Differential Diagnosis of VT and its Mapping Techniques

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심전도 진단

Idiopathic VT

- **RBBB + Left axis (Superior axis)**
- **LBBB + Right axis (Inferior axis), (DDx with ARVD)**

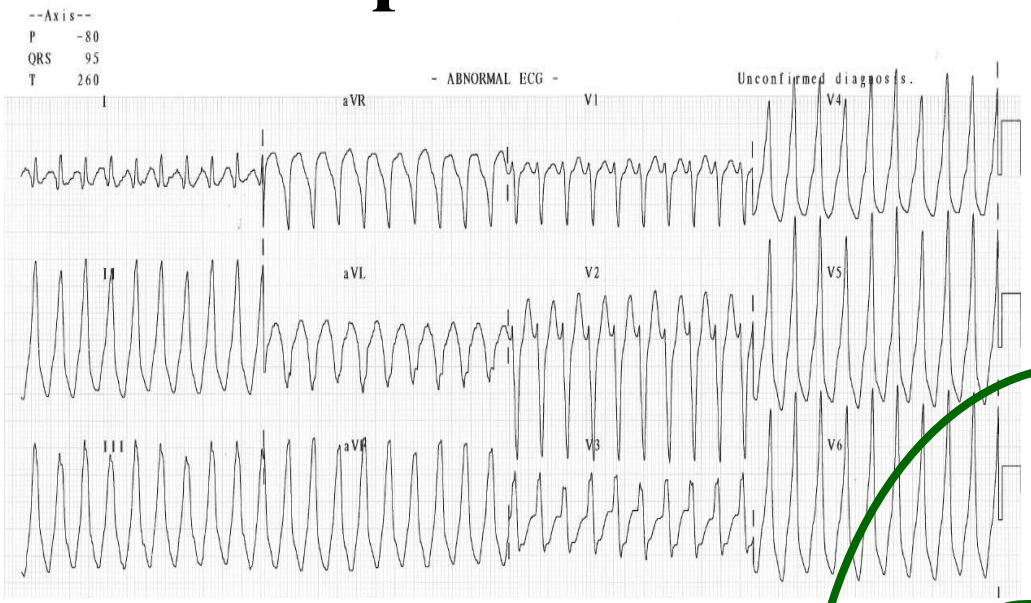
VT in structural heart disease: scar-related reentry or focal

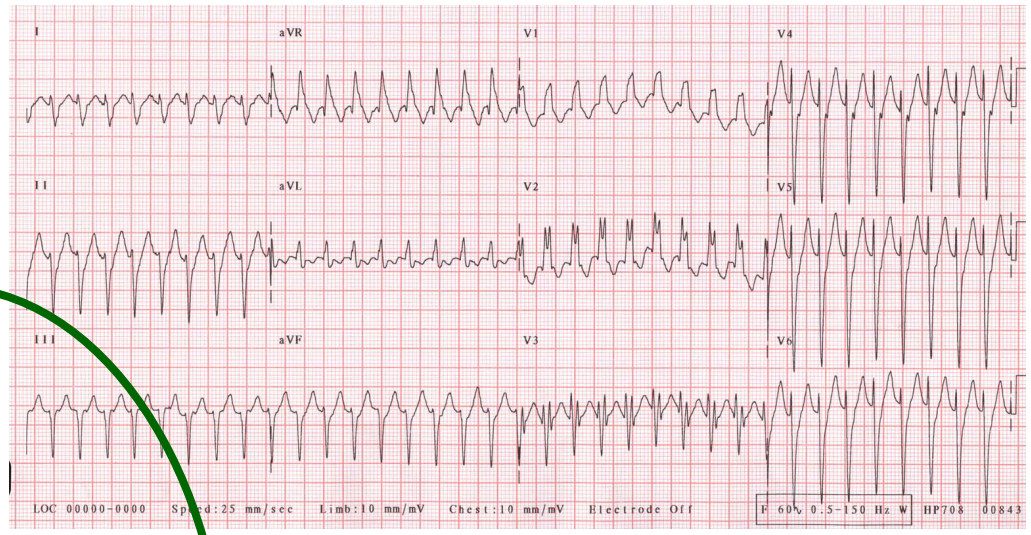
- **post-MI, Dilated CM, ARVD**

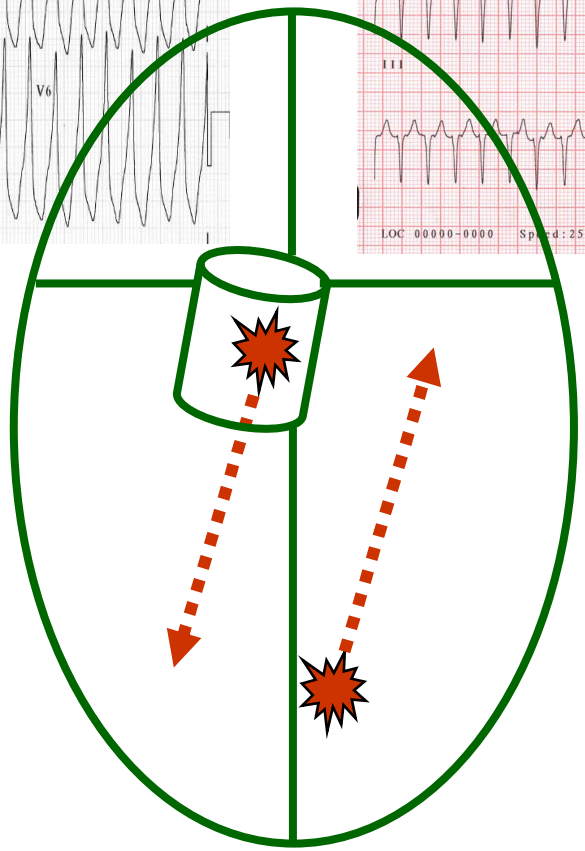
General approach to VT mapping

	Focal	Macroreentry
Mechanism	TA, Automacticity microreentry	BBR, intramyoc reentry
Etiology	No SHD > SHD	SHD >> No SHD
Target	focus of origin	isthmus
Mapping	Activation map Pace map	Activation Pacemap Entrain

Idiopathic VT: RVOT vs fascicular VT







LBBB

RAD

RBBB

LAD

(Sup axis deviation)

Outflow Tract VT

Outflow tract VT (OT-VT)

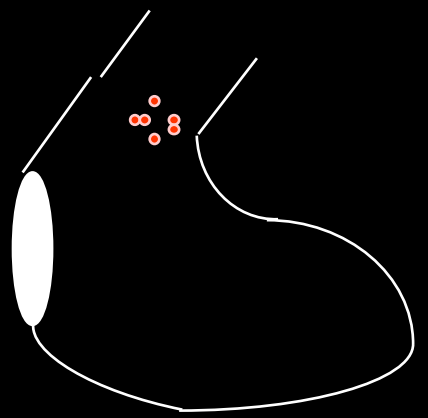
Paroxysmal sustained vs. Repetitive monomorphic (runs of nonsustained)

Excellent prognosis: More favorable response to AAD Rx than VTs in SHD (responsiveness to all classes of AAD)

Acute termination of RVOT VT: increase vagal tone by Valsalva, CSM adenosine IV bolus or IV verapamil

ß-Rc stimulation – cAMP - [Ca]I – I_{TI} - DAD: focal (Ca-dependent triggered activity)

Occurs frequently in the septal region, focal



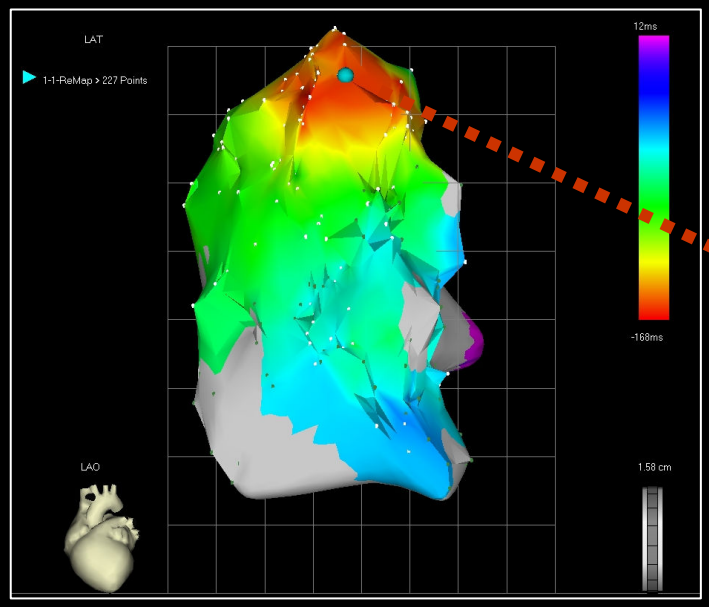
Activation sequence mapping

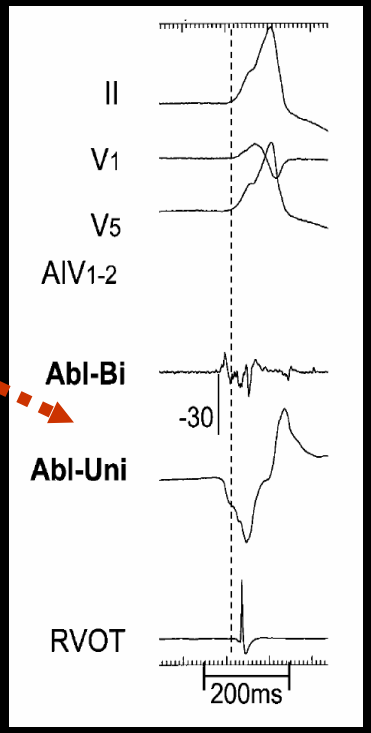
Reference: ECG, intracardiac egm

Creation of the “mental map” by the operator

Earliest ventricular activation (Unipolar egm QS pattern)

