Ventricular Arrhythmias- Diagnosis & Treatment

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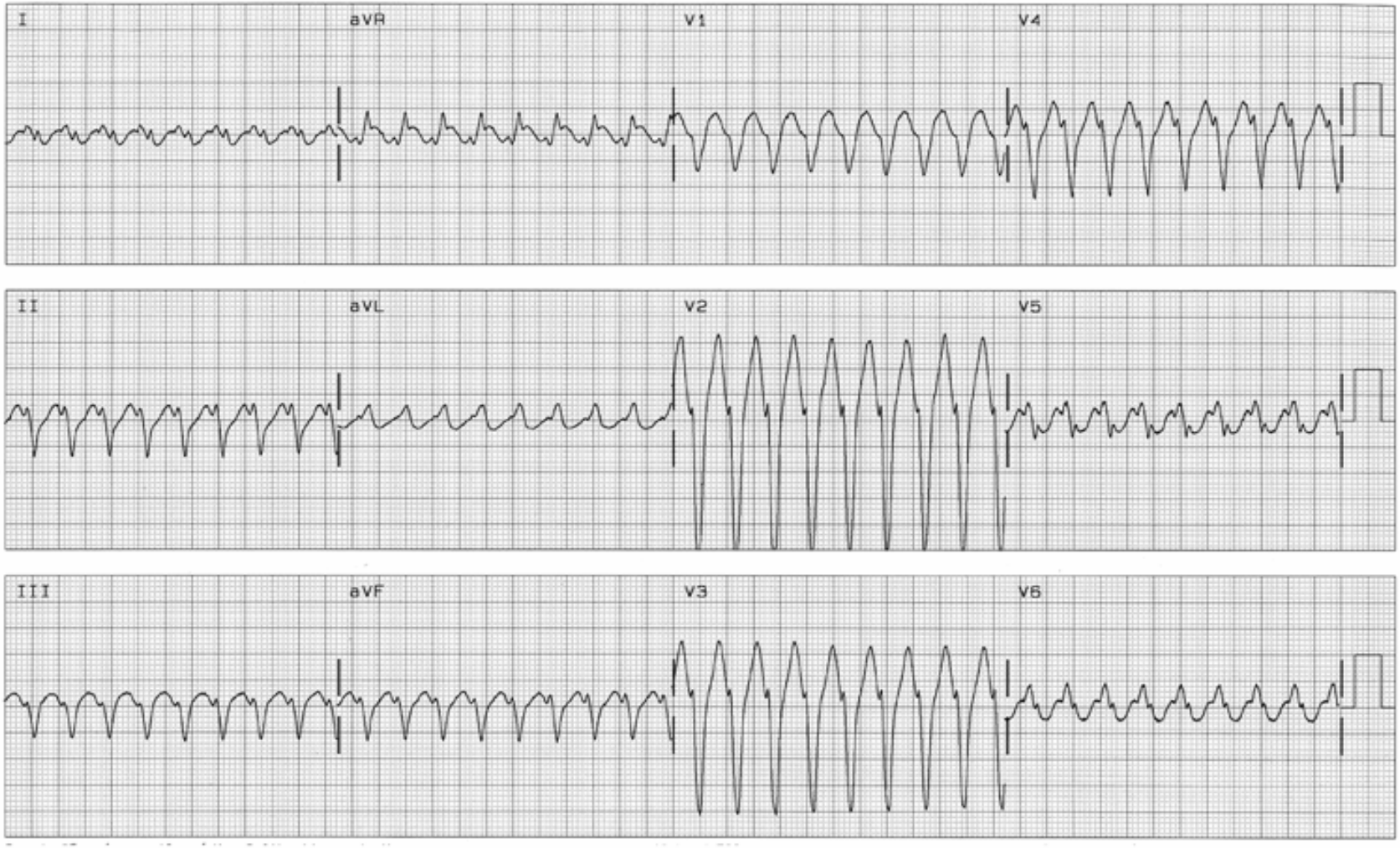
Topics

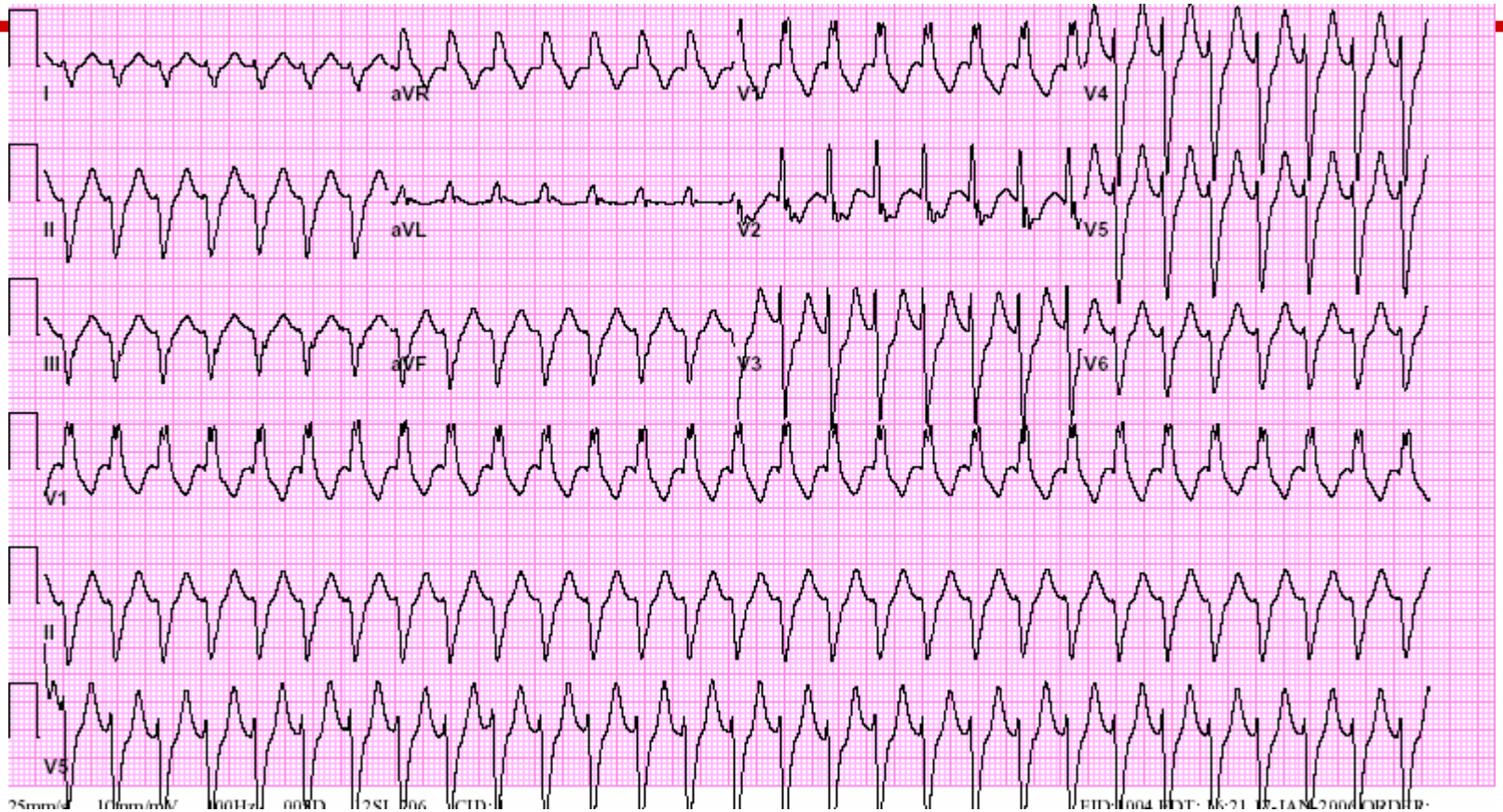
- Differentiating WCT
- Differentiating VT
- Acute management of specific VTs
  - Incessant VT
- VT with structural heart disease
  - **CAD**
    - **Primary and Secondary SCD prevention**
    - **VT ablation**
  - Dilated CM
  - HCM
  - RVCM (ARVD)
  - Myocarditis

Topics

- VT without structural heart disease
  - **Long QT**
  - **Brugada Syndrome**
  - CPVT
  - Short QT
  - Early repolarization
  - Idiopathic VF

Differentiating Wide Complex Tachycardia




I
aVR
V1
V4
II
aVL
V2
V5
III
aVF
V3
V6
V1
II
V5

Brugada algorithm

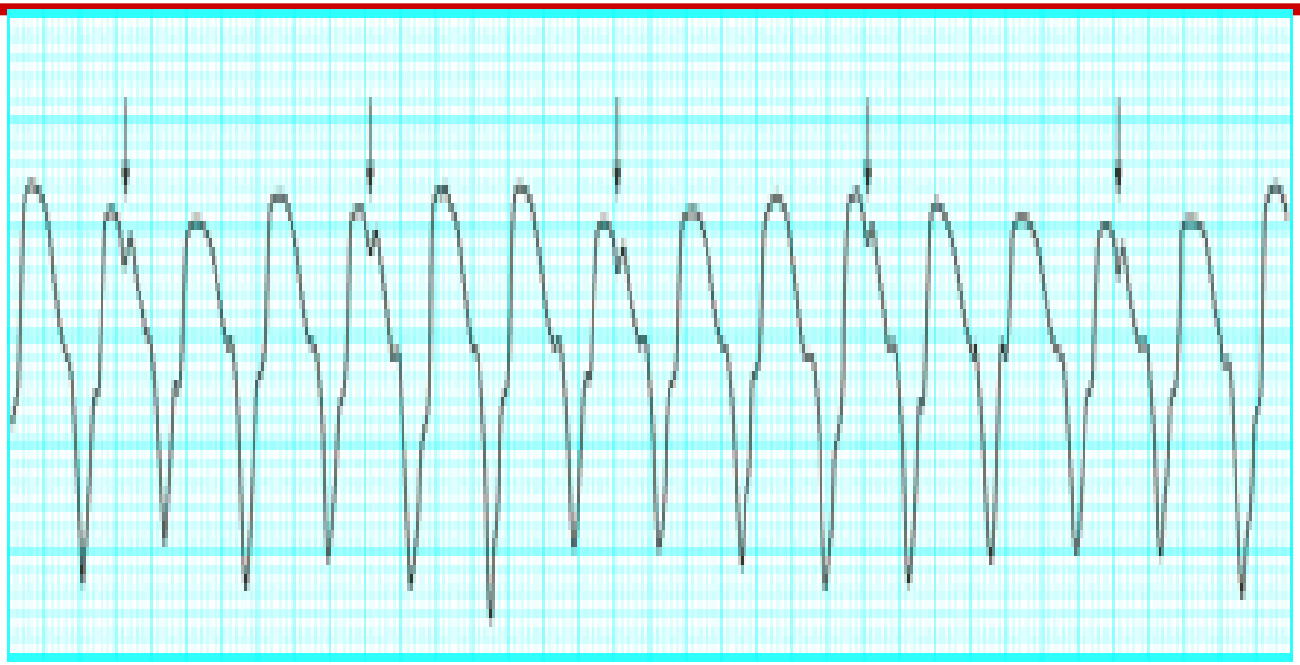
1. Absence of an RS complex in all precordial leads?

2. The longest R to S interval >100 ms in any precordial lead?

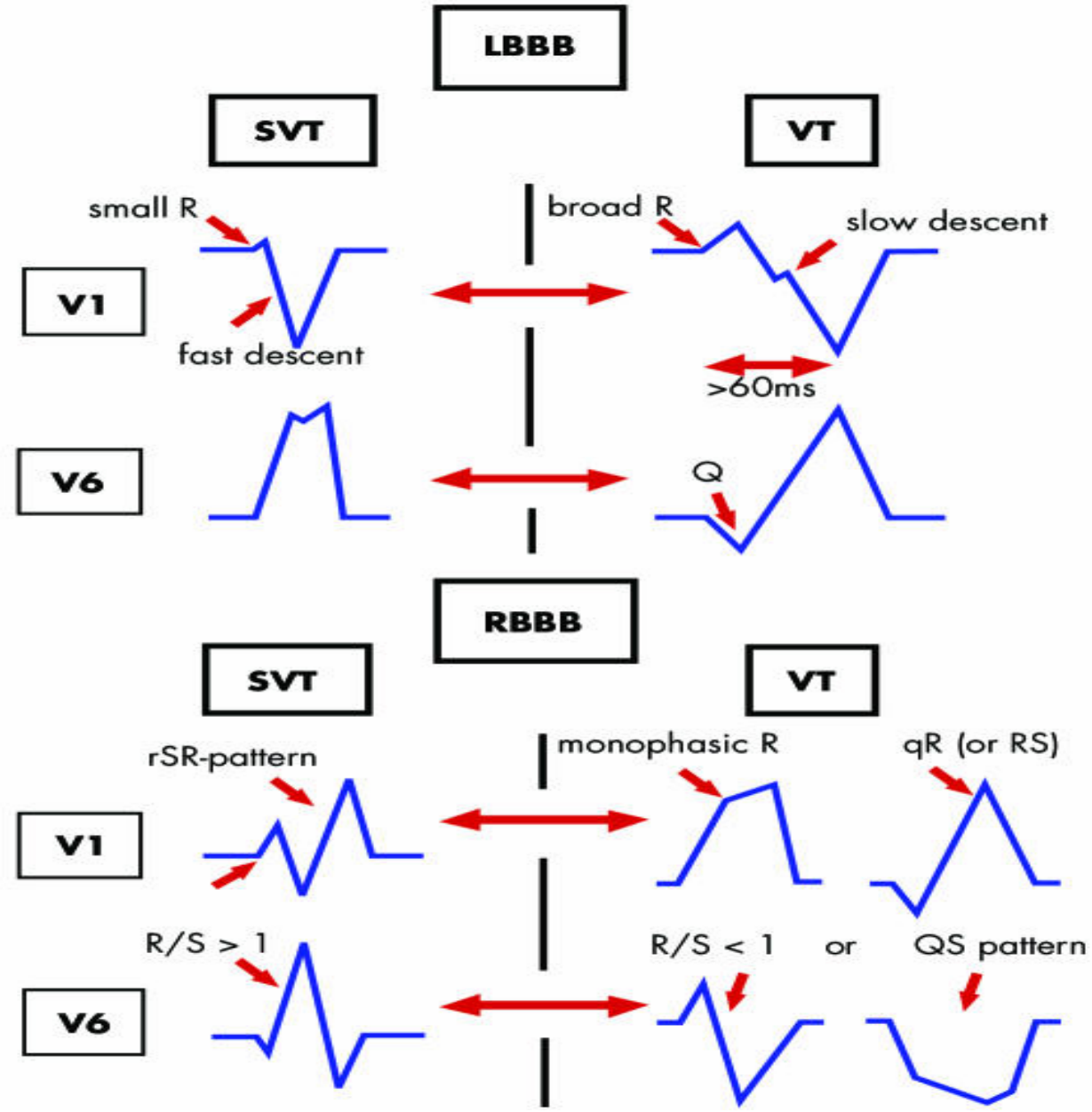
3. A-V dissociation?

