however it is unclear whether such pts require surgical intervention or can continue to be treated by transcatheter techniques. To evaluate the effectiveness of repeat BAV, a retrospective review was performed of all 14 pts with congenital aortic stenosis who underwent a second BAV at our institution between 1987–1995. Medical records and cineangiograms were reviewed to obtain age, pre and post gradients, and outcomes for the initial and repeat BAV. The inital BAV, performed at a median age of 6.0 yrs (range: 1 mo–18.1 yrs), achieved an immediate reduction in gradient from 83 ± 6 to 41 ± 4 mmHg (mean ± SE; $p < 0.001$). Trace aortic regurgitation (AR) was produced in 6 pts and 2+ AR developed in 1 pt. A second BAV procedure was performed for recurrent aortic stenosis at a median interval from initial BAV of 6.0 yrs (2 mo–9.8 yrs). The median age at the second BAV was 11.7 yrs (2.0–21.3 yrs). The recurrent gradient was reduced acutely from 73 ± 6 to 38 ± 5 mmHg ($p < 0.001$). Trace AR was produced in 4 pts and trace AR increased to 2+ in 3 pts. Three patients had unsatisfactory gradient relief (> 50 mmHg) and required surgical intervention (Ross procedure n = 2; valve replacement n = 1). One late death occurred in a child with restrictive cardiomyopathy following triple valve replacement. The remaining 10 pts have not required further intervention for aortic stenosis or regurgitation during a median follow-up period of 23 mos (3–96 mos) after repeat BAV.

Conclusion: Repeat BAV for recurrent aortic stenosis provides effective gradient relief without a high prevalence of significant AR. It offers worthwhile palliation for most patients with restenosis following previous BAV for congenital aortic stenosis.

926-14 Laser Valvotomy With Balloon Valvuloplasty for Pulmonary Atresia With Intact Ventricular Septum

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Laser valvotomy followed by balloon dilatation has been used to treat patients with pulmonary atresia and intact ventricular septum in our centre since 1991. Selection criteria included a tripartite right ventricle with no more than minor hypoplasia of the tricuspid valve. 9 infants aged 1–70 (median 4.5) days with weight of 2.1–4.7 (median 3.5) kg have been treated. A 4 or 5F Cobra catheter was manipulated below the imperforate pulmonary valve with the aid of hand injections of contrast and a frozen lateral left ventricular angiogram showing the pulmonary trunk opacified via the duct. Perforation of the valve was achieved using a Trimedyne 0.018" laser guide wire with 1–3 continuous wave laser firings of 3–5 watts of 3–5 s duration. The laser guide wire or an 0.018" Flex T wire was passed into the pulmonary trunk and into the right pulmonary artery or the descending aorta via the duct. Dilatation of the valve was performed first with a 3–3.5F coronary angioplasty balloon of 2–4 mm diameter and then by a 5–8 mm balloon. Valvotomy and balloon dilatation was successful in 8 patients, the failure being due to laser breakdown. The only complication was transient SVT. Prostaglandin E was discontinued immediately but was recommenced in 2 patients for 30 and 49 days. Right ventricular outflow velocities following ductal closure were 1.6–3.8 m/s (mean 2.6) and oxygen saturation were 60–97% (mean 76). Repeat balloon dilatation was required in 2 patients after 22 and 116 days. At follow up after 90–1720 (median 98) days, right ventricular outflow velocities were 1.6–4.5 m/s and oxygen saturations 70–97%. The oldest patient, now 4 years old had surgical relief of infundibular stenosis and closure of ASD. Another patient requires similar surgery. Laser valvotomy and balloon dilatation offers a safe and effective alternative to surgical pulmonary valvotomy in this group of patients.

927 Ventricular Repolarization: Clinical Findings

Monday, March 25, 1996, 3:00 p.m.–5:00 p.m.
Orange County Convention Center, Hall E
Presentation Hour: 4:00 p.m.–5:00 p.m.