Local activation precedes QRS by 10-60 msec





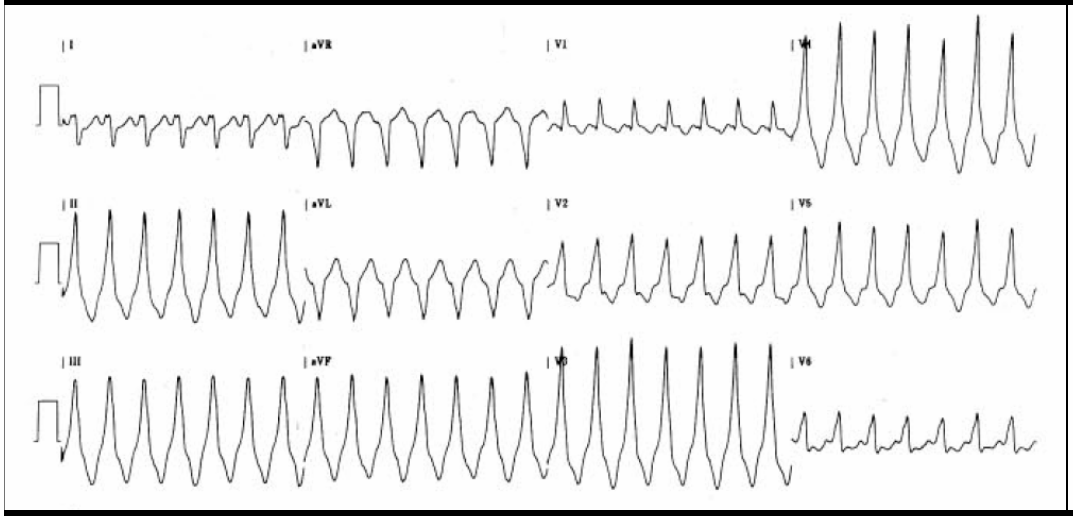
Pace mapping

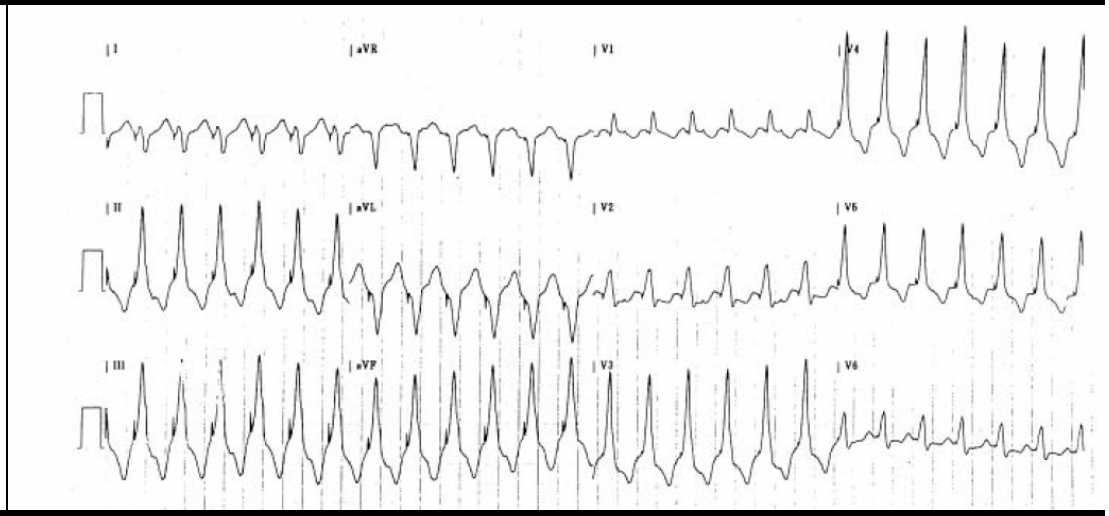
Identification of the source of focal or microreentry

Pace at the CL similar to that of the tachycardia

Compare surface ECG and intracardiac egm

Pitfalls: spatial resolution





Repetitive Monomorphic Tachycardia From the LVOT
DJ Callans, J Am Coll Cardiol 1997;29:1023–7)

ECG Localization of RVOT-VT

Anterior vs. Posterior

Lead I +, aVR > aVL

Lead I -, aVR < aVL

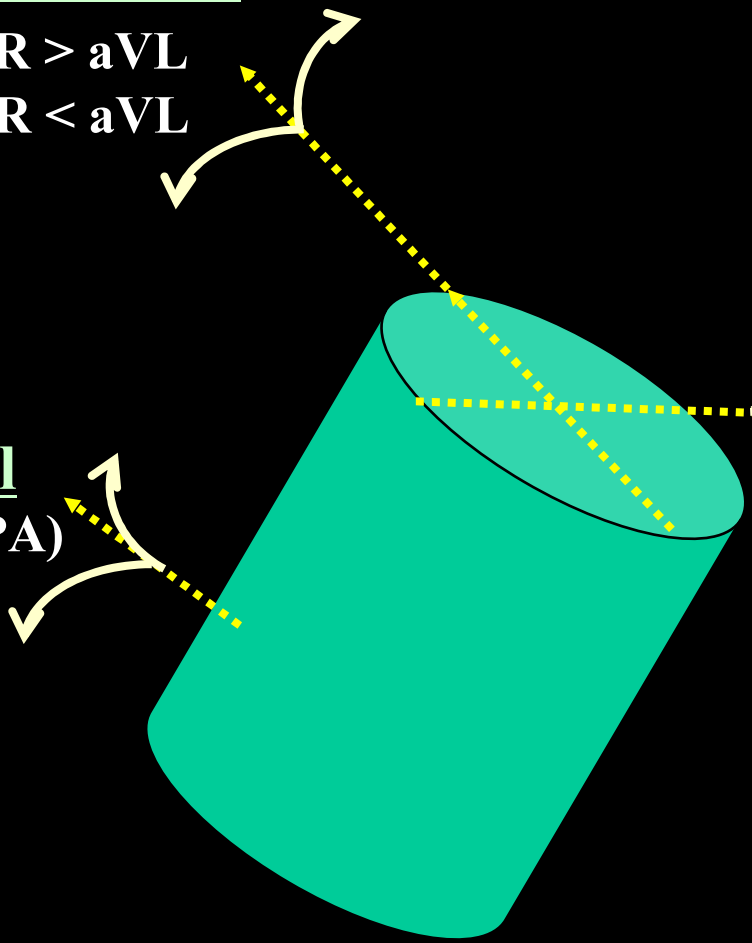
FW vs. septal

QRS > 140ms

Notched R in inferior leads

Caudal vs. Cranial

aVL+ (>2Cm from PA)

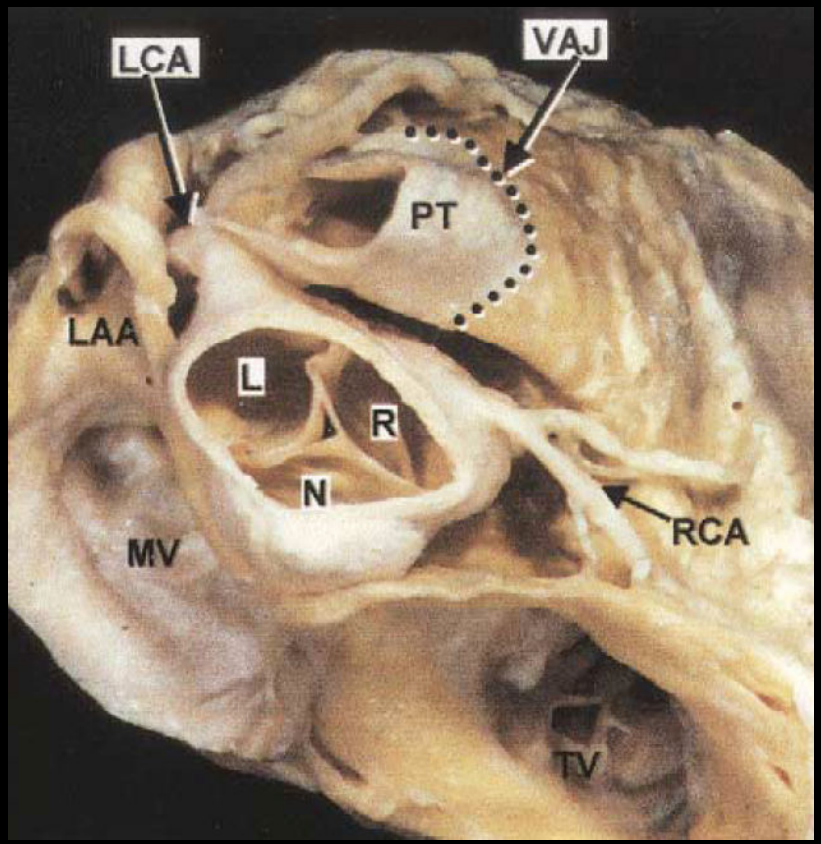


Wilber D, JCE 2005, 16:S52

Outflow tract VT (OT-VT)

An ‘Arc’ of Fire: (peri-valvular tissue)

- **RV inflow**
- **RVOT anteroseptal aspect**
- **Pulmonary artery**
- **Aortic Sinus of Valsalva**
- **anterior LV, LVOT**
- **LV epicardium near coronary v. aortomitral continuity**
- **Mitral annulus**

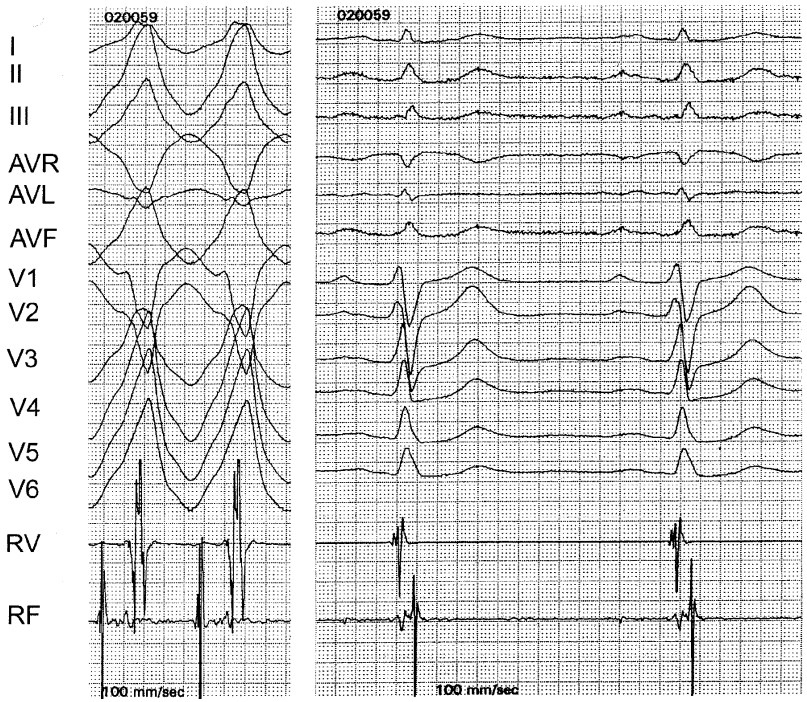


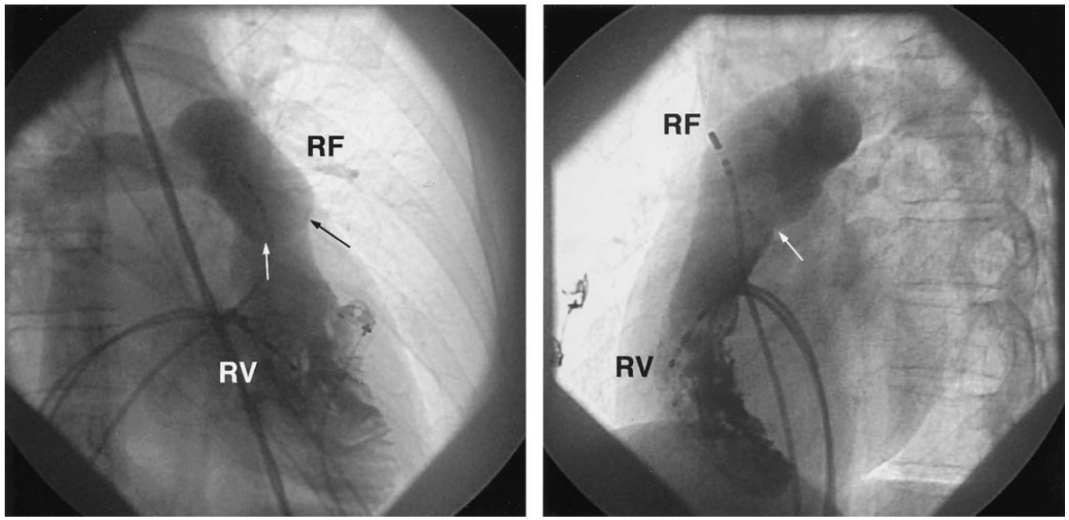
Repetitive Monomorphic VT Originating From the Aortic Sinus Cusp
Feifan Ouyang, J Am Coll Cardiol 2002;39: 500–8

VT from PA

Sharp potential preceding QRS by 24-60msec

Successful ablation several centimeters above the valve





Idiopathic LBBB–Shaped VT May Originate Above the Pulmonary Valve
Carl Timmermans, and Hein J.J. Wellens *Circulation* 2003;108;1960-1967;