4. Morphology criteria for VT present both in leads V_{1-2} and V_6?

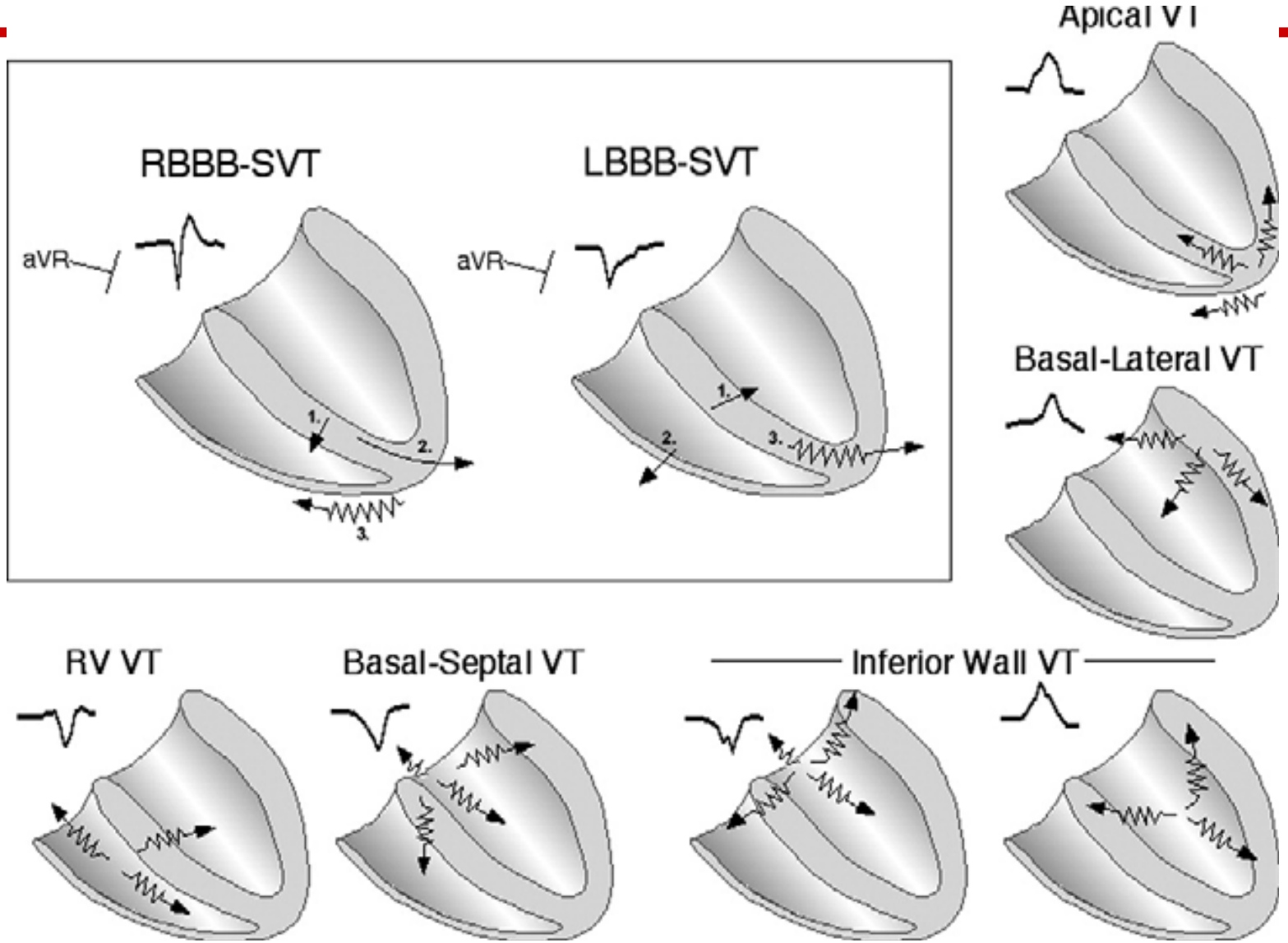
AV dissociation



Capture and Fusion Beats


LBBB
SVT
VT
small R
broad R
slow descent
V1
fast descent
>60ms
V6
Q
RBBB
SVT
VT
rSR-pattern
monophasic R
qR (or RS)
V1
R/S > 1
R/S < 1
or
QS pattern
V6

Lead aVR Based Algorithm



New aVR algorithm

In lead aVR:

Step 1. Presence of an initial R wave?

- No → **Step 2.** Presence of an initial r or q wave >40 ms?
- Yes → VT diagnosed

Step 2. Presence of an initial r or q wave >40 ms?

- No → **Step 3.** Presence of a notch on the descending limb of a negative onset and predominantly negative QRS?
- Yes → VT diagnosed

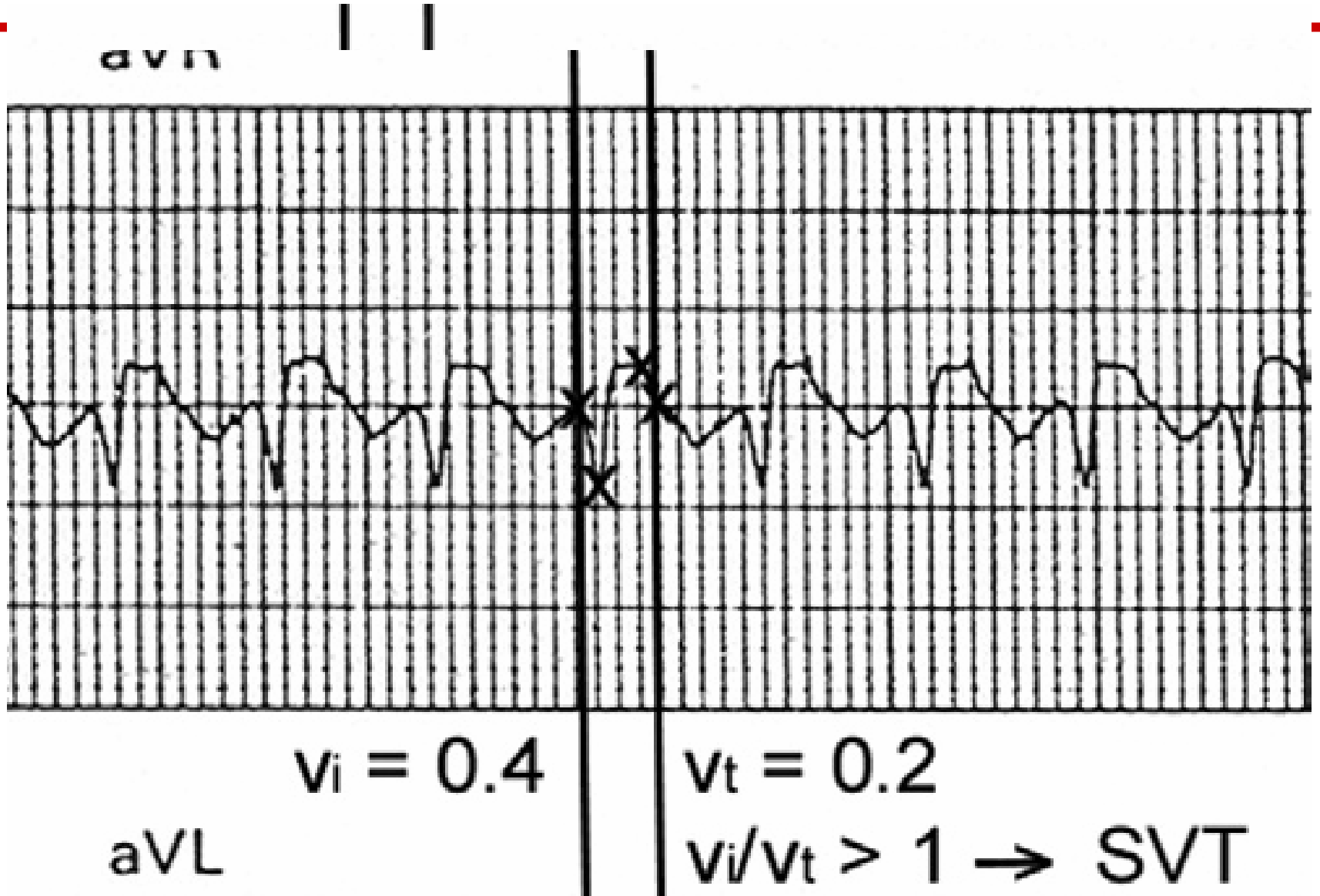
Step 3. Presence of a notch on the descending limb of a negative onset and predominantly negative QRS?

- No → **Step 4.** $v_i/v_t \leq 1$?
- Yes → VT diagnosed

Step 4. $v_i/v_t \leq 1$?

- No → SVT diagnosed
- Yes → VT diagnosed

New aVR Algorithm

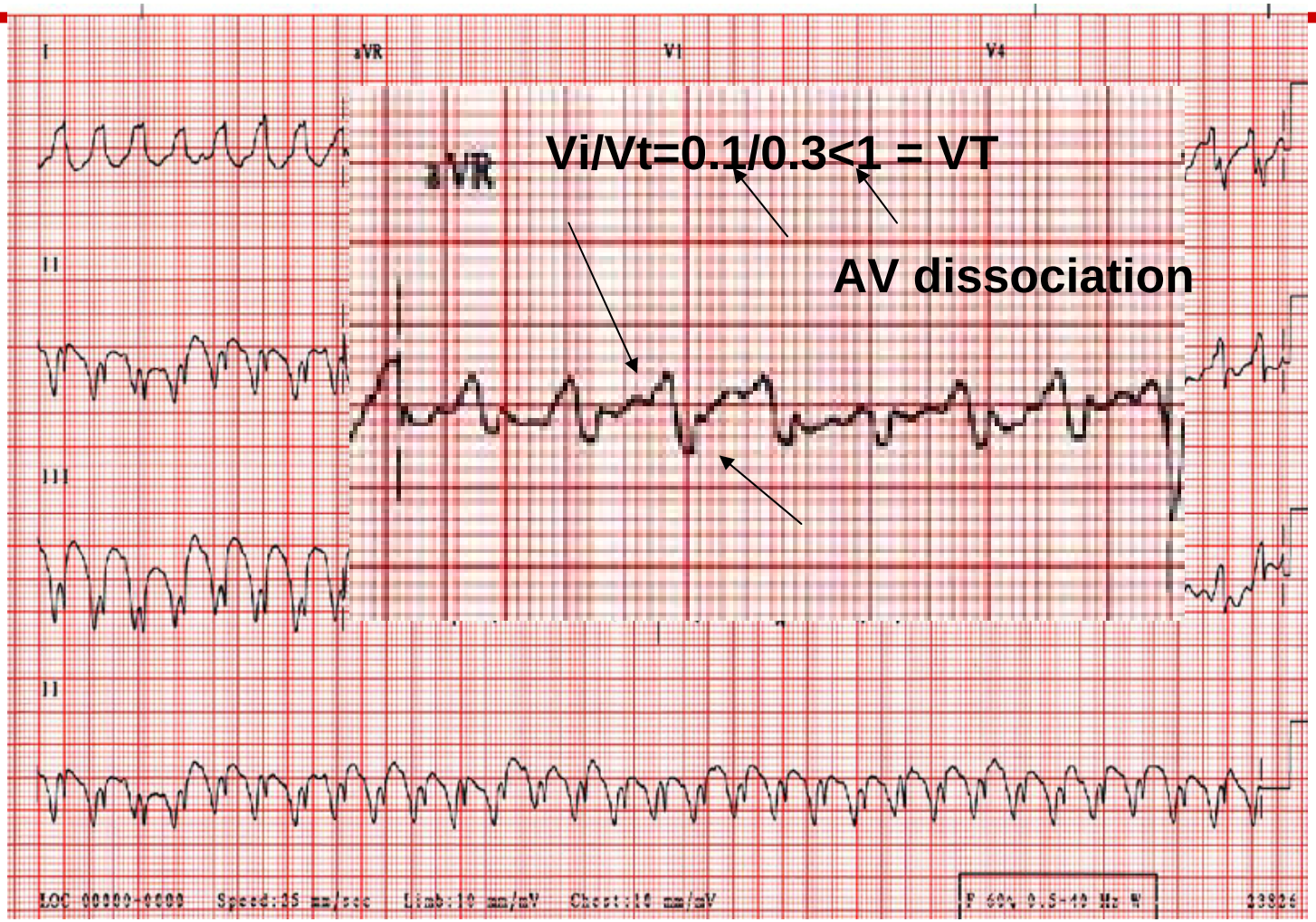


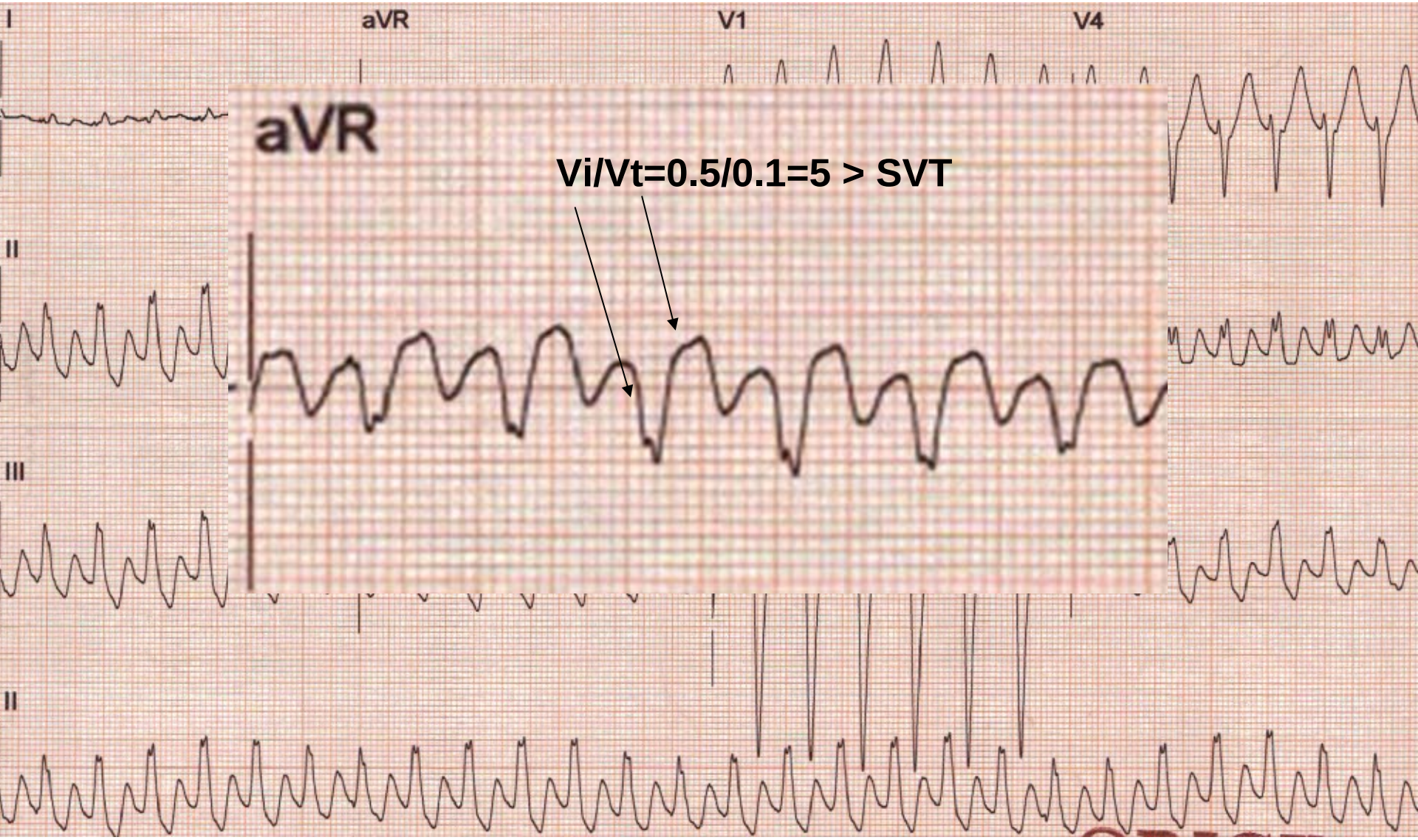
VT diagnosis

	Sensitivity	Specificity	PPV	NPV
Brugada Criteria[1]	89	73	92	67
New aVR Criteria[2]	97	75	93	87