927-15 Effects of Gender on the Dynamic Relation Between Ventricular Repolarization and Heart Rate

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Women have a longer QTc than men on surface electrocardiogram. To verify whether gender related differences exist in the dynamic relation between ventricular repolarization and cycle length, we analized 24-hour Holter recordings of 20 female (F) and 20 male (M) healthy young subjects. In 14 of them recordings were repeated after beta-blockade (BB, 3-day nadolol 80 mg daily). The early portion (QTp) and the entire QT interval (QTe) were automatically measured by a dedicated algorhythm (Ela Medical) and the linear regression slopes (QTp/RR and QTe/RR) were calculated. In control conditions F had a shorter RR interval than M (803 ± 129 vs 877 ± 86 ms, $p \approx 0.037$). QTp and QTe at constant cycle length (1000 ms) were longer in F than M (330 ± 20 vs 309 ± 18 ms, $p = 0.002$ and 410 ± 17 vs 389 ± 19 ms, $p = 0.002$, respectively). Both QTp/RR and QTe/RR slopes were steeper in F than in M (0.20 ± 0.04 vs 0.16 ± 0.03, $p \approx 0.001$ and 0.16 ± 0.04 vs 0.13 ± 0.03, $p \approx 0.027$, respectively). BB reduced QTp/RR slope by 21% ($p = 0.002$) in both genders and did not modify QTe/RR slope. Thus, the dynamic relation between ventricular repolarization and heart rate is affected by gender. The differences in QTa and QTe duration between males and females are more marked at long cycle lengths and seem to be independent of the level of sympathetic activity.

927-16 Are Repolarization Duration and Dispersion Related to the Heart Rate Variability Parameters in Ischemic Heart Disease Patients?

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Prolonged duration or increased dispersion of repolarization (Rep) and decreased heart rate variability (HRV) indicate an elevated risk of cardiac death in postinfarction patients. There are no clinical data as to whether these ECG parameters provide independent clinical information. The aim of our study was to examine association between Rep and HRV parameters in 57 stable ischemic heart disease pts (mean age: 61 ± 12 years). A standard 12-lead ECG served to analyze repolarization duration (QTc) and dispersion (JTd; max-min JT in 12 leads), and 24-hour Holter ECG recording was used to evaluate time-domain HRV parameters: 1) SDNN — standard deviation of all normal RR intervals; rMSSD — root mean square successive difference; SDANN — standard deviation of the mean of all 5-min segments of normal RR intervals; SDNNIX — mean of standard deviations of all normal RR intervals for all 5-min segments. Mean ± sd (ms) values for all parameters (in parentheses) with correlation coefficients for relationship between repolarization and HRV variables are presented below (all p values for correlation coefficients > 0.10):

HRV: / Rep:	SDNN (127 ± 33)	rMSSD (42 ± 27)	SDANN (111 ± 34)	SDNNIX (66 ± 31)
QTc (408 ± 31)	−0.18	−0.19	−0.08	0.01
JTd (62 ± 22)	−0.05	0.09	0.08	0.04

Conclusions: Repolarization duration and dispersion do not show any relationship with HRV parameters in stable ischemic heart disease patients. The simultaneous evaluation of repolarization and HRV parameters therefore provides complementary information about myocardial substrate and autonomic activity in patients with ischemic heart disease.

927-17 Influences of Autonomic Tone on QT Interval Rate-Dependence Can Be Assessed by 24-Hour ECG Recording

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A selective approach of ventricular repolarization (VR) has been studied by atrial pacing with pharmacological interventions during daytime. This study is based on spontaneous data obtained from 24-Hour ECG to dissociate the influences of heart rate (HR), autonomic tone and myocardial disease on spontaneous VR variations in 15 normal controls (C) and in 12 pts with chronic heart failure (CHF). Age and sex ratio were not different between the groups. The QRS complexes were classified according to the mean RR interval over the preceding minute which had to be stable (a variation of 15 ms was allowed). An average QRS template was created from those individual complexes to improve the signal-to-noise ratio. From each recording, day and night periods were processed separately. The QT apex intervals (QTa) and the slopes of the curves relating QTa and stable RR intervals were measured for each template. A diurnal and a nocturnal QTa were calculated for a stable RR interval equal to the mean RR interval over 24 hours to obtain a diurnal and a nocturnal QTa at similar constant HR. The difference between nocturnal and diurnal QTa was also calculated. Strong positive linear relationships between QTa and RR intervals were present in each pt at daytime and at night ($r > 0.91$). For the same stable RR interval, the QTa interval was shorter during the day than at night in both groups. The physiological circadian QTa variation (20 ± 6 ms) was reduced in CHF (8 ± 10 ms, $p = 0.002$) mainly due to steeper QTa/RR night slopes in CHF (0.15 ± 0.05) than in C (0.11 ± 0.04, $p < 0.05$). Thus, pts with CHF demonstrate an impairment in the circadian variation of VR duration independant of HR. The influences of HR, autonomic tone and myocardial disease on spontaneous QT interval

