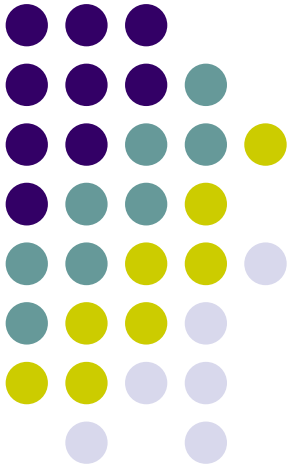
Understanding hemodynamics in various arrhythmic conditions with (tissue) doppler echo

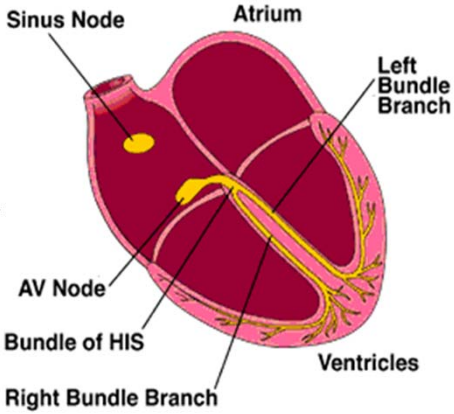


Cardiology, Internal Medicine

Kyungpook National University

Dongheon Yang

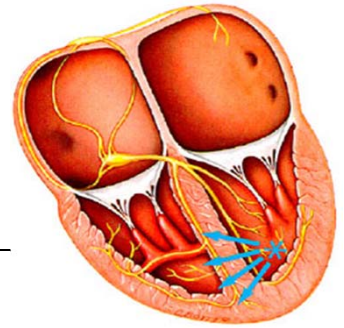
Various arrhythmia



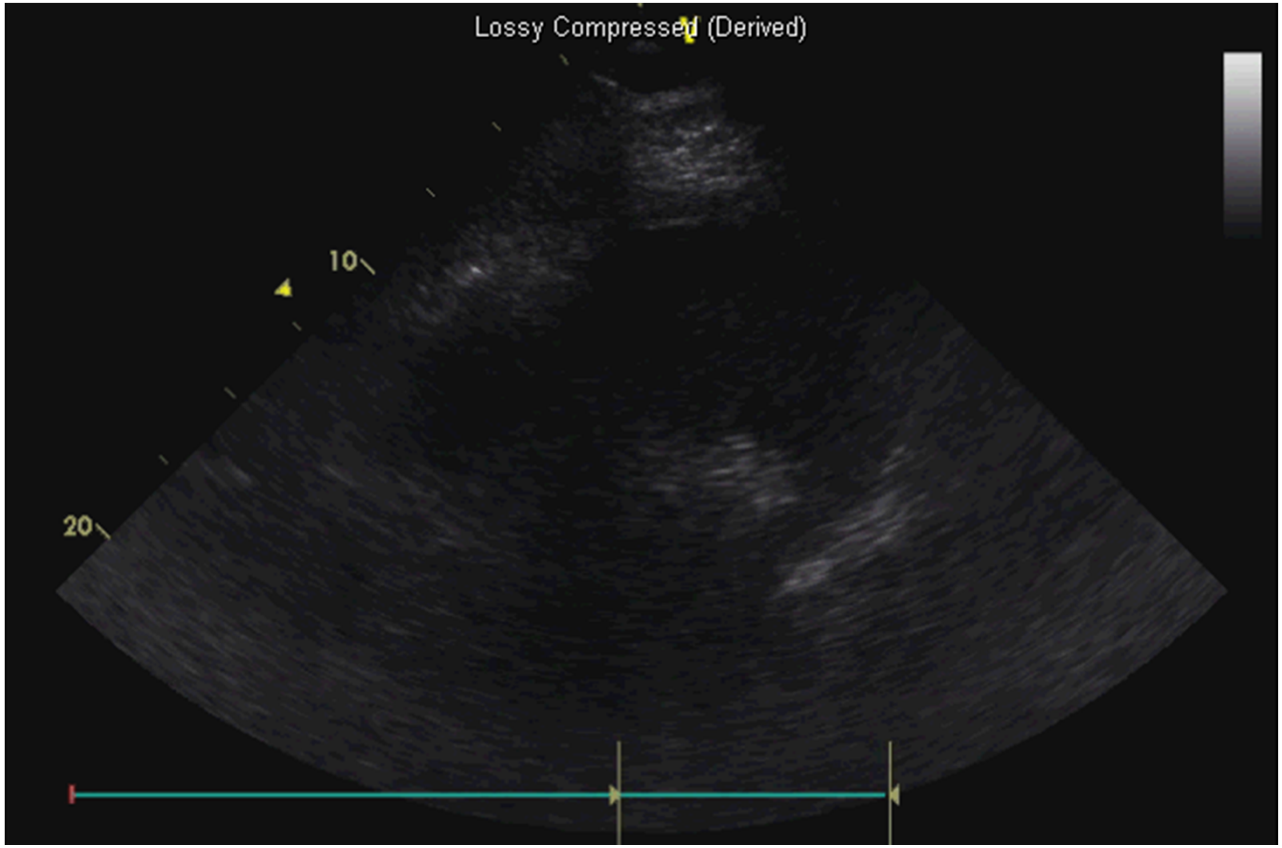
- **Bradyarrhythmia**
  - **Sinus bradycardia**
  - **Sick sinus syndrome**
  - **Sinus arrest**
- **Atrio-ventricular block**
  - **1st degree AVB**
  - **2nd degree AVB**
  - **Complete AVB**
- **Bundle branch block**
  - **Left bundle branch block**
  - **Right bundle branch block**
  - **Fascicular block**

→ **Cardiac Resynchronization Therapy**

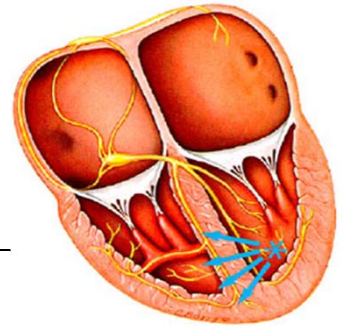
Various arrhythmia



- **Supraventricular arrhythmia**
  - **Sinus tachcardia**
  - **Atrial fibrillation**
  - **Atrial flutter**
  - **Paroxysmal supraventricular tachycardia**
  - **Atrial tachycardia**
  - **Junctional tachcardia**
- **Ventricular tachycardia**
  - **Ventricular tachycardia**
  - **Ventricular fibrillation**


Lossy Compressed (Derived)
10
20

Various arrhythmia



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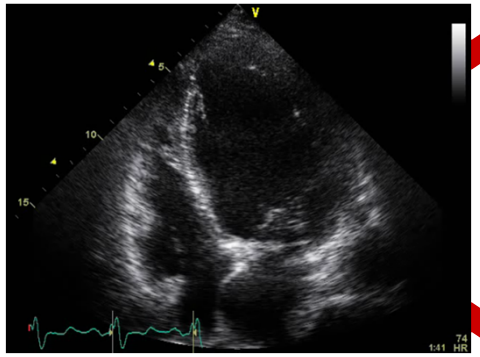
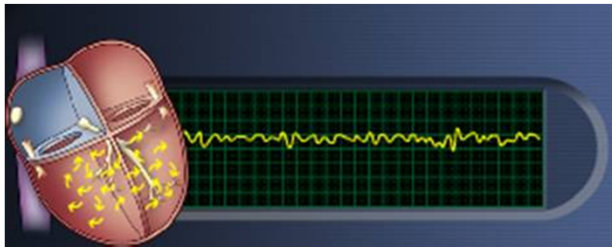
  - **Atrial tachycardia**
  - **Junctional tachcardia**
- **Ventricular tachycardia**
  - **Ventricular tachycardia**
  - **Ventricular fibrillation**

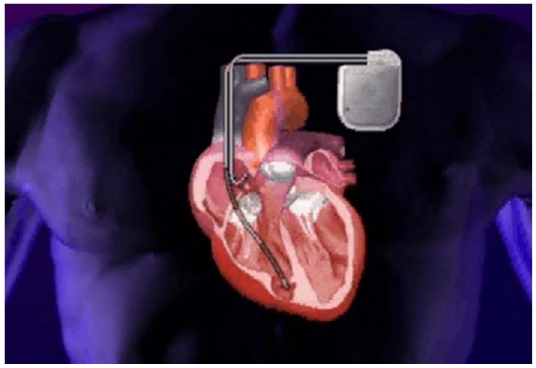
Prevention of SCD

Causes of death

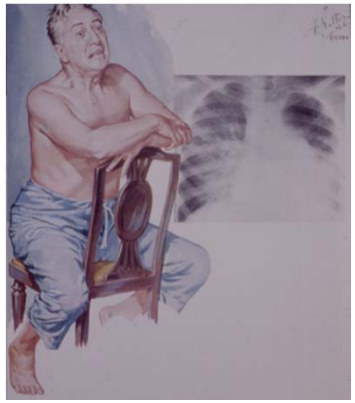


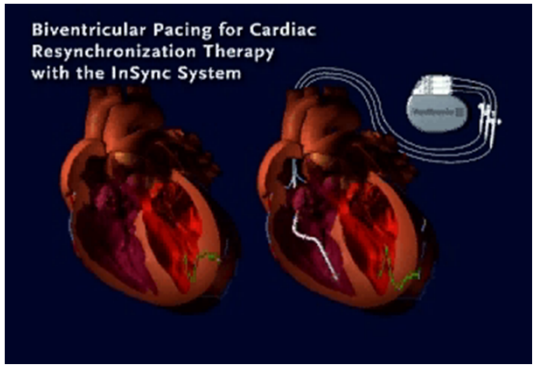
Arrhythmia → ICD



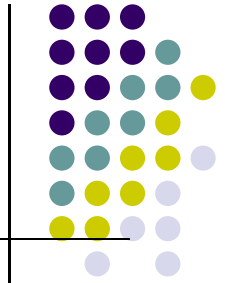


Pump failure → CRT



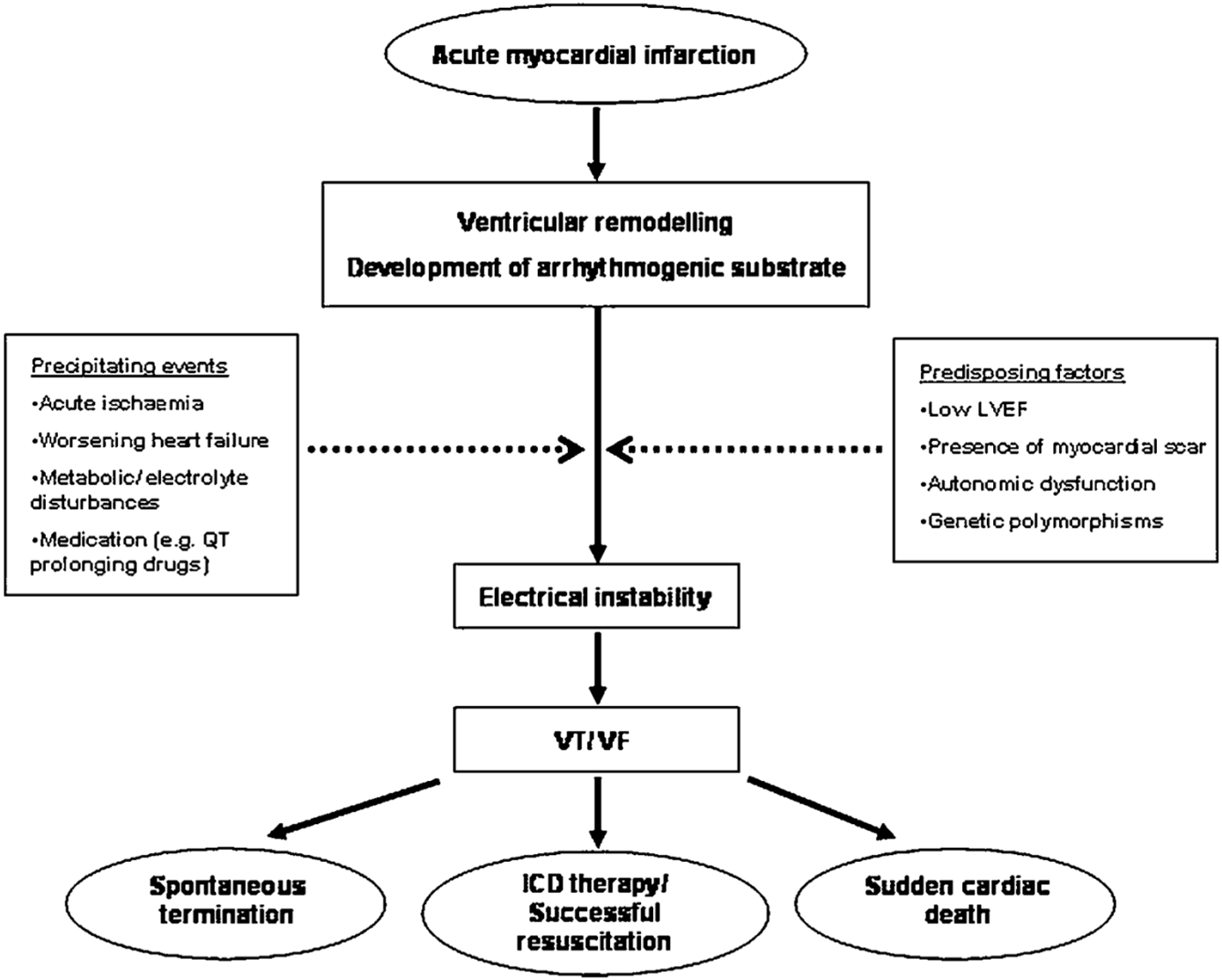


Ventricular tachycardia

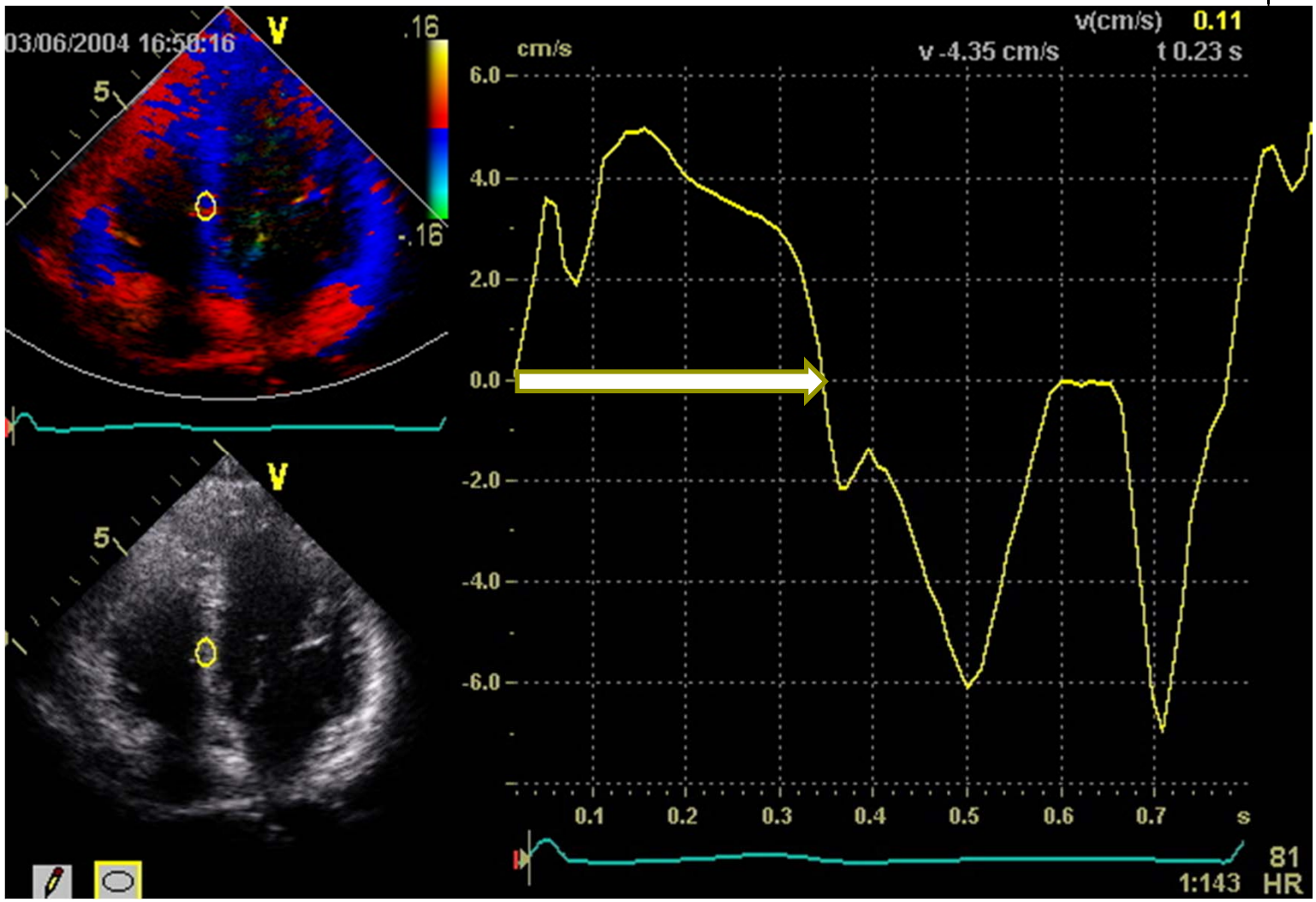


- **Channelopathy**
  - **Brugada syndrome**
  - **Long QT syndrome**
- **Arrhythmogenic right ventricular cardiomyopathy**
- **Cardiomyopathy**
- **Post-myocardial infarction**

