determinations than CD during both ischemia (1.19 ± 0.36 vs 1.75 ± 0.41 mV, $p < 0.01$, $n = 10$) and reperfusion (1.10 ± 0.69 vs 2.50 ± 0.54 mV, $p < 0.05$, $n = 4$; attrition due to VF).

Conclusion: FFT's intrinsic requirement of grouping a substantial number of beats (as many as 128) resulted in underestimation of T-wave alternans during ischemia (by 32%) and reperfusion (by 56%). Because CD tracks T-wave alternans on a beat-to-beat basis, it is more effective in assessing cardiac vulnerability during rapidly changing physiologic and pathophysiologic events. This finding carries important implications for ambulatory monitoring of T-wave alternans in patients with coronary artery disease, who experience transitory but significant bouts of ischemia and electrical instability in response to daily activities such as behavioral stress, exercise, and early morning rising.

2:15

796-2 Analysis of Exercise-Induced Downsloping ST Depression by Collateral Perfusion Determined With Positron Emission Tomography

Takuya Watanabe, Kenichi Harumi, Yasushi Akutsu, Takashi Katagiri. *Showa University School of Medicine, Tokyo, Japan*

Exercise-induced downsloping (D-type) ST depression is a common manifestion of severe myocardial ischemia. Although the greater depression of ST displacement is suspected to be more severe ischemia, the pure relationship to the change in regional myocardial blood flow (RMBF) has not yet been clarified. We determined the correlation between the degree of D-type ST depression and the change of RMBF by positron emission tomography (PET) using ^{13}N-ammonia. The exercise-cardiac PET was performed in 6 normal subjects and 72 patients with angiographically proven coronary heart disease. The left ventricle was divided into 11 regions of interest (ROIs), and the RMBF of each ROI was measured at rest and during supine bicycle exercise. The D-type ST depression was defined as the depression of 0.1 mV and more at J + 80 ms. There were 18 patients with D-type ST depression, of whom 15 patients had multivessel disease. According to the degree of ST depression, two groups were classified. One was group A with ST depression of 0.1–0.2 mV, and the other was group B with ST depression of 0.2 mV and more. Nine of the 10 patients in group A and only one of the 8 patients in group B had collateral circulation ($p < 0.01$). The RMBF in all ROIs was increased 56.0 ± 30.4% by exercise in the normal group. In group A, the RMBF in the ischemic area was unchanged or decreased, but the RMBF in its surround area was increased adequately (9.52 ± 23.1%, 49.7 ± 32.3%). In group B, the RMBF was unchanged in the ischemic area, and the RMBF in its surround area was increased inadequately (16.5 ± 24.1%, 40.8 ± 21.3%). The average number of ROIs with inadequate (less than 10%) increase was greater, and stroke volume index was lower in group B than group A. Thus, exercise-induced group A of D-type ST depression may reflect the underlying change of RMBF in the viable myocardium with collateral perfusion, and group B may reflect the underlying change of RMBF in the impaired myocardium without collateral perfusion.

2:30

796-3 ST-Segment Elevation During Dobutamine Stress Test: A Predictor of Late Improvement of Left Ventricular Function After a Recent Q-Wave Myocardial Infarction

Abdou Elhendy, Jos RTC Roelandt, Ron T. van Domburg, Galal M. El-Said, Mohammed M. Ibrahim, Medhat El-Refaee, Paolo M. Fioretti. *Thoraxcenter, Rotterdam, The Netherlands*

Exercise-induced ST-segment elevation (STE) after a recent myocardial infarction has been attributed to myocardial viability. However, its relation with functional improvement has not been evaluated. 70 patients were studied 8 ± 3 days after acute Q wave myocardial infarction with dobutamine (up to 40 μg/kg/min) stress echocardiography and a follow-up echocardiogram at 85 ± 10 days. Functional improvement was defined as a reduction of wall motion score from baseline to follow-up using a 16 segments-4 grade score model. STE (defined as new or additional J point elevation ≥ 0.1 mV lasting 80 ms in ≥ 2 Q leads) occurred in 40 patients (57%). Patients with STE had a higher prevalence of functional improvement (68% vs 30%, $p < 0.005$) and a higher number of improved segments at follow-up (1.9 ± 2.2 vs 0.5 ± 1.1, $p < 0.005$). Wall motion score decreased at follow-up in patients with STE (24.7 ± 8 vs 23.6 ± 6.9, $p < 0.05$) but not in patients without STE (22.3 ± 9.7 vs 23.2 ± 7.5). Accuracy of STE for predicting functional improvement was similar to low-dose dobutamine echocardiography in patients with anterior infarction (80% vs 83%) and in the 23 patients who underwent revascularization (78% vs 83%). *Conclusion:* Dobutamine-induced STE is a valuable marker of viability in patients with recent Q-wave myocardial infarction particularly when the test is performed without or with suboptimal echocardiographic imaging.