variations can be dissociated by 24-hour ECG recordings. VR variations may be more informative than conventional QT interval measurements to evaluate myocardial repolarization.

927-18 QTc and QTc Dispersion Increases With Age and Is Increased Among Females in a Normal Population

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The aim of the investigation was to study the relation between age, gender, QTc and QTc dispersion in a normal population.

Methods: From a population study we selected 1161 individuals with no history of cardiovascular disease including hypertension, no diabetes, not on drug treatment, and normal ECG. Age of individuals was either 30, 40, 50 or 60. 12 lead ECGs were recorded at 25 mm/sec.

RR and QT intervals were measured with a digitizer tablet. QTc (ms, mean of 12 leads) was calculated using Bazett's formula and QTc dispersion as the maximal difference between QTc in any 2 leads in ms. Values shown are means ± standard deviation.

Females, age:	30	40	50	60
n	140	209	238	40
QTc	403 ± 21	410 ± 21	411 ± 22	431 ± 19
QTc disp.	57 ± 20	57 ± 22	58 ± 29	68 ± 21
Males, age:	**30**	**40**	**50**	**60**
n	65	79	167	223
QTc	382 ± 20	392 ± 24	399 ± 22	398 ± 23
QTc disp.	59 ± 17	61 ± 33	68 ± 35	64 ± 27

The increase in QTc and QTc dispersion with age as well as the different values in females compared to males were highly significant ($p < 0.01$).

Conclusion: QTc measured as a mean observation in 12 leads increases with age and is higher among females than males. QTc dispersion also increases with age, but is slightly higher in males than in females.

927-19 QT Dispersion and Malignant Ventricular Arrhythmia in Patients With End-Stage Heart Failure Caused by Ischemic vs. Idiopathic Cardiomyopathy

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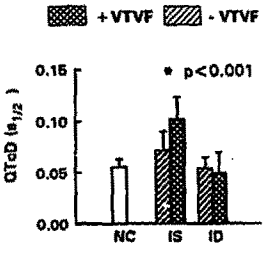
Patients with severe congestive heart failure (HF) are known to be at increased risk for life-threatening ventricular arrhythmias and sudden death. The inducibility of ventricular tachycardia (VT) is significantly higher in patients with myocardial infarction (MI) than without MI. To test the hypothesis that the increased dispersion of ventricular recovery time is a substrate for VT and ventricular fibrillation (VF), we compared the QT interval, QTc value, QT and QTc dispersion (QTD, QTcD), occurrence of VT and/or VF (VTVF), left ventricular ejection fraction (LVEF) and end-diastolic dimension (LVEDD) in patients with end-stage HF caused by ischemic (IS, n = 30) and idiopathic (ID, n = 30) cardiomyopathy undergoing heart transplantation. The mean QT and QTc values were significantly prolonged in both groups compared with that in normal controls (NC, n = 30, $p < 0.001$). However, the significant increases in QTD and QTcD were only found in the IS, but not ID group (QTD: 77 ± 18 vs. 42 ± 8 ms; $p < 0.001$; QTcD: 0.09 ± 0.02 vs. 0.05 ± 0.01 $s^{1/2}$; $p < 0.001$). Twenty-one patients in IS group had the symptomatic VTVF, but only 9 patients had VTVF in ID group ($p < 0.01$). In IS group, the QTD and QTcD were significantly higher in patients with (+VTVF) than without VTVF (–VTVF, $p < 0.001$). However, in ID group, the QTD and QTcD remained same in patients +VTVF and –VTVF. The mean LVEF and LVEDD were similar in both groups.