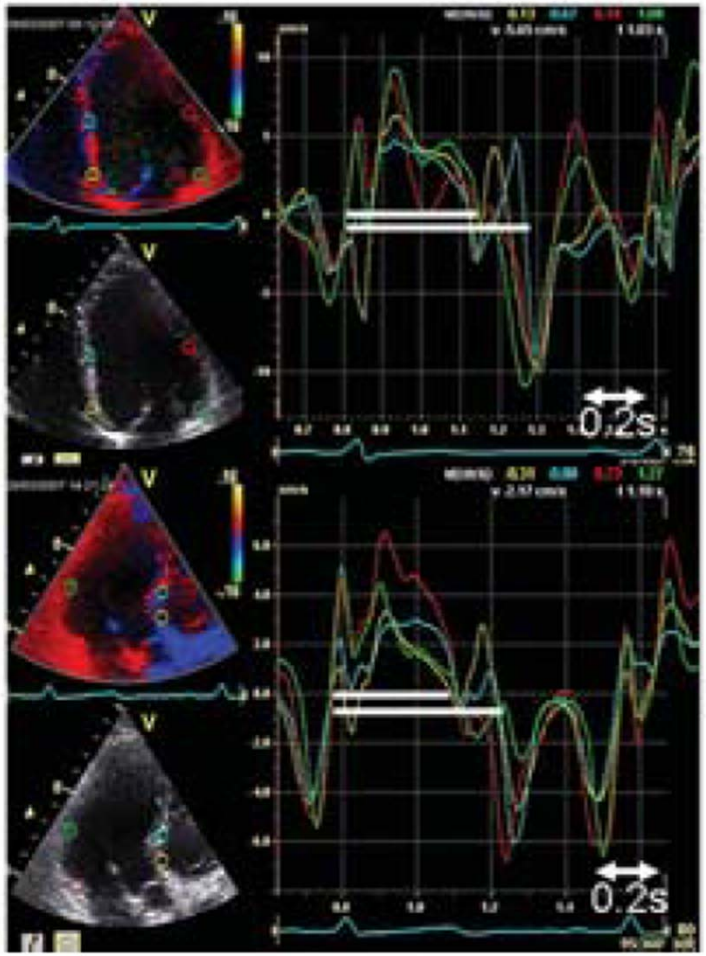
Ventricular tachyarrhythmia

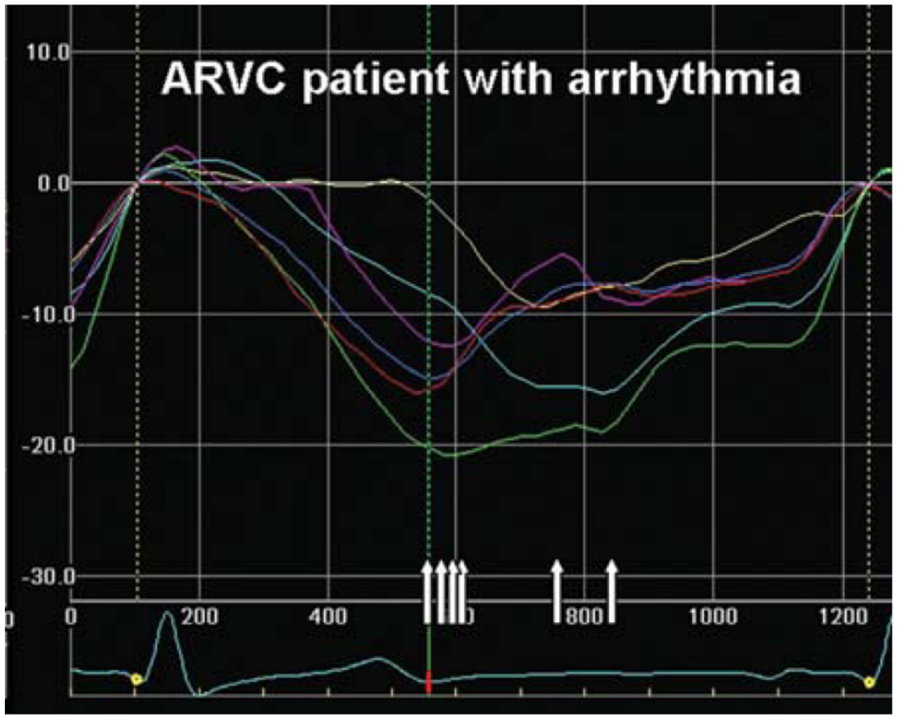


Tissue doppler image

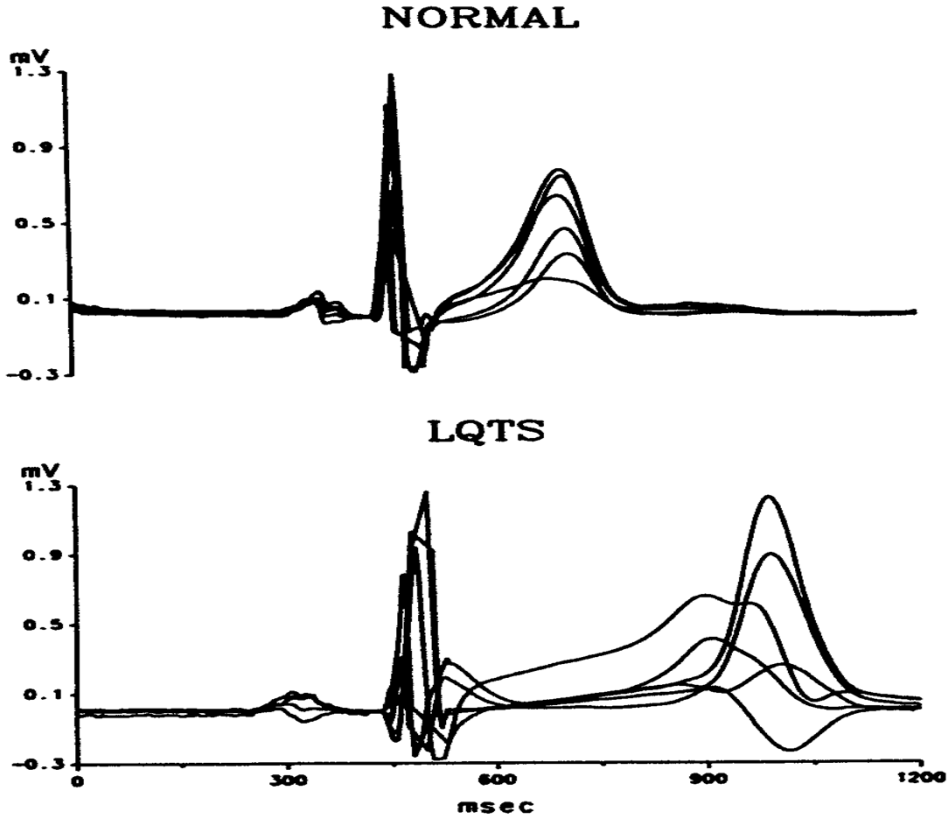


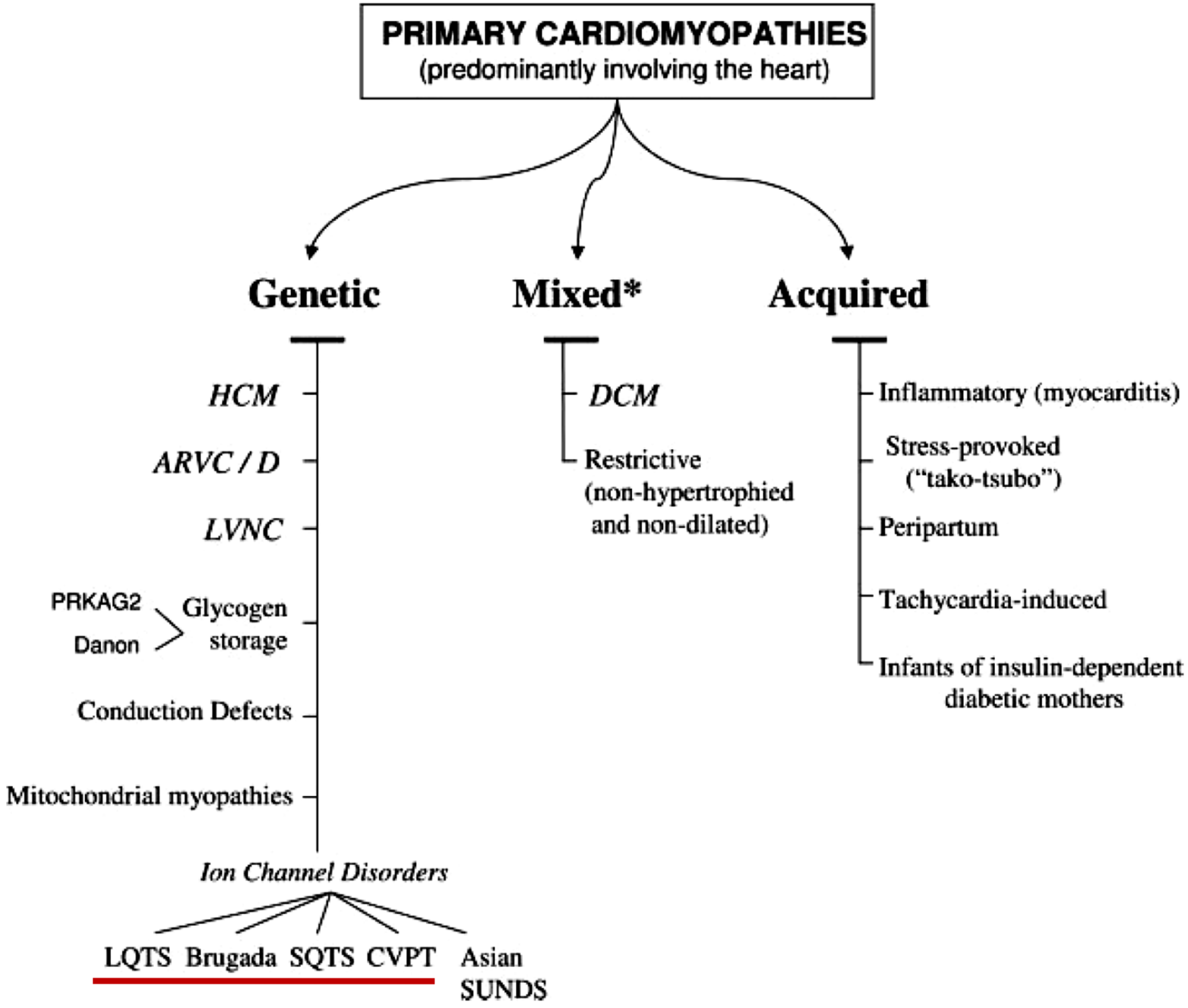
Mechanical dispersion



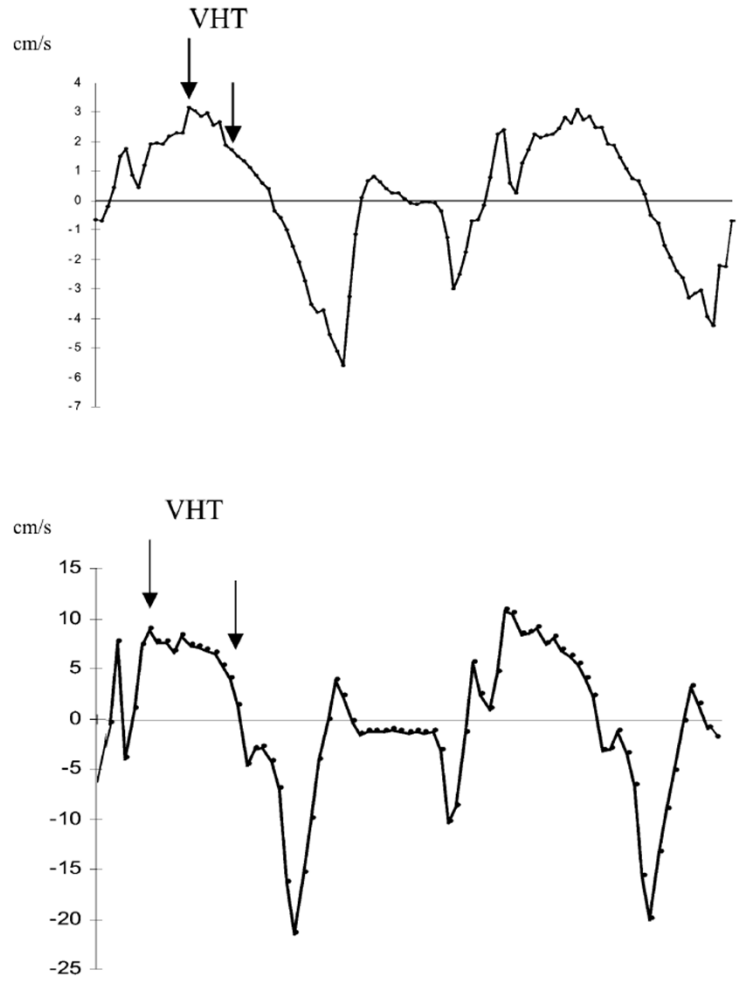


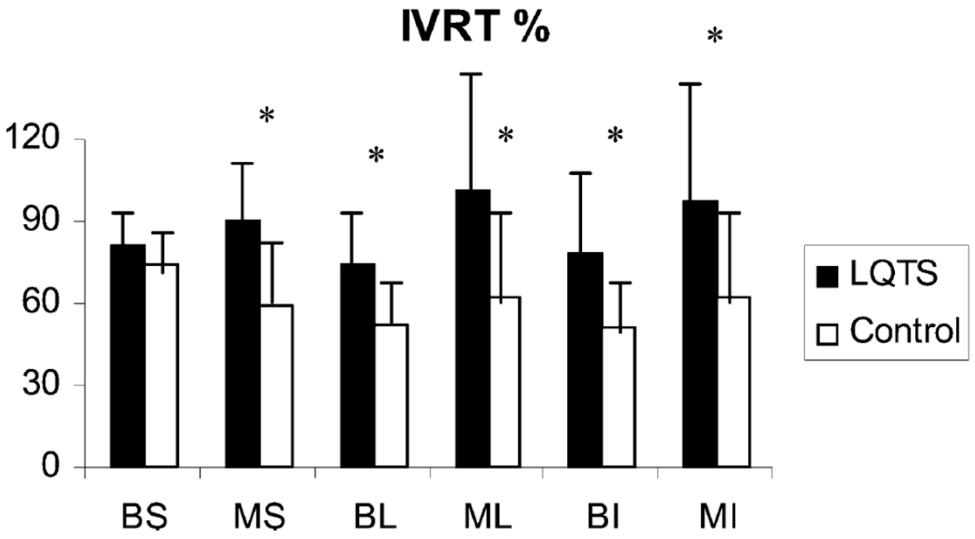
Long QT syndrome




PRIMARY CARDIOMYOPATHIES
(predominantly involving the heart)
Genetic
Mixed*
Acquired
HCM
ARVC / D
LVNC
PRKAG2
Danon
Glycogen storage
Conduction Defects
Mitochondrial myopathies
Ion Channel Disorders
LQTS
Brugada
SQTS
CVPT
Asian SUNDS
DCM
Restrictive (non-hypertrophied and non-dilated)
Inflammatory (myocarditis)
Stress-provoked ("tako-tsubo")
Peripartum
Tachycardia-induced
Infants of insulin-dependent diabetic mothers