VT from PA

Substrate: persistent remnant myocardium

poor intercellular coupling---slow propagation

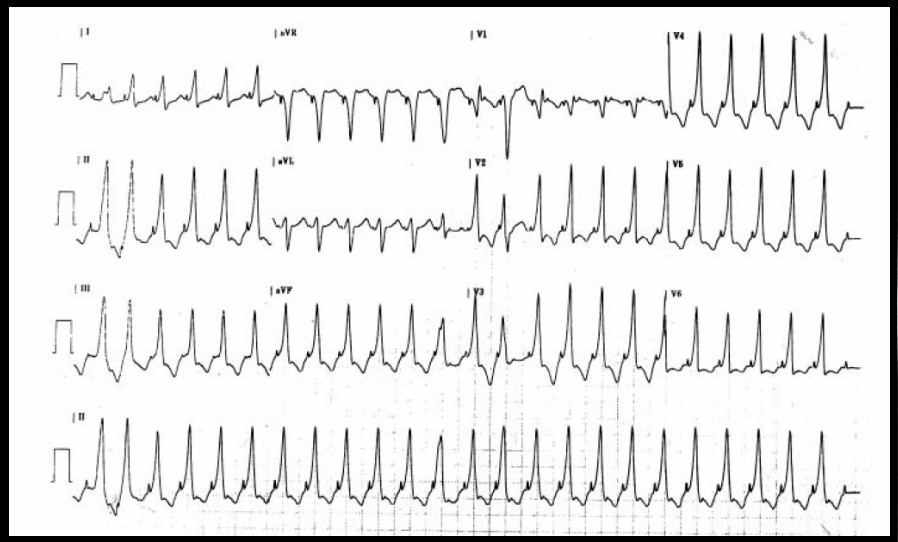
No specific ECG patterns for DDx from RVOT VT

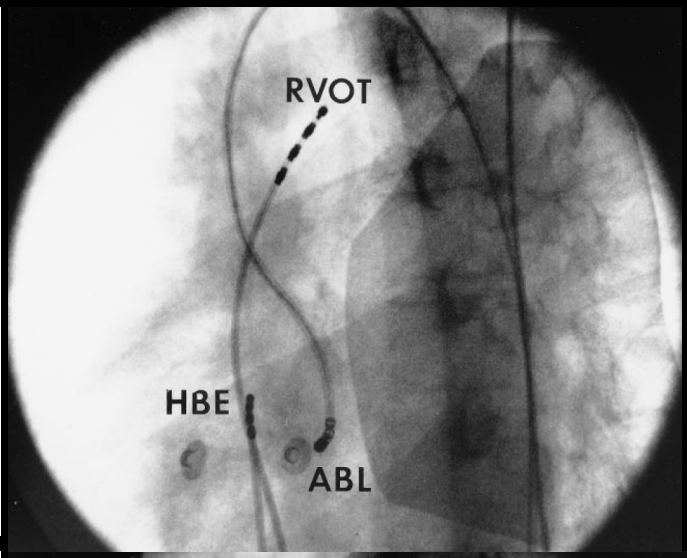
Implication:

If optimal pace map or activation map in RVOT,

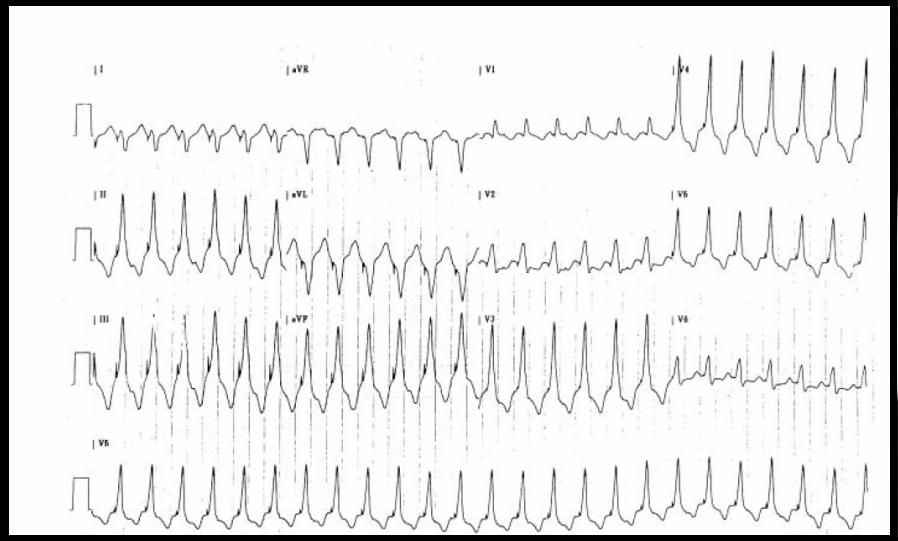
careful mapping of the PA should be performed !

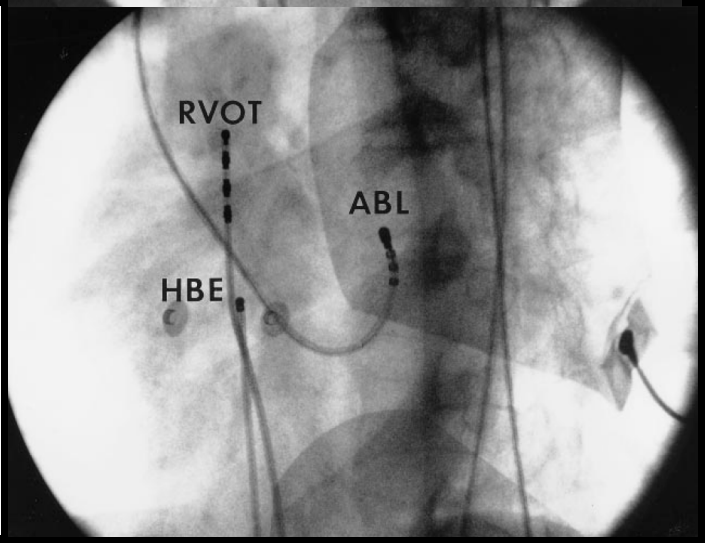
OT-VT (LV endocardial)





LAO

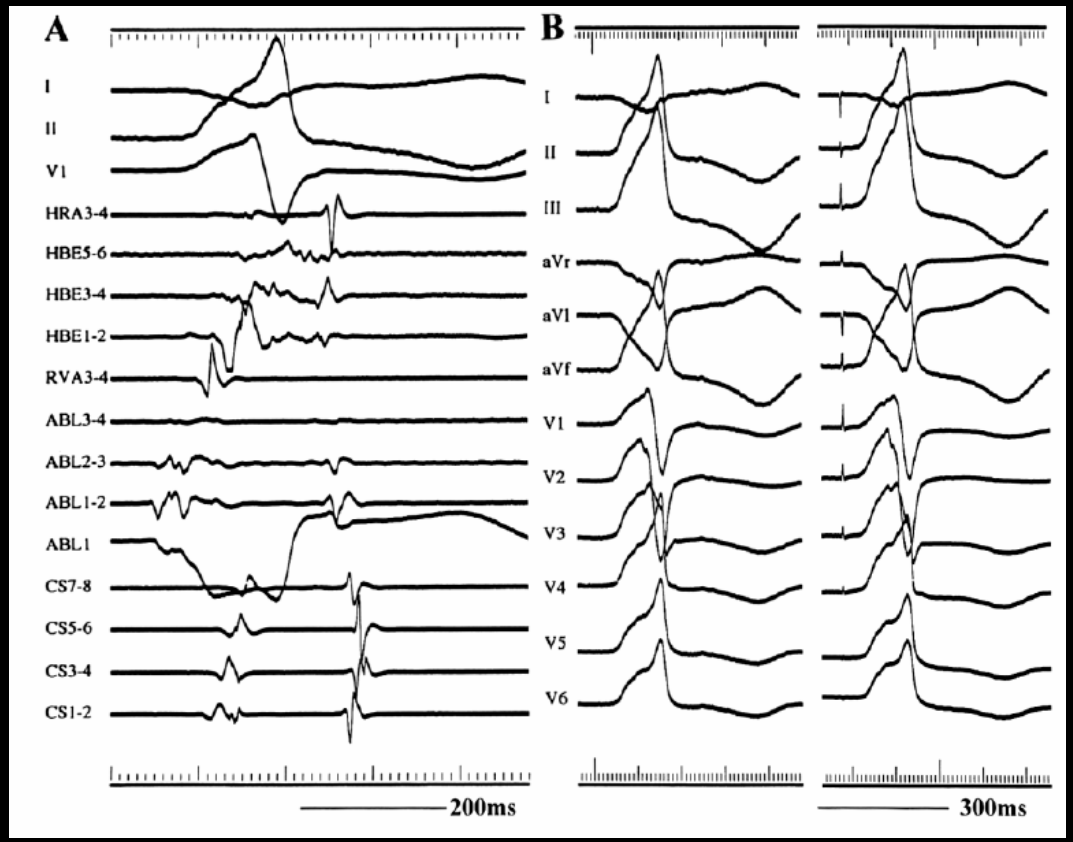


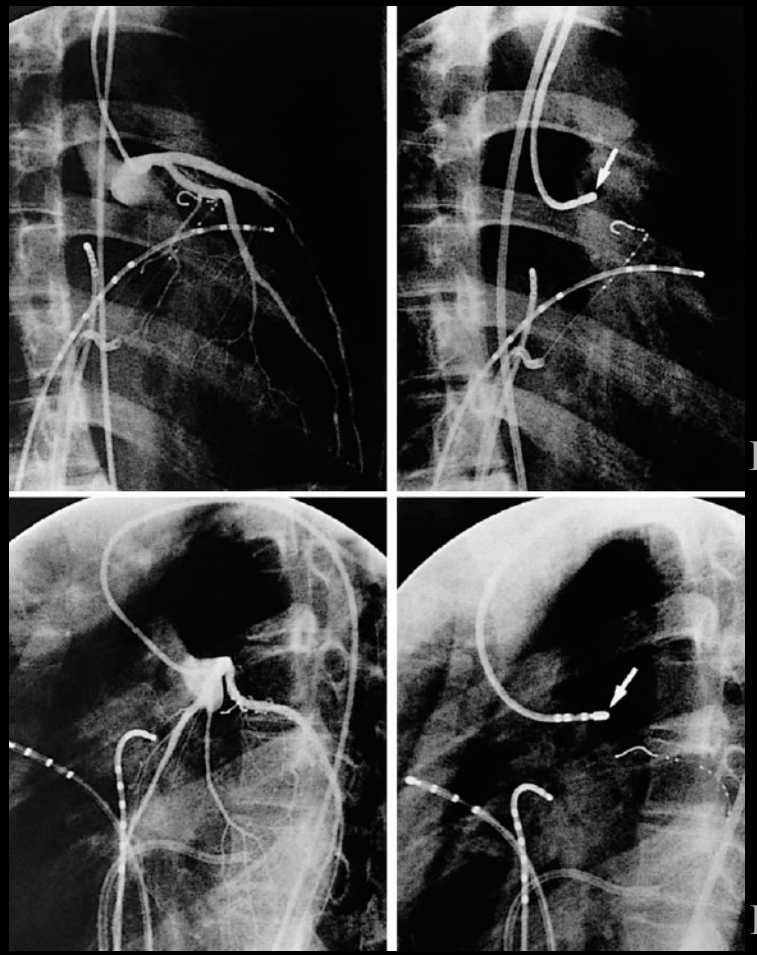


LAO

Repetitive Monomorphic Tachycardia From the LVOT
DJ Callans, J Am Coll Cardiol 1997;29:1023–7)