The present study demonstrates that: a) The significantly increased QTD and QTcD might directly contribute to the pathogenesis of the malignant ventricular arrhythmias or may simply be the markers of disease severity in IS cardiomyopathy with end-stage HF; b) The VT and VF in ID cardiomyopathy may be based on the mechanisms other than the heterogeneity in cardiac refractoriness.

927-20 Principal Component Analysis Identifies Abnormal Complexity of Repolarization in Post Myocardial Infarction Patients

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Dispersion of repolarization is measured as a difference between longest and shortest QT interval of 12-leads ECG (QT disp). We and others demonstrated that QT disp is profoundly affected by the subjective QT measurement. This may explain the inconsistent predictive value of QTdisp in post myocardial infarction (MI) pts. We used a new approach to evaluate complexity of repolarization using principal components analysis, a method assessing the degree of correlation between waveforms. When applied to T waves, it defines the components of repolarization. Usually, the first component accounts for most of repolarization, whereas an dishomogeneous repolarization is indicated by a relevant contribution of the second and other components. We analyzed T waves in 478 ECG recordings obtained during 12-leads Holter (Mortara Instruments) in controls (ctrls; n = 9) and in post MI pts (n = 12). The second /first component ratio (Complexity) was 9 ± 3% in ctrls and 23 ± 12% in post-MI ($p < 0.001$). Dynamic measurement of complexity showed that in postMI the 24 hrs SD of second component was also increased (8 vs 2.6%; $p < 0.001$). Pts with an anterior MI had a higher complexity than ctrls and pts with inferior MI ($p < 0.0001$ ANOVA). No correlation was found between complexity, QT, or QT disp. These preliminary data show that principal component analysis of T wave identifies complexity of repolarization in post MI pts and suggest that anterior MI pts-have more pronounced alterations in ventricular repolarization.

927-21 The Influence of Beta-Blockers on QT Interval in Patients With Long QT Syndrome

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Beta-blocker (BB) treatment is an accepted therapy for long QT syndrome patients (LQTS). Despite its wide use, there are limited data regarding the effect of BB on repolarization parameters. This study evaluated the influence of BB on repolarization duration in 311 LQTS pts (mean age 21 ± 17 years; 120 males and 191 females) with two consecutive ECGs available, one before and the other on BB therapy. The following ECG parameters were evaluated: RR, QT, QTp (to the T wave peak), and heart rate corrected (Bazett's formula) QTc and QTpc (mean values of measures from leads L2, V2 and V5). BB therapy resulted in significant ($p < 0.01$) changes (Δ) in mean values of these ECG parameters (↑ increase; ↓ decrease): ΔRR ↑ 149 ± 180 ms; ΔQT ↑ 20 ± 63 ms; ΔQTp ↑ 18 ± 49 ms; ΔQTc ↓ 19 ± 50 ms; ΔQTpc ↓ 12 ± 36 ms. Patients with baseline longer QTc (> 0.50 s) and without bradycardia (>60 bpm) had greater QTc shortening than pts with shorter QTc and bradycardia (HR — heart rate):

Baseline QTc	ΔQTc	Baseline HR	ΔQTc
<0.46 s	↑ 2 ± 32*	<60 bpm	↓ 15 ± 64*
0.46–0.50 s	↓ 6 ± 39*	60–80 bpm	↓ 16 ± 46
0.50–0.55 s	↓ 23 ± 49	80–100 bpm	↓ 24 ± 53
>0.55 s	↓ 70 ± 56	>100 bpm	↓ 27 ± 33

*nonsignificant changes, otherwise $p < 0.001$

Conclusions: Beta-blocker therapy results in a significant decrease of heart rate adjusted repolarization duration (QTc) in LQTS. The magnitude of beta-blocker-induced QTc changes is related to the QTc duration and heart rate recorded on the baseline ECG.

MONDAY POSTER