2:45

796-4 Blood Pressure Changes During Spontaneous Myocardial Ischemia in Patients With Stable Coronary Disease

Asif Rehman, Neil P. Andrews, David Mulcahy, Gloria Zalos, Arshed A. Quyyumi. *National Institutes of Health, Bethesda, MD*

Although random arterial blood pressure (BP) recordings have been made previously to assess the relation between BP and myocardial ischemia, the true relationship between heart rate (HR), BP and episodes of ST segment depression (Eps) has not been studied. Using a unique solid state ambulatory BP and ECG monitoring device (Smartlink, Stuart Medical Inc.) that triggers BP when the ST segment depresses below baseline, we studied 36 pts with stable coronary disease, 14 of whom had Eps ≥ 1 mm (44 Eps, 41 silent, mean duration 36 ± 19 min in 339 hrs). BP readings were triggered on 1.06 occasions *during* Eps; 30 times within 5 min of onset of ST depression, 25 times between 5–10 min after onset, and 51 times ≥ 10 min after onset. These readings were compared with 111 BP recordings obtained *before* onset of Eps; 34 times 1–4 hrs before, 48 times 20–60 min before, and 34 times 1–20 min before Eps. Systolic BP increased from 136 mmHg, a mean of 11 min before, to 157 mmHg, a mean of 2.5 min after the onset of Eps ($p < 0.01$). There was no change in diastolic BP (74 to 71 mmHg), but HR increased from 83 to 91 bpm ($p < 0.01$). Systolic BP and HR remained higher throughout the Eps and returned to preischemic levels after the end of Eps. Increases in systolic BP were observed both in pts who had Eps at low HR (< 90 bpm, systolic BP 138 to 149 mmHg), and in those who had Eps at high HR (> 90 bpm, systolic BP 136 to 164 mmHg). Thus, in pts with stable coronary disease, Eps are precipitated by increases in myocardial oxygen demand demonstrable as increases in HR and systolic BP but not diastolic BP. There is an increase in systolic BP even when Eps occur at low HR suggesting a similar mechanism but a lower threshold for precipitation of ischemia.

3:00

796-5 Effects of Zatebradine and Diltiazem on Ischemia During Ambulatory Monitoring

Richard F. Davies, Kathy Foris, Rodney Butt, for the Canadian Zatebradine in Angina Research (CZAR) Group. *University of Ottawa Heart Institute, Ottawa, Ontario, Canada*

Background: Zatebradine is a new agent whose only known cardiac action is to depress heart rate (HR) via a direct action on the SA node.

Objective: To compare the effects of zatebradine and diltiazem on myocardial ischemia during ambulatory monitoring (AM).

Methods: CZAR randomized patients with chronic stable angina to receive zatebradine, diltiazem, or placebo in a multicenter, double-blind, parallel group study. AM (24 hr) was done during off drug baseline and each treatment. AM recordings were scanned for the presence of ischemic episodes, defined as ≥ 1 min of ST depression ≥ 0.1 mV.

Results: Of the 143 patients, 47(32.9%) had at least 1 ischemic episode recorded during baseline, 15(31.9%) in the zatebradine, 20(40.8%) in the diltiazem, and 12(25.5%) in the placebo group. The frequency and duration of episodes on baseline and treatment were 2.4/15.1, 0.5/3.0 in the zatebradine, 2.4/14.1, 0.2/3.1 in the diltiazem and 2.2/9.5, 1.3/8.9 in the placebo group. The average HR changes between baseline and treatment were 16.5, 3.1 and 1.4.

Conclusions: While zatebradine reduces HR to a greater extent than diltiazem, they appear to be equivalent in the suppression of AM ischemia.

3:15

796-6 Antiarrhythmic Protection by Ischemic Preconditioning in Man

Vincenzo Pasceri, Gaetano A. Lanza, Giuseppe Patti, Patrizia Pedrotti, Filippo Crea, Attilio Maseri. *Catholic Univ, Roma, Italy*