[1] Brugada P, et al. Circulation1991

[2] Vereckei A, et al. Heart Rhythm 2009


Vi/Vt=0.1/0.3<1 = VT
AV dissociation


I
aVR
V1
V4
II
III
II
aVR
Vi/Vt=0.5/0.1=5 > SVT

Clinical Presentations of Patients with Ventricular Arrhythmias

- Asymptomatic individuals with or without electrocardiographic abnormalities
- Persons with symptoms potentially attributable to ventricular arrhythmias
  - Palpitations
  - Dyspnea
  - Chest pain
  - Syncope and presyncope
- Ventricular tachycardia that is hemodynamically stable
- Ventricular tachycardia that is not hemodynamically stable
- Cardiac arrest
  - Asystolic (sinus arrest, atrioventricular block)
  - Ventricular tachycardia
  - Ventricular fibrillation
  - Pulseless electrical activity

Acute Management of Specific Arrhythmia [ACC/AHA/ESC 2006]

Sustained Monomorphic VT

- Class I
  - Wide-QRS tachycardia should be presumed to be VT if the diagnosis is unclear.
  - Direct current cardioversion in patients with hemodynamic compromise.
- Class IIa
  - Intravenous **procainamide** is reasonable for stable patients
  - Intravenous **amiodarone** is reasonable in patients that are hemodynamically unstable, refractory to conversion with countershock, or recurrent despite procainamide or other agents.
  - Transvenous catheter **pace** termination can be useful to treat patients with VT that is refractory to cardioversion or is frequently recurrent despite antiarrhythmic medication

Acute Management of Specific Arrhythmia [ACC/AHA/ESC 2006]

Polymorphic VT

- Class I
  - Direct-current cardioversion for hemodynamic compromise
  - Intravenous **beta blockers** are useful especially if ischemia is suspected or cannot be excluded.
  - Intravenous loading with **amiodarone** is useful for patients in the **absence of abnormal repolarization** related to congenital or acquired LQTS.
  - Urgent angiography with a view to revascularization should be considered

Acute Management of Specific Arrhythmia [ACC/AHA/ESC 2006]

Torsades de Pointes

- Class I
  - **Withdrawal** of any offending drugs and correction of electrolyte abnormalities
  - **Acute and long-term pacing** is recommended for patients presenting with torsades de pointes due to heart block and **symptomatic bradycardia**.
- Class IIa
  - **Intravenous magnesium** sulfate is reasonable for patients who present with **LQTS**. Magnesium is not likely to be effective in patients with a normal QT interval.
  - **Acute and long-term pacing** is reasonable for patients who present with recurrent pause-dependent torsades de pointes.
  - **Beta blockade combined with pacing** is reasonable acute therapy for patients who present with torsades de pointes and sinus bradycardia.
  - **Isoproterenol is reasonable as temporary treatment** in acute patients who present with recurrent pause-dependent torsades de pointes who do not have congenital LQTS.

VT Storm/ Incessant VT

Class I

- **Revascularization and beta blockade** followed by intravenous antiarrythmic drugs such as procainamide or amiodarone are recommended for patients with recurrent or incessant polymorphic VT due to acute myocardial ischemia. (Level of Evidence: C)

Class IIa

- **Intravenous amiodarone or procainamide** followed by **VT ablation** can be effective in the management of patients with frequently recurring or incessant monomorphic VT. (Level of Evidence: B)

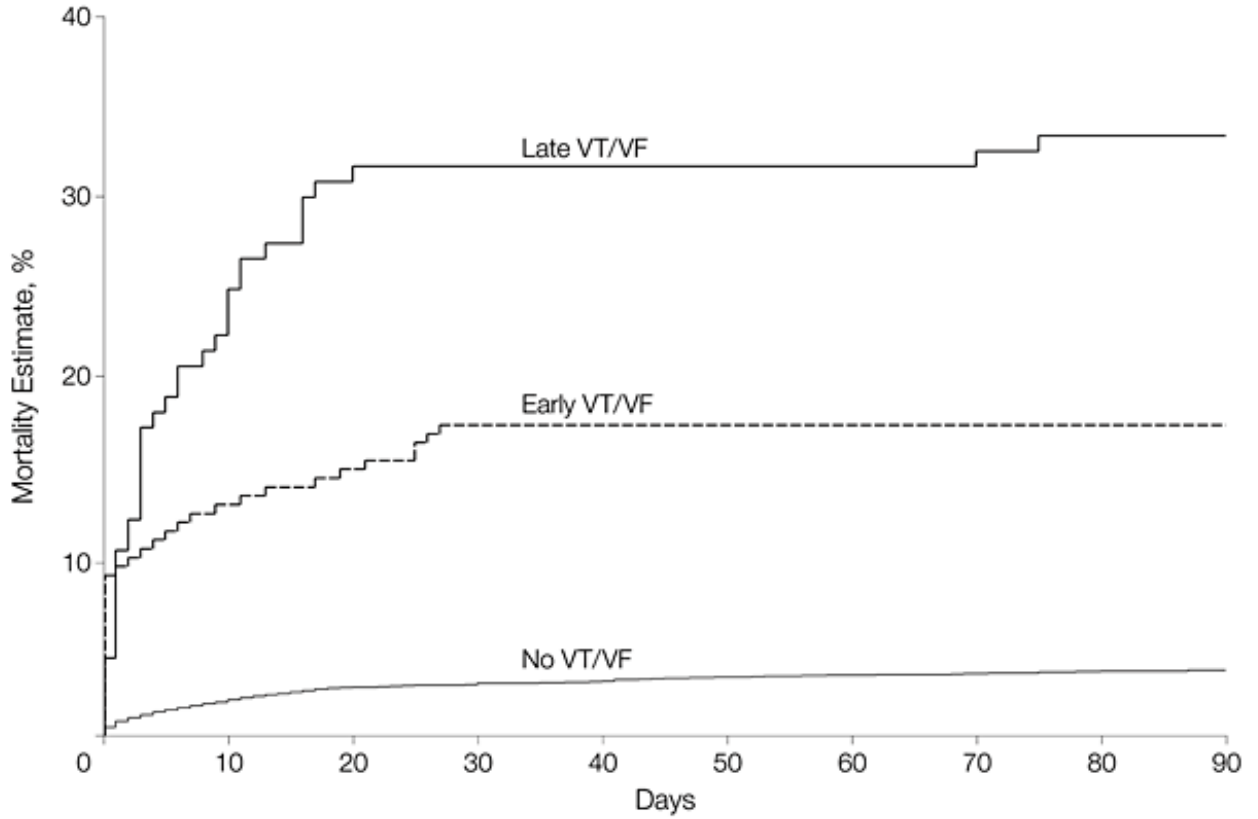
Special Considerations:

- ICDs- Interrogation, reprogramming
- Ischemia – IABP, emergency cath,
- Pause dependent- Pacing, Isuprel
- Brugada- Isuprel, Quinidine

VT and CAD

- “Primary” and “early” VT/VF
  - How early is “early”?
  - Impact on prognosis?
- VT associated with previous MI scar
  - Treatment
  - Risk stratification
  - Prevention of SCD

VT in patients with STEMI- Is early VT benign?



No. at risk										
Late VT/VF	117	91	81	80	80	80	80	80	78	76
Early VT/VF	203	177	173	168	168	168	168	168	168	163
No VT/VF	5405	5307	5264	5254	5245	5231	5224	5219	5212	5119

Mehta, R. H. et al. JAMA 2009;301:1779-1789.

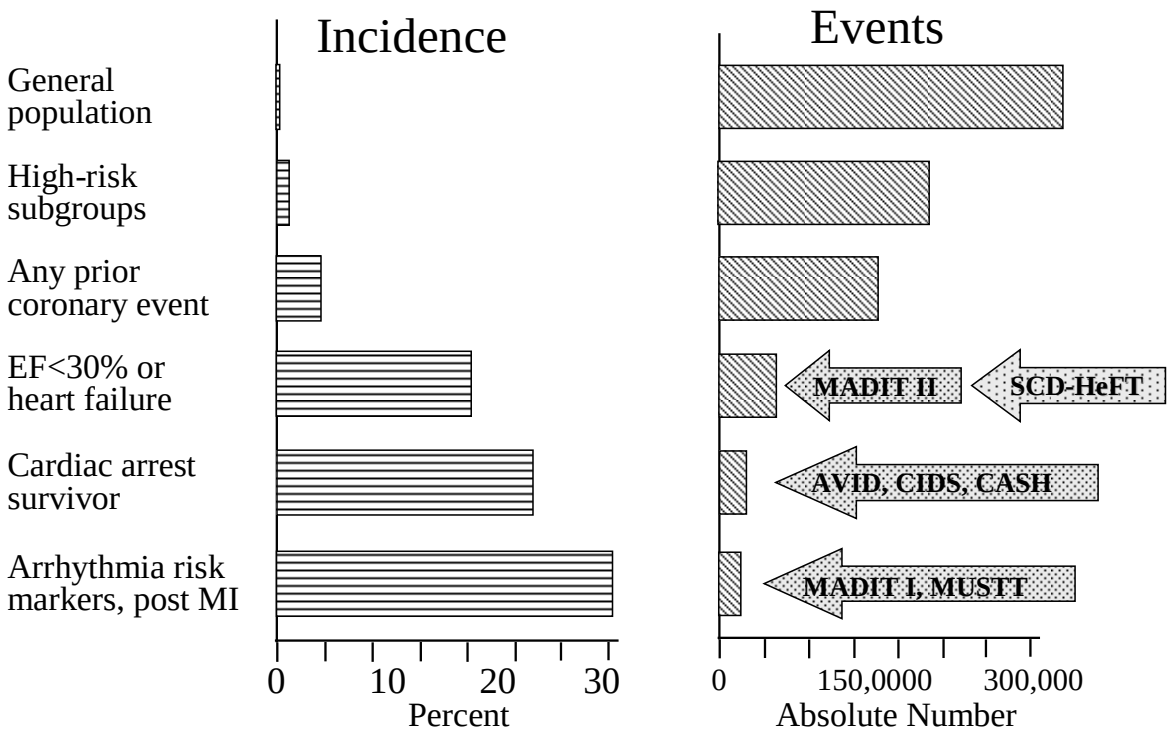
Drugs for VT/VF

Antiarrhythmic Drugs

- ♥ Beta Blockers: Effectively suppress ventricular ectopic beats & arrhythmias; reduce incidence of SCD
- ♥ Amiodarone: No definite survival benefit; some studies have shown reduction in SCD in patients with LV dysfunction especially when given in conjunction with BB.
- ♥ Sotalol: Suppresses ventricular arrhythmias; is more pro-arrhythmic than amiodarone, no survival benefit clearly shown
- ♥ **Conclusions: Antiarrhythmic drugs (except for BB) should not be used as *primary* therapy of VA and the prevention of SCD**

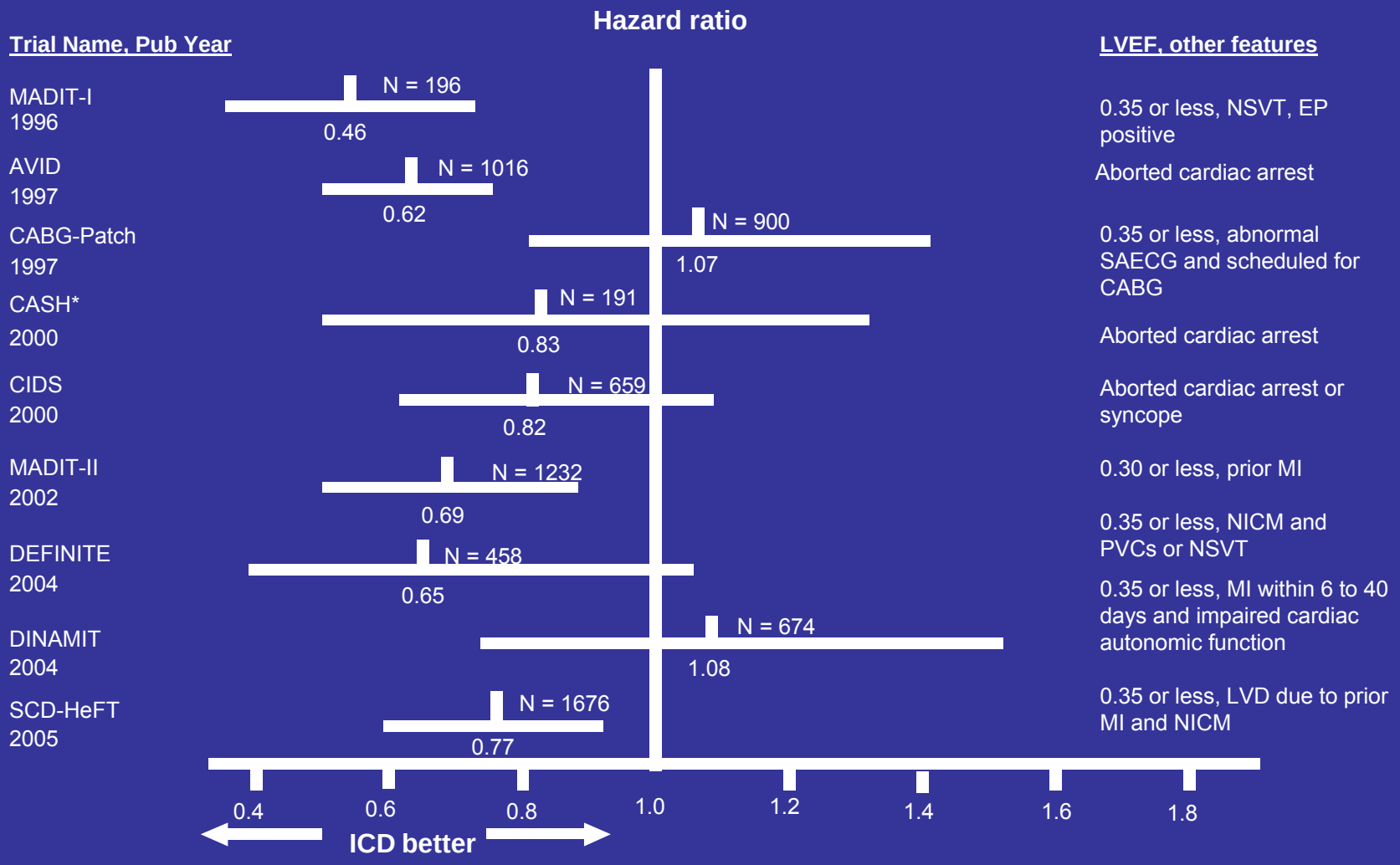
Epidemiology of VA & SCD

Incidence of Sudden Cardiac Death



Therapies for VA

ICDs: Results from Primary and Secondary Prevention Trials



VT treatment in post MI patients

Class I

- Treat HF
- Reduce Ischemia
- ICDs
  - patients who are survivors of cardiac arrest due to ventricular fibrillation or hemodynamically unstable sustained VT after evaluation to define the cause of the event and to exclude any completely reversible causes