Tissue Doppler Echo in LQTS

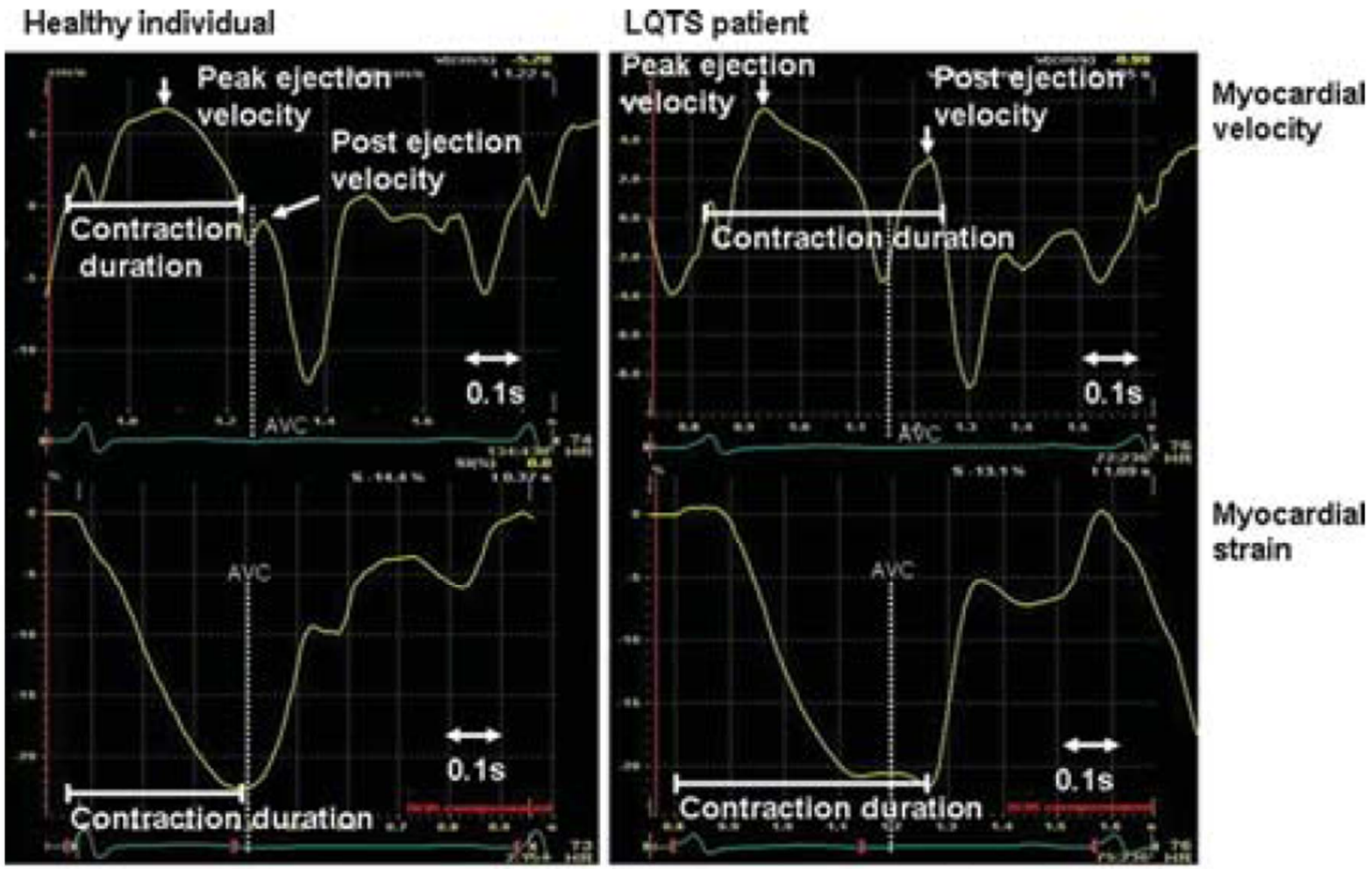




Velocity half time index in systolic profile

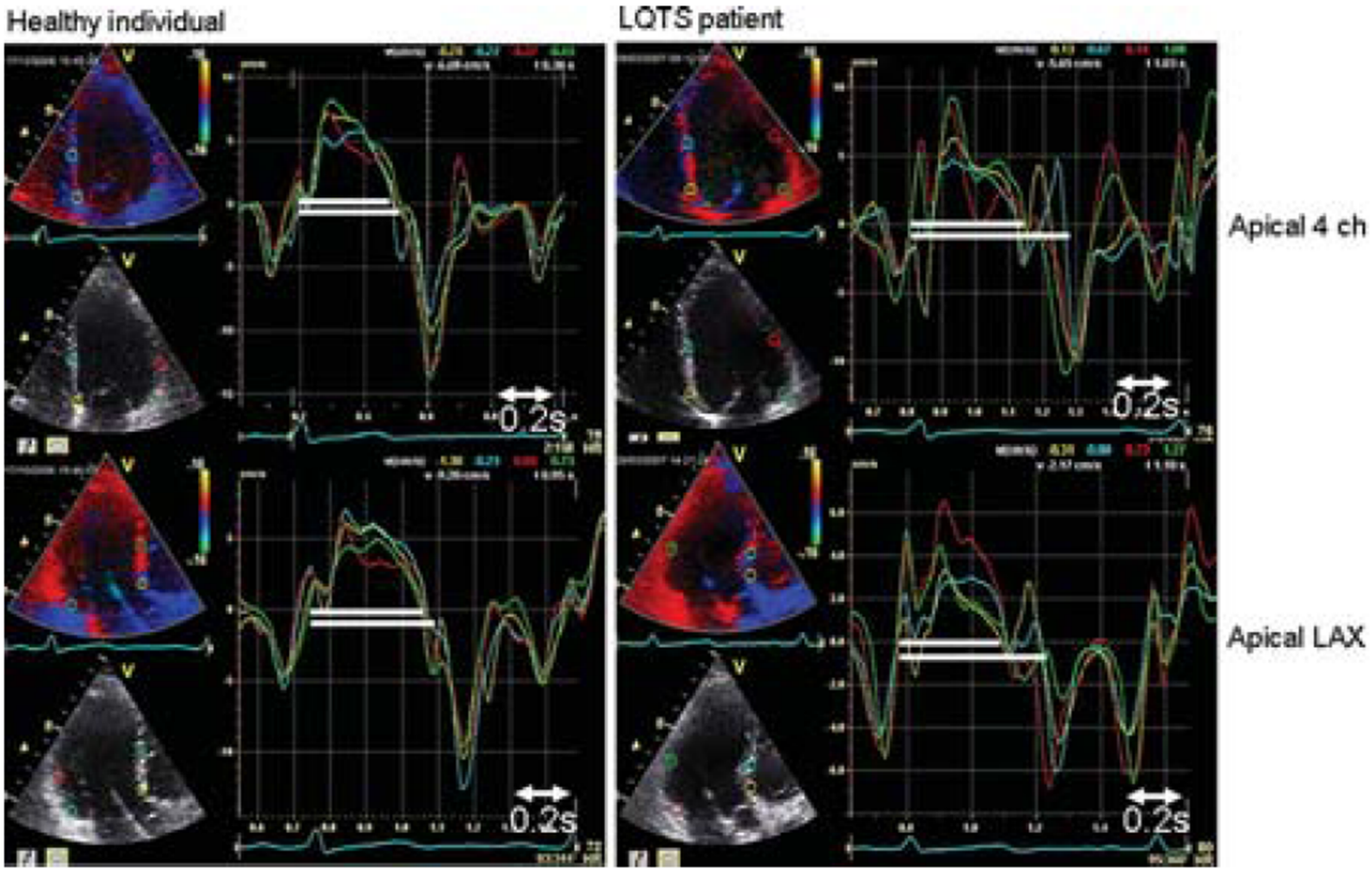
Savoye C et al. Eur J Echocardiography (2003) 4, 209–213

Tissue Doppler Echo in LQTS



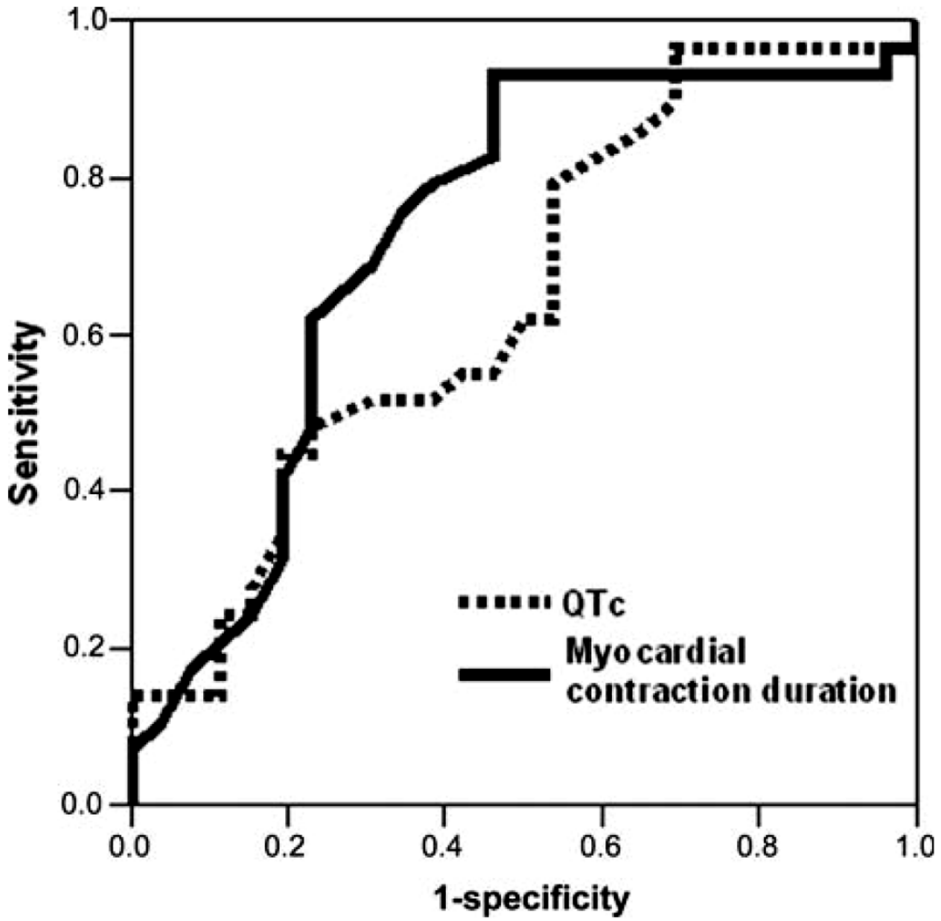
European Heart Journal (2009) 30, 330–337

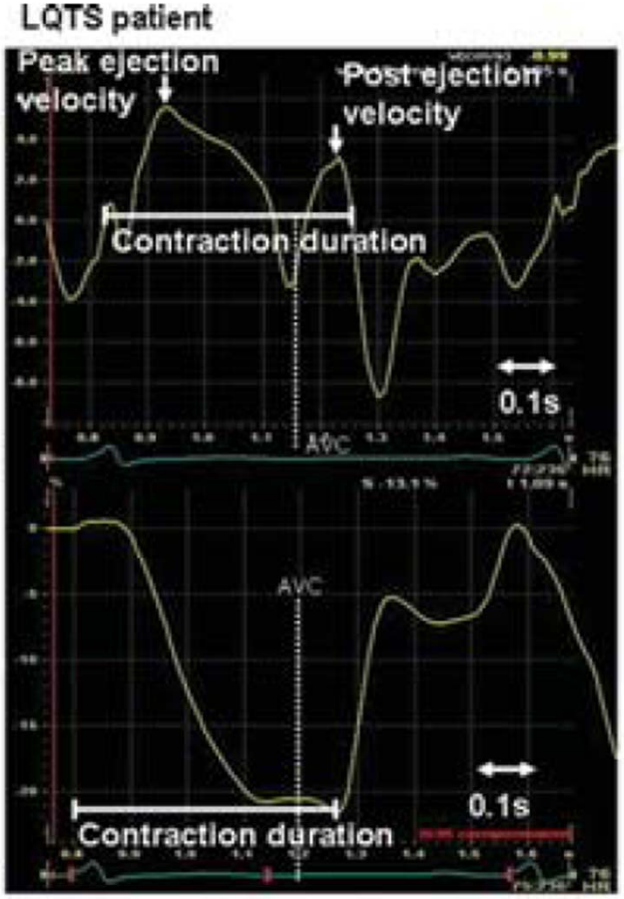
Tissue Doppler Echo in LQTS



European Heart Journal (2009) 30, 330–337

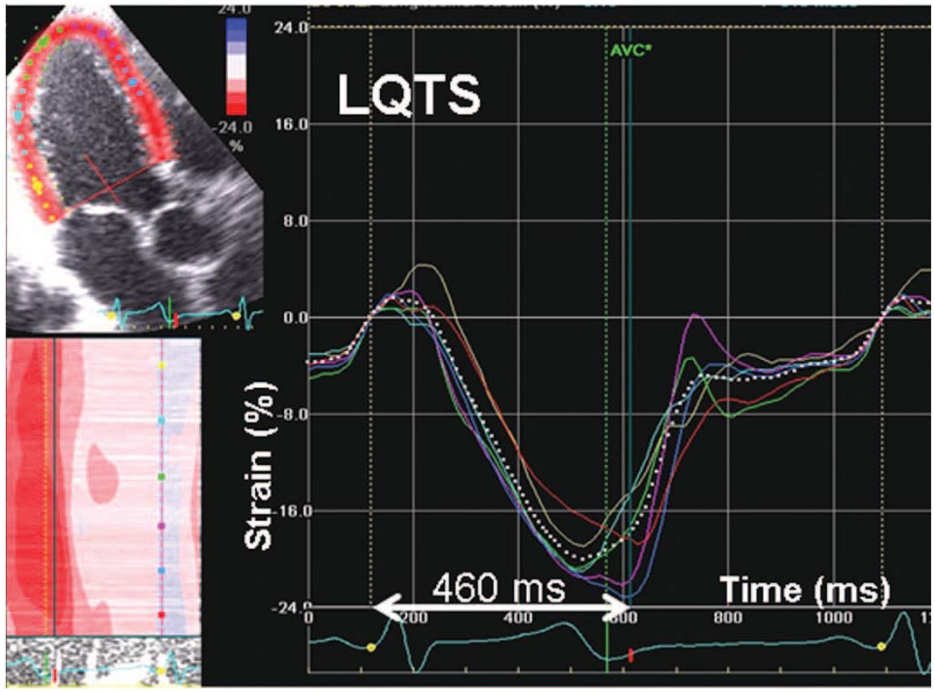
Tissue Doppler Echo in LQTS

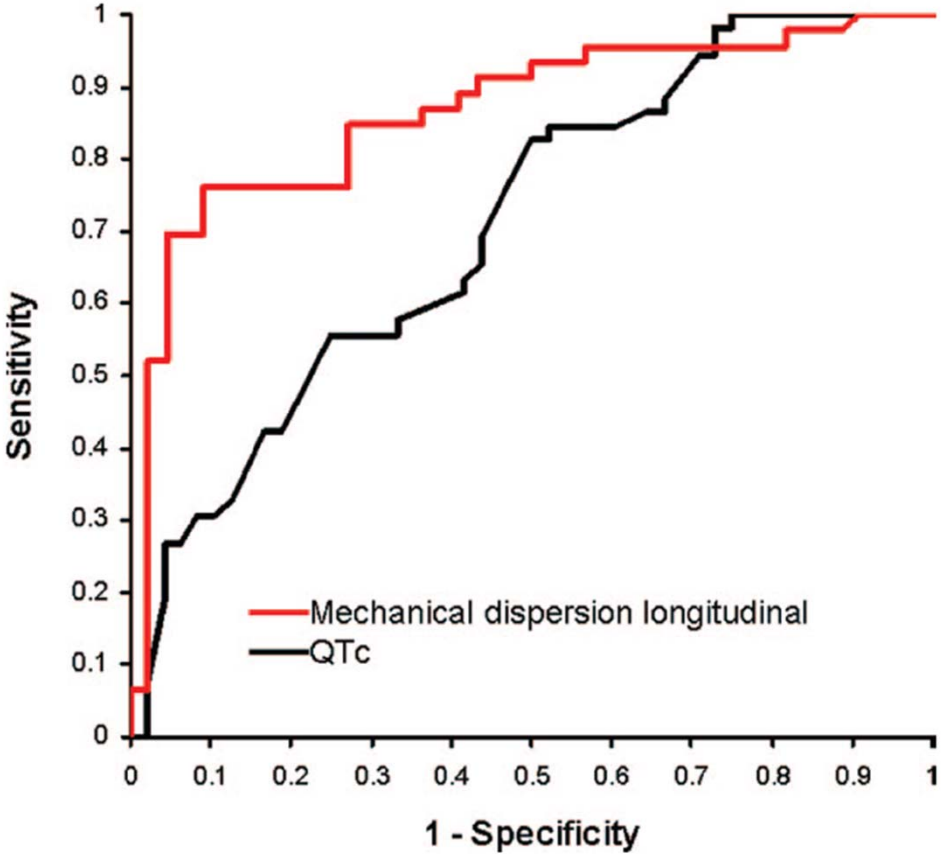




Receiver-operating characteristic curves of cardiac events (documented arrhythmia, syncope, or aborted cardiac arrest)

Strain Echo in LQTS





Circulation. 2010;122:1355-1363

European Heart Journal (2009) **30**, 253–255
doi:10.1093/eurheartj/ehn587

EDITORIAL

Long QT syndrome, a purely electrical disease? Not anymore

Gaetano M. De Ferrari[1] and Peter J. Schwartz[1,2,3,4]*

[1]Department of Cardiology, Fondazione IRCCS Policlinico San Matteo, Pavia, Italy; [2]Section of Cardiology, Department of Lung, Blood and Heart, University of Pavia, Pavia, Italy; [3]Laboratory of Cardiovascular Genetics, IRCCS Istituto Auxologico Italiano, Milan, Italy; and [4]Cardiovascular Genetics Laboratory, Hatter Institute for Cardiovascular Research, Department of Medicine, University of Cape Town, South Africa

Circulation
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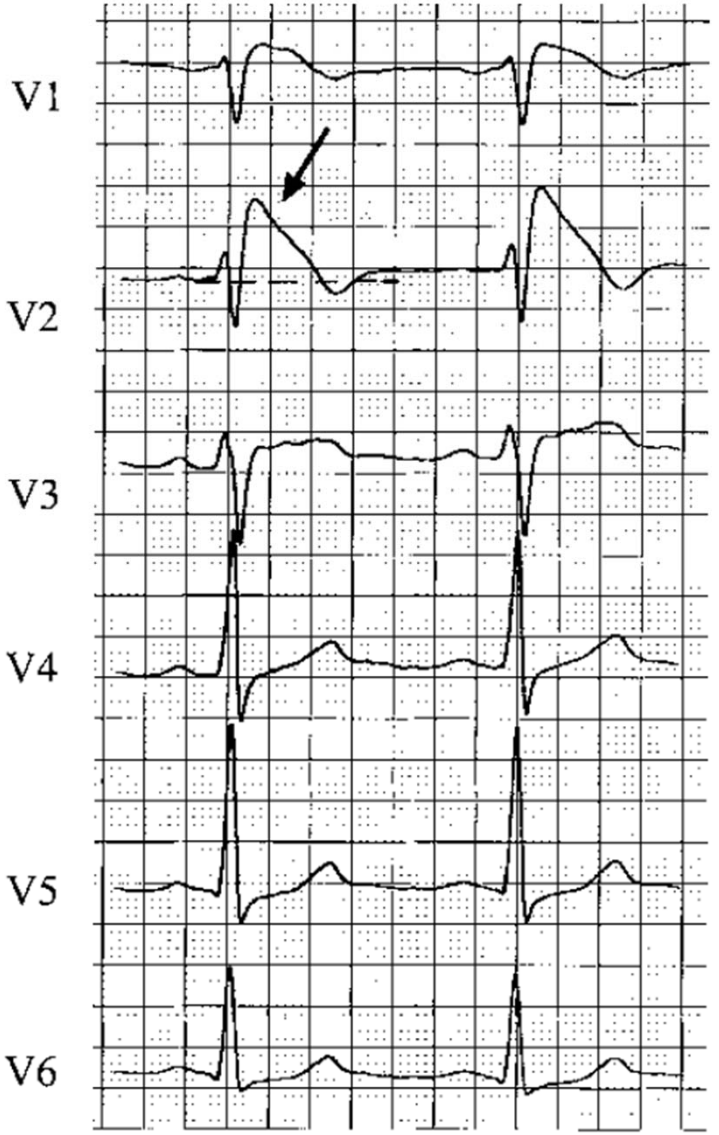
Editorial

Is Long QT Syndrome a Disease of Abnormal Mechanical Contraction?