In experimental models preconditioning by brief ischemic episodes protects myocardium from ventricular arrhythmias (VA) during a subsequent coronary occlusion. Aim of the present study was to evaluate whether in man protection from ischemia-induced arrhythmias may occur following spontaneous ischemic episodes. We analyzed episodes of ST elevation (ST↑) found during Holter recordings in 9 patients (pts, 8 men, age 60 ± 8 yrs) with variant angina who frequently developed VA (i.e. ≥ 5 premature ventricular beats/min. and/or runs of ventricular tachycardia) during ST↑. For each ischemic episode we determined the severity and duration of ST↑, the occurrence of VA and the interval from the previous episode of ST↑. A total of 118 episodes (20 associated with VA) were recorded. The interval between each ischemic episode with VA and the previous one (192 ± 286 min) was longer than that of episodes without VA (67 ± 86 min, $p < 0.05$). VA were found in 5% of ST↑ episodes (n = 58) occurring within 30 min from the previous one

and in 28% of ST↑ episodes (n = 60) not preceded by ST↑ in the previous 30 min ($p < 0.01$). Finally, we analyzed 12 clusters of ischemic episodes occurring in periods of 30 min and showing VA in at least one episode. The number of premature ventricular beats per min was strikingly higher during the first episode compared with the last one (27 ± 9 vs 2.7 ± 3.6, $p < 0.01$); the first and the last episode of the clusters did not differ in severity (1.9 ± 0.9 vs 2.0 ± 1.6 mm) and duration of ST↑ (4.0 ± 3.8 vs 6.5 ± 13 min). Thus, our data indicate that transient ischemia confers a significant protection from ischemia-induced VA in pts with variant angina, unrelated to a reduction in severity or duration of ischemia.

797 Atrial Fibrillation: Pacing, Defibrillation, and Clinical Outcome

Wednesday, March 27, 1996, 2:00 p.m.–3:30 p.m.
Orange County Convention Center, Room 224G

2:00

797-1 Increased Mortality, Stroke and Medical Costs Imposed by Atrial Fibrillation

Philip A. Wolf[1], William B. Kannel[1], Colin S. Baker[1], Ralph B. D'Agostino[1], Janet B. Mitchell[1]. [1] *Boston University School of Medicine, Boston, MA; Health Economics Research, Inc., Waltham, MA*

Epidemiologic data now indicate that atrial fibrillation (AF) is a common and serious condition associated with a 4–5 fold increased risk of stroke and a doubling of mortality. Data on the added cost imposed by AF are not available.

Methods: One year mortality, stroke rates, in-hospital and out-patient costs were determined in a sample of hospitalized patients, aged 65–84 years, based on US Medicare data. Logistic and multiple linear regression analyses were done to take associated cardiovascular diseases (CVD) and length of follow-up into account in 12,625 patients with recent onset AF, compared to 13,809 patients without AF matched for age, sex and associated CVD.

Results: 1-yr. mortality was increased by 25–70% and stroke occurrence from 1.65 to 2.26 fold in those with AF compared to comparable persons with CVD without AF. Total 1-year medical costs were increased by $2,500 (15.4%) in men with no age differential. In women, the cost was greater in those under age 75 (21.5% added cost) than above age 75. The added costs imposed by AF were almost entirely attributable to the *in-hospital* costs.

		AF/Non-AF Odds Ratio		Excess Total Medical Costs with AF ($)
		Mortality	Stroke	
Men	65–74	1.25*	1.85	2,784
	75–84	1.44	1.77	2,454
Women	65–74	1.70	2.26	3,580
	75–84	1.36	1.81	1,711

*Not significant (All other AF–non-AF differences significant at $p < 0.05$ level.)

Conclusions: AF is clearly not benign exacting a substantial toll in mortality, morbidity and medical costs above that of the associated medical conditions.

2:15

797-2 Effect of Polarity on the Success of Transthoracic Shocks in Patients With Atrial Fibrillation

Keith H. Newby, Robert Waugh, Michael Hardee, Joe Mertz, Andrea Natale. *Duke University/VA Medical Center, Durham, NC*

We evaluated the effect of polarity on transthoracic monophasic shocks in patients with atrial fibrillation requiring elective DC cardioversion. 102 consecutive patients (84 M, 18 F, mean age 63 ± 11) undergoing elective cardioversion were randomized to either standard or reverse polarity shocks using an external defibrillator. Electrode patches (surface area 93 cm^2) were placed in an anterior-posterior position on the chest wall with standard polarity defined as anterior patch (–), and reverse polarity as anterior patch (+). Cardioversion was performed using a step-up protocol beginning at 100 J, and increasing the energy to 150, 200, 300, and 360J as needed until sinus rhythm was achieved. Results were as follows:

	Standard	Reverse	P value
Patients	51	51	
DFT (J)	193 ± 93	140 ± 68	<0.001
Impedance (ohms)	67.9 ± 17	72.9 ± 17	NS
EF (%)	44.4 ± 14	46.5 ± 14	NS
LA size (cm)	4.58 ± 0.63	4.9 ± 0.68	<0.01
Number of Shocks	2.7 ± 1.6	1.7 ± 1.08	<0.0007

We conclude: 1) Despite the larger left atrial size in the reverse polarity group, the mean energy requirements for successful cardioversion of atrial fibrillation proved significantly lower using reverse polarity transthoracic shocks as opposed to standard polarity shocks.