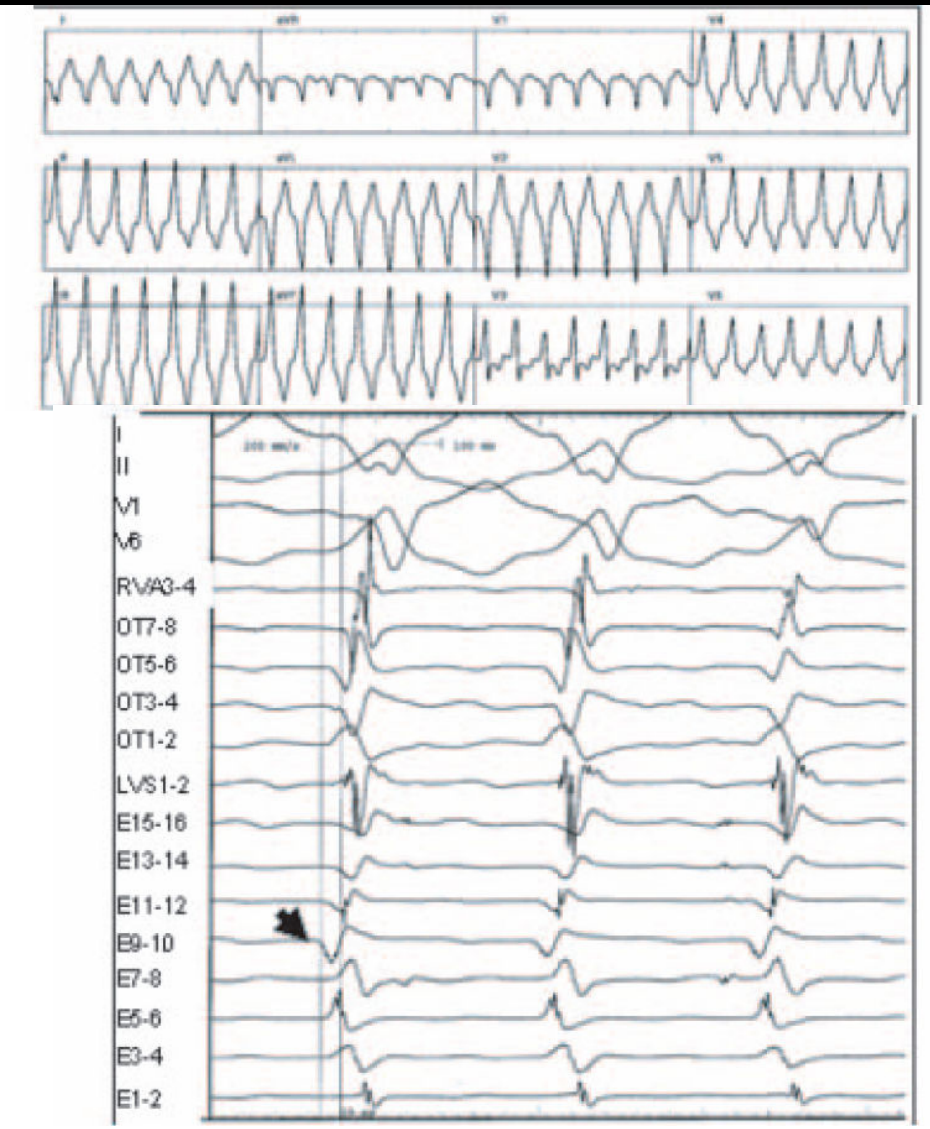
Epicardial OT-VT (aortic sinus cusp)

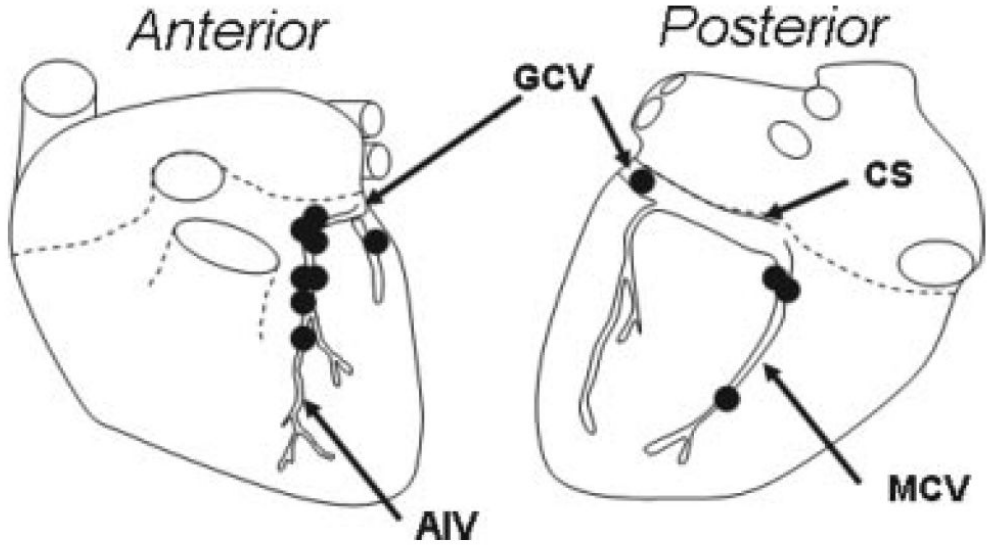




Left Ventricular Epicardial Outflow Tract Tachycardia
Hiroshi Tada, *Jpn Circ J* 2001; **65:** 723– 730

LV epicardial VT





Idiopathic Epicardial LV Tachycardia Originating Remote From the Sinus of Valsalva
David J. Wilber *Circulation* 2006;113;1659-1666

ECG differential diagnosis

RVOT
PA } **LBBB, transition at ≥ V_4**

ASOV

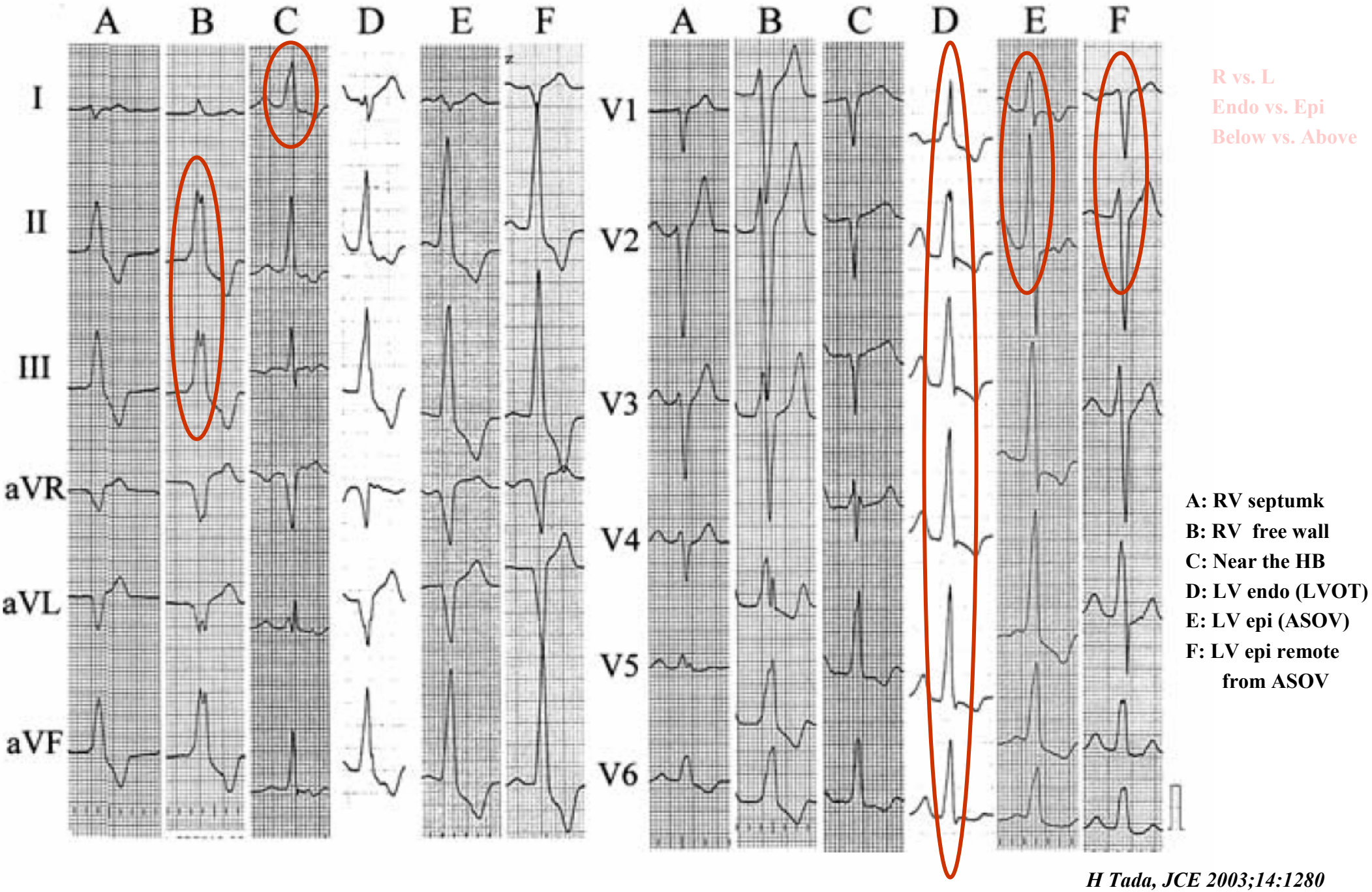
LVOT (sup LV septum below AoV),

Epicardial (including GCV, AIV)

R wave duration index at $V_{1,2}$	**>50%**
R/S amplitude index at $V_{1,2}$	**>30%**

LVOT (AMC or left fibrous trigone)

Monomorphic R wave (RBBB) in V_1 - V_6



H Tada, JCE 2003;14:1280

Idiopathic LV tachycardia (fascicular VT)

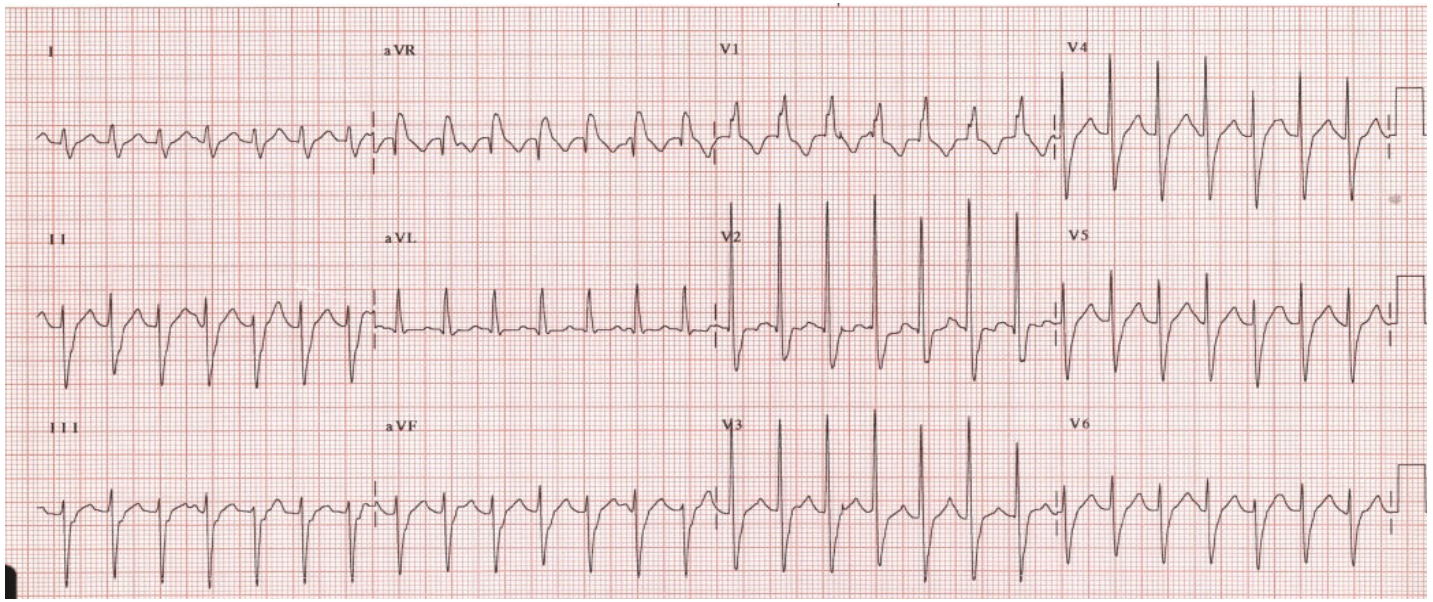
Fascicular VT

Idiopathic left ventricular tachycardia (ILVT, fascicular tachycardia)