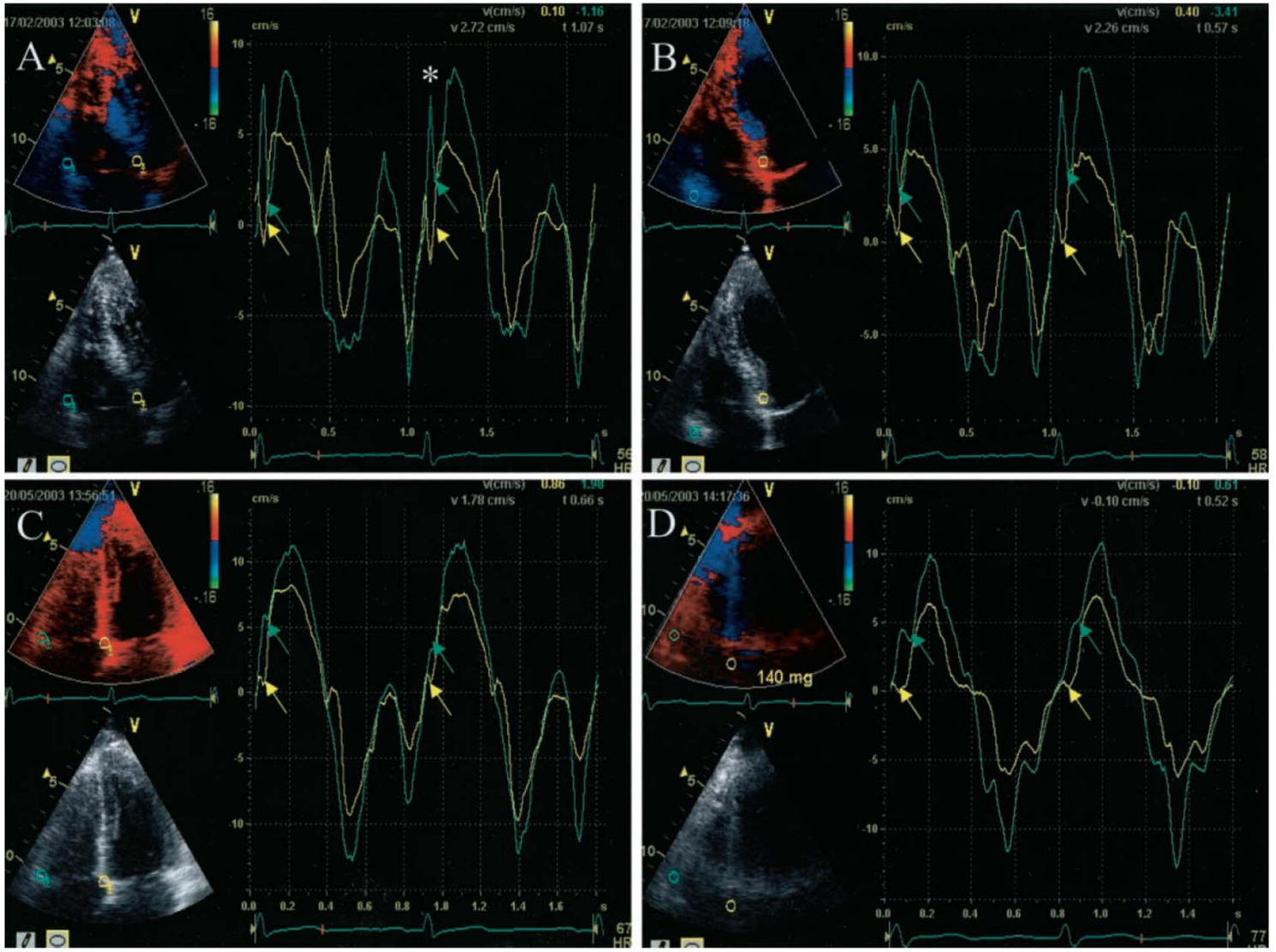
David S. Rosenbaum, MD

Brugada syndrome

- **inherited, autosomal dominant disorder characterized by**
  - **sudden death from ventricular tachyarrhythmias,**
  - **ECG right precordial ST-segment elevation,**
  - **conduction slowing**
  - **Inducible ST elevation by Na^+ channel blocker**

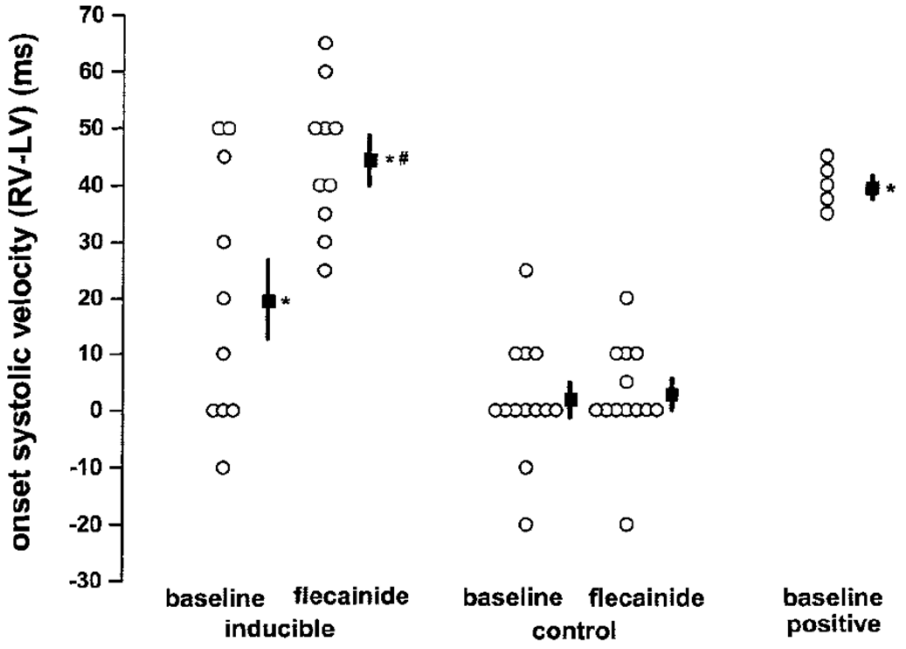


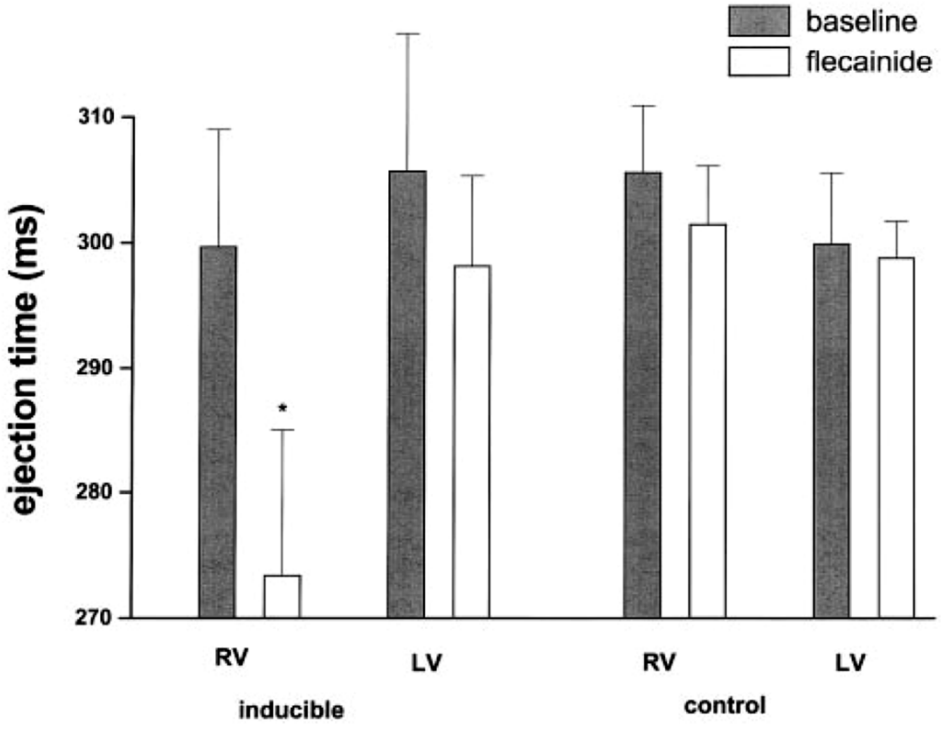
Brugada syndrome



Circulation 2004;109:1272-1277

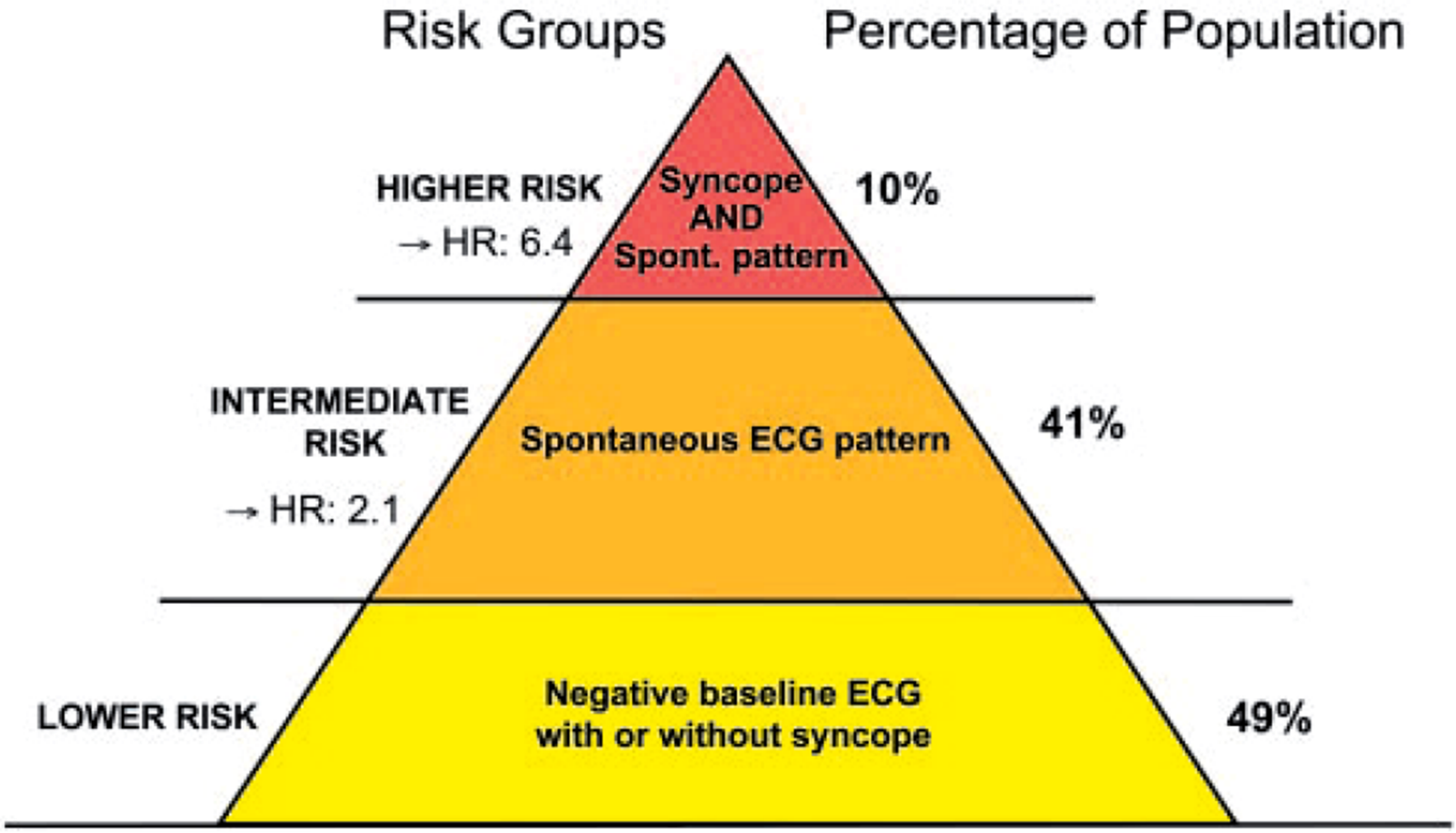
Brugada syndrome





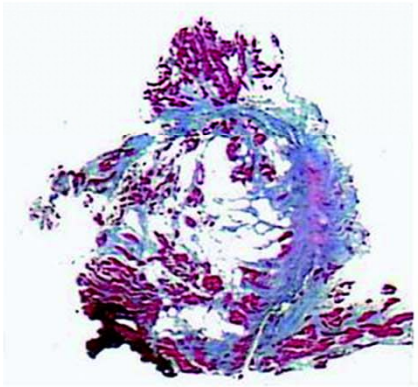
Circulation 2004;109:1272-1277

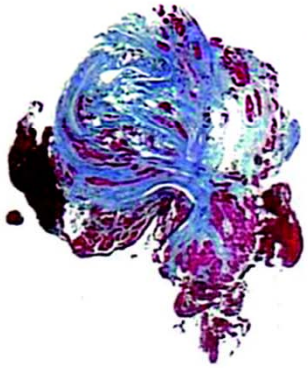
Risk stratification of SCD

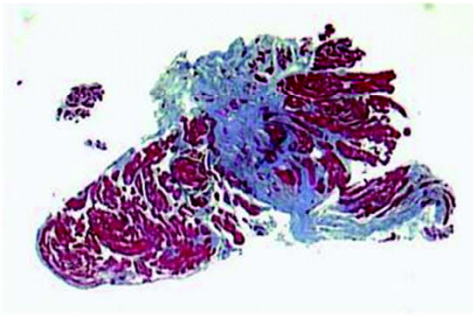


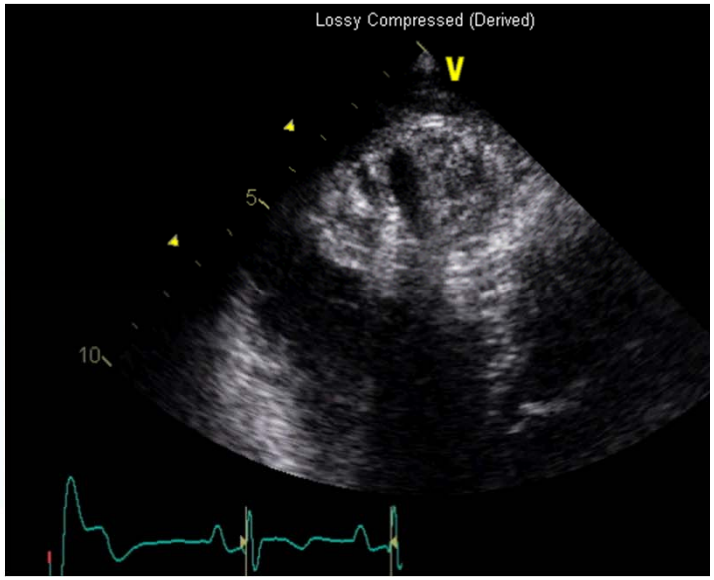
ARVC/D

- predominantly a genetically determined heart muscle disorder
- pathologically by fibrofatty replacement of the right ventricular (RV) myocardium