VT treatment in post MI patients

Class I- cont

- ICDs
  - in patients with structural heart disease and spontaneous sustained VT, whether hemodynamically stable or unstable
  - in patients with syncope of undetermined origin with clinically relevant, hemodynamically significant sustained VT or VF induced at electrophysiological study

VT treatment in post MI patients

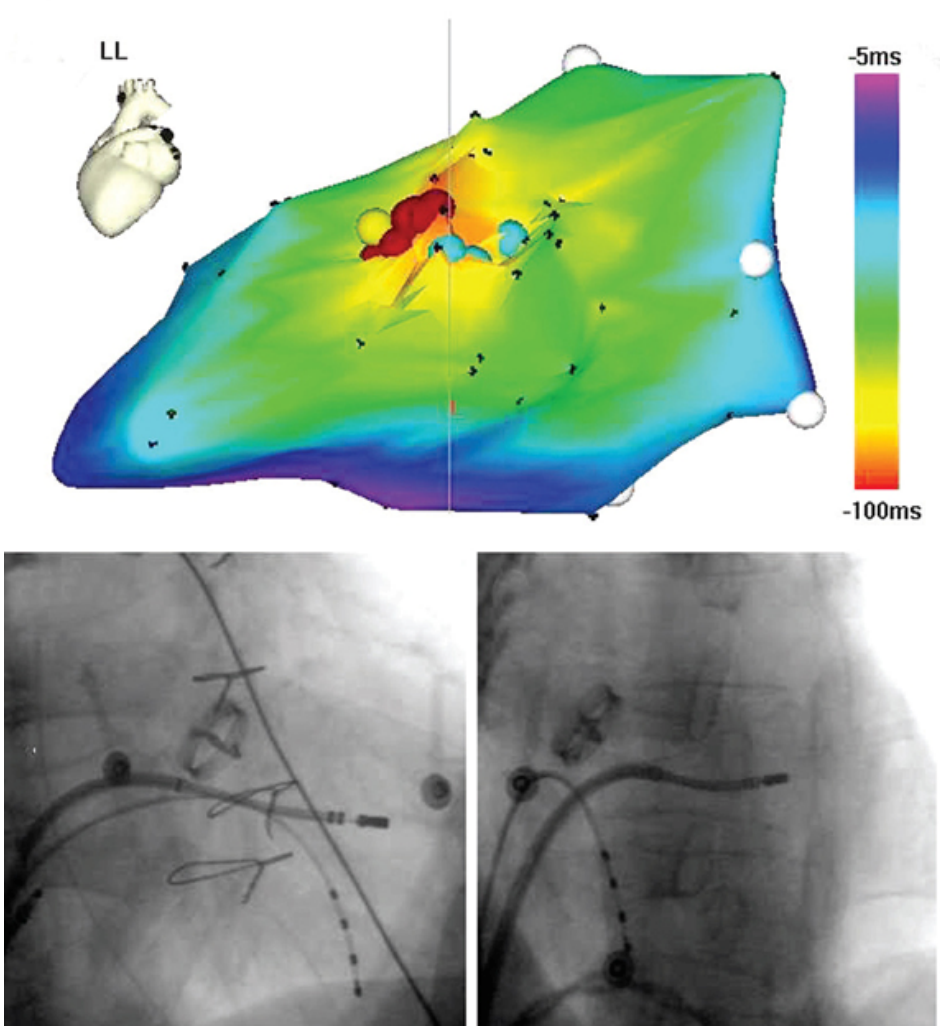
Class I- cont

- ICDs
  - in patients with LVEF less than or equal to 35% due to prior MI who are at least 40 days post-MI and are in NYHA functional Class II or III
  - in patients with LV dysfunction due to prior MI who are at least 40 days post-MI, have an LVEF less than or equal to 30%, and are in NYHA functional Class I.
  - in patients with nonsustained VT due to prior MI, LVEF less than or equal to 40%, and inducible VF or sustained VT at electrophysiological study

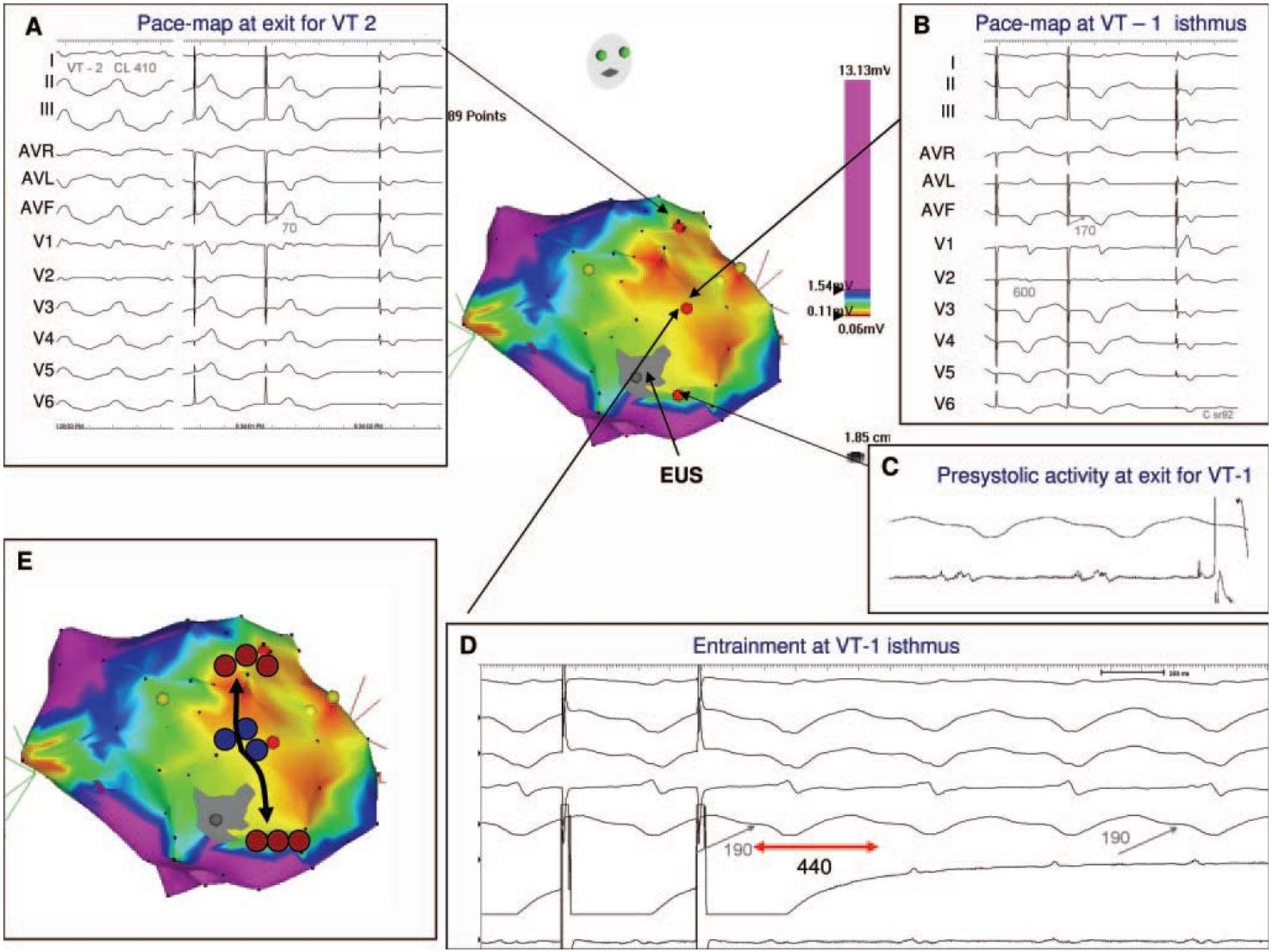
Catheter ablation of VT

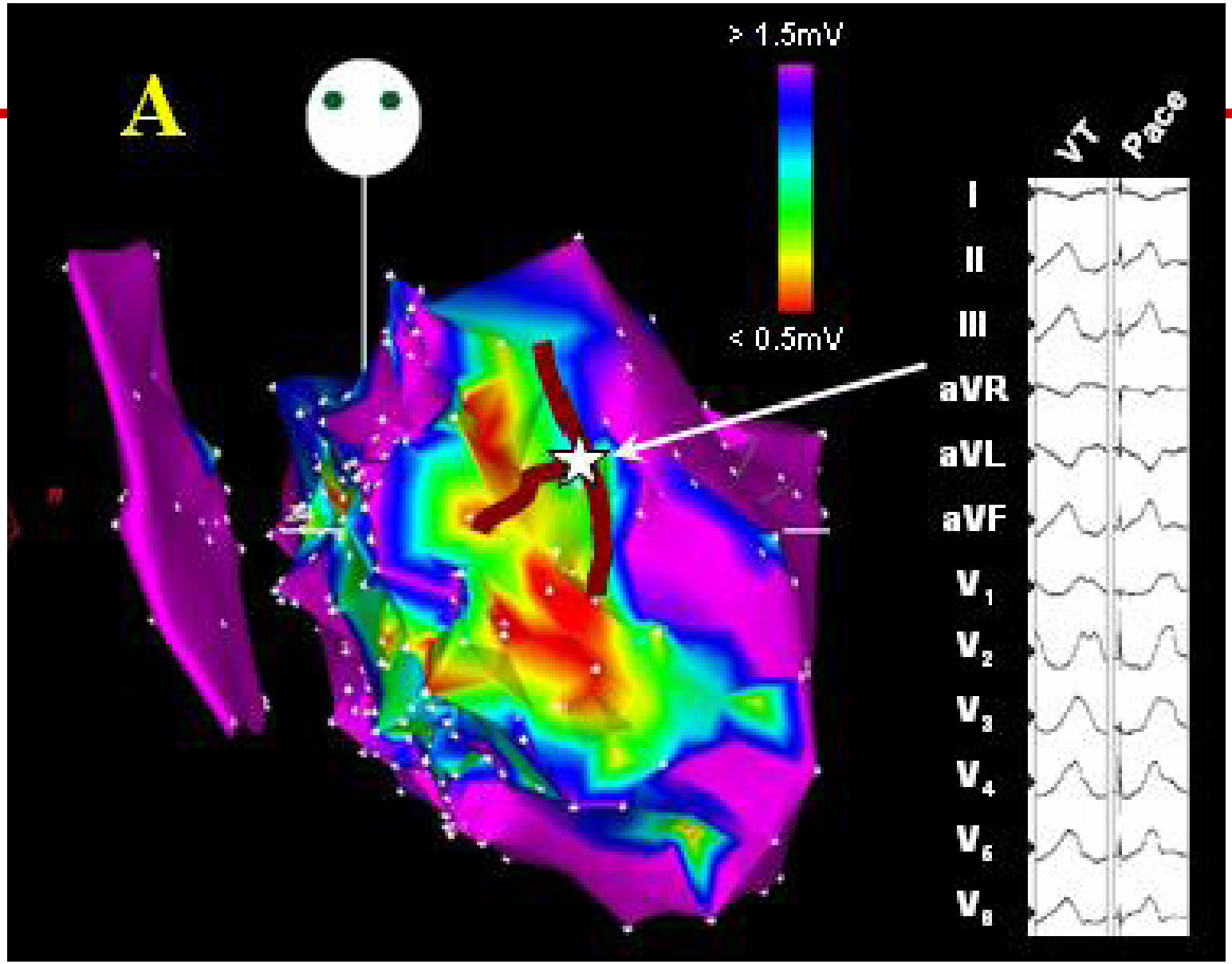
- VT mapping
  - Pace
  - Activation
  - Entrainment
- Substrate modification
  - Unstable VTs
  - 3-D voltage mapping

Activation Mapping



Substrate and Pace Mapping



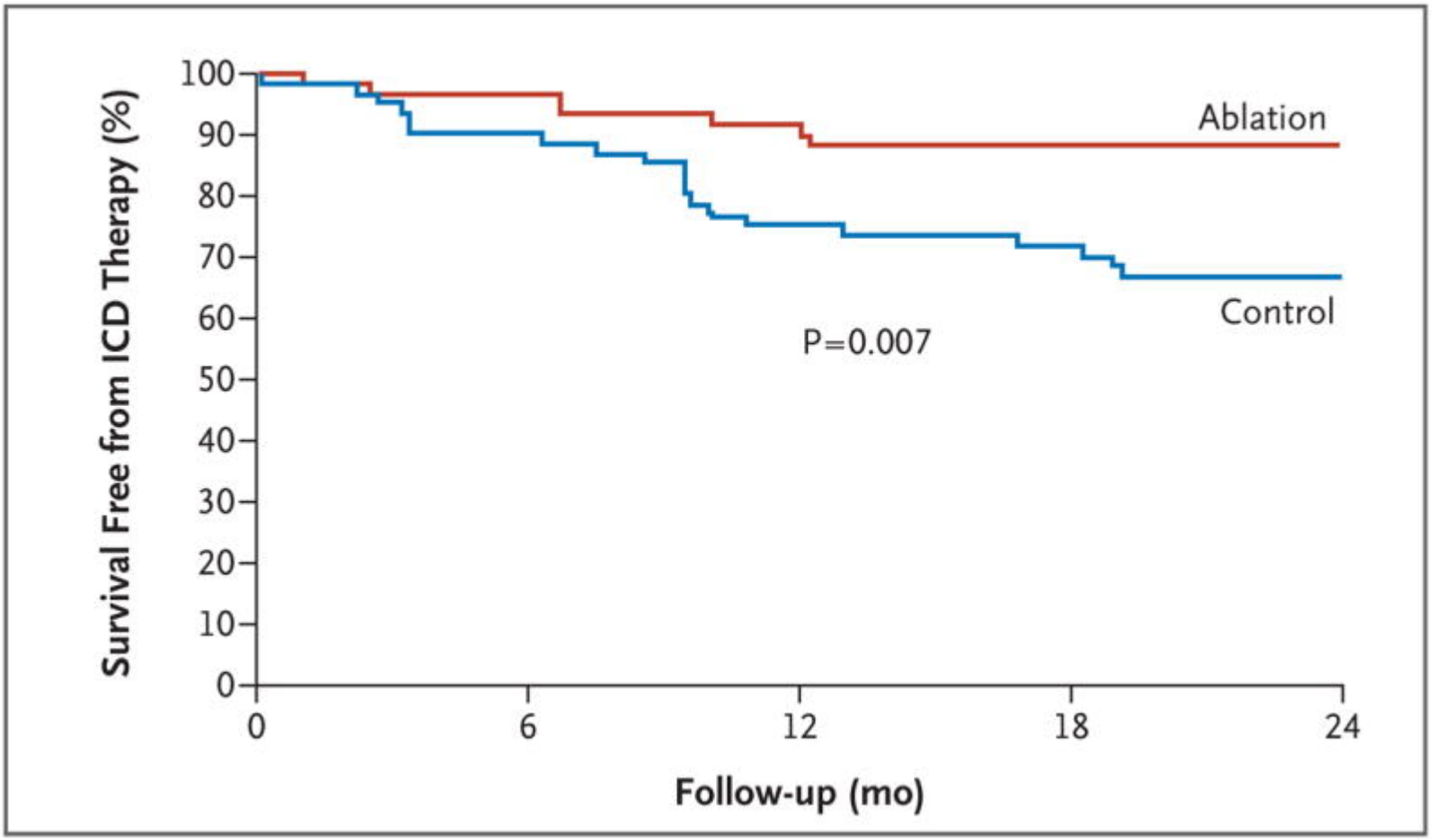

A
> 1.5mV
< 0.5mV
VT
Pace
I
II
III
aVR
aVL
aVF
V1
V2
V3
V4
V5
V6

SMASH-VT: Clinical end points

End point	Ablation group (n=64), n (%)	Control group (n=64), n (%)	Hazard ratio (95% CI)
ICD events	8 (12)	21 (33)	0.35 (0.15–0.78)
ICD shocks	6 (9)	20 (31)	0.27 (0.11–0.67)
ICD storm	4 (6)	12 (19)	0.30 (0.09–1.00)
Death	6 (9)	11 (17)	0.59 (0.22–1.59)

Reddy V et al. *N Engl J Med* 2007; 357:2657-2665.