- **structurally normal heart**
- **Right bundle branch block+Left axis deviation**
- **verapamil-sensitive**
- **good longterm prognosis**

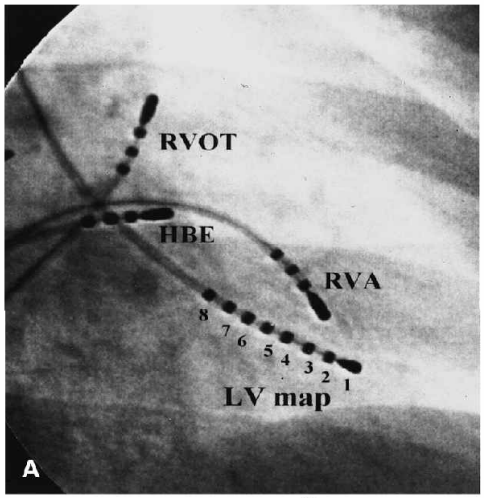
Mechanism of ILVT

- **Triggered activity**
- **microreentry**
- **<u>Purkinje reentry</u>**

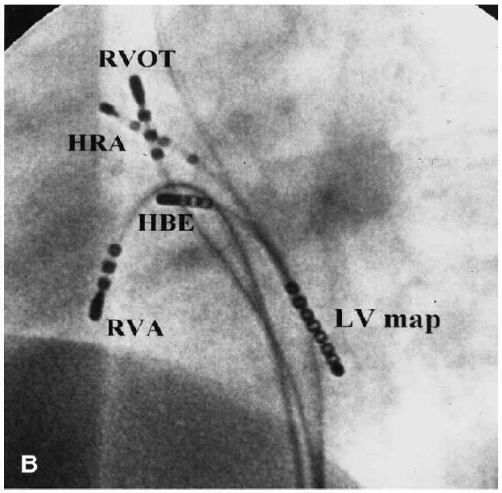


Anatomic extent of the reentry circuit in ILVT has not been defined.

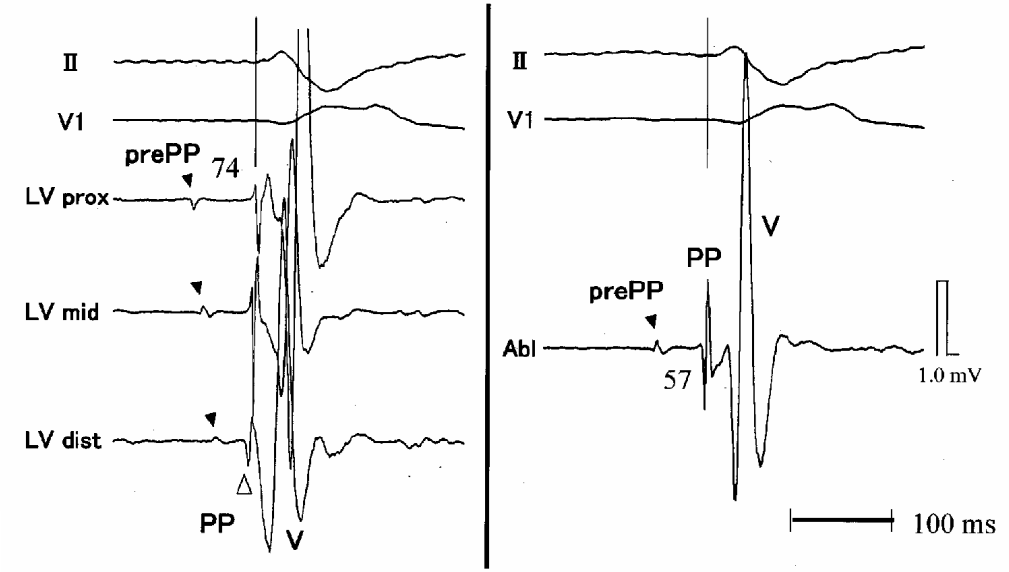
Fascicular VT

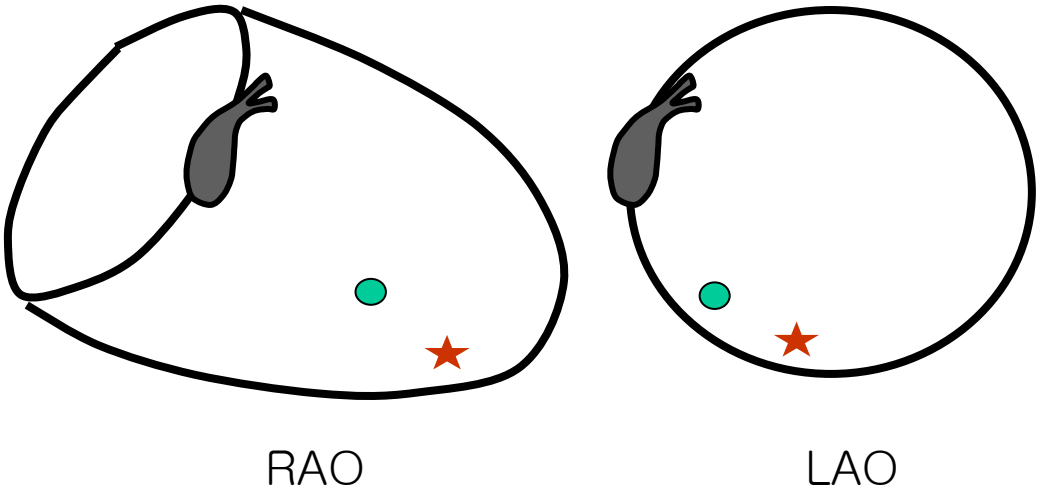


RAO 30°

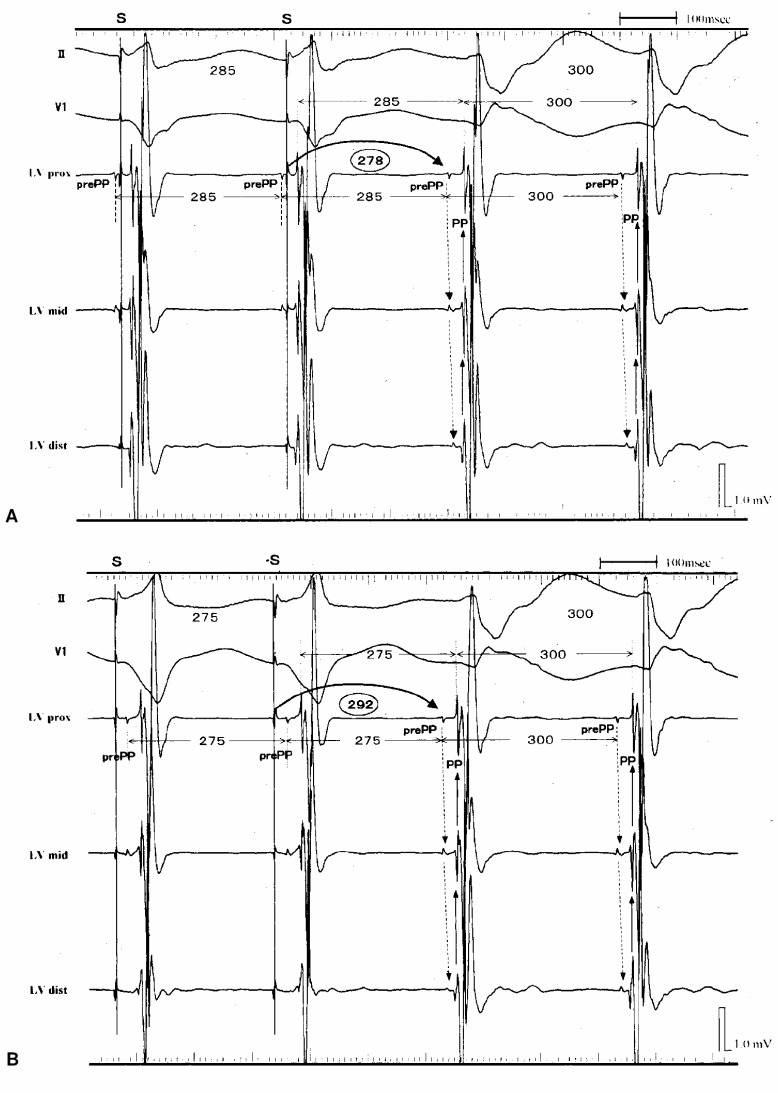


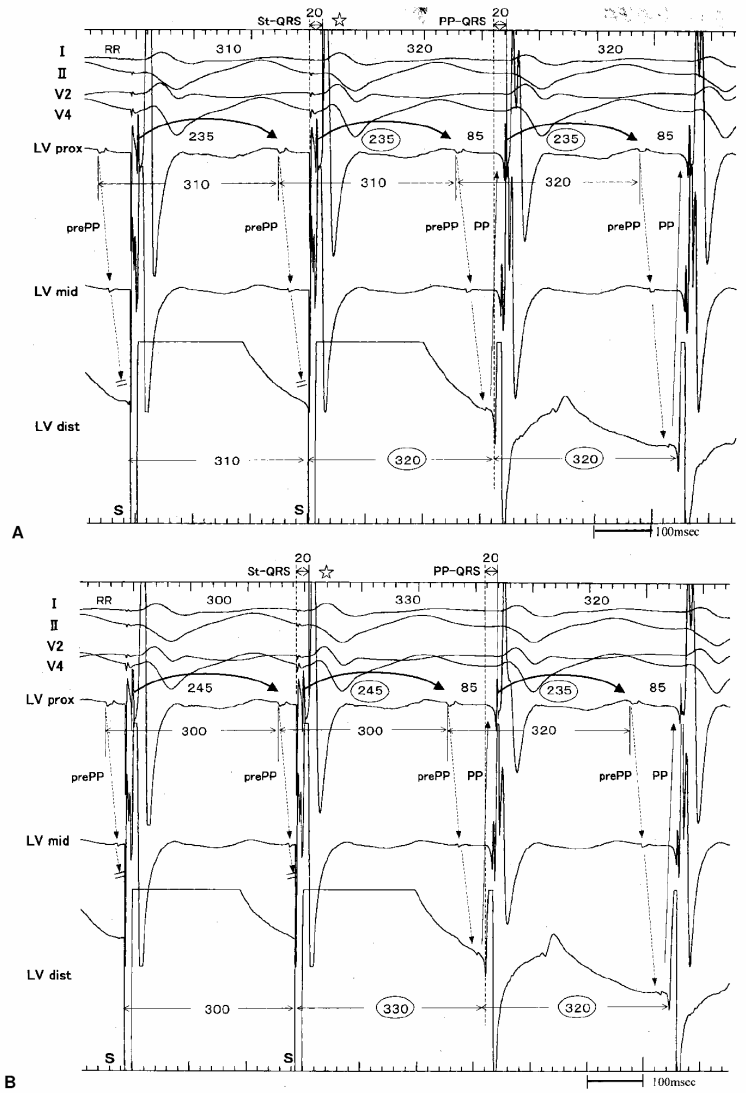
LAO 60°





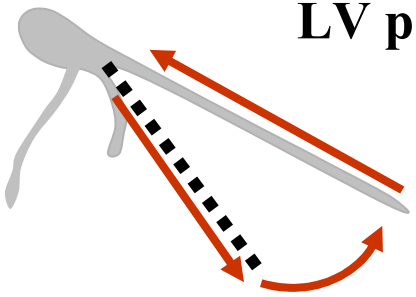
The Role of Purkinje and Pre-Purkinje Potentials in the Reentrant Circuit of Verapamil-Sensitive Idiopathic LV Tachycardia
TAKESHI AIBA, *PACE 2001; 24:333–344*