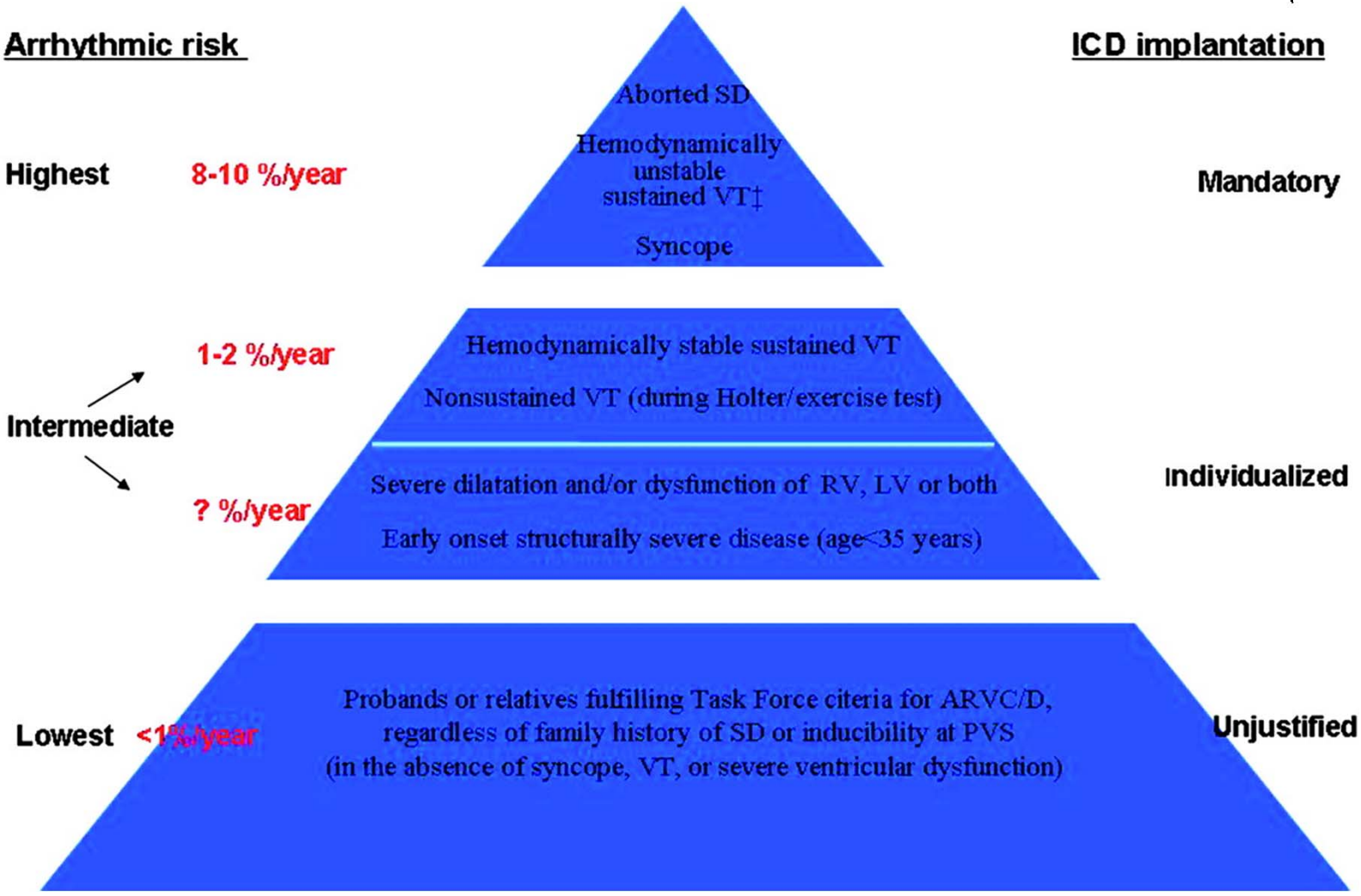




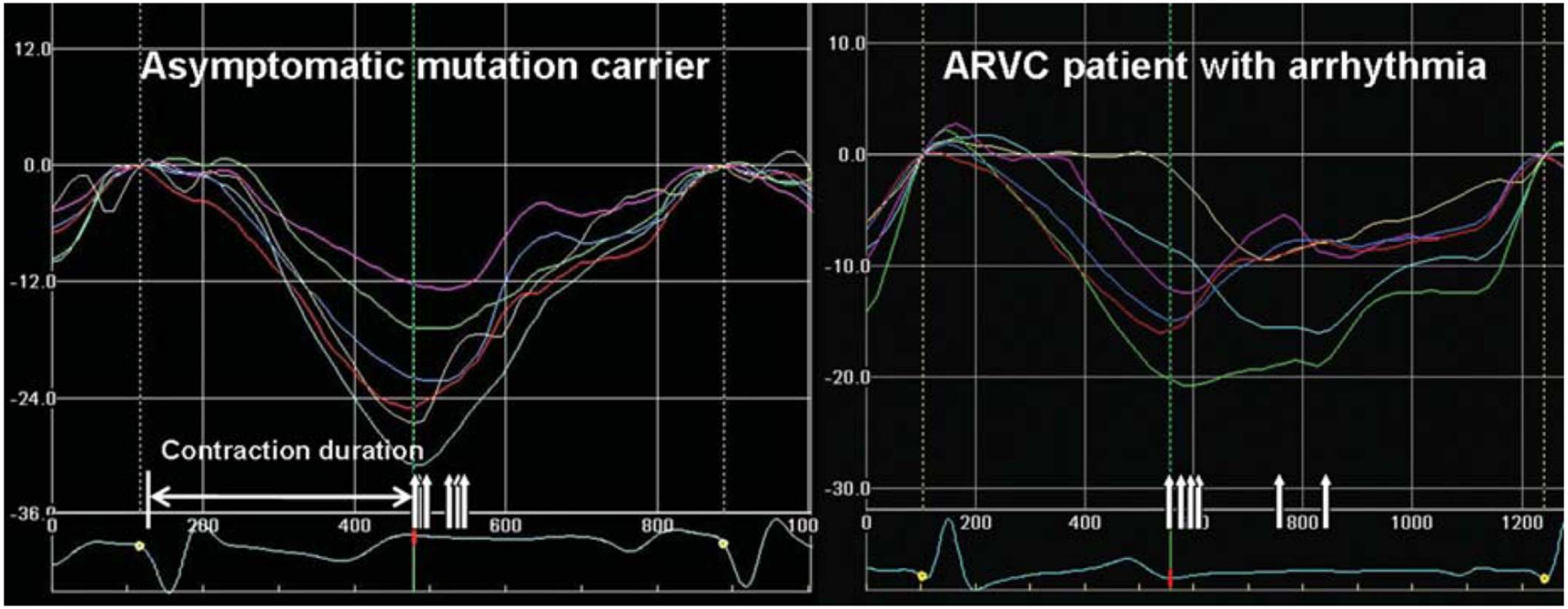




Arrhythmic risk stratification pyramid and current indications for implantation of an implantable cardioverter defibrillator (ICD) based on observational studies on ICD therapy in arrhythmogenic right ventricular cardiomyopathy dyplasia (ARVC/D).



RV mechanical dispersion



RV mechanical dispersion is SD of contraction duration in 6 RV segments.

European Heart Journal doi:10.1093/eurheartj/ehr069

Predictors of arrhythmia in ARVC patients

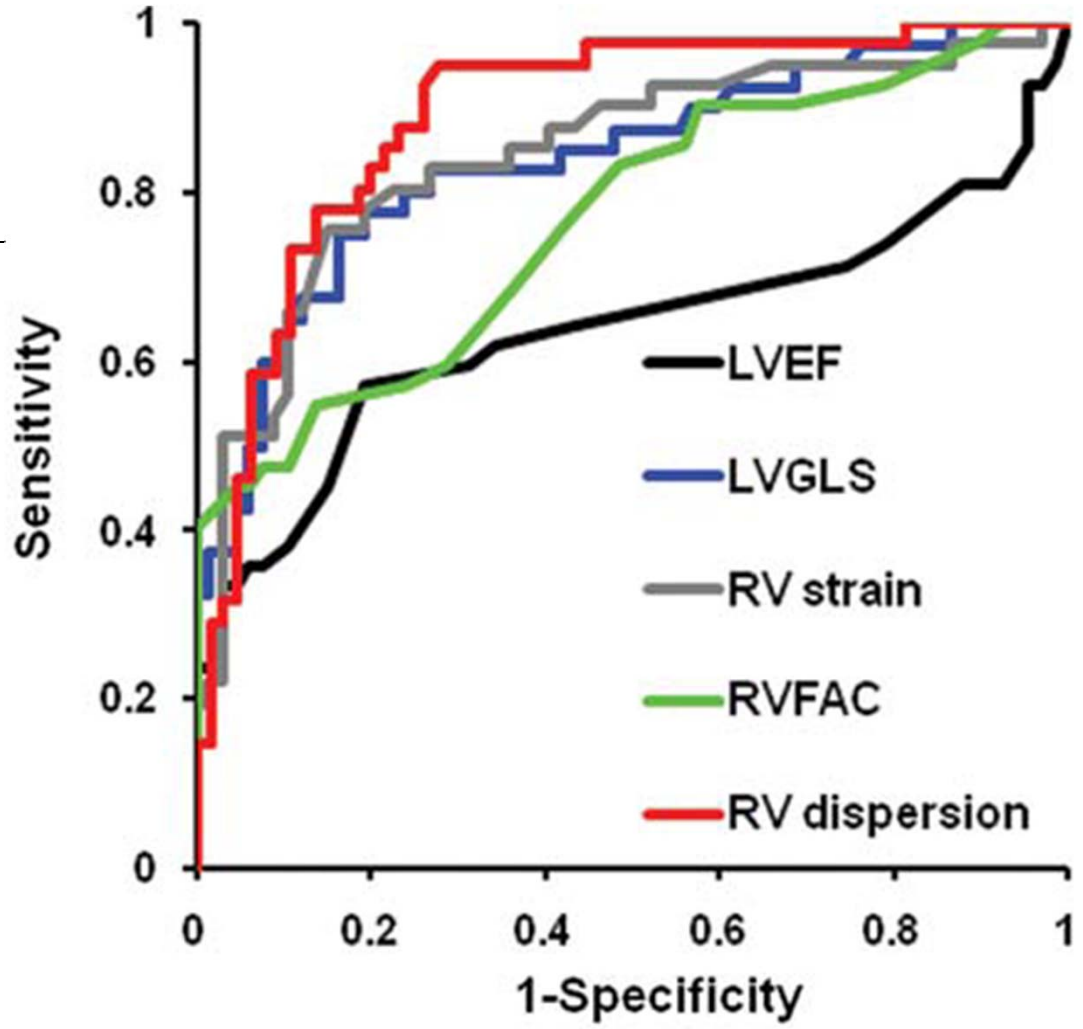
	Univariate logistic regression			Multivariate logistic regression		
	OR	95% CI	*P*-value	OR	95% CI	*P*-value
SAECG positive (*n*) (yes vs. no)	4.01	1.28–12.5	0.02	2.27	0.53–9.79	0.27
LVEF (per 5% decrease)	1.31	0.96–1.78	0.09	1.15	0.68–1.96	0.60
LVGLS (%)	1.41	1.12–1.76	0.003	1.22	0.89–1.67	0.22
RV strain (%)	1.25	1.08–1.44	0.003	0.98	0.76–1.26	0.85
RV dispersion (per 10 ms increase)	1.71	1.22–2.39	0.002	1.66	1.06–2.58	0.03
RVFAC (per 5% decrease)	2.33	1.44–3.76	0.001	2.16	1.04–4.47	0.04

SAECG, signal-averaged ECG; LVEF, left ventricular ejection fraction; GLS, global longitudinal strain; RVFAC, right ventricular fractional area change.

Predictors of arrhythmia in symptomatic arrhythmogenic right ventricular cardiomyopathy patients and asymptomatic mutation carriers

European Heart Journal doi:10.1093/eurheartj/ehr069

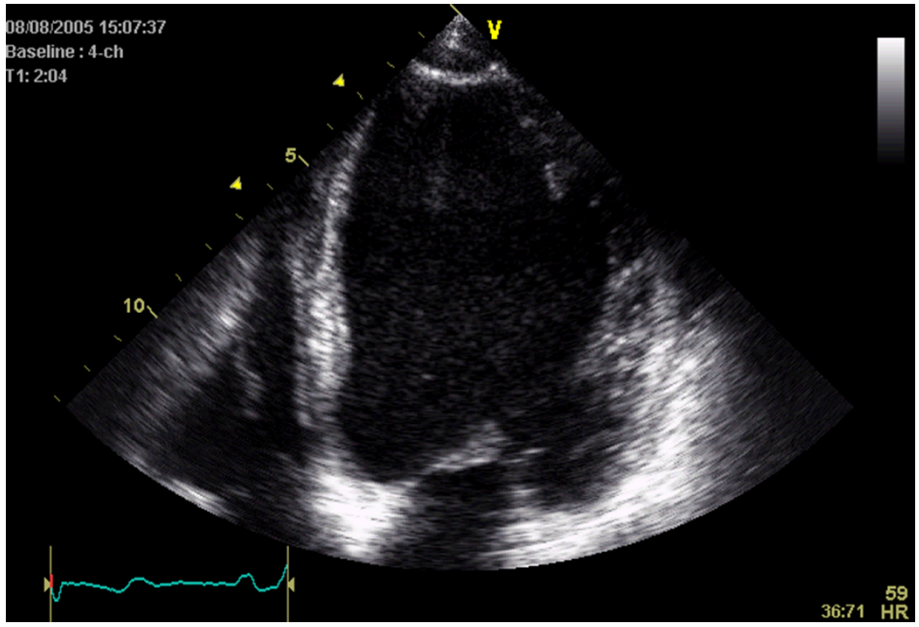
ROC curve

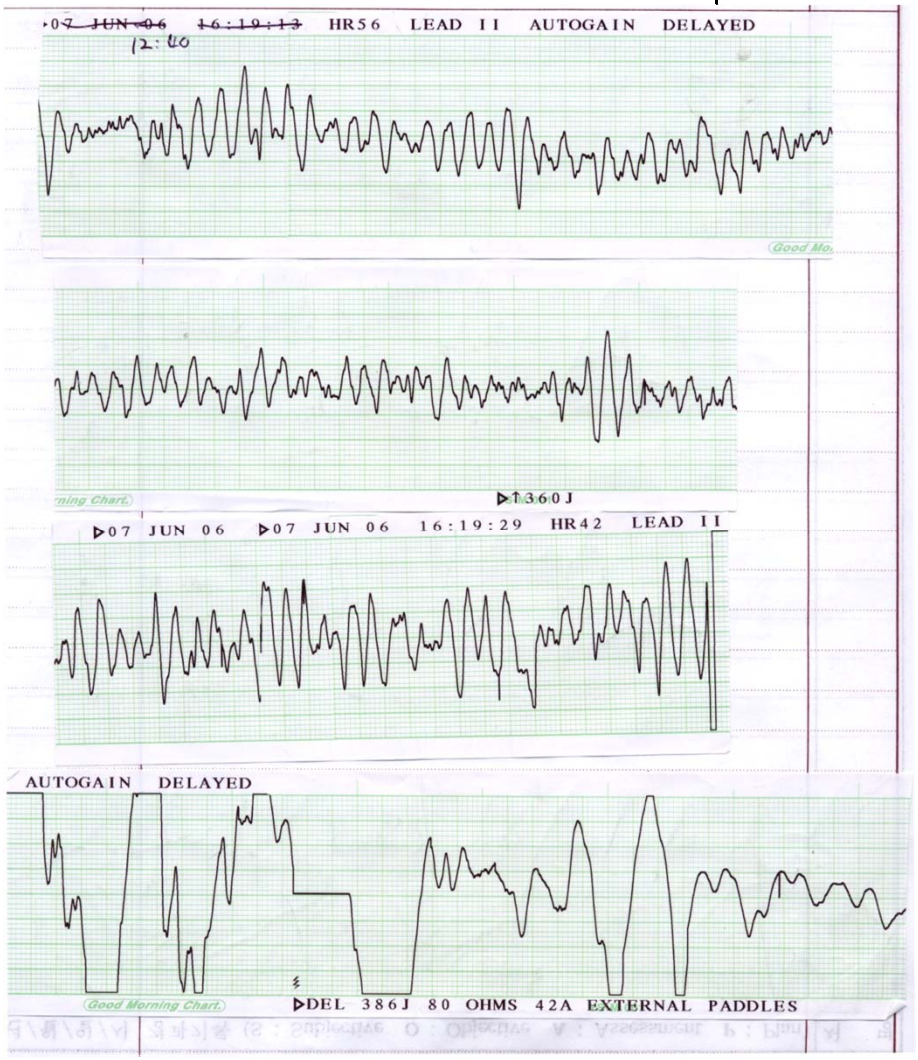


	AUC	95% CI	Optimal cut-off	Sensitivity (%)	Specificity (%)
LVEF (%)	0.64	0.51-0.76	63	62	66
LVGLS (%)	0.84	0.76-0.92	-20	83	73
RV strain (%)	0.84	0.76-0.93	-22	83	73
RVAF (%)	0.77	0.67-0.86	42	69	64
RV dispersion (ms)	0.89	0.83-0.95	29	88	77