SMASH-VT: Survival Free from ICD Therapy



Reddy V et al. *N Engl J Med* 2007; 357:2657-2665.

Catheter ablation of VT is recommended

1. for symptomatic sustained monomorphic VT (SMVT), including VT terminated by an ICD, that recurs despite antiarrhythmic drug therapy or when antiarrhythmic drugs are not tolerated or not desired;

2. for control of incessant SMVT or VT storm that is not due to a transient reversible cause;

3. for patients with frequent PVCs, NSVTs, or VT that is presumed to cause ventricular dysfunction;

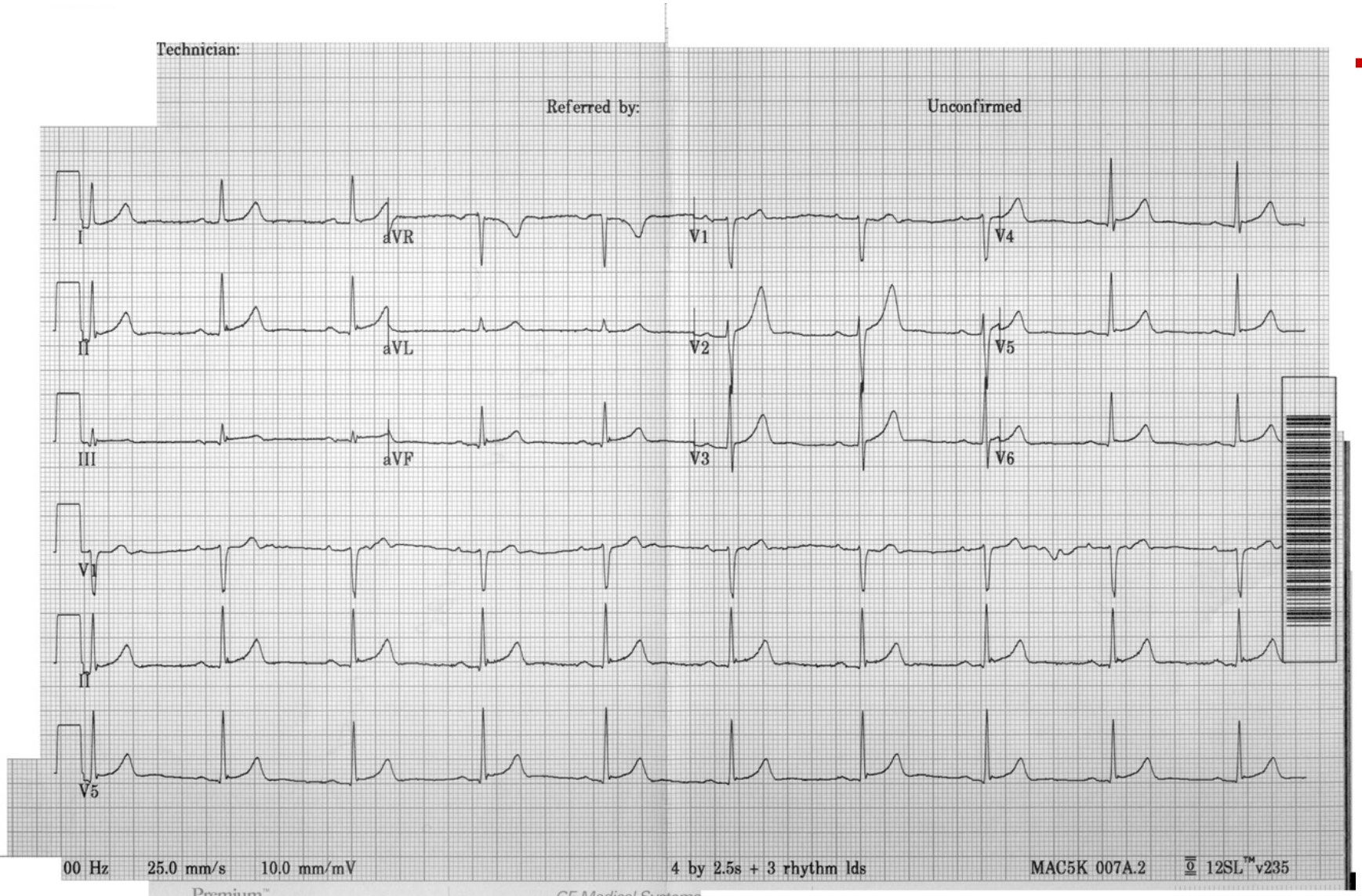
4. for bundle branch reentrant or interfascicular VTs;

5. for recurrent sustained polymorphic VT and VF that is refractory to antiarrhythmic therapy when there is a suspected trigger that can be targeted for ablation.

EHRA/HRS Expert Consensus on Catheter Ablation of Ventricular Arrhythmias 2009

A case

- A previously healthy 35 y.o. man was admitted after a collapse at his office.
- EMS recorded VF that was successfully defibrillated into NSR.
- Due to rapid CPR, he regained full consciousness
- His ECG:


Technician:
Referred by:
Unconfirmed
I
aVR
V1
V4
II
aVL
V2
V5
III
aVF
V3
V6
VI
II
V5
00 Hz
25.0 mm/s
10.0 mm/mV
4 by 2.5s + 3 rhythm lds
MAC5K 007A.2
12SL™v235
Premium™
GE Medical Systems

A case

- A bedside Echo study: mild LV dysfunction
- The next step?

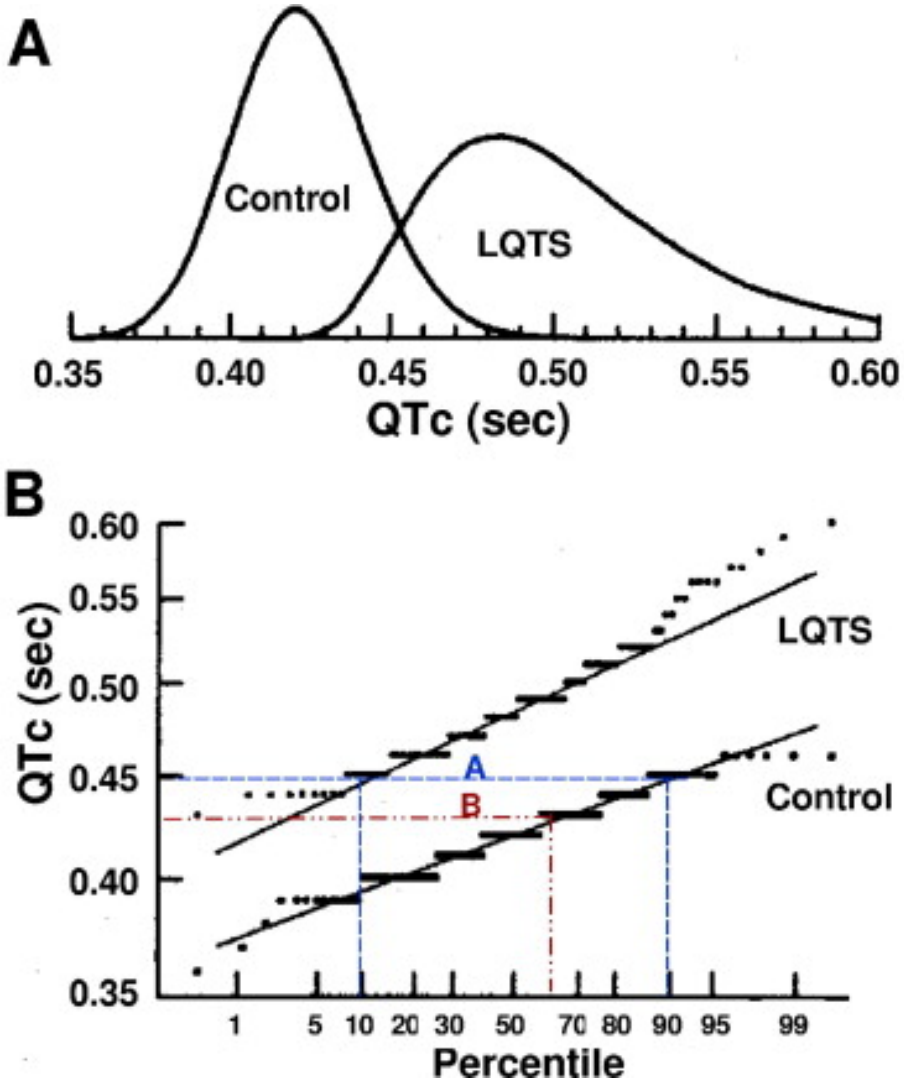
1. Immediate cath
2. IV Amiodarone
3. IV Mg
4. EP consult

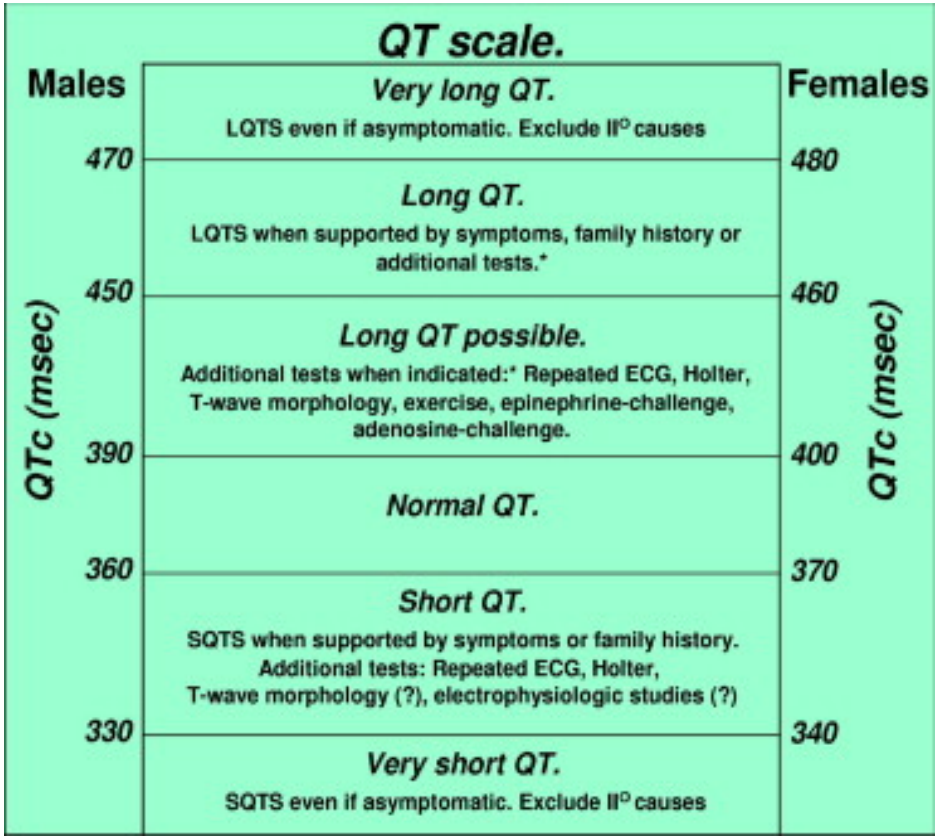
- Pt. had nonsignificant CAD, LV function normalized

Differential Dx- VF in a “structurally normal” heart

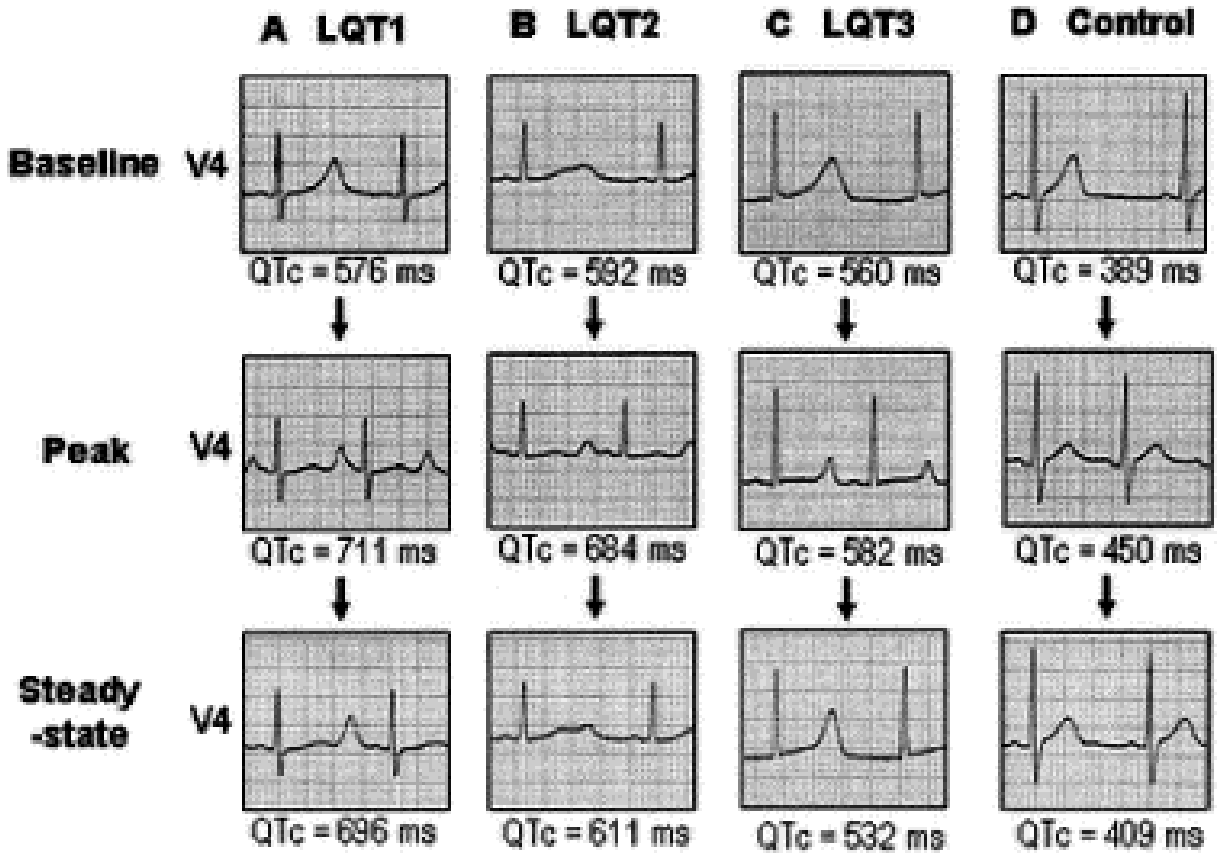
- Primary electrical disease
  - Long QT
  - Brugada syndrome
  - CPVT
  - Short QT
  - Early repolarization
- Other
  - Myocarditis
  - ARVD
  - Coronary spasm
- Idiopathic VF

LQT ?