RV pacing(RVOT)

LV pacing (Purkinje): ECF



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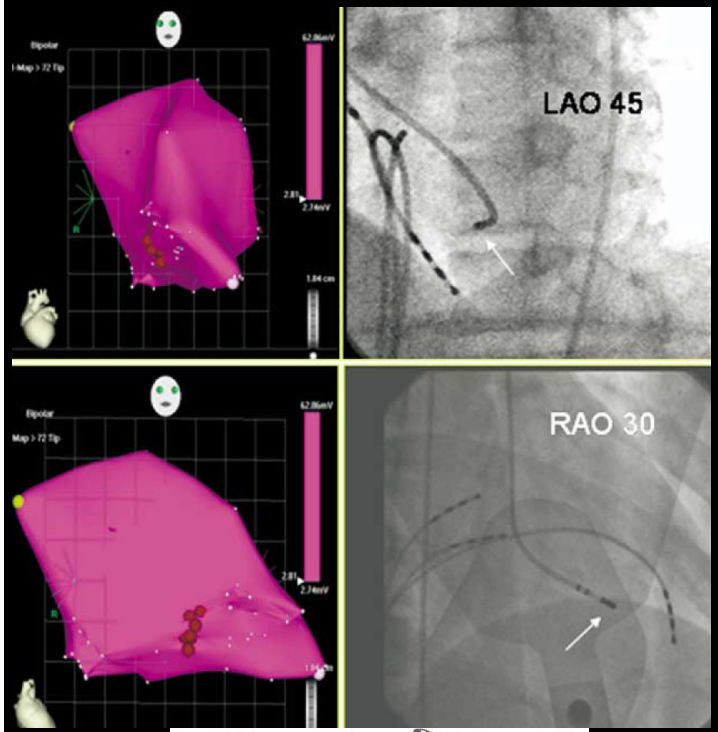
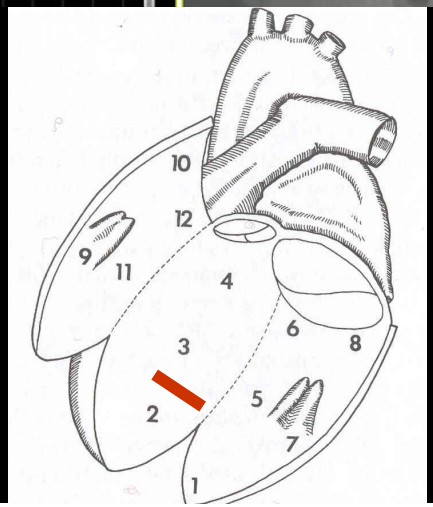
Fascicular VT





A detailed (150 points) 3D electroanatomic map

RF lesions

- perpendicular to the long axis of the ventricle,
- approximately midway from the base to the apex
- mid to mid-inferior apical septum

Further guided by the presence of Purkinje potentials

A "perfect" pace map was not a necessary requirement

Length of the linear lesion: 1.2- 2.2 cm (mean 1.7)

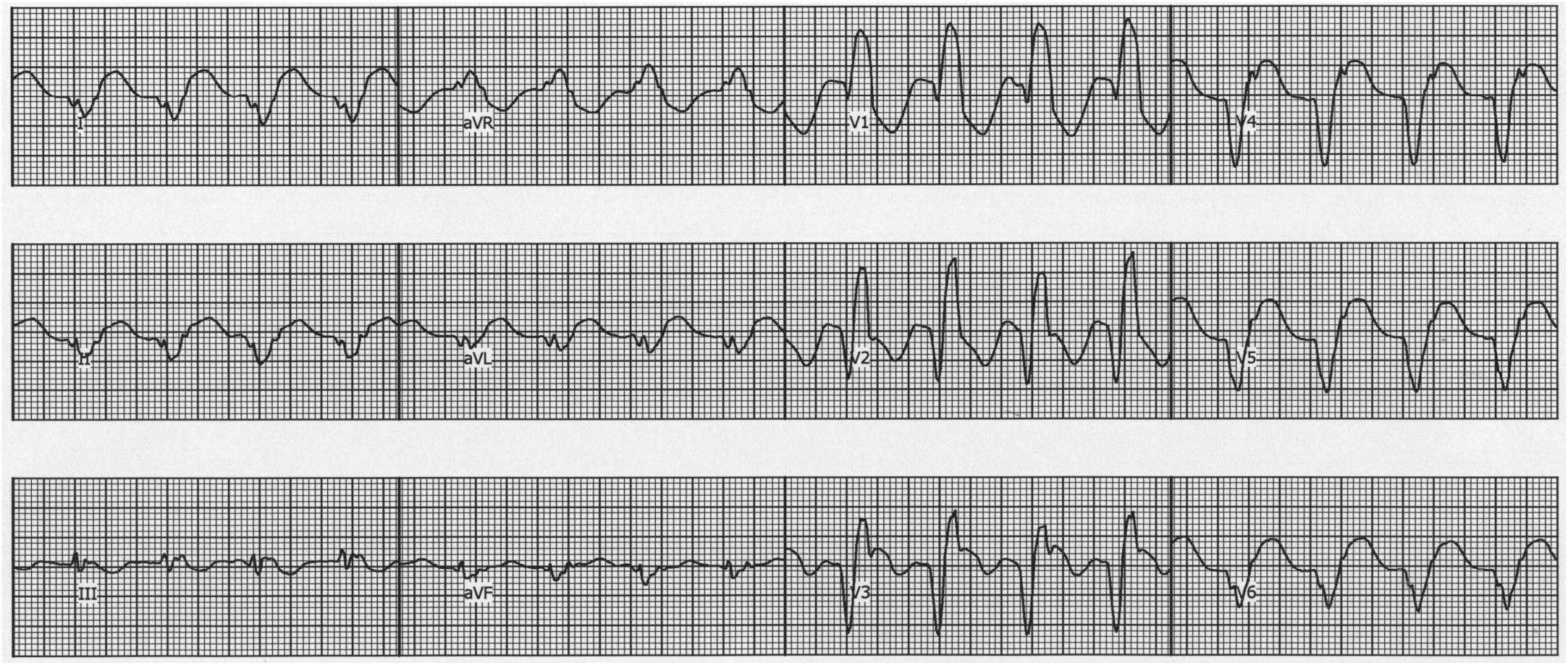
Idiopathic fascicular left ventricular tachycardia: Linear ablation lesion strategy for noninducible or nonsustained Tachycardia
David Lin, Francis E. Marchlinski, Heart Rhythm 2005;2:934 –939

Scar-related VT

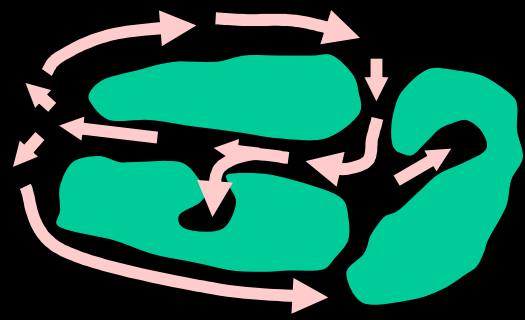
ECG localization of the VT exit
QRS morphology clues to VT exit sites

Frontal Axis (I, II, aVF)	superior axis - inferior site
	inferior axis - superior site
Lateral precordial leads	predominant QS in $V_{4,5,6}$ - apical
	any R in $V_{4,5,6}$ - basal
V_1 configuration	LBBB - septal wall
	RBBB - free wall or septal

LV apical, inferior, lateral



Mapping in Scar-related VT



1. ECG: poorly matched

   (large apical vs inf MI, RBBB vs LBBB VT)

   * conduction abnormality(aniosotropic)

2. Pace mapping

   pace-mapped QRS morphology ≠ tachycardia exit

   (esp. in anterior MI)

   * centrifugal vs unidirectional (orthodromic) propagation

   * different BBB morphology within 1-2 Cm

3. Entrainment mapping + electrogram during VT or NSR

Entrainment mapping

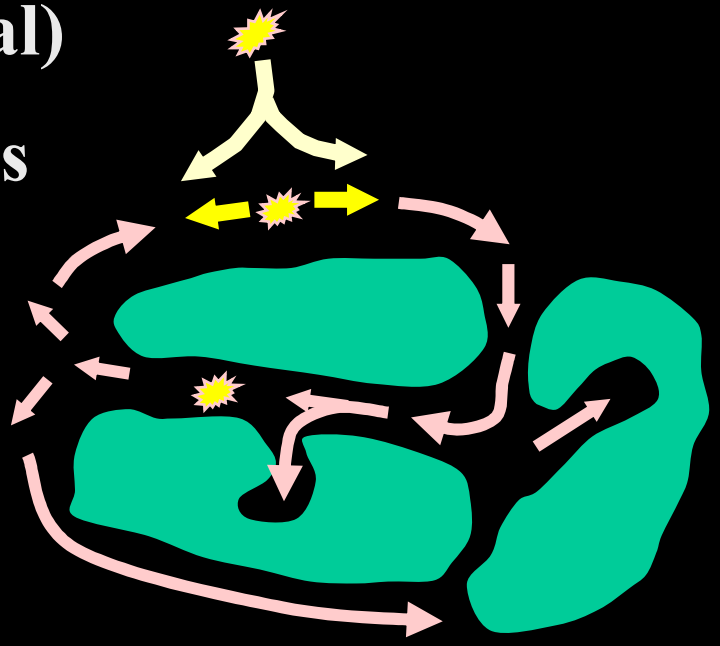
Pacing at a CL shorter (10-30ms) than VT CL