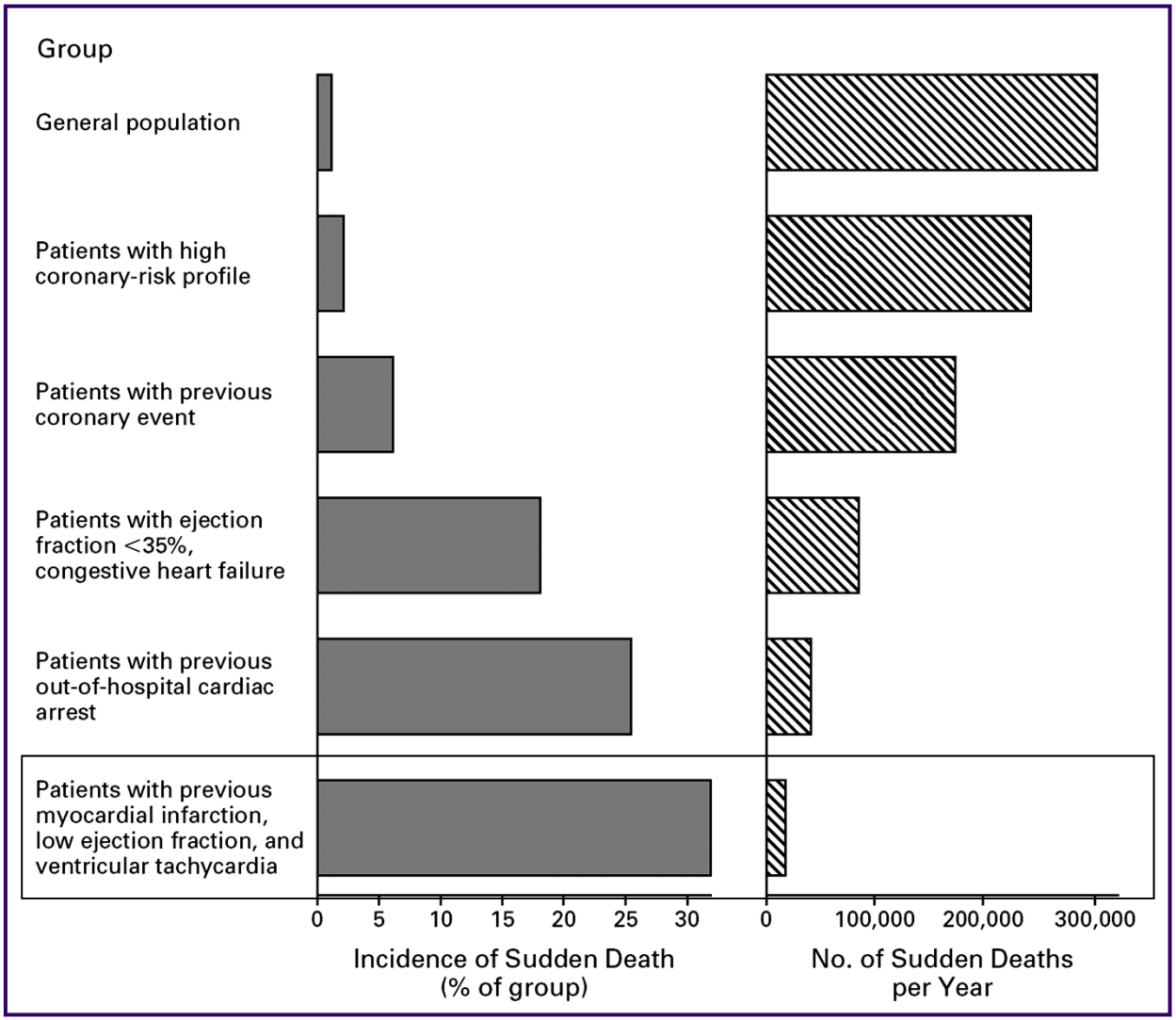
European Heart Journal doi:10.1093/eurheartj/ehr069

post-MI SCD


08/08/2005 15:07:37
Baseline : 4-ch
T1: 2:04
V
5
10
59
36:71 HR


HR56 LEAD II AUTOGAIN DELAYED
360J
07 JUN 06 07 JUN 06 16:19:29 HR42 LEAD II
AUTOGAIN DELAYED
DEL 386J 80 OHMS 42A EXTERNAL PADDLES

Sudden cardiac death

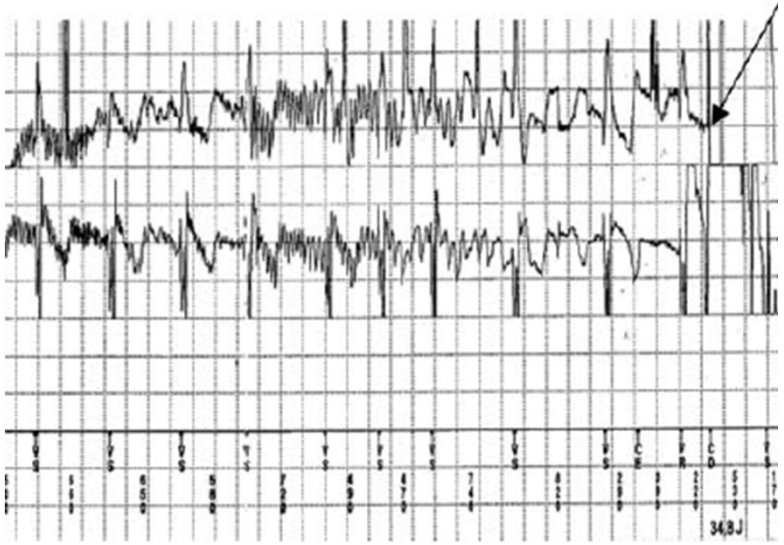


Primary prevention

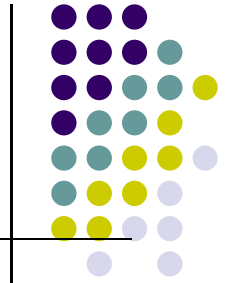
Cautions of device therapy

- **ICD**
  - **Inappropriate shock → progression of HF**
  - **Device-related complication**

- **CRT**
  - **Non-responder**
  - **Pro-arrhythmic (?)**



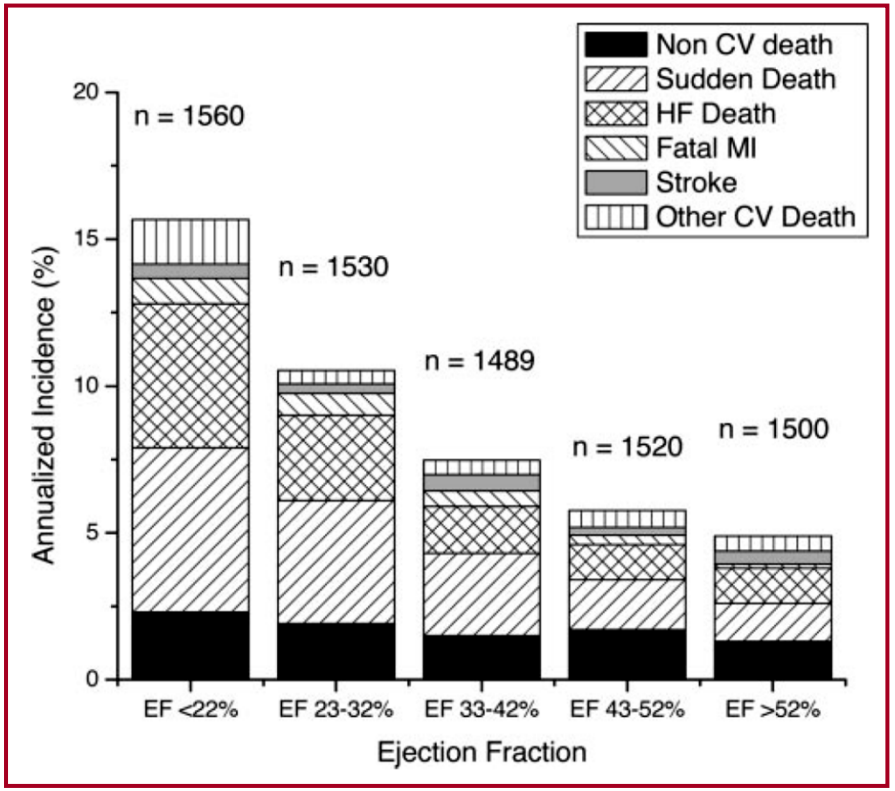
Risk stratification for SCD after AMI



- **ECG**
- **Signal-averaged ECG**
- **T-wave alternans**
- **Holter : HR variability / turbulence**
- **Electrophysiological study**
- **Cardiac MRI**
- **Echocardiography**

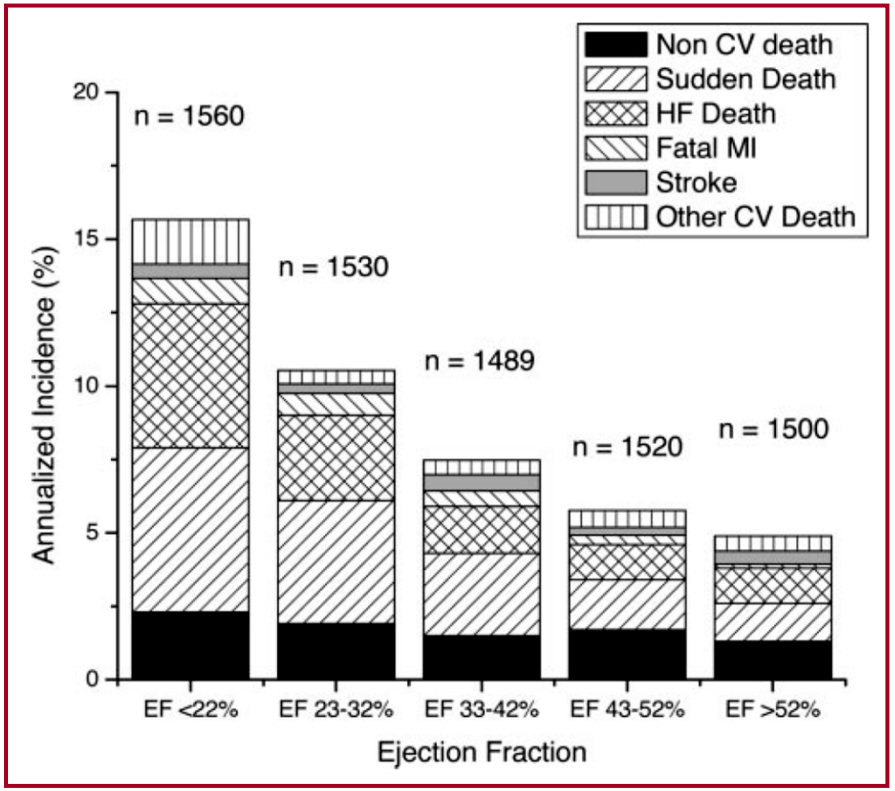
Echocardiography - LVEF

- **Advantages**
  - **Available in almost all hospitals**
  - **Routinely performed in patients post AMI**
  - **Provides additional information (eg, valvular function)**
  - **Cut-off values for ICD insertion stated in guidelines**

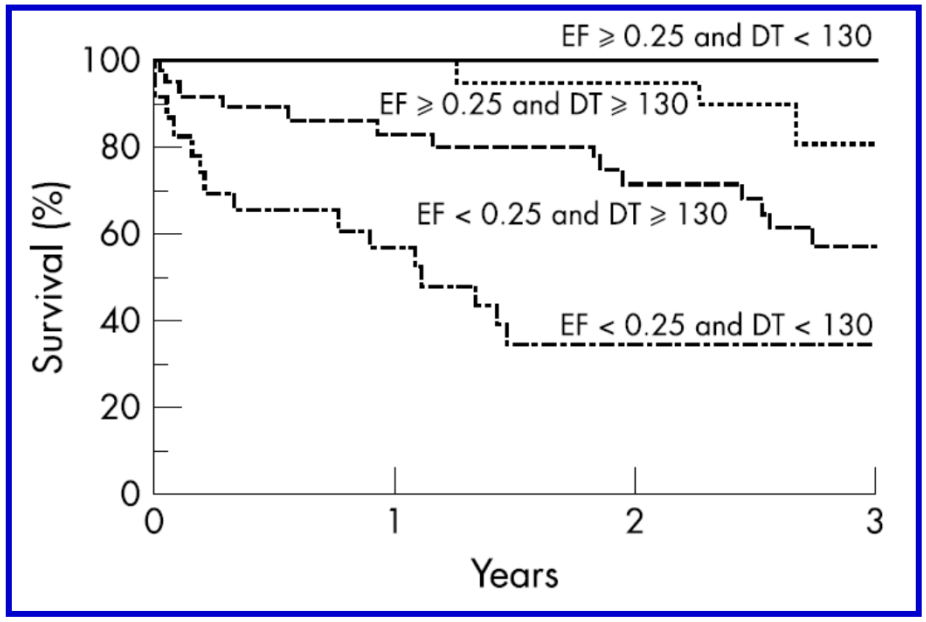


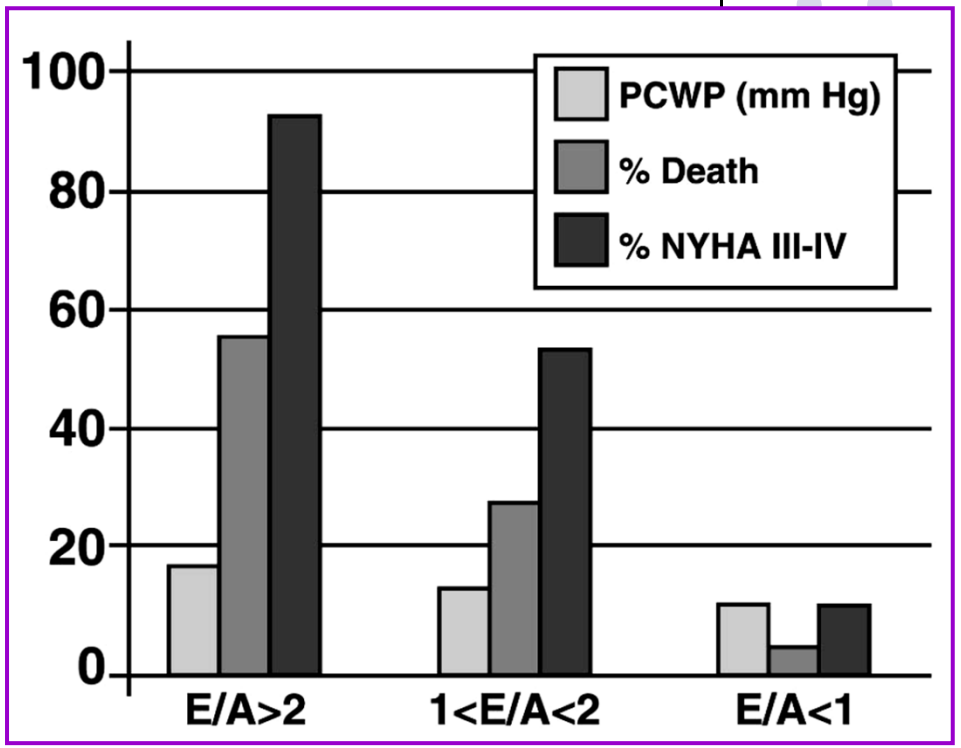
Echocardiography - LVEF

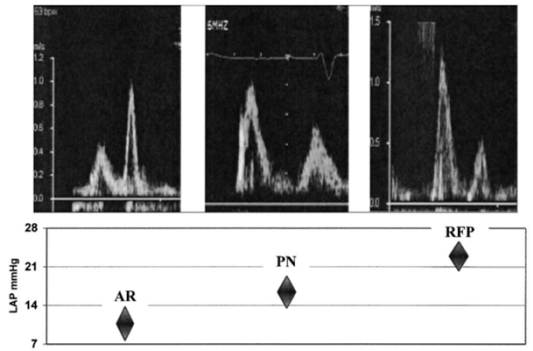
- **Disadvantages / limitations**
  - **Although low LVEF has been effectively used to select high-risk patients for application of therapy to prevent sudden arrhythmic death, LVEF has limited sensitivity:**
  - **The majority of SCDs occur in patients with more preserved LVEF**
  - **LVEF may improve with time (with medication or revascularization)**