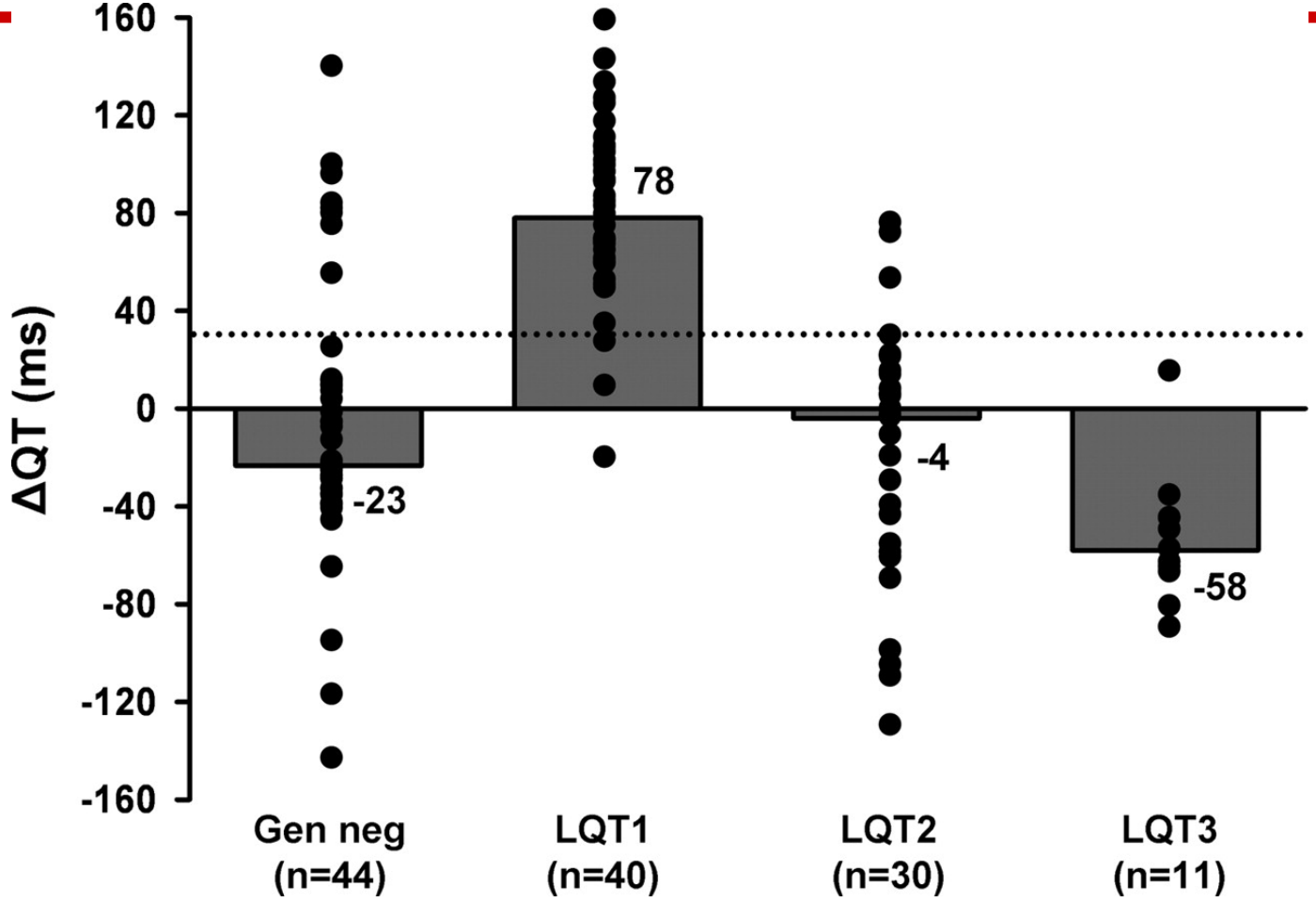

A
Control
LQTS
0.35
0.40
0.45
0.50
0.55
0.60
QTc (sec)
B
QTc (sec)
0.60
0.55
0.50
0.45
0.40
0.35
LQTS
Control
A
B
1
5
10
20
30
50
70
80
90
95
99
Percentile


QT scale.
Males
Females
QTc (msec)
QTc (msec)
Very long QT.
LQTS even if asymptomatic. Exclude II° causes
470
480
Long QT.
LQTS when supported by symptoms, family history or additional tests.*
450
460
Long QT possible.
Additional tests when indicated:* Repeated ECG, Holter, T-wave morphology, exercise, epinephrine-challenge, adenosine-challenge.
390
400
Normal QT.
360
370
Short QT.
SQTS when supported by symptoms or family history.
Additional tests: Repeated ECG, Holter,
T-wave morphology (?), electrophysiologic studies (?)
330
340
Very short QT.
SQTS even if asymptomatic. Exclude II° causes

Adrenaline infusion unmasks LQT and types it. Shimizu et al JACC 2001, Heart Rhythm 2004