Two wavefronts: antidromic and orthodromic

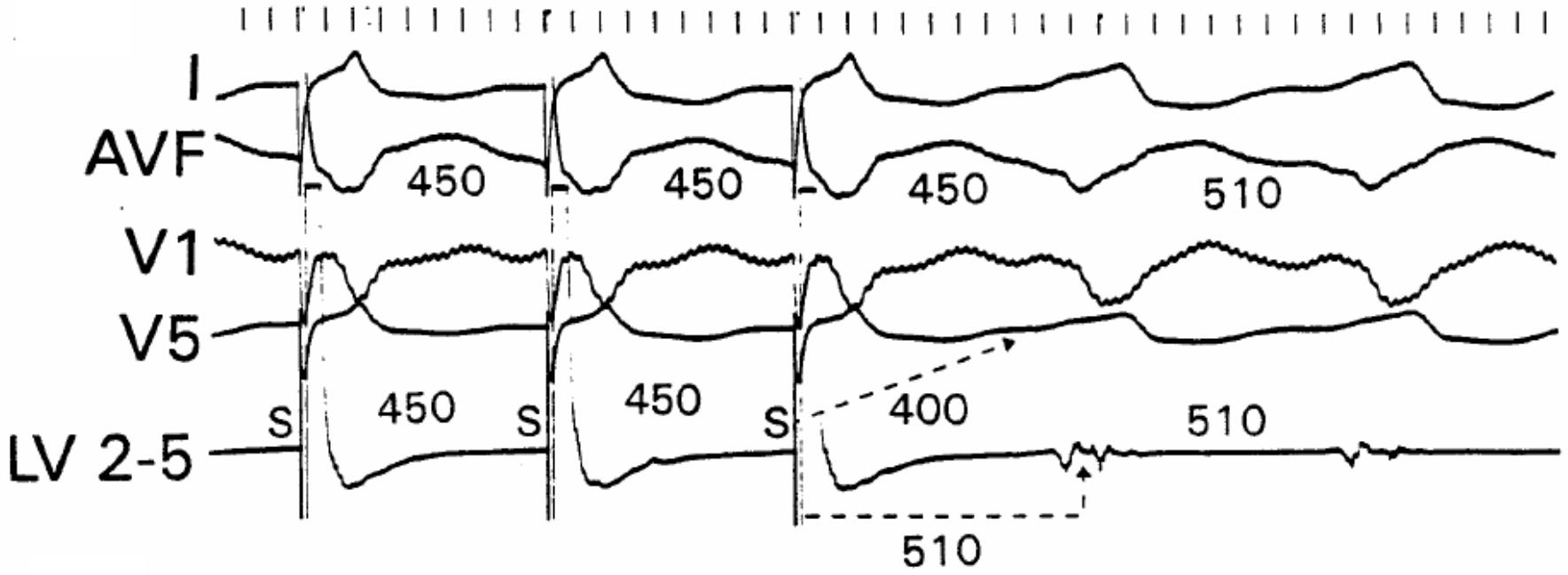
Manifest entrainment vs Entrainment with concealed fusion

Importance of PPI (post-pacing interval)

PPI – TCL < 10-30 msec: isthmus



Clue to the mechanism of tachycardia: entrainment

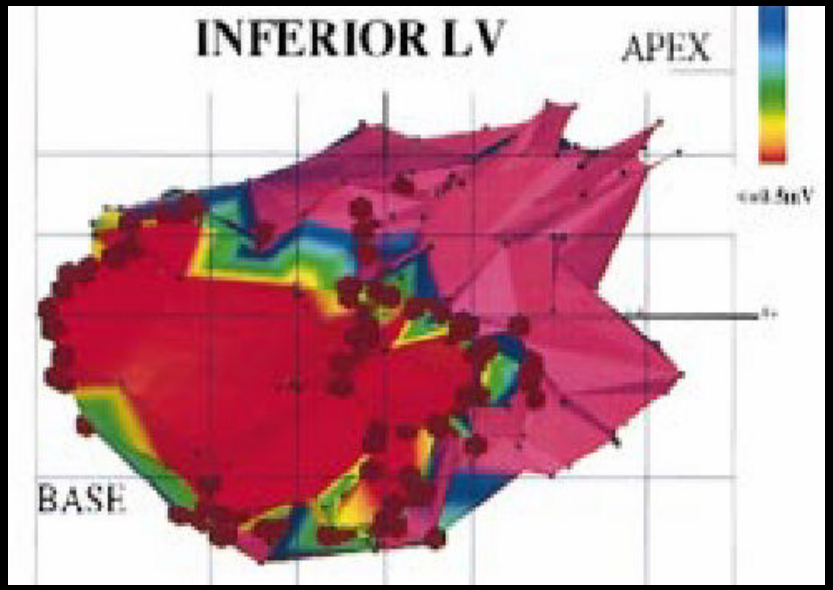


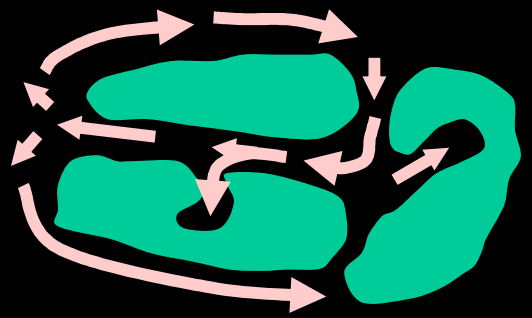
Entrainment- evidence of reentry !!!

Exploring Postinfarction Reentrant VT With Entrainment Mapping
WILLIAM G. STEVENSON, **J Am Coll Cardiol 1997;29:1180**

Sinus rhythm mapping

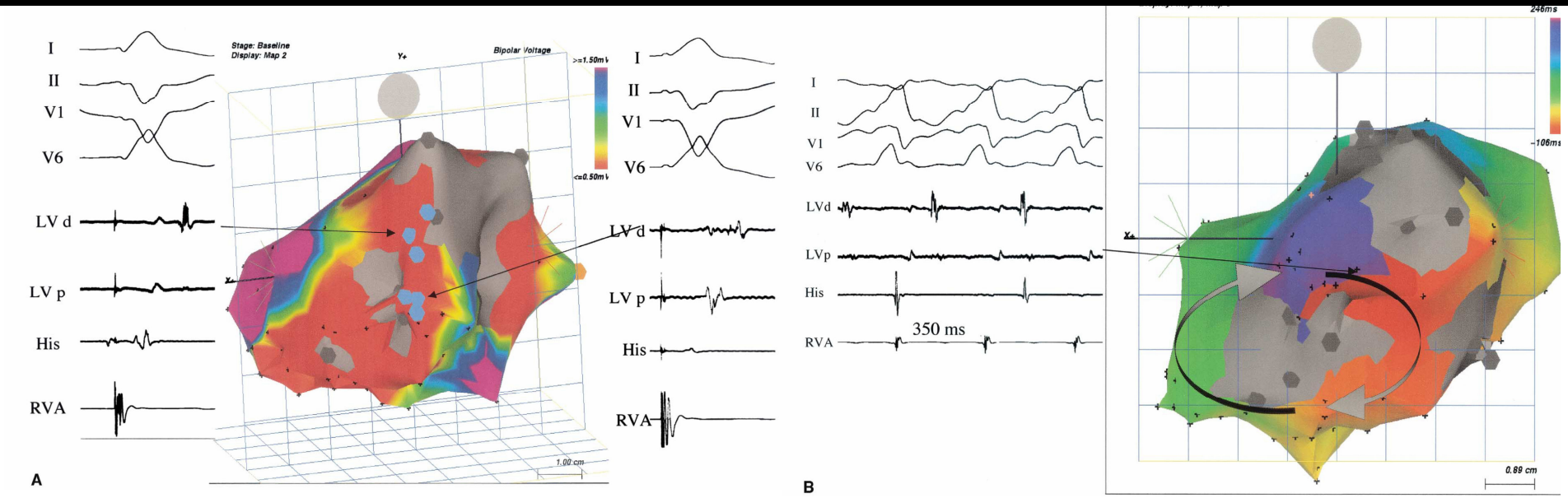
1. Normal egm: >1.5mV (cf. scar<0.5mV), within duration of QRS
2. Abnormal conduction: multiple, low-amplitude(<0.5mV)
   fractionated potential, extend beyond QRS
   - not specific (isthmus, bystander)
   - do not differentiate conducting channels from scar

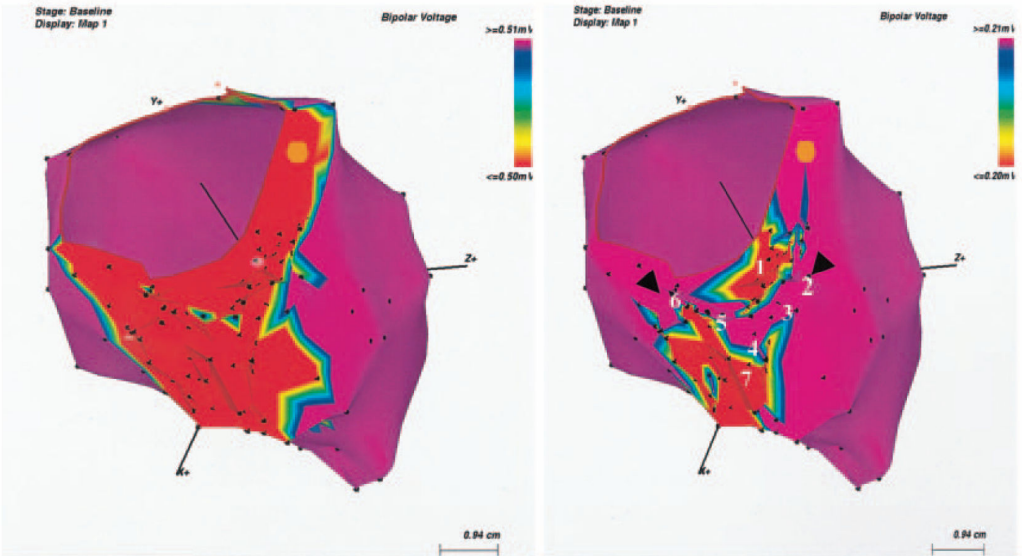




Marchlinski F. Circulation 101:1288,2000

Mapping during RV pacing, adjustment of voltage scar definition

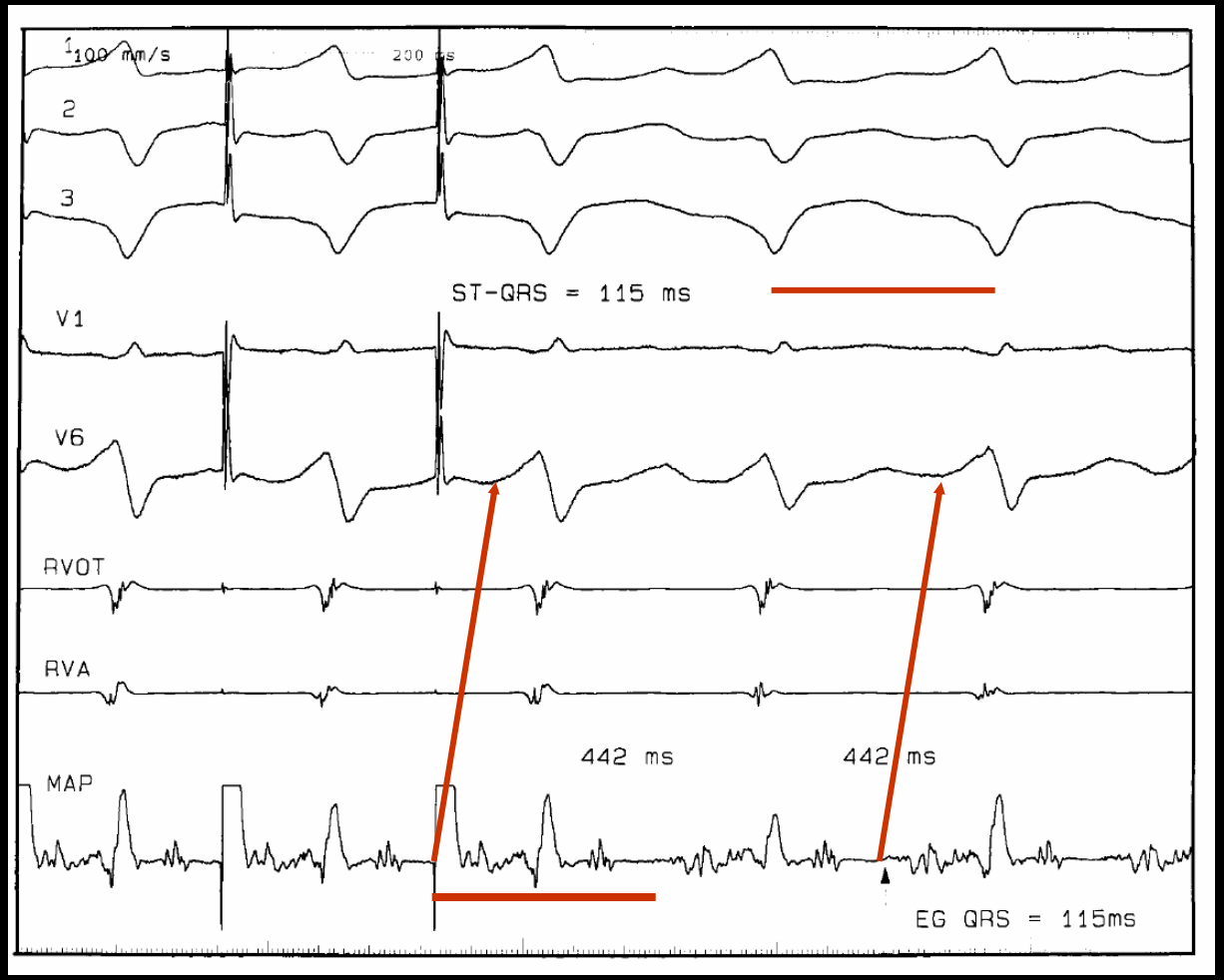




Ablation of Electrograms With an Isolated, Delayed Component as Treatment of Unmappable Monomorphic VT in Patients With Structural Heart Disease
Angel Arenal, J Am Coll Cardiol 2003;41:81