2:30

797-3 The Safety of Atrial Defibrillation in the Presence of Bundle Branch Block: A Proposal for New Criteria

Edward T. Keelan, David Krum, John Hare, Kashef Mughal, Huagui Li, Masood Akhtar, Mohammad R. Jazayeri. *Sinai Samaritan/St. Luke's Medical Center, Milwaukee, WI*

Although we have shown recently that atrial defibrillation shocks (ADS) synchronized to normally conducted supraventricular beats do not cause ventricular fibrillation (VF), our data may not be valid when the QRS complex is wide. Ventricular vulnerability to ADS might be increased in the presence of bundle branch block because of delayed repolarization of the ipsilateral ventricular myocardium. Complete right or left bundle branch block (RBBB/LBBB) was created in 2 groups of 10 dogs by catheter ablation. ADS were delivered between decapolar catheters in the coronary sinus and lateral right atrium. After crushing the sinus node, atrial burst, single premature and short-long-short (S-L-S) pacing protocols were used to determine the safety of ADS preceeded by the shortest R-R intervals achievable. ADS were coupled to the last paced beat (R_2), starting 60 ms after the end of R_2 and scanning decrementally through R_2 until VF was induced.

Results: The intervals between ADS and local ventricular electrograms recorded in the right ventricle (V_2-ADS) were determined for ADS causing VF. In 7 dogs with RBBB and 4 with LBBB, VF was induced by ADS delivered within R_2 complex indicating encroachment of R_2 on the vulnerable period (VP) of the preceeding (R_1). The values for these 11 dogs are shown in the table:

	(Values in ms)	Burst	Premature	S-L-S
RBBB	R-R	225 ± 7	253 ± 20	303 ± 26
(n = 7)	V_2-ADS [Range]	10 ± 7 [5–15]	15 ± 12 [0–30	10 ± 11 [0–30]
LBBB	R-R	205 ± 7	205 ± 13	245 ± 21
(n = 4)	V_2-ADS [Range]	20	13 ± 15 [0–30]	20 ± 28 [0–40]

Conclusions: 1. In the presence of bundle branch block, R_2 may coincide with the VP of R_1. 2. In this study, a minimum R-R interval of 350 ms would have been required to avoid ADS-induced VF. 3. ADS delivered within the R_2 complex with V_2-ADS ≥ 50 ms did not cause VF regardless of the preceeding R-R intervals.

2:45

797-4 Vagal Stimulation Reduces Spatial Organization of Atrial Fibrillation and Increases Internal Atrial Defibrillation Threshold

Brett M. Baker, Gregory W. Botteron, H. Dieter Ambos, Joseph M. Smith. *Washington University, St. Louis, MO*

We used graded amounts of vagal stimulation in a canine model of atrial fibrillation (AF) to test the hyphothesis that 1) increased vagal tone decreases the spatial organization of atrial activation during AF and 2) increased vagal tone increases the internal atrial defibrillation threshold (aDFT). Sustained AF was induced in 12 dogs by burst atrial pacing performed during bilateral vagal stimulation at the lowest intensity of vagal stimulation that would sustain AF (mean = 5.83 ± 3.59 Hz) and at 20 Hz. Bipolar atrial electrogram sequences were recorded in the right atrium using a specially designed basket catheter with five decapolar arms. The spatial organization of atrial activation was quantified as the activation space constant (ASC), defined as the average distance over which activation sequences remained well correlated during AF. Internal atrial defibrillaton was performed across electrode catheters positioned at the right atrial appendage (cathode) and in the coronary sinus (anode). Atrial defibrillation threshold was defined as the lowest energy which terminated AF on at least 2 of 10 attempts.

A significant reduction in the spatial organization of atrial activaton was seen in nine of 12 animals, with the mean ASC decreasing from 3.49 ± 3.52 at low vagal stimulation to 1.05 ± 0.35 at 20 Hz vagal stimulaton ($p < 0.05$). This increase in vagal stimulation was also associated with a significant increase in aDFT in 11 of 12 animals (mean aDFT = 0.45 ± 0.29 vs. 0.98 ± 0.41 joules, $p < 0.01$). Thus increased vagal tone decreases the spatial organization of atrial activation during AF and increases internal atrial defibrillaton threshold in this canine model of atrial fibrillation.