ΔQT>30 ms with Adrenaline Infusion Predicts LQT1



Sens=93%

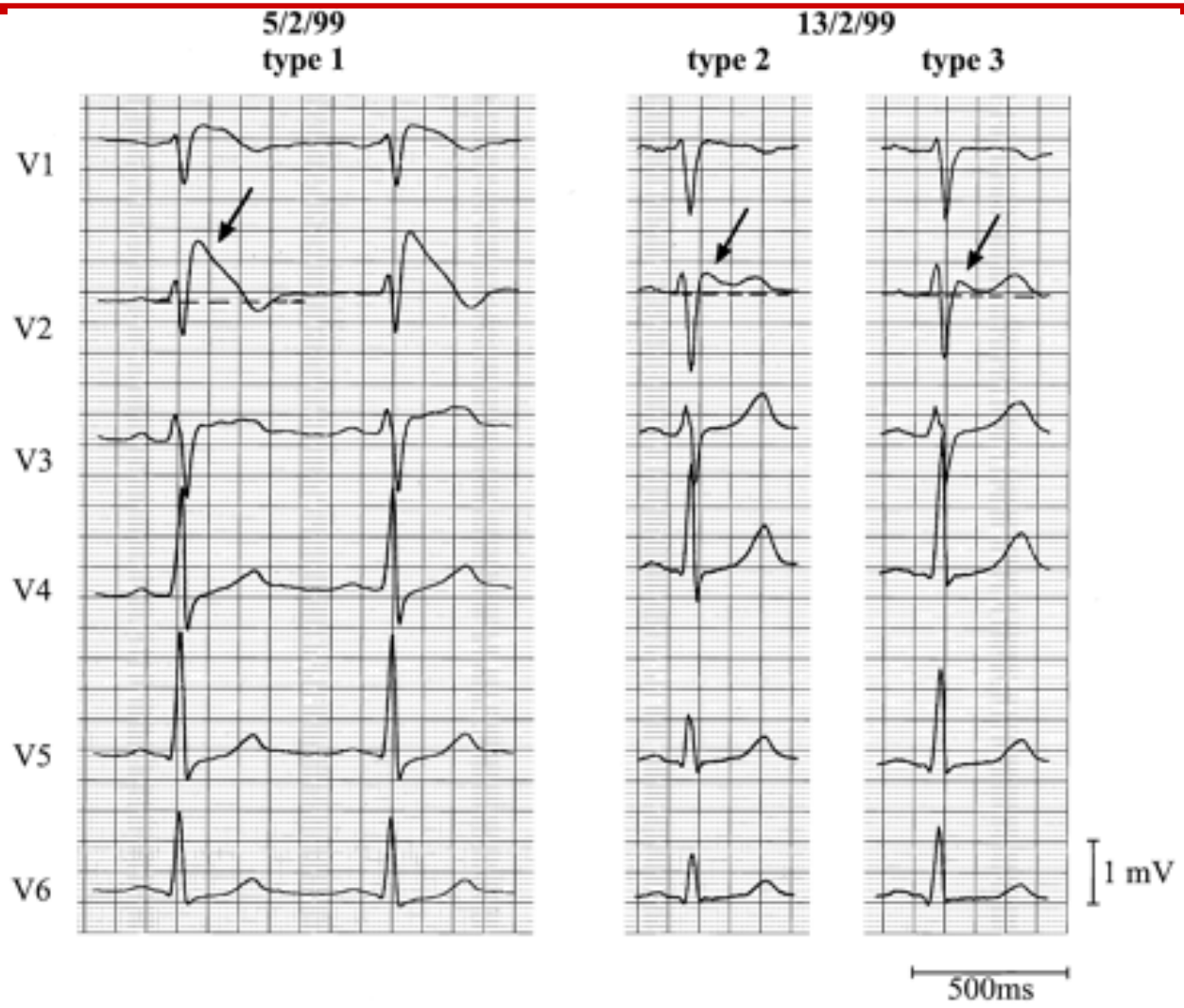
Spec=86%

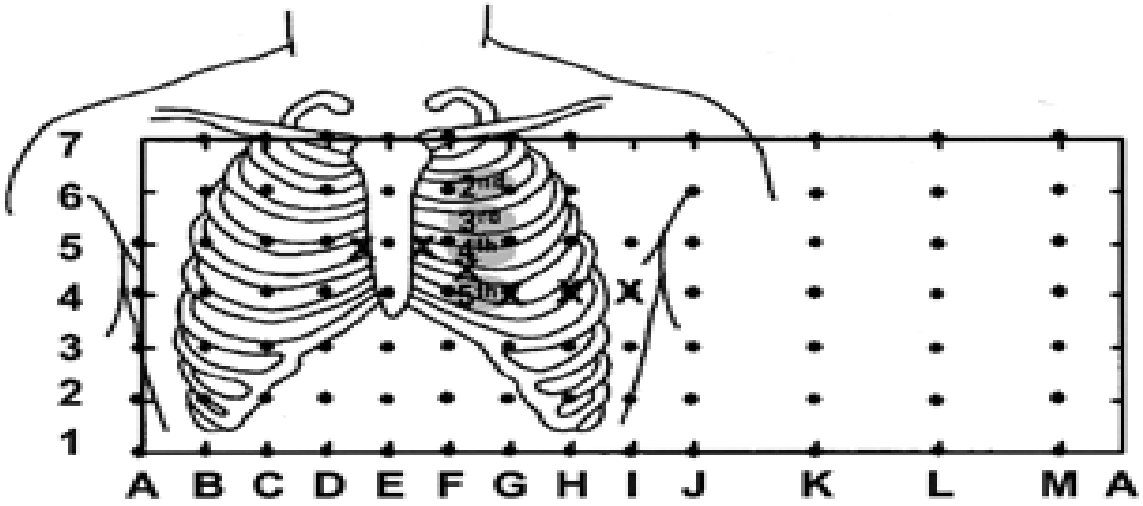
PPV=76%

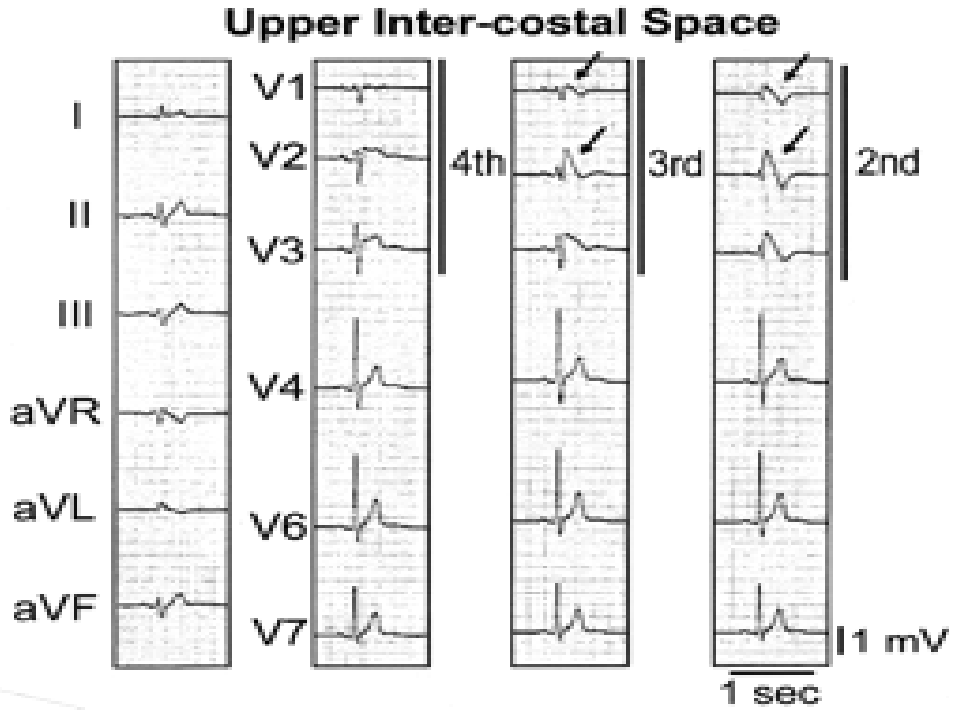
NPV=96%

Vyas, H. et al. Circulation 2006;113:1385-1392

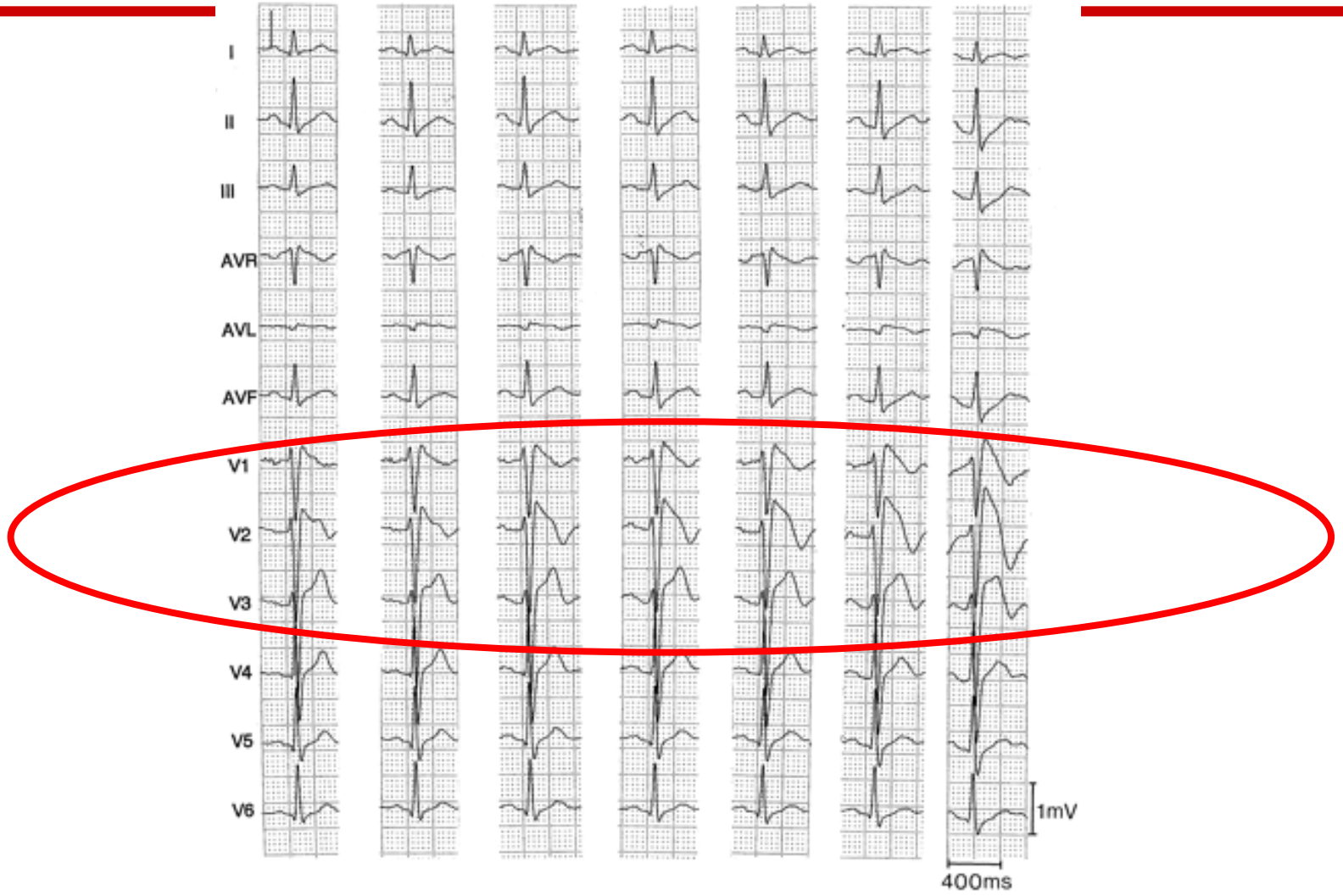
Brugada Syndrome

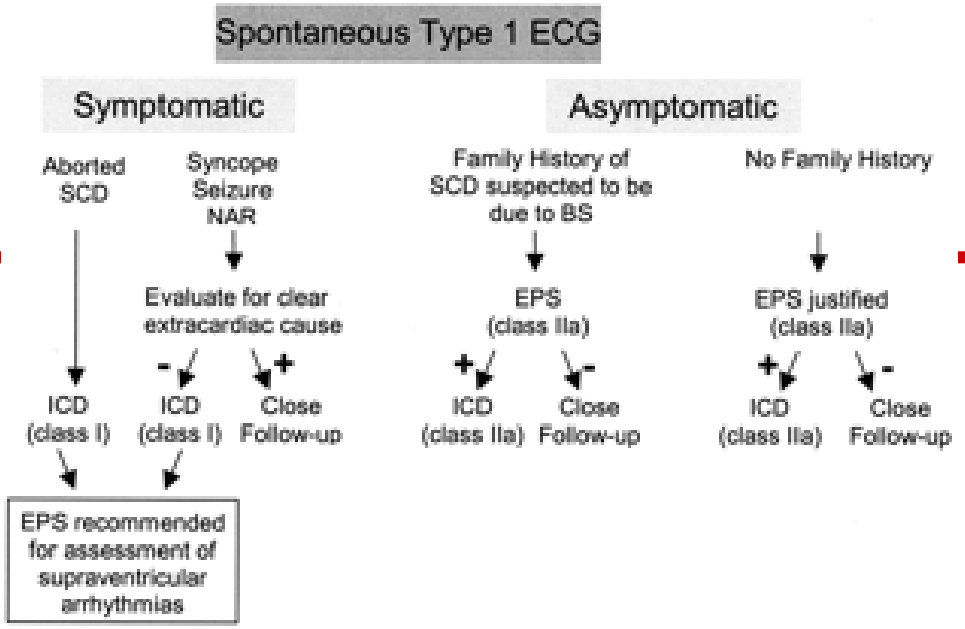


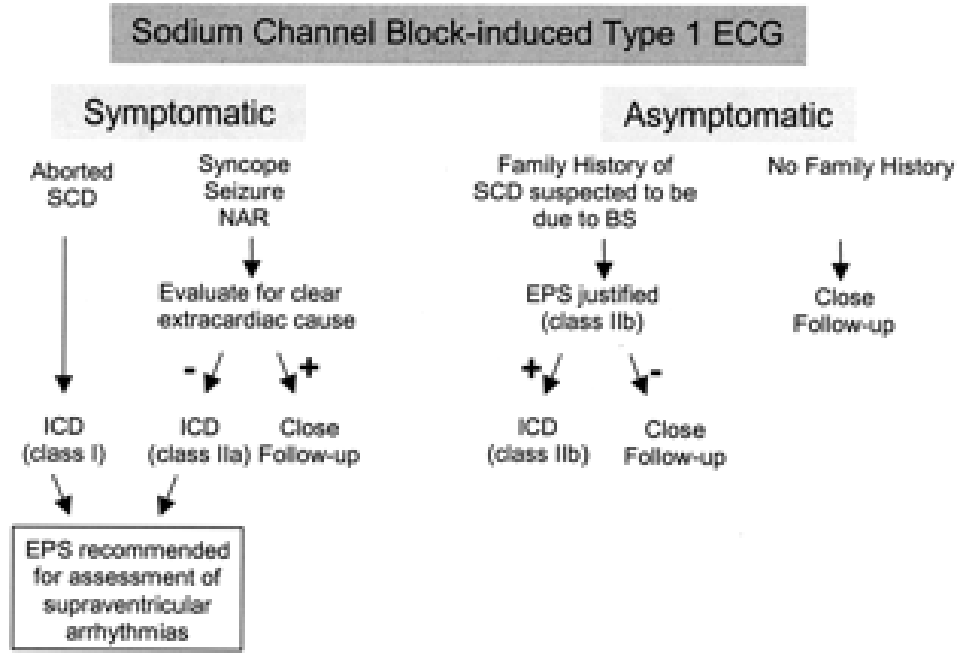

7
6
5
4
3
2
1
A B C D E F G H I J K L M A


Upper Inter-costal Space
I
II
III
aVR
aVL
aVF
V1
V2
V3
V4
V6
V7
4th
3rd
2nd
1 mV
1 sec

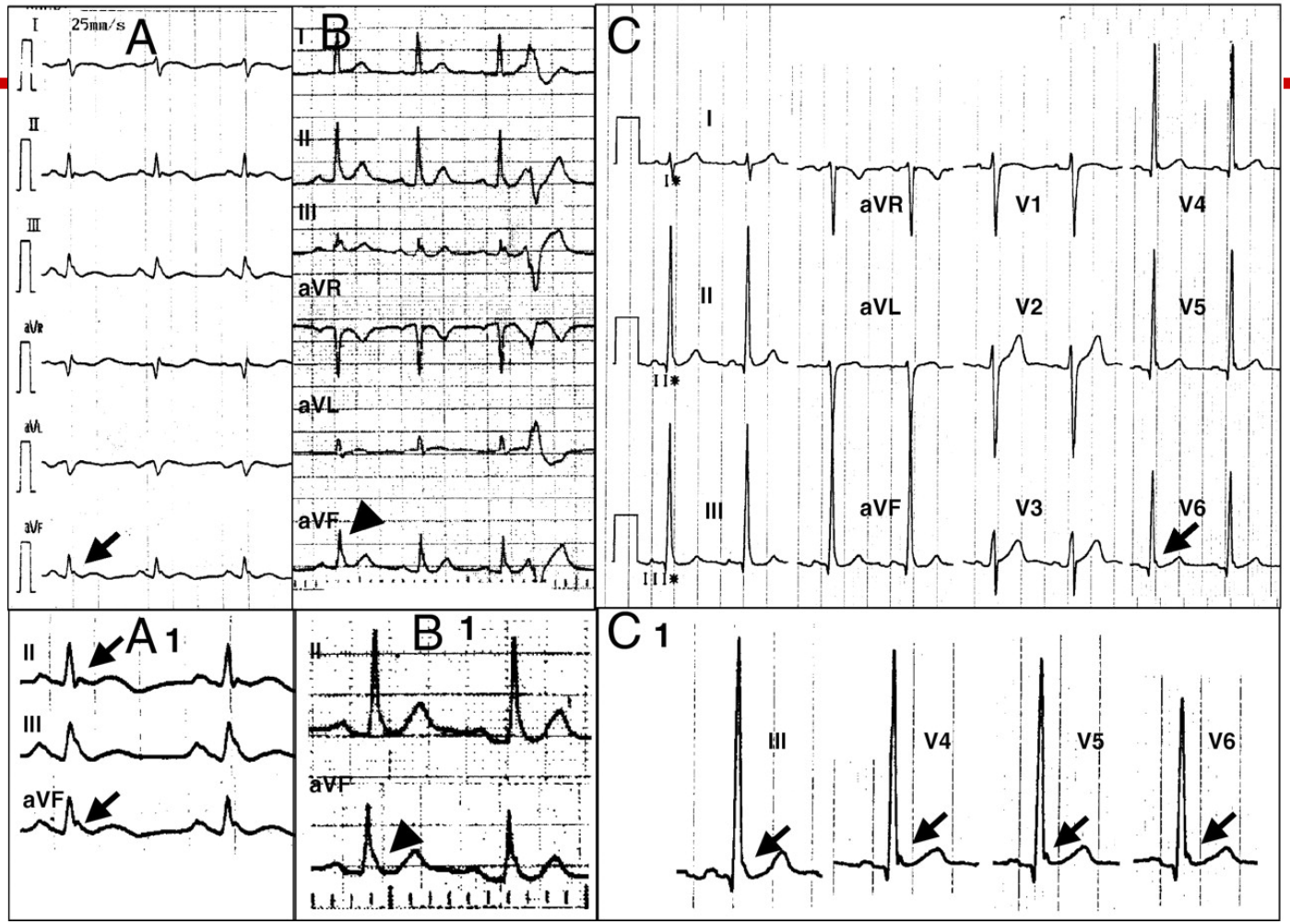
Flecainide test




Spontaneous Type 1 ECG
Symptomatic
Asymptomatic
Aborted SCD
Syncope Seizure NAR
Family History of SCD suspected to be due to BS
No Family History
Evaluate for clear extracardiac cause
EPS (class IIa)
EPS justified (class IIa)
ICD (class I)
ICD (class I)
Close Follow-up
ICD (class IIa)
Close Follow-up
ICD (class IIa)
Close Follow-up
EPS recommended for assessment of supraventricular arrhythmias


Sodium Channel Block-induced Type 1 ECG
Symptomatic
Asymptomatic
Aborted SCD
Syncope Seizure NAR
Family History of SCD suspected to be due to BS
No Family History
Evaluate for clear extracardiac cause
EPS justified (class IIb)
Close Follow-up
ICD (class I)
ICD (class IIa)
Close Follow-up
ICD (class IIb)
Close Follow-up
EPS recommended for assessment of supraventricular arrhythmias