Influence of the Voltage Scar Definition
Angel Arenal *Circulation*. 2004;110:2568

(1) an exact QRS match in the 12-lead ECG during entrainment
(2) a return cycle length <10 ms of the VT cycle length
(3) presystolic potentials (<70% of VT cycle length) with an activation time to the QRS within 10 ms of the stimulus to QRS.

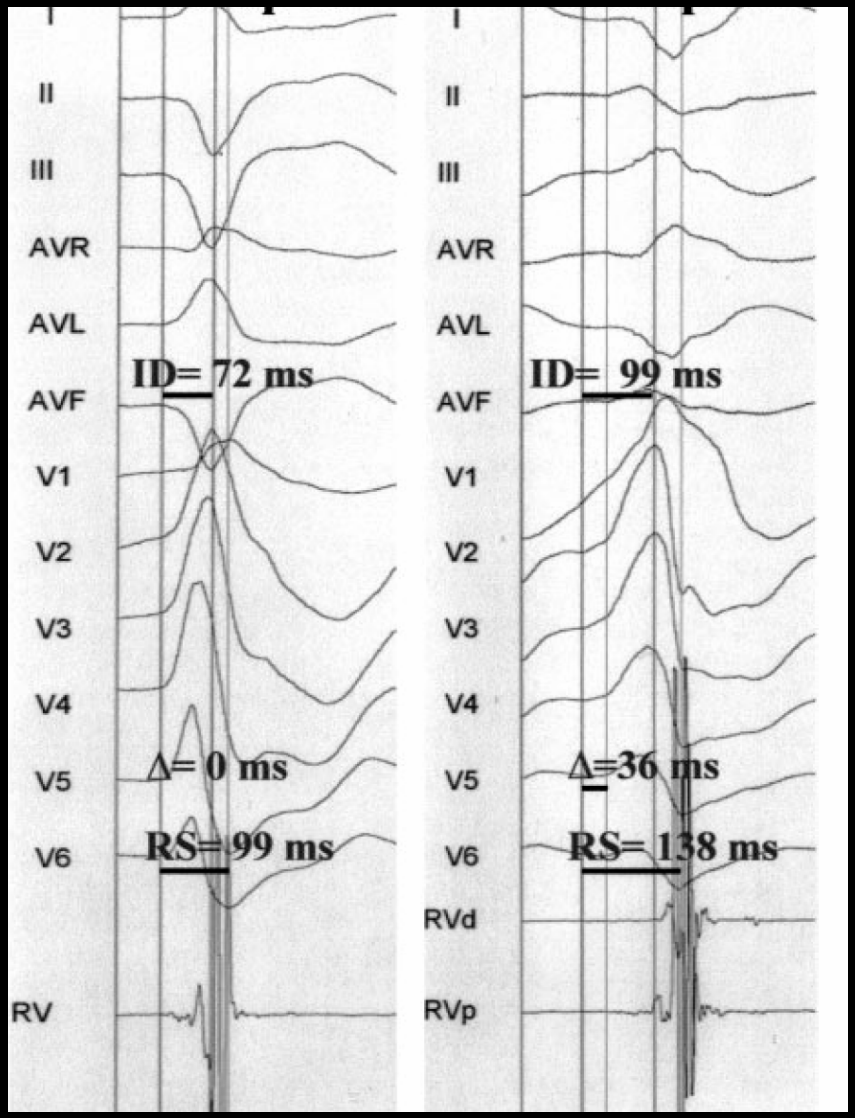


VT was terminated with a single RF lesion in 19 of 19 sites meeting all criteria;

RF failed to terminate VT at 24 of 25 sites at which all 3 criteria were not met.

Entrainment/Mapping Criteria for the Prediction of Termination of VT by Single RF Lesion in Patients With CAD
Mark E. Josephson, ***Circulation*. 1999;99:2283-2289**

ECG clues to the epicardial VT



Endo VT Epi VT

A. pseudodelta wave (to the earliest fast in V leads)

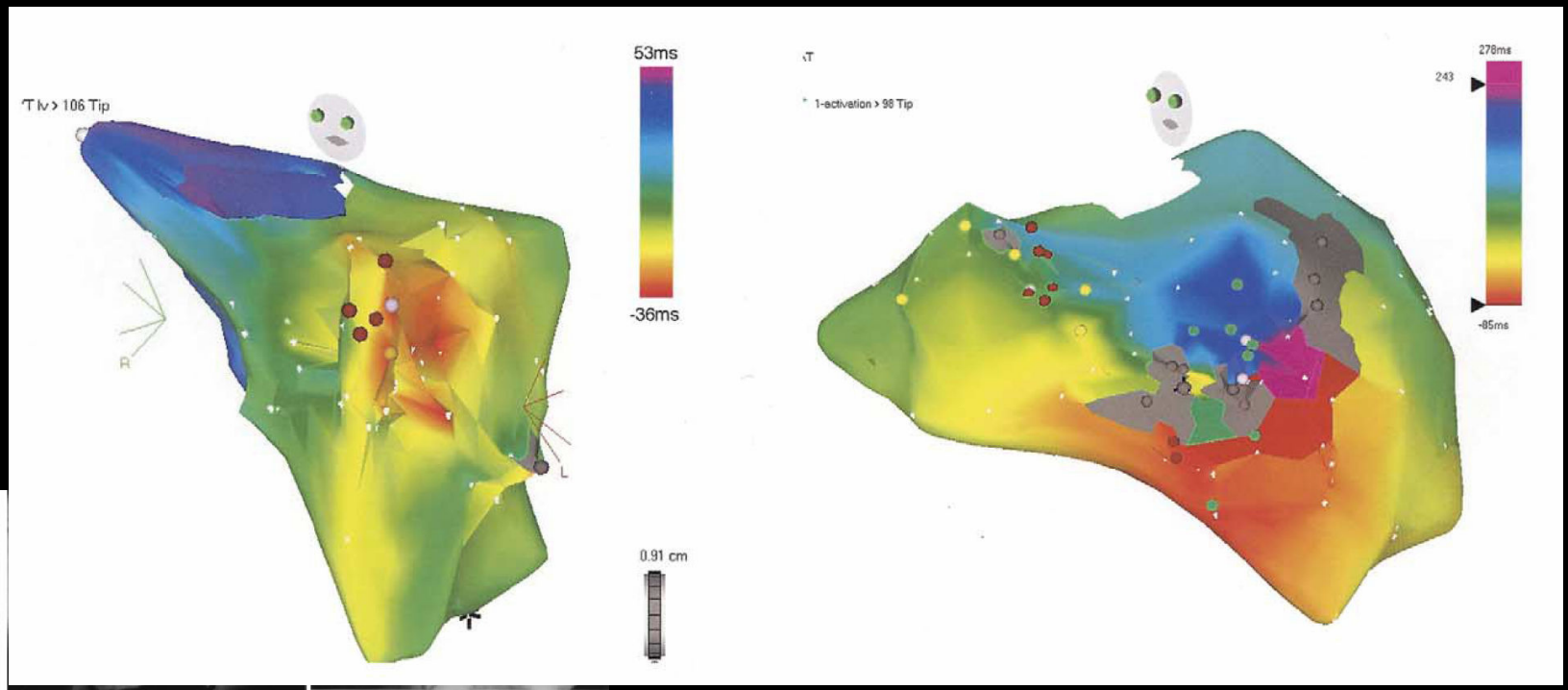
B. an intrinsicoid deflection time ≥ 85 ms (V_2 peak)

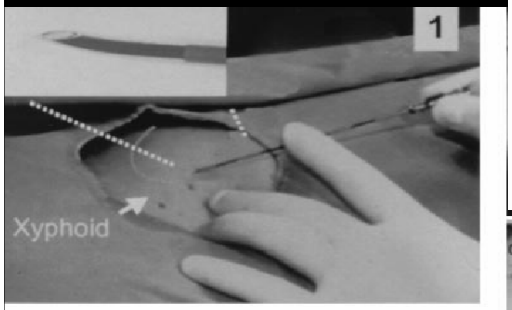
C. RS complex duration ≥ 121 ms (shortest in V leads)

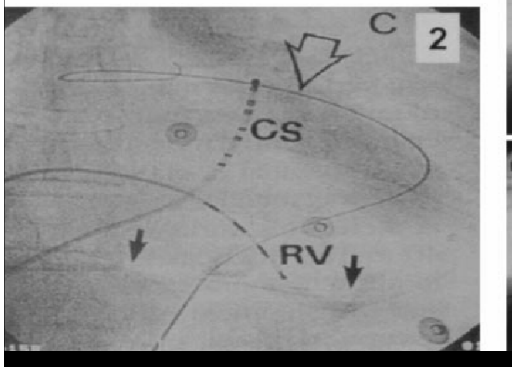
Electrocardiographic Recognition of the Epicardial Origin of VT
Antonio Berruezo, Josep Brugada, ***Circulation*. 2004;109:1842-1847**

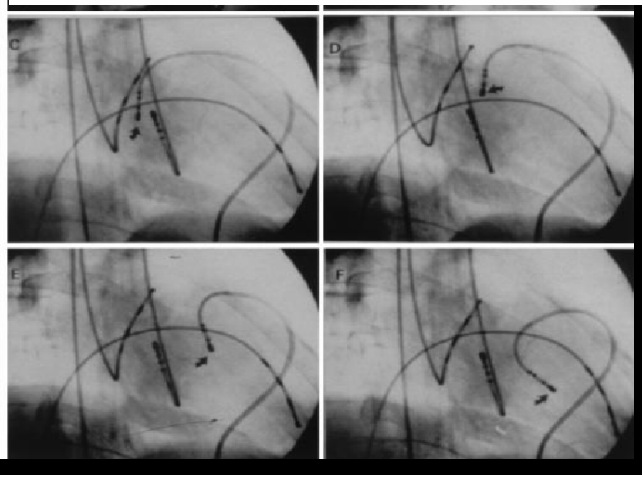
Epicardial mapping

In post-MI VT, DCM, Chagas









Endocardial and Epicardial RF Ablation of VT Associated With D-CM
Kyoko Soejima, J Am Coll Cardiol 2004;43:1834–42