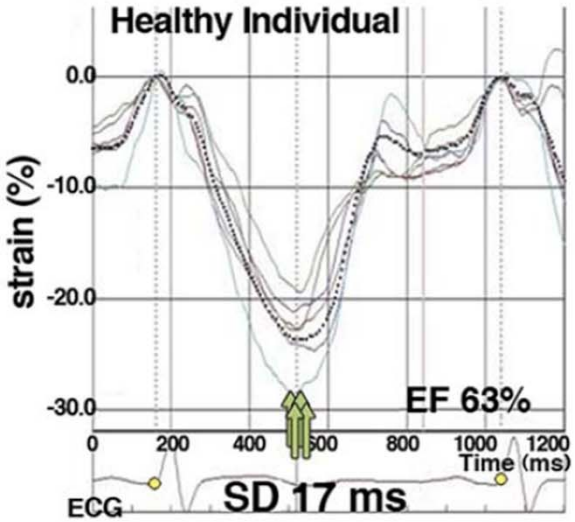
Prognostification in HF

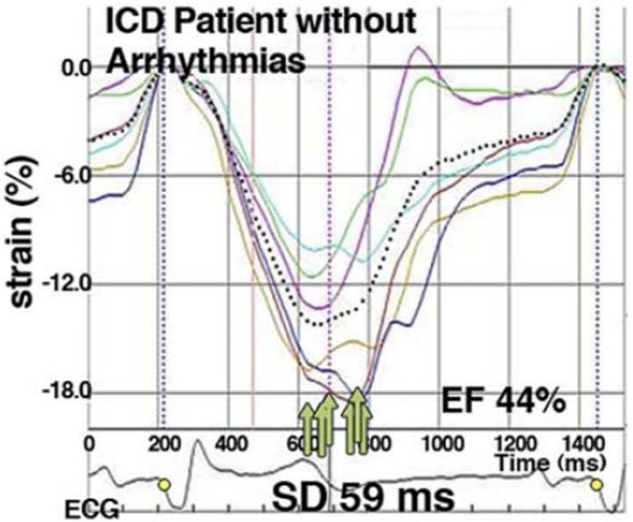


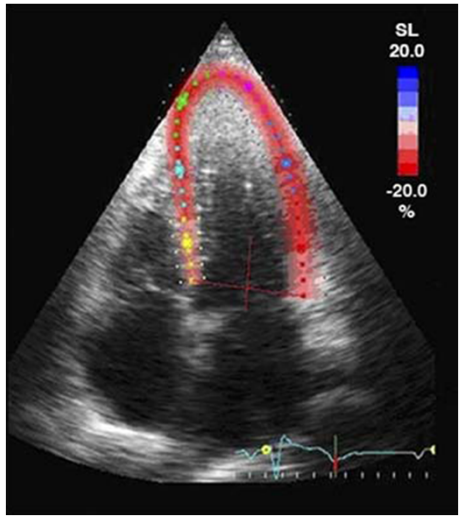


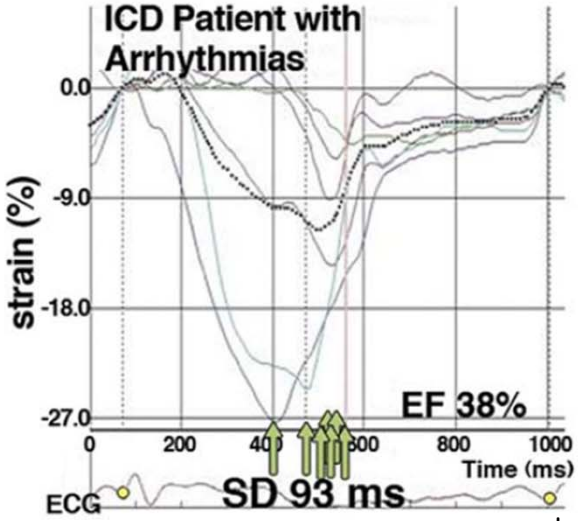


Mechanical Dispersion by Strain Echocardiography









J Am Coll Cardiol Img 2010;3:247–56

Predictors of arrhythmia

	Variable			
	Primary Prevention Criteria Patients (n = 44), HR (95% CI)	p Value	Secondary Prevention Criteria Patients (n = 41), HR (95% CI)	p Value
Univariate analyses				
Age (per 5-yr increase)	1.12 (0.90–1.40)	0.30	1.14 (0.88–1.48)	0.33
Sex (male vs. female)	1.04 (0.23–4.56)	0.95	5.42 (0.72–40.8)	0.10
Heart rate (per 5-beats/min increase)	0.96 (0.77–1.19)	0.69	0.90 (0.74–1.08)	0.25
QRS (per 10-ms increase)	0.76 (0.50–1.15)	0.20	0.97 (0.76–1.24)	0.78
QTc (per 10-ms increase)	1.02 (0.94–1.10)	0.71	0.95 (0.79–1.14)	0.56
Amiodarone therapy (yes vs. no)	1.54 (0.35–6.86)	0.57	1.06 (0.40–2.86)	0.91
Revascularization therapy (yes vs. no)	1.01 (0.39–2.62)	0.97	0.97 (0.36–2.59)	0.95
nsVT/inducible VT (yes vs. no)	2.62 (0.59–11.56)	0.21		
EF (per 5% increase)	0.80 (0.59–1.08)	0.15	1.13 (0.90–1.42)	0.30
Global strain (per 1% increase)	0.84 (0.71–0.99)	0.03	1.00 (0.89–1.12)	0.98
Mechanical dispersion (per 10-ms increase)	1.25 (1.10–1.43)	<0.01	1.30 (1.09–1.55)	<0.01
Delta contraction duration (per 10-ms increase)	1.05 (1.01–1.08)	<0.01	1.06 (1.02–1.10)	<0.01
Multivariate analyses				
Age (per 5-yr increase)	1.20 (0.93–1.55)	0.15	1.23 (0.94–1.59)	0.14
Sex (male vs. female)	0.92 (0.18–4.78)	0.92	3.80 (0.50–29.44)	0.20
EF (per 5% increase)	0.90 (0.56–1.45)	0.68	1.10 (0.83–1.46)	0.51
Global strain (per 1% increase)	0.92 (0.76–1.11)	0.37		
Mechanical dispersion (per 10-ms increase)	1.24 (1.07–1.43)	<0.01	1.31 (1.08–1.58)	<0.01

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Predictors of arrhythmia

	EF <35%			EF >35%		
	Without Arrhythmic Events During Follow-Up (n = 26)	With Arrhythmic Events During Follow-Up (n = 16)	p Value*	Without Arrhythmic Events During Follow-Up (n = 21)	With Arrhythmic Events During Follow-Up (n = 22)	p Value*
Age (yrs)	60 ± 9	64 ± 8	0.52	64 ± 10	67 ± 11	0.32
EF (%)	27 ± 5	27 ± 5	0.99	44 ± 8	41 ± 5	0.23
Global strain (%)	−8.9 ± 2.2	−7.2 ± 3.0	0.04	−14.0 ± 4.0	−12.0 ± 3.0	0.05
Mechanical dispersion (ms)	52 ± 13	93 ± 31	<0.001	61 ± 12	80 ± 27	0.01
Delta contraction duration (ms)	170 ± 40	340 ± 120	<0.001	225 ± 80	280 ± 110	0.06
QRS duration (ms)	104 ± 14	107 ± 26	0.88	95 ± 13	101 ± 28	0.49
ICD secondary prevention, no. (%)	12 (46)	3 (19)	0.07	11 (52)	15 (68)	0.29
ICD primary prevention, no. (%)	14 (54)	13 (81)	0.07	10 (48)	7 (32)	0.29

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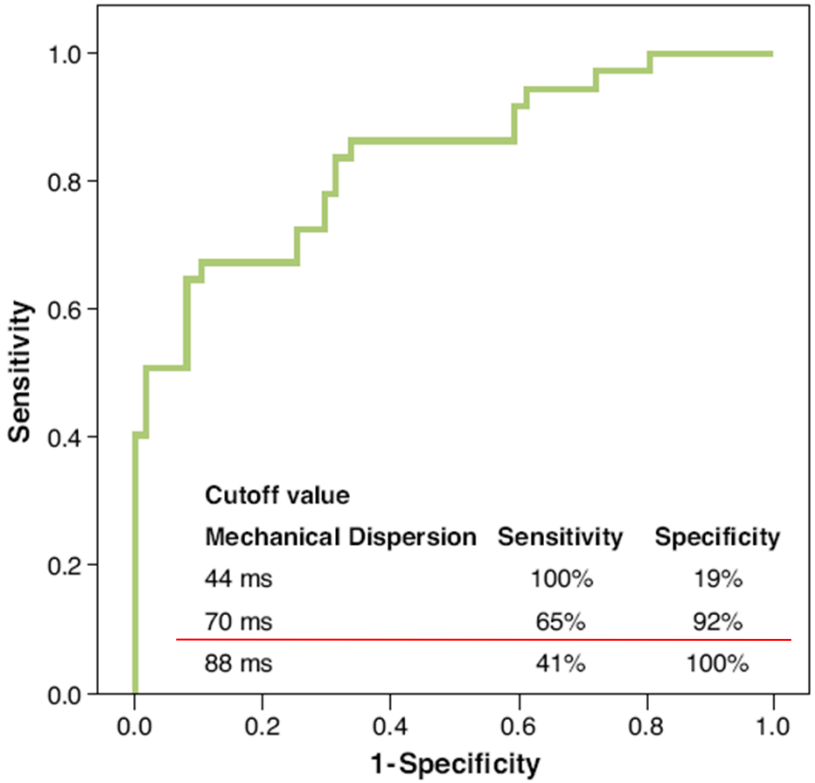
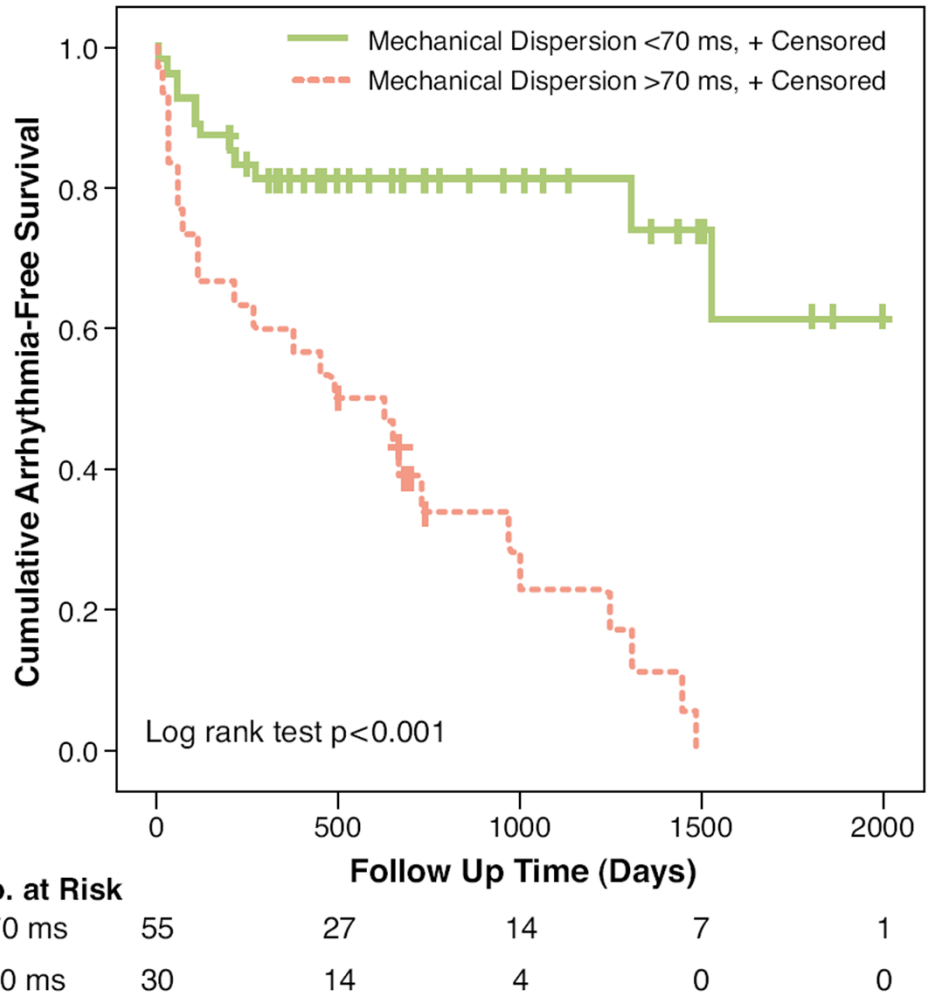
Predictors of arrhythmia



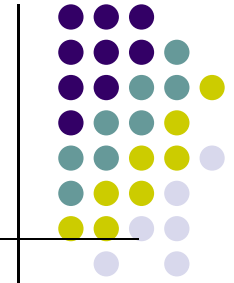


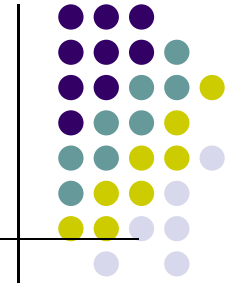
J Am Coll Cardiol Img 2010;3:247–56

Summary

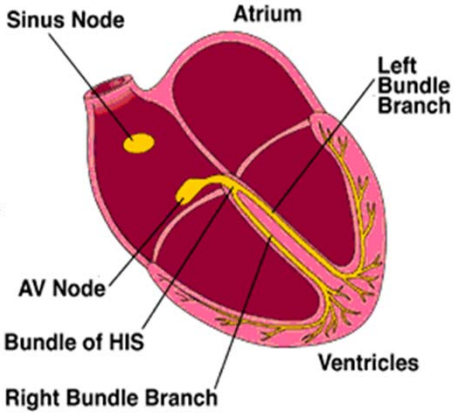
- Electrical dispersion and regional differences of myocardial contraction in various arrhythmogenic CVD
- Subtle contraction heterogeneity can be demonstrated by tissue doppler or myocardial strain echocardiography as mechanical dispersion.
- Mechanical dispersion may be promising parameters to predict arrhythmic events in these patients.

Thank you for your attention



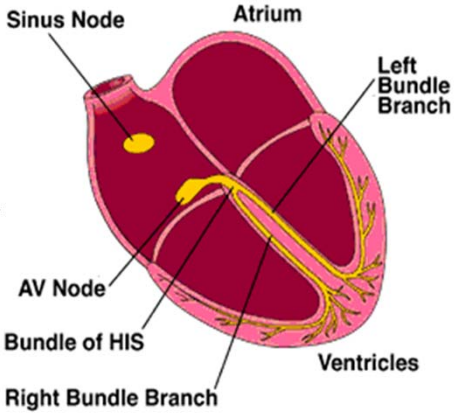


Various arrhythmia



- **Bradyarrhythmia**
  - **Sinus bradycardia**
  - **Sick sinus syndrome**
  - **Sinus arrest**
- **Atrio-ventricular block**
  - **1st degree AVB**
  - **2nd degree AVB**
  - **Complete AVB**
- **Bundle branch block**
  - **Left bundle branch block**
  - **Right bundle branch block**
  - **Fascicular block**