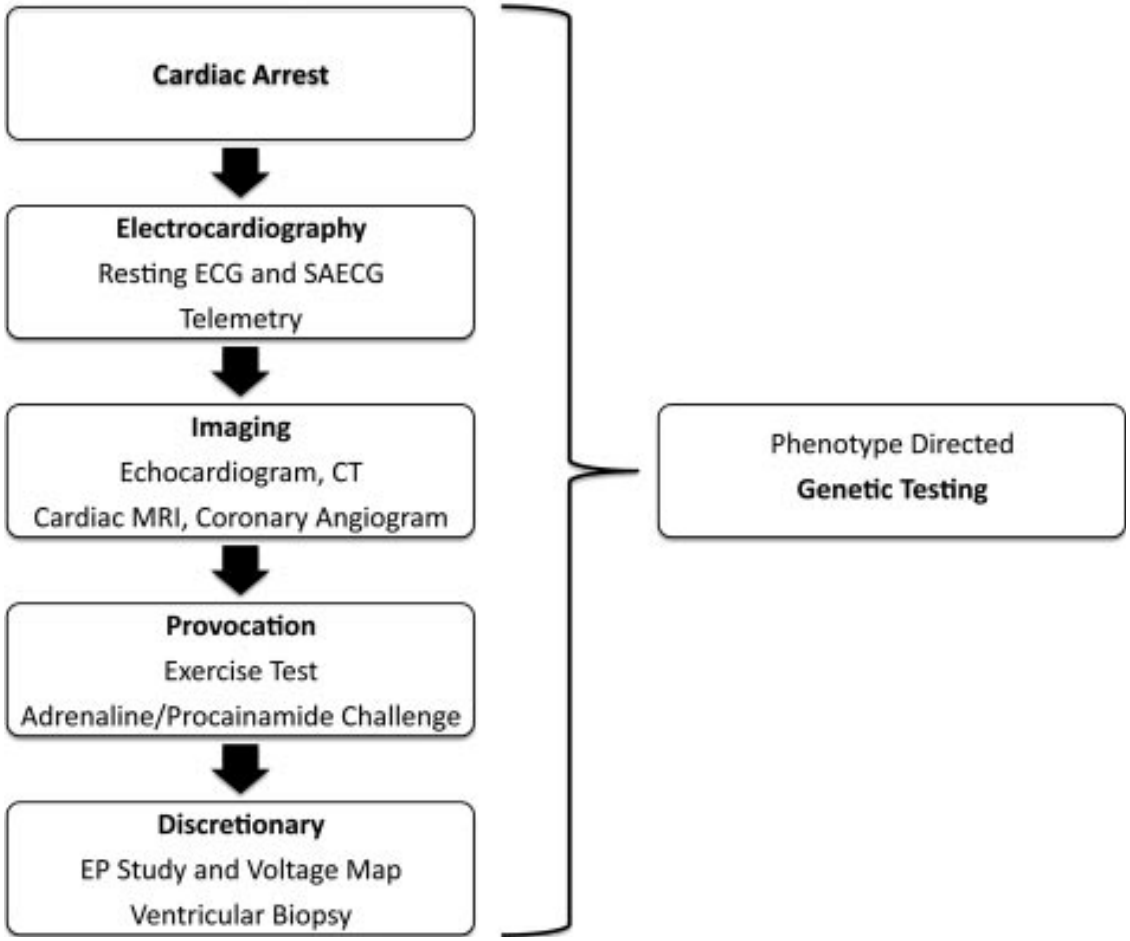
J-Point Elevation and R-Wave Slurring



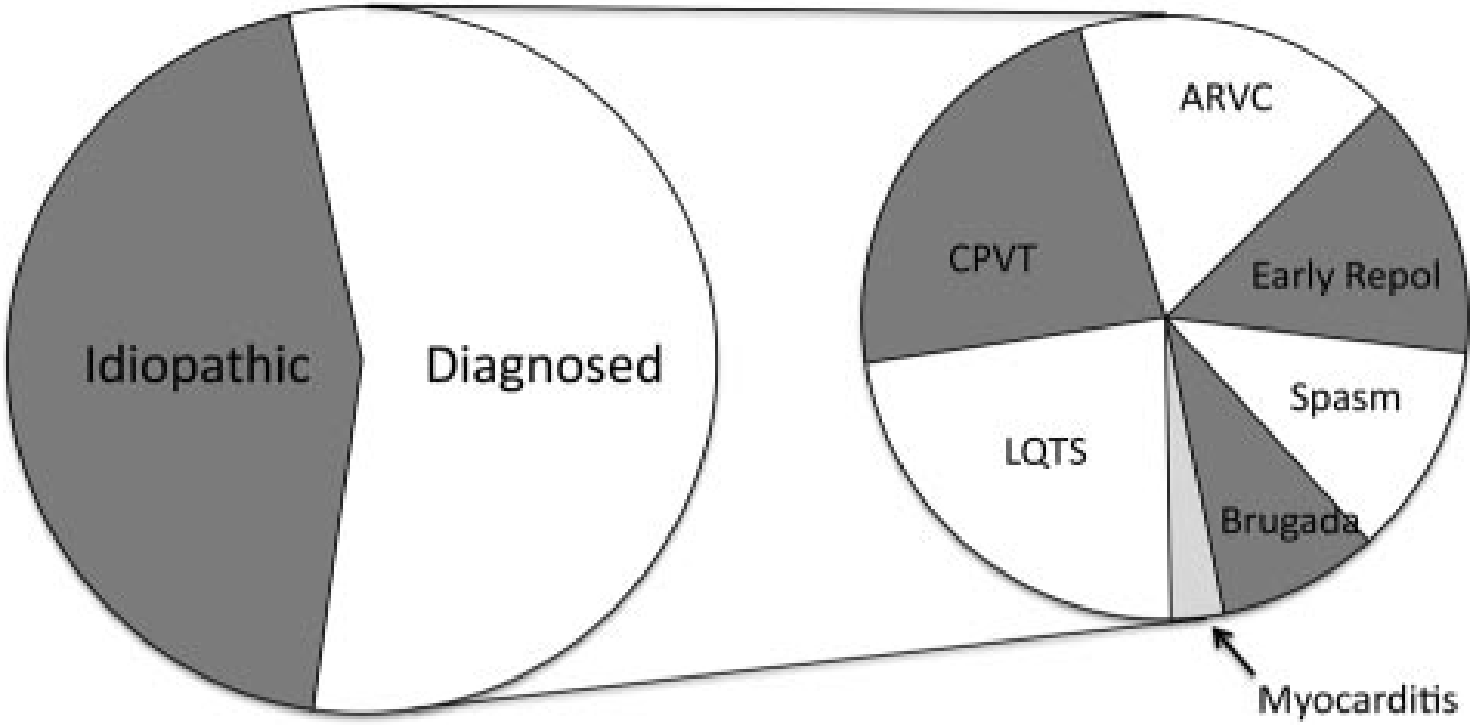
Rosso, R. et al. J Am Coll Cardiol 2008;52:1231-1238

Systematic Assessment of Patients With Unexplained Cardiac Arrest.

Krahn et al. Heart Rhythm 2009



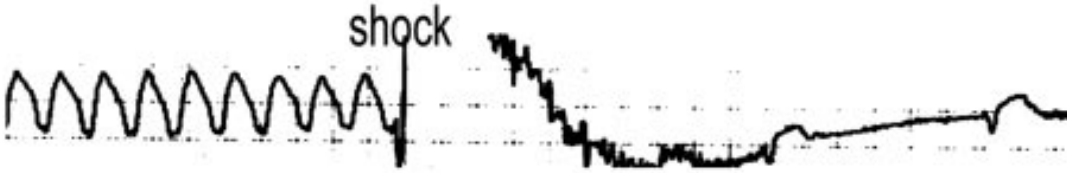
Diagnosed 35 of 63 Cases



Sustained Ventricular Tachycardias

Polymorphic VT

- acute myocardial ischemia
- abnormalities of ion channels
  - acquired long QT syndrome
  - genetic arrhythmia syndromes
    - Long QT, Short QT, Brugada,
    - Familial catecholaminergic polymorphic VT
- Idiopathic ventricular fibrillation
- Structural disease: hypertrophy, recent infarction, cardiomyopathy



Monomorphic VT

Scar-related reentry

- prior infarction
- cardiomyopathies
  - <u>predominant LV</u>
    - idiopathic, familial, post viral
    - inflammatory: sarcoid, Chagas
    - idiopathic aneurysms
  - <u>predominant RV</u>
    - arrhythmogenic RV dysplasia
    - sarcoid, idiopathic
- surgical incisions: ventriculotomy, repaired Tetralogy of Fallot

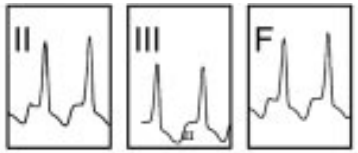
Purkinje disease

- Bundle branch reentry
- Automaticity

Idiopathic VT

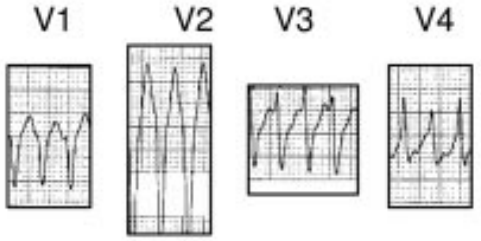
Outflow type VTs with focal origin

ECG: inferior axis



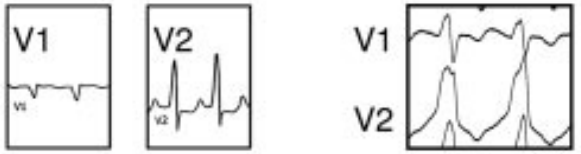
RVOT, pulmonary artery

ECG: LBBB, transition V3-V4



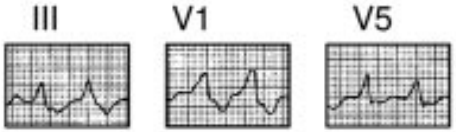
LVOT, Aortic sinus, epicardial

ECG: prominent r or R in V1 or V2



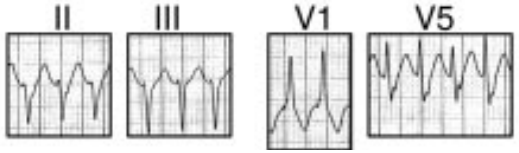
Focal mitral annulus VT

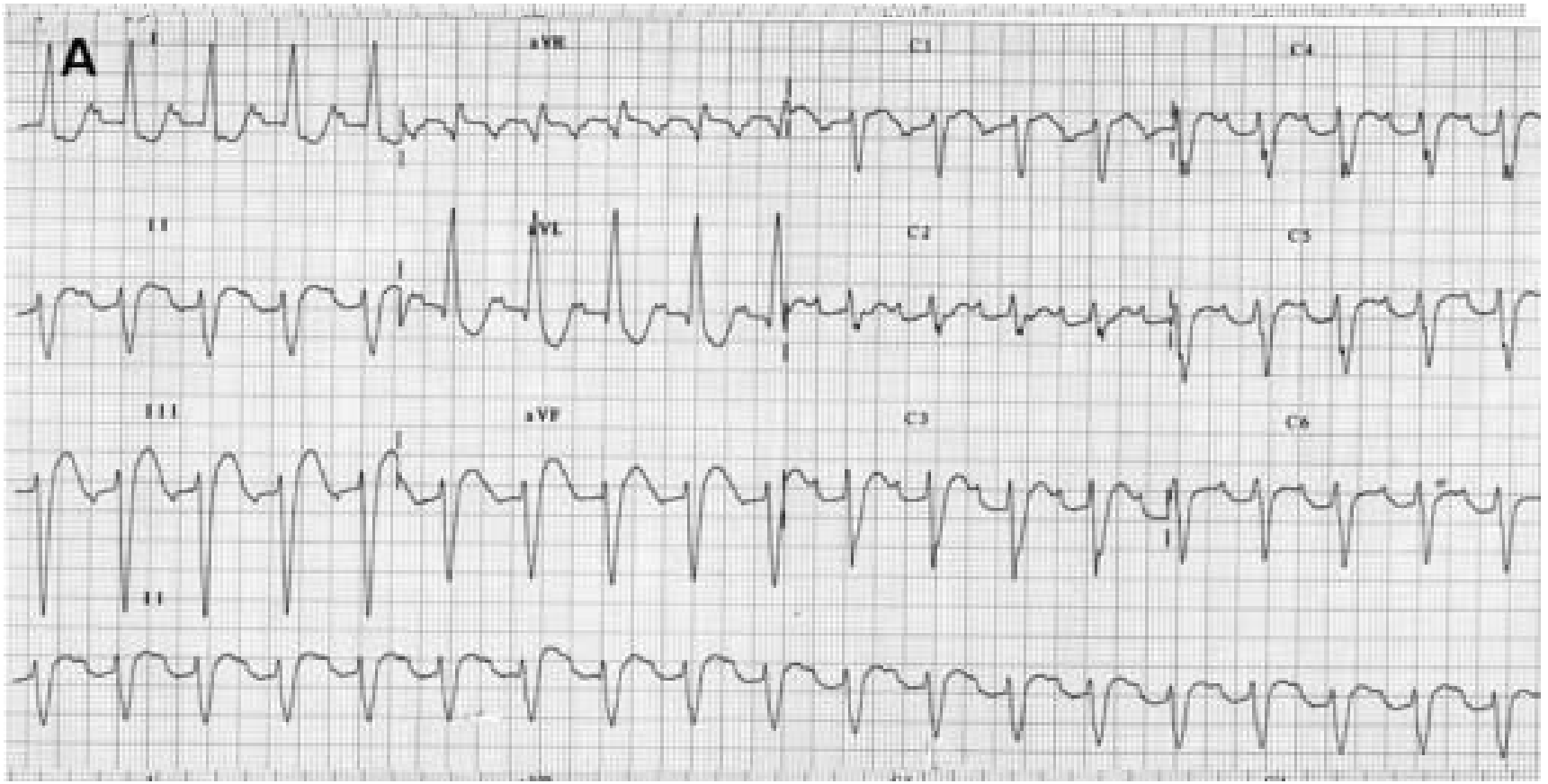
ECG: RBBB, prominent R or r in V2-V6

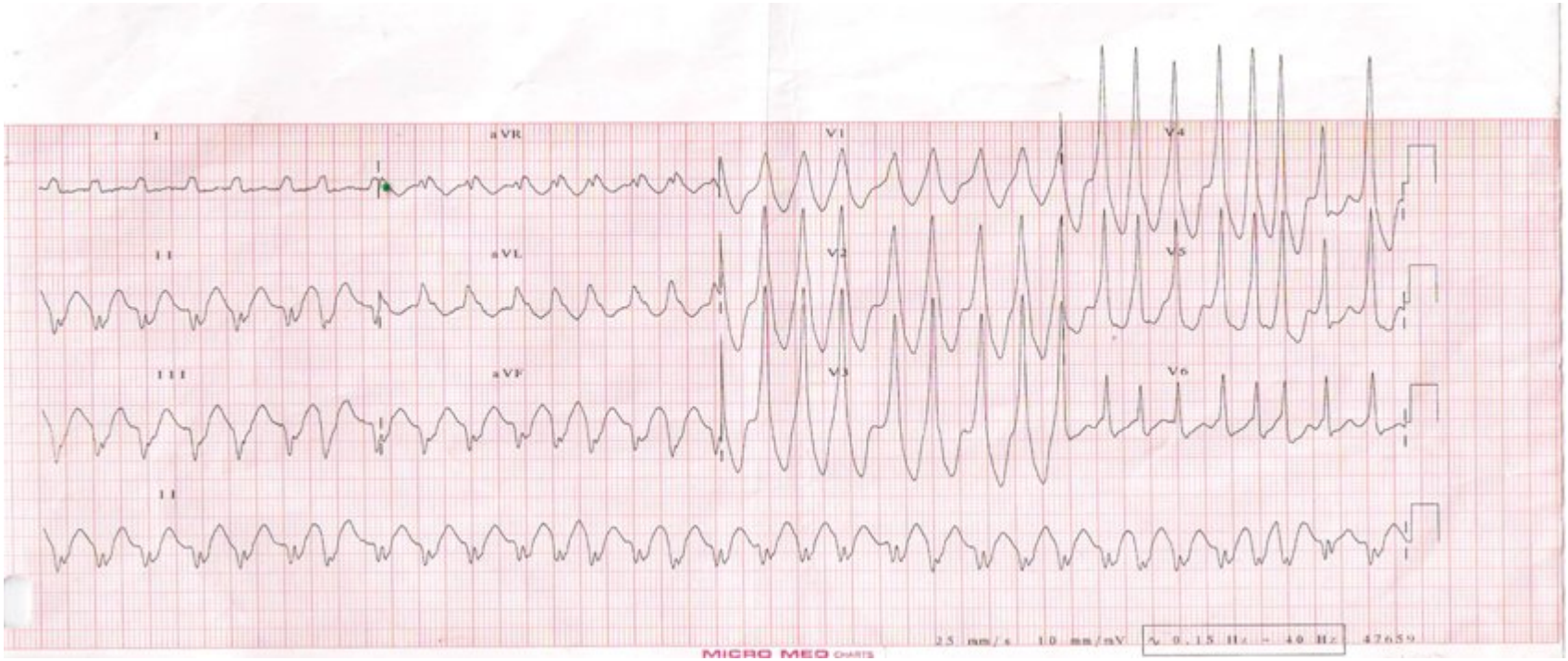


Verapamil sensitive fascicular reentry

ECG: RBBB L or R axis




A
I
aVR
C1
C4
II
aVL
C2
C5
III
aVF
C3
C6
II


I
aVR
V1
V4
II
aVL
V2
V5
III
aVF
V3
V6
II
MICRO MED CHARTS
25 mm/s 10 mm/mV 0.15 Hz - 40 Hz
47659

TODA RABA