RI at rest on Tl clearance from the peripheral blood. A total of 53 pts were studied. In all pts Tl (75 MBq) was injected at maximal Ex. In 26 pts 37 MBq was reinjected immediately after completing the Ex-images and in the remaining 27 pts Tl (37 MBq) was reinjected after completing 3-h redistribution images. Venous blood samples were taken at 2-minute intervals during the first 30 min after Tl administration and residual Tl activity was measured shortly before RI. From blood activity curves peak activity, residual activity and decay constants were calculated.

Results	Ex-injection (75 MBq)	Early RI (37 MBq)	Late RI (37 MBq)	P-value
peak activity (% of initial peak)	100	95 ± 55	76 ± 59	n.s.
residual activity (% of initial peak)		8 ± 6	6 ± 7	n.s.
λ_1, min^{-1} (1–10 min)	0.17 ± 0.09	0.14 ± 0.05	0.13 ± 0.03	n.s.
λ_2, min^{-1} (11–30 min)	0.029 ± 0.05	0.007 ± 0.015	0.003 ± 0.011	n.s.

Conclusions: 1. Increase of Tl blood concentration after RI of half the ini-