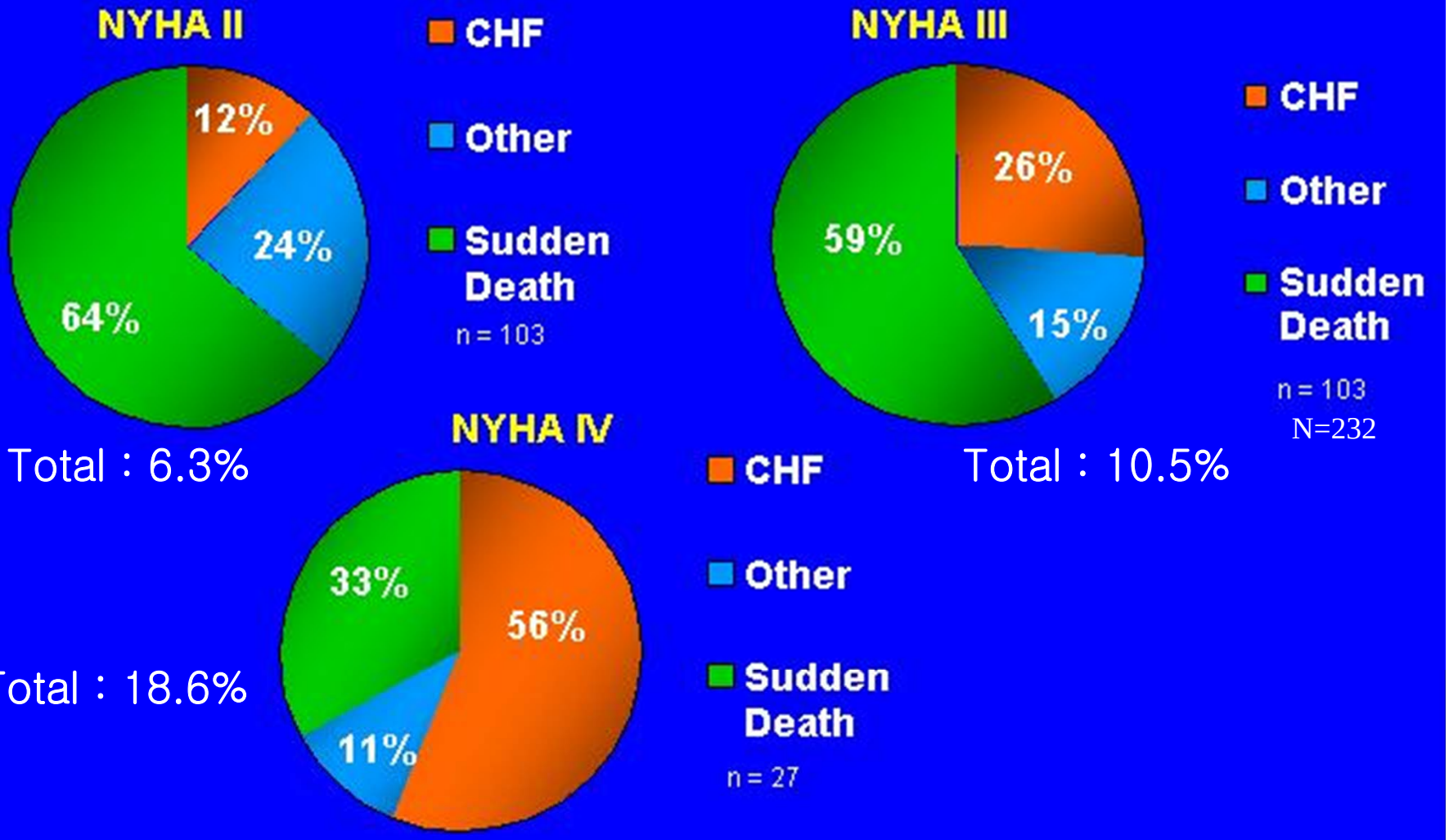
Various arrhythmia



- **Supraventricular arrhythmia**
  - **Sinus tachcardia**
  - **Atrial fibrillation**
  - **Atrial flutter**
  - **Paroxysmal supraventricular tachycardia**
  - **Atrial tachycardia**
  - **Junctional tachcardia**
- **Ventricular tachycardia**
  - **Ventricular tachycardia**
  - **Ventricular fibrillation**

Severity of Heart Failure

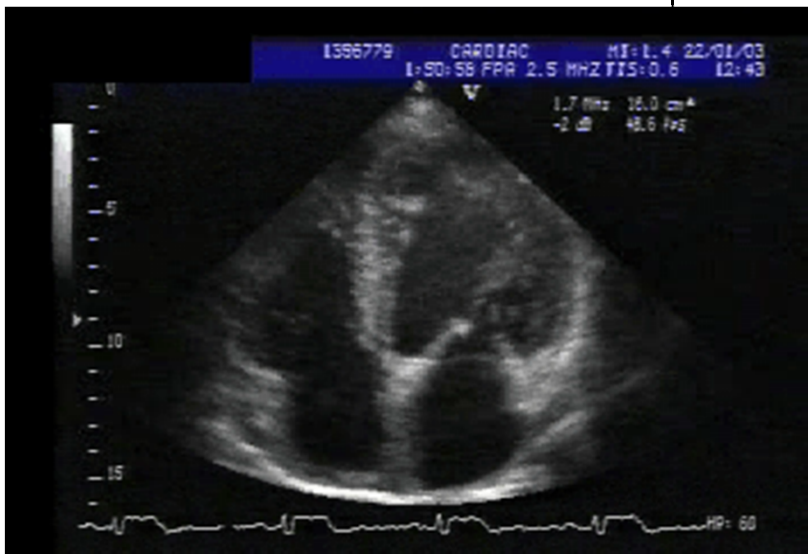
Modes of Death

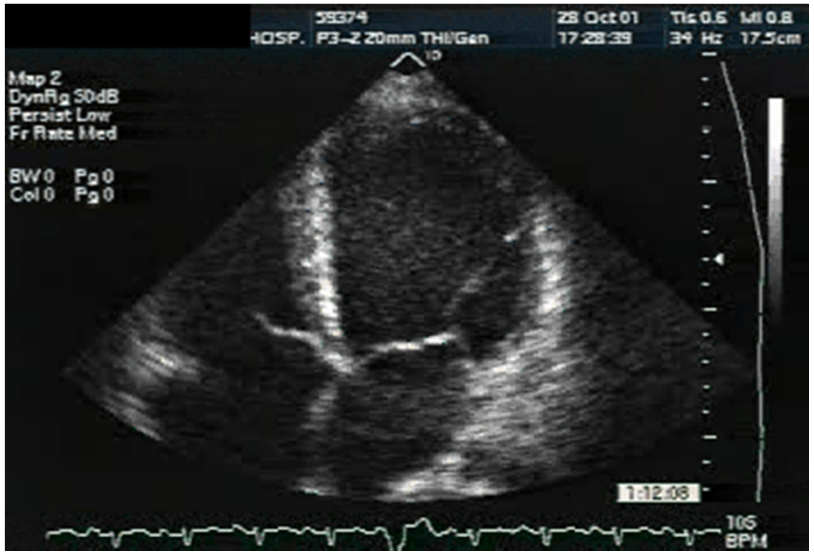


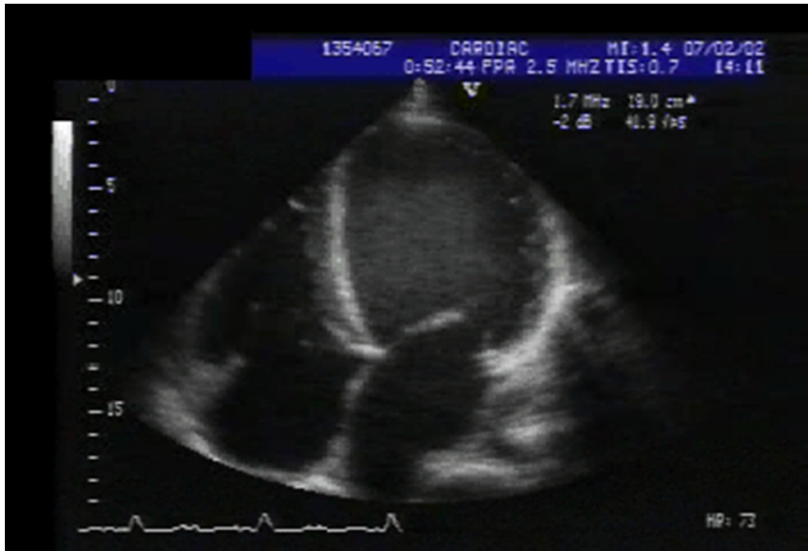
MERIT-HF Study Group. Effect of Metoprolol CR/XL in chronic heart failure: Metoprolol CR/XL randomized intervention trial in congestive heart failure (MERIT-HF). *LANCET*. 1999;353:2001-07.

Case of HF


1396779 CARDIAC MI:1.4 24/02/02
1:07:21 FPA 2.5 MHZ TIS:0.7 15:57
HR: 90

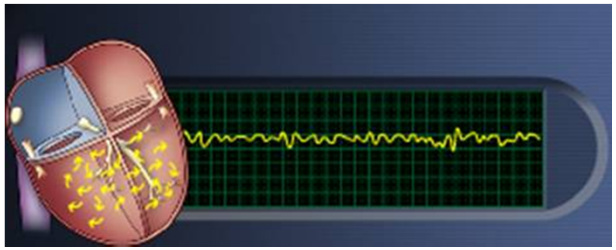

1396779 CARDIAC MI:1.4 22/01/03
1:50:58 FPA 2.5 MHZ TIS:0.6 12:43
HR: 60


59374
HOSP. P3-2 20mm THI/Gen
28 Oct 01
17:28:39
TIs 0.6 MI 0.8
34 Hz 17.5cm
Map 2
DynRg 50dB
Persist Low
Fr Rate Med
BW 0 Pg 0
Col 0 Pg 0
1:12.08
105
BPM

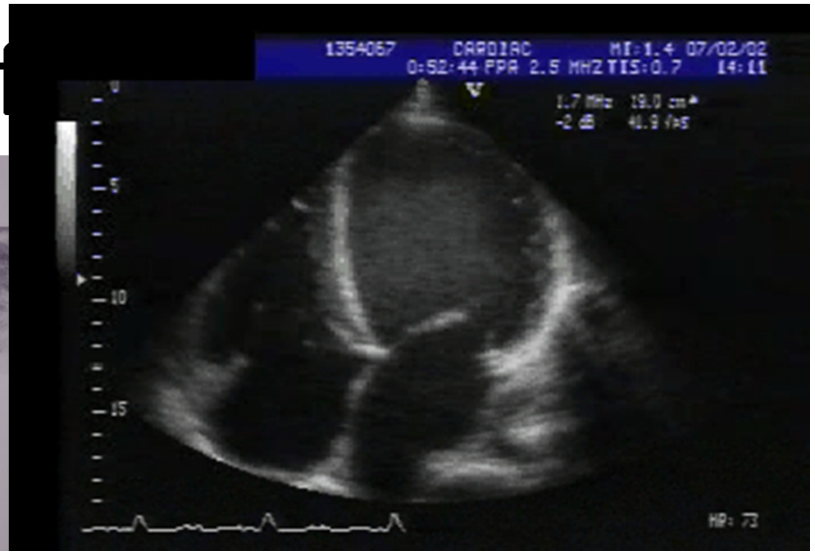

1354067 CARDIAC MI:1.4 07/02/02
0:52:44 FPA 2.5 MHZ TIS:0.7 14:11
HR: 73

Causes of death

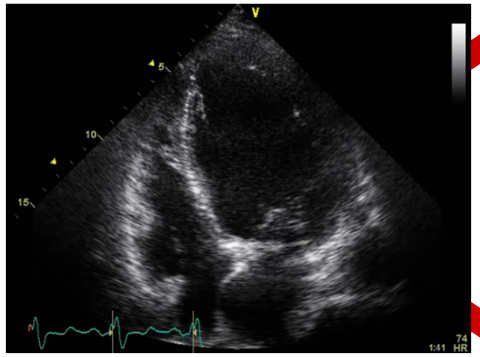
Arrhythmia



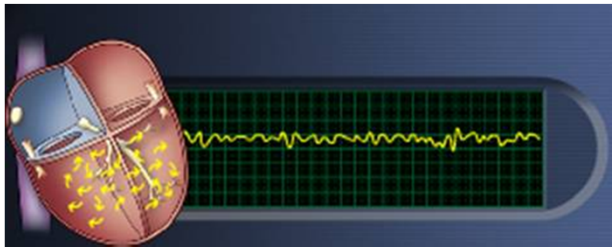
Pump f

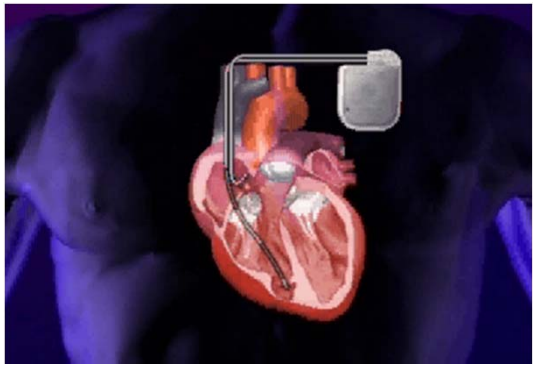


Causes of death

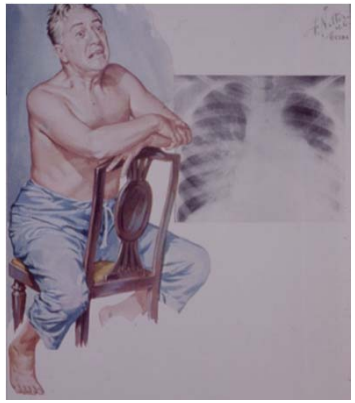


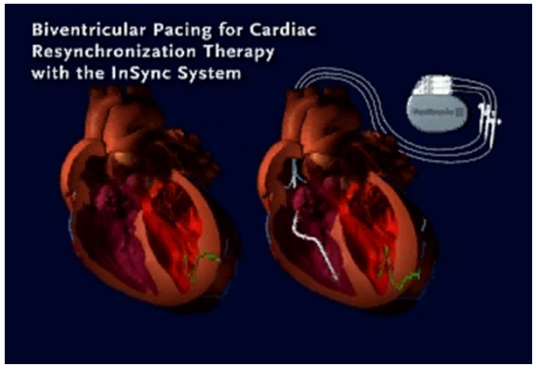
Arrhythmia → ICD



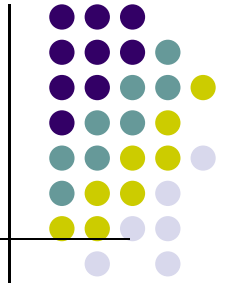


Pump failure → CRT





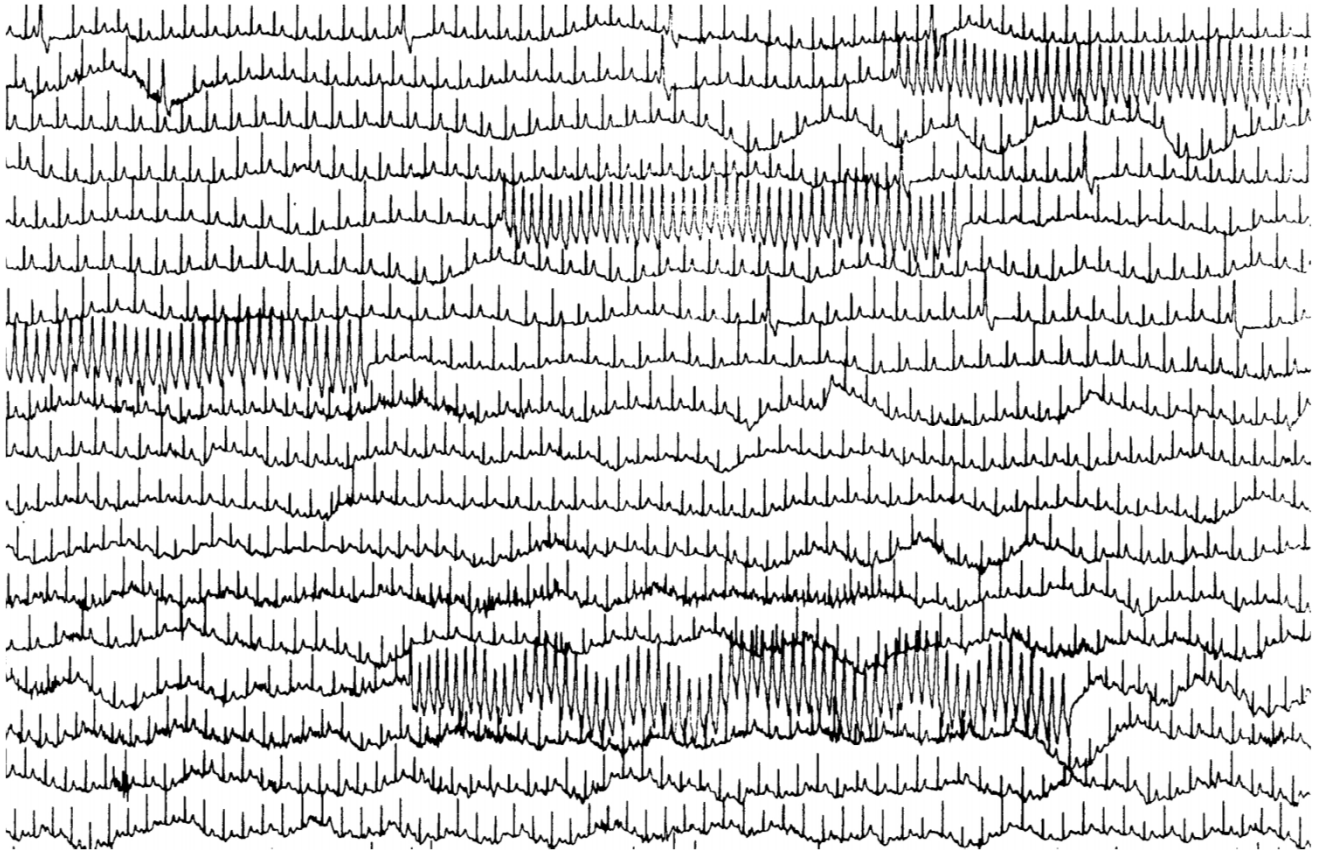
Echocardiography - LVEF



- **Advantages**
  - **Available in almost all hospitals**
  - **Routinely performed in patients post AMI**
  - **Provides additional information (eg, valvular function)**
  - **Cut-off values for ICD insertion stated in guidelines**

- **Disadvantages / limitations**
  - **Although low LVEF has been effectively used to select high-risk patients for application of therapy to prevent sudden arrhythmic death, LVEF has limited sensitivity:**
  - **The majority of SCDs occur in patients with more preserved LVEF**
  - **LVEF may improve with time (with medication or revascularisation)**

Natural history of ARVC ???



Arrhythmic risk stratification pyramid and current indications for implantation of an implantable cardioverter defibrillator (ICD) based on observational studies on ICD therapy in arrhythmogenic right ventricular cardiomyopathy dyplasia (ARVC/D).